Executive Summary to Final Report

Financial and Economic Advisory for a Solid Waste Management Project in the Greater Accra Region, Ghana

September 2021

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Definitions

BOT	Build-Operate-Transfer
CAPM	Capital Asset Pricing Method
CRP	Country Risk Premium
DBFOM	Design-Build-Finance-Operate-Maintain
EPC	Engineering, Procurement, and Construction
GAMA	Greater Accra Metropolitan Area
GARID	Greater Accra Resilient and Integrated Development Project
GHS	Ghanaian cedi
KPI	Key Performance Indicator
MDB	Multilateral Development Bank
MMDA	Metropolitan, Municipal, and District Assembly
MRF	Materials Recovery Facility
O&M	Operations and Maintenance
PSP	Private Sector Participation
SPV	Special Purpose Vehicle
TPA	Tons per annum
WACC	Weighted Average Cost of Capital

1 Overview of the assignment

The World Bank Group, with other partners, is assisting the Government of Ghana with the implementation of the Greater Accra Resilient and Integrated Development (GARID) project. Under the GARID project, the World Bank intends to finance the Ayidan project (the Project) to address immediate gaps in Accra's final waste disposal capacity. The Government is currently procuring designs for the Project that will include a sanitary landfill and options to include a materials recovery facility and up to two transfer stations at a 26.2-hectare site in Ga West Municipal Assembly, shown in Figure 1.1.

Figure 1.1: Landfill and transfer station selected sites in the GAMA

Source: Mott MacDonald, using Google Earth

In addition to expanding final waste disposal capacity, the Government has an opportunity to adopt a new operating model with the Project to:

- Create transparency around costs
- Enable long-term budgetary planning
- Act as an example of cost recovery for the sector
- Move the sector towards sustainable operations and management of solid waste.

Despite the clear benefits the Project could deliver, including increasing the amount of waste that is treated safely, it cannot solve all the sector's needs on its own.

Castalia and Mott Macdonald (the Consultant) have been engaged to evaluate the Ayidan Project's technical and commercial structure, assess potential Private Sector Participation (PSP) models for

the Project, and opine on the enabling environment for PSP for the Project. This report explores the options surrounding the Project and how the Government's choices will impact the affordability of the Project and its ability to move the broader sector toward sustainability. The analysis presented has been prepared with consideration given to the views of investors and market participants. This report summarizes the key findings and messages of the deliverables prepared under this assignment:

- Inception Report, submitted on 23rd September 2020, which included the list of documents received, interviews completed, and initial findings;
- Technical Report, submitted on 31st January 2021, which described market volume, expected market share, a critique of preliminary designs, and visually observable environmental and social issues;
- Enabling Environment Report, submitted on 19th February 2021, which presented the analysis of key regulatory and institutional issues;
- Commercial Report, submitted on 28th February 2021, which described potential business models, revenue mechanisms, a validation of financial modeling assumptions (CAPEX, OPEX, revenues), financial modeling results, and an initial risk matrix.

The Summary presents the choices the Government must make with respect to the Project's business models and describes the impact that these choices will have on the overall affordability of the Project to the Government. The structure of the report is set out as follows:

- Section 2 explores the role of the Project and key considerations for Government, along with the Project's market share.
- Section 3 then discusses uncertainty around potential funding for the sector and the methods used to estimate existing funding.
- Section 4 analyzes potential funding for the Project and realistic business models that could be applied, including a bundled build-operate-transfer (BOT) model and an unbundled operations and maintenance (O&M) model.
- Section 5 describes the key costs considerations around the Project, including Capex, Opex, and the cost of capital.
- Section 6 analyzes the revenues, results, and fiscal projections under the various business models to show the advantages and disadvantages of each option (Section 6.1), along with a sensitivity analysis (Section 0).
- Section 0 recommends the steps that must be taken to ensure the Project's success.

2 The Project's role in the sector and considerations for Government

The Greater Accra Metropolitan Area does not have any sanitary final solid waste disposal capacity, and the Government intends for the Ayidan Project to meet that need. The Project is

expected to add sanitary landfill capacity of up to 3.6 million tons over to the sector over its lifetime.

For the Project to operate over the longer term, Government will need to choose how to control the quantity of waste it receives each year. This choice means that a greater proportion of GAMA's total waste needing final disposal (around 63 percent in 2022) would continue to be disposed of in non-sanitary ways, at least for the short term. If the Project were structured with a shorter life, it could accept more waste in the short term, and reduce the waste flowing to non-sanitary sites.

2.1 The state of the sector and considerations for Government

The sector faces key issues related to the state of the market, control of waste flows, and regulation that will impact the Project. These issues and opportunities for change in these areas are discussed below.

2.1.1 State of the market

The Project's competitive position depends, to some extent, on the role that Government assigns it. However, its position vis-à-vis the incumbent monopolist, will significantly impact its ability to compete in the sector.

One firm owns and operates most transfer, treatment, and final disposal sites in the GAMA, and also operates in collections and thus has significant monopoly power in the sector. In principle, it has the power to set tipping fees above the costs of service at existing landfill sites. However, the Consultant could not secure a meeting with this firm to confirm fees charged or revenues recovered. Stakeholders in the sector also expressed that political influence plays a role in awarding contracts and payments towards this primary operator. The firm received the sole rights to secondary waste collection under the Sanitation Improvement Package (SIP), and the terms and conditions of the contract are undisclosed.[1]

Theory suggests that an incumbent vertically integrated monopoly could affect the success of new projects like Ayidan. A monopolist's control over collections and final disposal means that it could direct collection vehicles to dispose of waste at its own sites only. A monopolist could, in principle, affect the Project from a competitive angle as a monopolist could undercut a new project by pricing disposal at its landfills below its cost of service.

2.1.2 Control of waste

The Government has limited instruments to control waste flows to transfer, treatment and final disposal facilities, which contributes to higher costs across the sector. For landfill operators who receive more waste than facilities are designed to process, maintenance costs exceed

[1] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 213

expectations. This has implications on cost recovery for these operators, with gaps being covered by the Government.[2] The history of the Kpone landfill site demonstrates this.

Designing disposal zones for specific landfill sites could alleviate some of these problems, but the Government does not have any proven methods to effectively designate and enforce service areas for final disposal facilities. The Government currently uses collection zones, which are allocated to specific operators for waste collection. The Government could structure disposal zones, from which waste must flow to a designated landfill or transfer station, which would provide greater control on the flow of waste.

Collection contracts are not standardized, and service areas for collection companies are often undefined and overlap, with collection companies able to choose where to tip waste. Some dispose of waste at sites that are the most profitable for them, rather than at sites that are operationally efficient for the sector. Some operators choose to travel to dumpsites that are further away than transfer stations to tip waste because the cost to tip waste at a transfer station exceeds the additional fuel costs incurred to travel and queue at final disposal sites. Disposal of waste at transfer stations could help reduce queues at dumpsites, which was commonly cited as a major inhibitor of improved operational efficiency and service delivery, but waste collectors have limited incentives to change behavior.

While the current operational model for the sector presents a long-term challenge to sustainability for the sector and the Project, opportunities to improve exist. The Government could designate disposal zones, by which specific Metropolitan, Municipal, and District Assemblies (MMDAs) deliver waste directly to specific landfills or transfer stations, to control waste flows to the Project and institute best practices for the sector. A second option is to first increase the use of, and then optimize, the operations of existing transfer stations. An initial step could begin with the introduction of incentives, such as lower tipping fees to use the transfer stations and material recovery facilities (MRFs), thus disincentivizing operators from bypassing them. The change in process could help to reduce queue times and improve collection efficiency across the sector.

2.1.3 Regulation and finance

Inconsistent regulation and the absence of regular and predictable payments across the value chain have prevented the sector from improving service provision. Regulation in the sector has gaps, especially in the overall monitoring and enforcement of standards. These gaps allow service providers to provide lower quality services, as there are few standards set and few enforcement mechanisms available to the Government, like withholding of payments to operators.

Further, financial flows to the sector are also unpredictable and inconsistent. At various points across the value chain, it appears that users may pay less than the cost of service, creating viability gaps and revenue shortfalls.[3] For medium to large-scale formal waste collection and transport

[2] MoF claims to make payments for tipping fees only when MMDAs are not able to, but MMDAs claim that the Central Government pays all tipping fees

[3] This statement could not be confirmed through data though, as described in Section 3.

service providers, profitability is highly variable. Previous studies have found that collection and transport providers have not been able to operate profitably consistently.[4]

Though regulatory and payment uncertainty is a clear barrier to the sector's sustainability, the sector has several steps it could take to make progress in these areas. In operationalizing the National Sanitation Authority, Government could mandate it to collect and report on all sector financial flows, waste quantities and flows, sector contracts, and fiscal commitments and payment arrears to bring needed transparency to the sector. Another option is to develop a standard set of KPIs for the Project to be applied across the sector, which could help a monitoring agency assess operators' performance and would enable effective and consistent enforcement of standards in the future.

Consistency in payments is also required to ensure continued service. A contract structured following best practice will include mechanisms such as a minimum revenue / quantity or service guarantee. A survey of international and domestic operators conducted during this study confirmed that some form of guarantee on the quantities of waste would be required, as well as a guarantee on payments, ideally from an external party. A detailed market sounding conducted during a full feasibility study will inform which type of guarantee will be most attractive to the market. Given that the Government does not have a strong track record of making consistent payments to operators, these guarantees may be required in addition to other credit enhancement mechanisms.

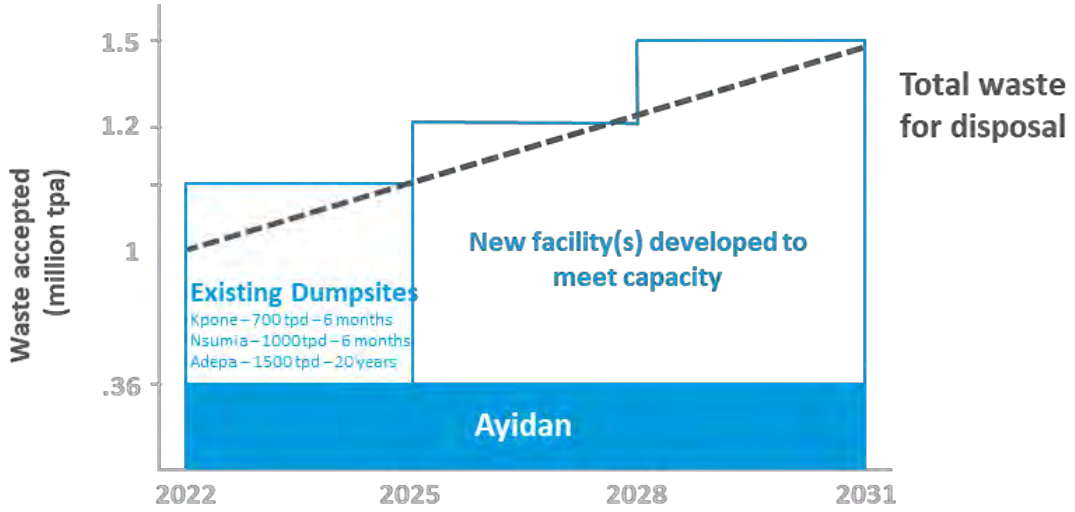
2.2 The Project's market share

The Project could become the first piece in a longer-term strategy to address the GAMA's final waste disposal problem. For the Project to achieve a useful life of 10-years, aligning the Project life with the useful life of mobile equipment (also referred to as operating equipment), waste flows to the Project would need to be regulated to approximately 360,000 tons per year, or 37 percent of total waste available for final disposal in GAMA. Waste that the Project does not accept would be sent to existing disposal facilities, which are non-sanitary sites, providing the Government time to develop additional long-term sites.

At present, the operational dumpsites in the GAMA are Kpone, Nsumia, and Adepa. Kpone and Nsumia have operating capacities of 700 and 1,000 tons per day, respectively, and an estimated remaining life of six months. The Adepa dumpsite has an operating capacity of 1,500 tons, and an estimated remaining life of 20 years. It is also understood that the sector's incumbent operator is developing three new disposal sites. Multiple requests for information on these sites were not responded to, so it is not possible to state: what standard they will be constructed to; the capacity of the facilities; or the potential locations of these facilities. Figure 2.1 shows the role the Project could play in the sector.

[4] Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 10

Figure 2.1: The Project's market share



Note: Under Existing Dumpsites, facilities' operating capacity in tons per day and available operational life are shown.

The Government's ability to regulate the Project's market share is critical to maximizing value, as detailed below. The Government may need to designate disposal zones for specific landfill sites to deliver this scenario.[5] Implementing this scenario could bring some stability to the sector, as it could move the sector away from short-term solutions and toward well-planned, sustainable operations. Some advantages of this scenario include:

- The choices required to make this solution viable will demonstrate the benefits of long-term planning and put the sector on the pathway towards sustainability. Developing the capacity to plan long-term will help the Government be proactive and develop projects to meet future demand before needs become critical.
- The Project would be structured to last a minimum of 10 years, and this term aligns more closely to the lifecycle of the equipment, which could make bundled private-sector participation models possible, including some with significant risk transfer.
- This scenario could reduce costs over the long term through greater integration of project functions and the ability to engage in whole-of-life costing.[6]
- Improved risk management as the envisaged structure will transfer risks that a private firm is well-placed to handle, like cost overruns or delays, reducing the Project's total costs.
- It increases opportunities to maximize economic benefits through the environmental treatment, management, and disposal of waste and reducing illegal dumping and burning.

[5] To note, the market may limit waste that flows to the Project because of price competitiveness or monopoly power, which could have a similar effect.

[6] "PPP Reference Guide 3.0" International Bank for Reconstruction and Development / The World Bank, 2017. Page 18

As the Project would take up not all waste, additional capacity must be found. Engineered landfill capacity will not be available immediately, so waste must continue to be disposed of in semi-engineered, semi-controlled, and uncontrolled landfills.

3 Sector Funding

Ghana's solid waste sector receives funding through multiple sources, including money from the central Government, funds internally generated by individual Metropolitan, Municipal, District Assembly (MMDAs), and fees collected through user payments.

The Consultant approached the Central Government to understand sector payments and cash flows. These were not available, largely because there is no single body responsible for tracking these payments. A second approach built up sector costs using known and estimated tipping fees and estimates of waste flows up the value chain. A third approach attempted to estimate funds available to MMDA's through Central Government transfers and internally generated funds using averages and proxy data. All methods provided different estimates of funding and financial flows to the sector. Without a clear view of costs or revenues flowing through the sector currently, it is not possible to opine on the affordability of the Project to the Government.

The key takeaways include:

- Bottom-up analysis suggests that users pay between US$47 million and US$204 million per year for waste collection services in GAMA, based on survey data of expenditure on waste disposal per household[7]
- On average, transfers from the National Government account for 52 percent of total funds available to MMDAs to fund sector operations, with the remaining 48 percent coming from internally generated funds at the MMDA level[8]

Data shared on payments made to private operators by Central Government does not contain sufficient information to understand the period of service or service area(s) the payments cover.

4 Project funding and business models

This section discusses the potential sources of funding for the Project, as well as the business models that could be used to structure the Project and the risks and advantages of each of them.

4.1 Funding for the Project

It is understood that the World Bank Group will fund the Project's Capex. Payments for Opex will come from Government payments, or user fees, or a combination of the two. The Government will

[7] MSWR Socio-Economic Survey Report -Revised (November 2019) Page 59

[8] Internally generated funds are generated from property tax, business licences, market fees and various user charges.

likely make most payments and cover most, if not all, of the Project's costs in the short term. The sources for funding may include general funds and tax revenues, user charges and tipping fees, and internally generated funds at the MMDA level. However, no clear estimation of funds available to the sector was possible and as such, there is also no clarity on funds that will likely be available to the Project.

The Project's ultimate sources of revenue will depend on how the Government allocates risks and structures the Project. For example, the Government may choose to transfer availability risk to the operator and take quantity risk. Availability risk is the risk of bringing the facility online and running it to the level needed to accept a certain daily quantity of waste. In this model, the Government would make availability payments to the operator. Alternatively, the Government could transfer quantity risk to the operator, which means that the operator would receive revenues and earn profits from user charges based on the quantity of waste delivered to the landfill. Models that share these risks also exist, combining fixed availability payments with variable payments based on waste treated.

4.2 Business models suitable for the GAMA's context

This section explores the potential business models and their advantages and disadvantages.

4.2.1 Possible business models

An unbundled EPC with a long-term[9] O&M contract and a bundled BOT project both have pathways to commercial viability and sustainability. Both models could align the economic life of operating equipment with the life of the landfill, which would enable a private operator to optimize costs and mitigate risks over the anticipated 10-year life of the Project. The EPC with long-term O&M and the BOT can deliver similar benefits, except for the additional benefits achievable through the bundling of functions in the BOT model. These additional benefits include cost reductions and greater efficiency achieved through whole of life costing. Both models have potential to deliver value for money as private investment in the Project and the alignment of useful lives incentivize firms to practice whole-of-life costing.

Figure 4.1 shows the unbundled model in which the O&M firm finances the purchase of operating equipment. The O&M contract could be structured as a long-term, 10-year contract, which ensure the provision of services of a high standard. The O&M firm recovers its investment and operating and maintenance costs through the tipping fees paid by waste collectors or Government. The EPC company would be contracted with an EPC fee which includes a profit margin for the operator. It is anticipated that the World Bank would provide a loan to fund this Capex.

[9] Long-term in this case means 10-years, in order to align the contract length with the planned landfill life.

Figure 4.1: EPC & O&M with private investment in operating equipment

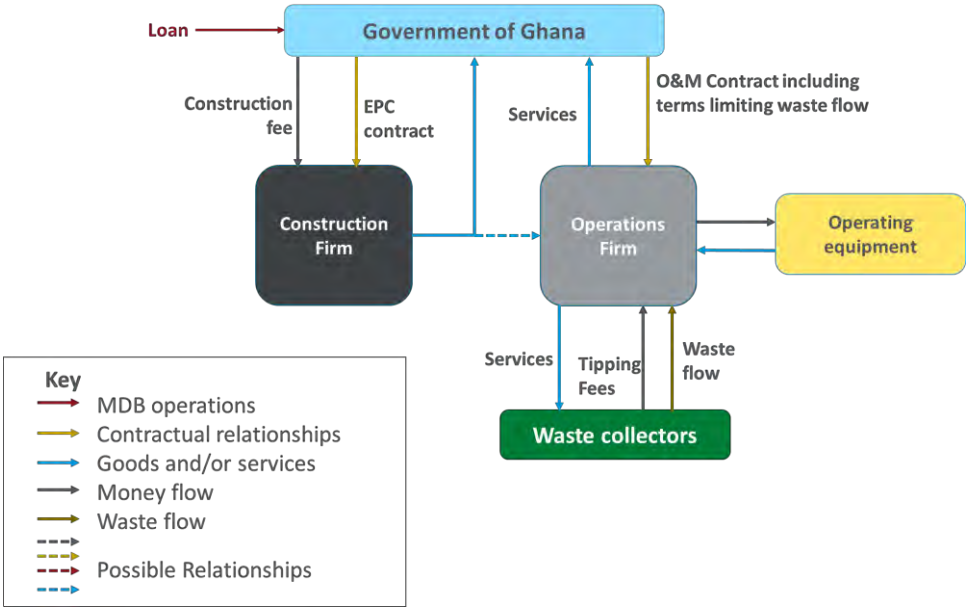
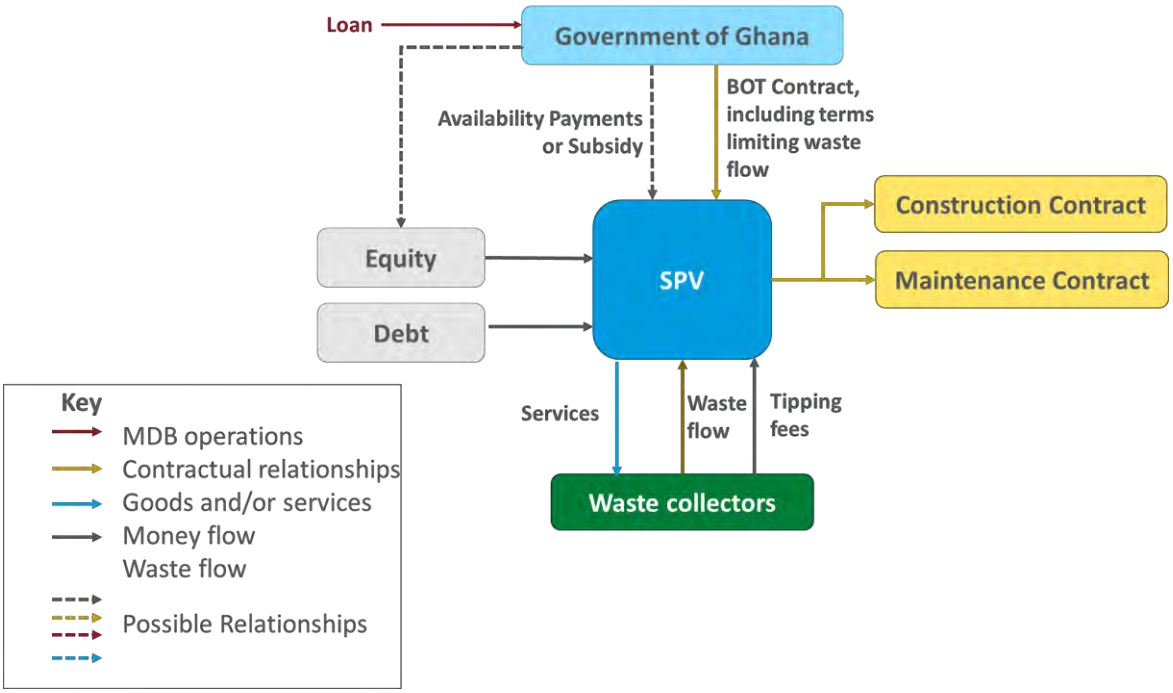


Figure 4.2 illustrates a bundled PPP model based on a BOT contract. Private investors, and potentially multilateral development banks (MDBs), place equity and debt in a special purpose vehicle (SPV). The SPV signs a contract with the Government to build, operate and maintain the Project. The SPV, directly or through subcontracts, executes the functions agreed within the contract and delivers services at agreed standards. The Government funds the construction of the Project, but the SPV finances the operating equipment. It recovers its costs through tipping fees, and if it fails to provide service at the contracted standard, faces financial penalties. It is also anticipated that the World Bank would provide a loan to the Government to finance Capex.

Figure 4.2: Build - Operate -Transfer



This bundled model is only likely to be viable under certain conditions. This bundled model is only likely to be viable under certain conditions. During a detailed market sounding at the feasibility stage, investors may indicate that a guarantee on waste flows would be required for them to feel comfortable participating in the project. Also, the contract term is most likely to be attractive if it covers a period of 10 or so years. This view was supported by the market survey, in which most operators indicated that they would prefer a term of 10 years or less, though some were open to extensions. A term of greater than 10 years is unlikely to be viable as a longer project would put added pressure on the Government to regulate waste flows to the Project. Further, though industry-standard contracts are 20-25 years[10], the Government does not have a track record of delivering long-term agreements, which means investors would likely perceive the deal as unnecessarily risky.

4.2.2 Models not considered

A full design-build-finance-operate-maintain (DBFOM) model does not appear to be a realistic option. The Government has already begun the procurement process for selecting the design consultant, making integration of all components challenging. This model is unlikely to be

[10] Waste management contracts involving landfills and other treatment or transport infrastructure in African and Middle Eastern markets

commercially sustainable. Given the Government's credit and fiscal positions, this model is not likely to attract competitive or affordable bids.

4.2.3 Summary of realistic business models and risks associated with each

Table 4.1 describes the various models that could be successful along with the payment mechanisms and risks associated with each of them.

Table 4.1: Summary of realistic business models

Name	Functions and roles	Description	Payment mechanism	Risks
Unbundled model - EPC of fixed infrastructure and private finance of mobile equipment along with a long-term O&M	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	▪ The Government or World Bank funds capital expenditure. The Government awards an EPC contract for the Project facilities and a separate agreement to another company to operate and maintain the Project ▪ The O&M contract has a term of 10-years and is written to industry standards ▪ The O&M firm finances mobile operating equipment	The Government pays a fixed fee for EPC, with cost overruns and delays dealt with through change orders. The O&M firm finances mobile equipment and collects tipping fees to recover those equipment costs and the costs of maintenance and operations.	▪ Government still takes cost overrun risks ▪ This will require implementing measures to control waste flows to the site to restrict waste flows to approximately 360,000 tpa
Bundled model - Build-Operate-Transfer (10 years or less)	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	▪ A private company builds and operates the Project and transfers the facilities back to the Government after 10-years. ▪ The private partner finances the cost of mobile equipment.	The Government/World Bank finances capital costs, except for mobile equipment. Operator finances private equipment and collects user fees to recover these costs.	▪ This will require implementing measures to control waste flows to the site ▪ Over or under-delivery of waste could trigger contingent liabilities ▪ Private sector interest may be low given contract length and challenges in controlling waste flows

5 Key cost considerations

The costs associated with the Project include capital costs (Capex), operational costs (Opex), and the cost of capital. These are described below.

5.1.1 Capex

The table below provides a list of the Project's capital expenditures. These estimates are based primarily on benchmarks taken from two integrated waste management projects in Africa and informed by professional engineering evaluation of the situation in GAMA. The configuration of each benchmark project broadly aligns to that of the technical concept for the Project.[11] The range presented is based on pre-design estimations from Mott MacDonald and from the World Bank Group and will need to be refined based on design choices at a later stage.

The benchmark data has been adjusted to reflect the Project's tonnage profile and sizing (footprint). These costs include profit and design and delivery contingencies but do not include contract or risk allocation margins.

Table 5.1: Capital Expenditures

Capital expenditure	Description	Million US$
Landfill	Civil infrastructure, gas, leachate	17.5 - 25.6
Transfer Station	All civil infrastructure and plant costs (excluding haulage)	8.0 - 10.8
Landfill Mobile Plant	Compactors, dozers	2.7 - 3.7
Haulage	Vehicles moving waste between the transfer stations and landfill but not including those moving waste from the MRF to the landfill	4.1
MRF	Civil infrastructure and equipment	12.2
MRF Mobile Plant	Forklifts, diggers, transport for residues to landfill	2.5
Total		**47.0 - 58.9**

Note: All costs calculated in 2021 US$.
Source: Mott MacDonald

The drivers of these costs include:

- Physical size of the facilities,

[11] One benchmark is located in Northern Africa, the other in Sub-Saharan Africa. The source data is based on quoted or actual values from the operators of these projects, and both feature engineered landfills and/or semi-automated MRF and/or transfer stations. Source: Mott MacDonald Proprietary data.

- Projected throughput, and
- Technological capabilities. For example, a MRF that captures a higher percentage of recyclables would be more expensive.

5.1.2 Opex

Like Capex, the Project's Opex is broken down across each of the Project's components. These estimates are based primarily on the same benchmark projects. These costs exclude operating margins.

Table 5.2: Operating costs

Cost item	Description	Unit cost per ton – margins not included US$/ton (GHS/ton)	Unit cost per ton – 33% operating margin included US$ (GHS)	Annual costs on O&M (without margin) US$ (GHS)	Cumulative O&M costs (without margin) US$ (GHS)
Landfill	Waste transfer, daily covering of waste, and maintenance	3.3 (19.4)	4.4 (25.8)	1,177,742 (69,278,937)	11,777,419 (6,927,894)
Transfer Station	Movement of waste and maintenance	1.5 (8.8)	2.0 (11.7)	450,000 (26,470,588)	4,500,000 (2,647,059)
Haulage	Includes haulage of waste between the transfer stations and landfill, but does not include movement of waste from the MRF to the landfill	1.2 (7.1)	1.6 (9.4)	348,000 (20,470,588)	3,480,000 (2,047,059)
MRF	Reception of waste, waste capture, and maintenance	2.3 (13.5)	3.1 (18.0)	867,652 (51,038,338)	8,676,518 (5,103,834)

Note: All costs calculated in 2021 US$
Source: Mott MacDonald

These costs are driven by the scale of operations and the composition of waste flows. The number of vehicles that deliver waste to facilities also affects costs, as a higher number of vehicles on the site increase operational costs.

5.1.3 Cost of capital

Two costs of capital are used for the financial analysis. For the EPC and O&M scenario, the margins that typical EPC and O&M contracts add are considered. For the return on private financing of equipment, a real weighted average cost of capital (WACC) has been calculated and used in the analysis. These are shown in Table 5.3.

Table 5.3: Cost of capital and profit margin assumptions

Cost	Value (%)	Source
Government cost of debt[12] - Real (US$)	6.50%	Government of Ghana cost of borrowing in US$, February 2020 14-year US$ Bond Issuance[13]
EPC margin[14]	14.00%	NYU Stern – Environmental and Waste Gross Margin
O&M margin[15]	33.00%	NYU Stern – Environmental and Waste Gross Margin
Weighted average cost of capital - Real (US$)	11.98%	Consultant calculations[16]

A post-tax WACC has been calculated using the following formula:

$$WACC = R_{e*}\left(\frac{E}{E+D}\right) + R_d\left(\frac{D}{E+D}\right) * (1-T)$$

Where:

- R_e is the cost of equity
- R_d is the cost of debt
- (E / (E + D)) is the proportion of equity
- (D / (E + D)) is the proportion of debt
- T is the corporate tax rate

The cost of equity has been calculated using the Capital Asset Pricing Method (CAPM):

$$R_e = R_f + \beta_{levered} * (R_m - R_f) + CRP$$

Where:

- R_f is the risk-free rate, which is the interest rate an investor can expect to earn on an investment that carries zero risk.
- $\beta_{levered}$ is the levered beta for environmental and waste services

[12] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount - 14-year bond issuance of February 2020

[13] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount

[14] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[15] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[16] For the purpose of this analysis, it is assumed that the costs of capital under the privately financed options include the margins of EPC and O&M providers. These margins are spread across the SPV's total costs, which are then recovered at the WACC. In practice, it is likely that some of these margins would be passed on to Government, though the extent of which cannot be determined at this stage of analysis.

$$Levered\ beta = Unlevered\ beta * (1 + (1 - Corporate\ Tax\ rate) * Debt/Equity\ Ratio)$$

- $R_m + R_f$ is the market risk premium for the US, which is the excess return earned by an investor when they invest in the stock market (R_m) over a risk-free rate (R_f).
- CRP is the country risk premium for Ghana

The cost of debt is given by:

$$R_e = R_f + Country\ default\ risk\ spread$$

The country default risk spread reflects the debt investor's perception of the default risk. The values and sources for each of these inputs follow in Table 5.4.

Table 5.4: Components of the WACC

Component	Term	Value	Source
Gearing	D / (E +D)	75.00%	IFC Benchmark figure within the range of acceptable gearing levels for the sector[17]
Risk-free rate, United States (nominal US$)	$R_{f\ (US)}$	2.30%	U.S. Treasury 20-year yield[18]
Risk-free rate, Ghana (nominal US$)	$R_{f\ (Ghana)}$	7.9%	Government of Ghana cost of borrowing in US$, February 2020 14-year US$ Bond Issuance[19]
US inflation		1.4%	Trading economics[20]
Unlevered beta	$\beta_{unlevered}$	0.85	NYU Stern - Environmental and Waste Services
Levered beta	$\beta_{levered}$	2.76	Consultant calculations
Market risk premium (US)	$R_m + R_f$	5.60%	NYU Stern[21]

[17] Ranges provided by the IFC for a similar project evaluated in the GCC. As a range of potential gearing percentages is possible, sensitivity analysis has been conducted on the WACC.

[18] US Treasury "Daily Treasury Yield Curve Rates" 20 year https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield. Date: 25 February 2021

[19] Government of Ghana, Ministry of Finance. See: https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount. Accessed 26 February 2021

[20] See: https://tradingeconomics.com/united-states/inflation-cpi

[21] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html Accessed: 26 February 2021

Corporate income tax rate	T	25.00%	Ghana Corporate Income Tax Rate[22]
Country default risk spread (Ghana)		5.75%	NYU Stern[23]
Country risk premium (Ghana)	CRP	6.30%	NYU Stern[24]

6 Financial analysis

This section presents the performance of the business models. Section 6.1 compares the performance of models described in Section 4 of this report to each other. Section 6.2 explores how changes in cost drivers— including Opex, Capex, and the cost of capital—will have impacts of varying degrees on the performance of the business model.

6.1 Performance of business models

This section presents financial analysis of two business models. For each of the models, the annual capacity of the transfer stations (300,000 TPA) and the MRF (400,000 TPA) are expected to be the same, as is the total capacity of the landfill (3,600,000 tons). The two models evaluated are an unbundled EPC + long-term O&M model and a bundled BOT model. Both these models include private financing of operating equipment.

Table 6.1 presents the outcome of the financial analysis. First, the table shows the operational costs per ton in US dollars for each project component. These costs include margins in the EPC + O&M models and the return on capital for the privately financed models. Next, the table presents the PV of all payments to the Project over its term. All payments are discounted at the Government of Ghana's borrowing cost in US dollar terms.[25] The annual payments in real US dollar terms to the contractor follow, and the last row presents the present value of cumulative 10-year O&M cash flow per ton of waste processed (levelized O&M cost) for each of the business models discounted at the Government of Ghana's borrowing cost.

Table 6.1: Analysis of business models

	Unbundled model: EPC & O&M + private finance of equipment	Bundled model: BOT

[22] See: https://tradingeconomics.com/ghana/corporate-tax-rate

[23] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html. Accessed: 26 February 2021

[24] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html Accessed: 26 February 2021

[25] Government of Ghana cost of borrowing in US$ (7.9%), February 2020 14-year US$ Bond Issuance Government of Ghana, Ministry of Finance. See: https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount. Accessed 26 February 2021

Project Life (Years)	10	10
Degree of Capital Cost Recovery	Capital costs of mobile equipment are recovered	Capital costs of mobile equipment are recovered
Source of mobile equipment	Funded by private operator	Funded by private investor
Outputs		
Landfill O&M cost (US$/ton)	7.13	5.71
MRF O&M cost (US$/ton)	4.70	3.75
Transfer Station O&M cost (US$/ton)	7.11	5.91
PV of payments (US$ Million)	44.34	35.69
Annual Payment to Contractor (US$ Million)	**6.55 (GHS 39)**	**5.27 (GHS 31)**
PV of cumulative 10-year O&M cash flow per ton of waste processed (US$/ton)	**6.64 (GHS 39)**	**4.99 (GHS 29)**

A key driver of the differences in the performance of the two models is how the private operator profits or earns a return on capital. In the unbundled business model, average EPC and O&M margins are applied to the unadjusted Capex and Opex. In the bundled model, a different approach is taken. Rather than markup Capex and Opex at the contractor margins, it is assumed that the private company earns a return equal to its weighted average cost of capital, which has been estimated following the approach set out in Section 5.1.3.

Implicitly, the conditions simulated for the bundled model represent a transfer of risk from Government to the private operator, such that the management of costs associated with the EPC and O&M contracts within the bundled model are internalized and fall to the private operator. In practice, the transfer of risk, and subsequently costs, is likely to be less complete, such that the total cost of providing services under the BOT model are likely to be higher than the costs presented in this study. The degree of difference cannot be known at this stage and should be studied in detail during the full feasibility study.[26]

[26] The extent of the private company's ability to manage subcontractor margins and to internalize them with its own cost of capital will vary from operator to operator. These costs can be reduced by introducing competition into the selection of EPC and O&M contractors.

6.2 Recommendation for further study of the bundled model

As the Project is currently at the pre-feasibility stage, key cost drivers will change along with a clear definition of the Project's scope and business model. Changes in these cost drivers—including Opex, Capex, and the cost of capital—will have impacts of varying degrees on all the models. While these impacts will change between options, the extent of the change across options will remain relatively constant. Therefore, sensitivity analysis has been conducted on only the bundled BOT option with private financing of operating equipment (Base Case), which is the best performing model for balancing cost reductions and risk transfer.

The technical analysis shows that a suitable MRF for Ayidan would only reduce waste for final disposal by approximately 7 percent while accounting for 25 percent of Capex. The choice to include the MRF or not should be framed around its ability to extend the useful life of the Project such that the marginal cost of processing another ton of waste at the MRF does not exceed the marginal benefit achieved from doing so.

Removing the MRF could have several outcomes on the Project. At this stage of analysis though, it is not possible to determine the ultimate impact. Neither the magnitude of the impact, nor the direction of that impact, can be quantified because the relationships between the cost and benefit drivers is not fully understood. For example, removing the MRF would reduce Capex and increase the airspace of the site available for final disposal, allowing the Project to take additional waste, which would likely reduce costs and extend its life. The additional airspace available may require investment in additional operating equipment to process the additional waste the site could take, which would increase the financing required for equipment and the total O&M costs. Additional study is required as part of the feasibility assessment to determine which of these effects would prevail.

7 What must be in place for the Project to work?

In order to deliver a sustainable Project, the sector must develop mechanisms to control waste flows as well as operator’s performance. It also needs clarity around financial flows and must take steps to improve cost recovery. The sector also would benefit from a shift toward a more competitive market that creates market-driven incentives. The sections below explore the specific steps that the sector could take in each of these areas.

7.1 Managing waste flows to the Ayidan Project

Operators require predictable volumes and compositions of waste to manage costs. For the 26-hectare Ayidan facility to operate effectively and in a financially viable manner, it is critical to ensure the flow of waste to the site is controlled throughout its projected useful life. This control can be achieved through a set of reforms aimed at introducing control over waste flows across the GAMA. Choices about the design and scope of the Project can also impact the flow of waste

throughout GAMA, as well as the amount of waste that requires final disposal at Ayidan and other sites. A set of possible choices include:

- Defining disposal zones that require waste to flow to specific sites and perhaps through specific transfer stations. In addition to limiting waste flows to the Project, introducing disposal zones across GAMA can deliver additional benefits, including reducing travel time of waste trucks and the sector's carbon footprint.

  In considering whether and how to set these zones, thought will need to be given to the tradeoffs required and their implications. Some MMDAs, or areas within MMDAs may need to be excluded because they do not fit within an optimized model, while others may need to be included for various policy objectives. Choices like these will impact the total cost of the Project to Government and may create additional challenges.

- Refining the scope of the Project to achieve a balance between costs, level of service, and complexity of the deal. Reducing the number of transfer stations required for the Project would reduce costs and increase its affordability Government. Likewise, so would descoping the MRF.

  The analysis undertaken in this study suggests that the Project can be delivered with one transfer station and without an MRF. The changes to scope may be possible, in part, due to how waste is collected in GAMA and to the composition of the that waste. Interviews with operators and data on waste composition indicate that segregating waste at the source would have the most significant impact on the quantities of waste for final disposal. Segregating waste at source represents a fundamental change to collections, and while valuable, is unlikely to be possible within the development period of the Project. As such, project structures that maximize affordability while achieving a desired level of service within the current environment should be assigned higher importance.

  Further, technical analysis shows that a suitable MRF for Ayidan would only reduce waste for final disposal by approximately 7 percent while accounting for 25 percent of Capex. The choice to include the MRF or not should be framed around its ability to extend the useful life of the Project such that the marginal cost of processing another ton of waste at the MRF does not exceed the marginal benefit achieved from doing so. At this stage, analysis suggests that the marginal costs will exceed the marginal benefits of including the MRF, which should be confirmed during a full feasibility study.

7.2 Transparency in financial management, performance, and cost recovery

The sector must have clarity over all financial flows across the value chain, which is important for several reasons, such as:

- Transaction structuring,
- Soliciting market interest,
- Assessing risk premiums and,

- Driving performance of Projects by demonstrating whether it is performing and, where not, enabling that performance is corrected.

The challenges faced in gathering data for this study demonstrate that significant room for improvement exists. The United States Environmental Protection Agency (US EPA) recommends that policymakers, especially in developing countries, know the true costs of providing solid waste management within a service area. Once those are known, the US EPA suggests that policymakers identify untapped sources of revenues that can be raised, the barriers that exist to raising them, and the actions that policymakers can take to removing them.[27]

One step to bringing transparency around these costs and financial flows to the sector is for Government to assign responsibility for collecting and managing sector data to one central agency, like the National Sanitation Authority. Under such an arrangement, the NSA could collect and report on all sector financial flows, waste quantities and flows, sector contracts, and fiscal commitments and payment arrears.

A second step to improving transparency and certainty around financial flows is to change how users pay for services. The Government could include a solid waste fee on utility bills to bring consistency to how users pay for services across GAMA. These charges can be set at cost recovery or could be set lower and supplemented by other internal revenues or charging mechanisms. In Maputo, Mozambique, the government charges a variable rate to users, using a proxy for economic status. It levies the fee on electricity bills, charging users who consume more electricity more for waste collection services, assuming that households and businesses that consume more power generally have achieved higher economic status than those that consume less.[28] The Government of Ghana could use a similar approach, but should only do so with a clear plan and communication strategy to bring stakeholders on board.

Even with additional clarity around the sector's finances, private investors and operators may still require credit enhancement on contracts and payments to manage the risk of payment defaults. These enhancements could take the form of:

- Escrow accounts, which can be used to hold funds until payments are due
- Multilateral development bank guarantees, which also helps the Project's creditworthiness through the bank's reputation
- Minimum revenue guarantees/assurance on waste inflows.

With clear processes for cost reporting and price setting, the sector's attractiveness to private investors would also increase.

[27] Best Practices for Solid Waste Management: A Guide for Decision-Makers in Developing Countries. United States Environmental Protection Agency. Page 39. EPA 530-R-20-002. October 2020. See: https://www.epa.gov/sites/default/files/2020-10/documents/master_swmg_10-20-20_0.pdf

[28] Ibid.

7.3 Competition in procurements and regulation of services

Government can further improve the sector's efficiency by introducing greater competitive tension in procurements and through more effective, consistent, and credible regulation of current operators. Balancing these objectives can bring lower costs of service and higher-quality services across the sector.

Should the Government continue the path it has set for the Project, it would represent an appropriate step towards delivering a competitively procured project with credible regulation, both of which are necessary to achieve a 10-year operational life for Ayidan. A well-run procurement for Ayidan will have the following characteristics:

- *Clear project scope*. While the temptation to let bidders decide the full scope of the Project exists, the procurement is more likely to meet the sector's current need and deliver value for money if the role that any private partner is to play is clear, fit-for-purpose, and achievable given current and near-term market conditions. Before launching the transaction, Government should decide on technical aspects of the Project (i.e., number of transfer stations; whether to include an MRF; service area for the Project) and be clear on the Project's affordability vis-à-vis expected costs and revenue requirements.
- *Credible payment mechanisms and revenue sources.* These will be defined by contract, but will need to be supported by data, which can be consolidated in a central agency, or compiled prior to the operationalization of the agency to communicate with potential bidders, and to ensure that Government is likely to be able to afford the Project.
- *An engagement or marketing strategy to attract the interest of bidders both domestically and internationally*. After finalizing the scope of the Project, Government should conduct outreach to suitable domestic and international partners to inform them of the pending transaction.
- *Transparent and open processes*. Following the processes set out in either the Public Procurement (Amendment) Act of 2016 and the PPP Act of 2020, as the final structure of the Project dictates, will reinforce the Government's credibility to the market and help to deliver outcomes that are more likely to achieve value for money than directly negotiated projects.

In the short-term, running the procurement for Ayidan following these principles is more likely to:

- Deliver bids at a lower cost per ton to the Government than could be achieved otherwise
- Build credibility with the market
- Add capacity within Government for running complex transactions in the sector
- Create a model to follow for future transactions.

The success of this strategy is contingent on regulation being clear, costs being understood, and the consistent enforcement of clear service standards. No single step can deliver these objectives, though. Instead, it is advised that the Government start with necessary items like the definition of disposal zones for Ayidan as a precursor to a larger package of reforms. Likewise, clarity around

costs and the eventual affordability of the Project is necessary to understand and achieve the long-term benefits expected from the Project.

After agreeing to disposal zones, regulation for the Project is most likely to be set by contract. Ensuring that the Project delivers services at contractually mandated standards will represent an important step towards improved regulation in the sector. The Government can then use the contract and its enforcement as a model for future contracts in the sector with incumbents and new operators alike to deliver high-quality services across the GAMA.

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Final Report

Financial and Economic Advisory for a Solid Waste Management Project in the Greater Accra Region, Ghana

September 2021

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Definitions

ACARP	Accra Compost and Recycling Plant
BOT	Build-Operate-Transfer
CAPEX	Capital expenditure
CAPM	Capital Asset Pricing Method
DBFOM	Design-Build-Finance-Operate-Maintain
EPC	Engineering, Procurement, and Construction
ESPA	Environmental Service Providers Association
GAMA	Greater Accra Metropolitan Area
GARID	Greater Accra Resilient and Integrated Development Project
GDP	Gross Domestic Product
GHS	Ghanaian cedi
GNCPC	Ghana National Cleaner Production Centre
IFC	International Finance Corporation
IUESMP	Integrated Urban Environmental Sanitation Master Plan
MDB	Multilateral Development Bank
MLGRD	Ministry of Local Government and Rural Development
MMDA	Metropolitan, Municipal, and District Assembly
MoF	Ministry of Finance
MRF	Materials Recovery Facility
MSW	Municipal solid waste
MSWR	Ministry of Sanitation and Water Resources
NSA	National Sanitation Authority
O&M	Operations and Maintenance
OPEX	Operating expenditure
PPP	Public Private Partnership
PSP	Private Sector Participation
PV	Present Value
SIP	Sanitation Improvement Plan
SPV	Special Purpose Vehicle
TPA	Tons per annum

TPD	Tons per day
TS	Transfer Station
WACC	Weighted Average Cost of Capital

1 Introduction

The World Bank Group, with other partners, is assisting the Government of Ghana with the implementation of the Greater Accra Resilient and Integrated Development Project (GARID) project. Under the GARID project, the World Bank intends to finance the Ayidan project (the Project) to address immediate gaps in Accra's final waste disposal capacity. The Government is currently procuring designs for the Project that will include a sanitary landfill and options to include a materials recovery facility and up to two transfer stations at a 26.2-hectare site in Ga West Municipal Assembly, shown in Figure 1.1.

Figure 1.1: Landfill and transfer station selected sites in the GAMA

Source: Mott MacDonald, using Google Earth

In addition to expanding final waste disposal capacity, Government has an opportunity to adopt a new operating model with the Project to:

- Create transparency around costs
- Enable long-term budgetary planning
- Act as an example of cost recovery for the sector
- Move the sector towards sustainable operations and management of solid waste.

Despite the clear benefits the Project could deliver, including increasing the amount of waste that is treated safely, it cannot solve all the sector's needs on its own. Of these needs, full funding of individual projects and the sector as a whole is critical. Likewise, the Project cannot push the sector towards universal collection, as waste collection is outside of the scope of the Project.

Castalia and Mott Macdonald (the Consultant) have been engaged to evaluate the Ayidan Project's technical and commercial structure, assess potential Private Sector Participation (PSP) models for the Project, and opine on the enabling environment for PSP for the Project. This report explores a potential role for the Project in the sector and the Government's choices around business models for the Project. The analysis presented has been prepared with consideration given to the views of investors and market participants. This report summarizes the key findings and messages of the deliverables prepared under this assignment:

- Inception Report, submitted on 23rd September 2020, which included the list of documents received, interviews completed, and initial findings;
- Technical Report, submitted on 31st January 2021, which described market volume and expected market share;
- Enabling Environment Report, submitted on 19th February 2021, which presented the analysis of key regulatory and institutional issues;
- Commercial Report, submitted on 28th February 2021, which described potential business models, revenue mechanisms, a validation of financial modeling assumptions (CAPEX, OPEX, revenues), financial modeling results, and an initial risk matrix

The Report presents the choices Government must make with respect to the Project and describes the impact that these choices will have on the overall affordability of the Project to the Government. The structure of the report is set out as follows:

- Section 2 describes the sector as it exists and operates currently;
- Section 3 explores the Project's role in the sector, its market share, competitiveness, and views on how it may be regulated;
- Section 4 explains options for funding and delivering the Project and describes business models that could be suitable for financing and delivering the Project, including a bundled build-operate-transfer (BOT) model and an unbundled operations and maintenance (O&M) model;
- Section 5 describes the key costs considerations around the Project, including Capex, Opex, and the cost of capital
- Section 6 analyzes the revenues, results, and fiscal projections under the various business models to show the advantages and disadvantages of each option (Section 6.1), along with a sensitivity analysis (Section 6.2).;
- Section 7 opines on challenges that exist to bringing the sector and Project to sustainable operations;
- Section 8 describes what must be in place for the Project to work.

2 Overview of the sector

Ghana's solid waste management sector is decentralized and driven by various public institutions at both the national and sub-national levels. This section first describes the sector's institutional and regulatory (Section 2.1) and funding (Section 2.2) arrangements. It finishes by explaining how the sector functions across the value chain, from waste reduction and reuse (Section 2.3), to collections (Section 2.4), waste transfer (Section 2.5), and treatment (Section 2.6), to final disposal (Section 2.7).

2.1 Institutional and regulatory arrangements

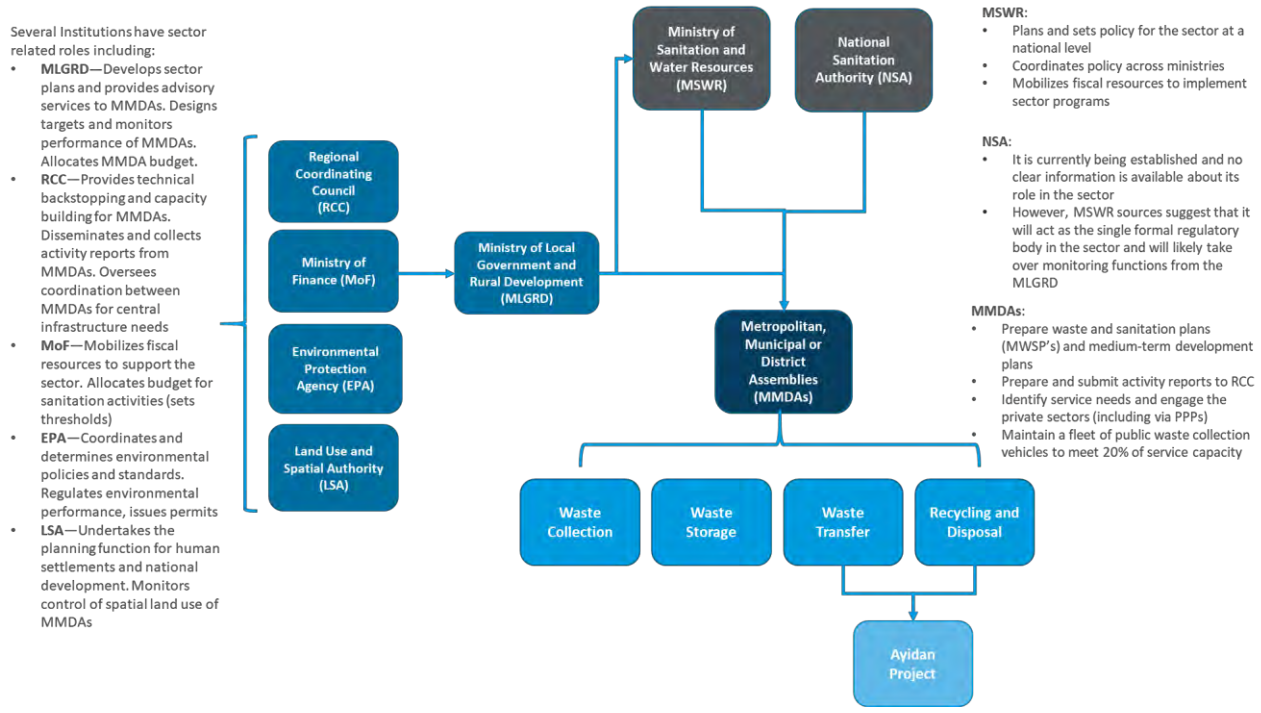
In Ghana, the solid waste management sector is decentralized and driven by various public institutions at both the national and sub-national level. The Ministry of Sanitation and Water Resources (MSWR) sets the sector's policy at the national level. Metropolitan, Municipal, and District Assemblies (MMDAs) identify solid-waste management service needs in their assemblies and procure service providers at the sub-national level. The Government has recently established the National Sanitation Authority (NSA), which will be the single regulatory body for the solid waste sector.

Several other institutions have sector-related responsibilities, including

- Ministry of Local Government and Rural Development: Develops sector plans and provides advisory services to MMDAs
- Ministry of Finance: Mobilizes fiscal resources to support the sector
- Environmental Protection Agency: Coordinates and determines environmental standards
- Regional Coordinating Councils: Provide technical backstopping and capacity building for MMDAs and disseminates and collects activity reports from MMDAs
- Land Use and Spatial Authority: Monitors control of spatial land use of MMDAs

Figure 2.1 describes the roles of the various institutions of the Government that are part of Ghana's solid waste sector.

Figure 2.1: Preliminary Overview of Key Government Parties in the Solid Waste Management Sector

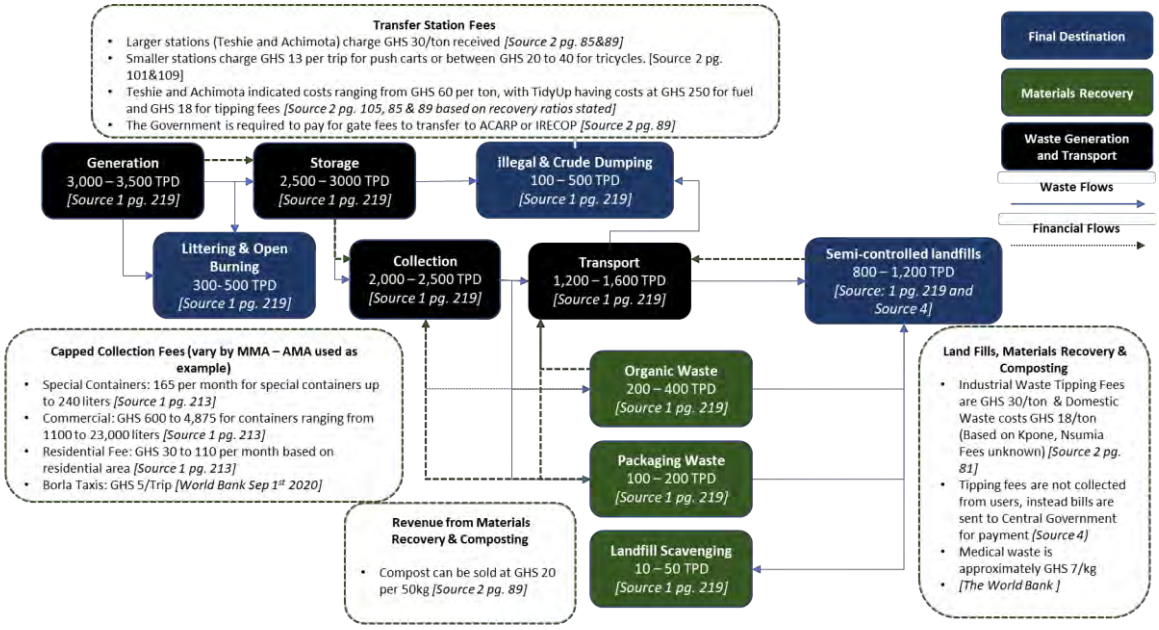


Source: Adapted from IEUSMP Strategic Action Plan 2020 Table 2.18.
Other sources: Stakeholder consultation, "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 15

Waste collection, treatment, and disposal services are highly fragmented and managed by several different bodies. MSWR has overall responsibility for solid waste management, with devolved responsibility allocated to the Metropolitan Municipal and District Assemblies (MMDAs). Figure 2.2 maps the financial and waste flows. The data relates solely to municipal solid waste only.[1]

[1] The sector generates additional waste from commercial and industrial sources which is outside of the scope of this study.

Figure 2.2: Waste Flows Tons per Day (TPD) and Financial Flows for GAMA



Source 1: "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana
Source 2: "Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana
Source 3: World Bank Communications"
Source 4: Stakeholder interviews

The Ministry of Finance (MoF) makes payments to the sector and the Ministry for Local Government and Rural Development, which used to be responsible for solid waste management, still retains a role in the sector.

2.2 Sector funding

Ghana's solid waste sector receives funding through multiple sources, including money from the central Government, funds internally generated by individual Metropolitan, Municipal, District Assembly (MMDAs), and fees collected through user payments.

This study attempted to create an understanding of the sector's funding and financial flows using both top-down and bottom-up approaches. The purpose of this analysis is to evaluate the affordability of the project to Government. However, few conclusions can be drawn on the state of the sector's finances. Publicly available data and the additional data gathered during this assignment could not complete a dataset or provided conflicting views on the state of sector funding.

As part of the top-down approach, the Consultant approached the Central Government to understand sector payments. These were not available, largely because there is no single body responsible for tracking these payments. One bottom-up approach built up sector costs using known and estimated tipping fees and estimates of waste flows up the value chain. A second bottom-up approach estimated funds available to MMDA's through Central Government transfers and internally generated funds. All methods provided different estimates of funding and financial

flows to the sector. Without a clear view of costs or revenues flowing through the sector currently, it is not possible to opine on the affordability of the Project to the Government.

Appendix A describes the approaches in detail, with key takeaways including:

- Bottom-up analysis suggests that users pay between US$47 million and US$204 million per year for waste collection services in GAMA, based on survey data of expenditure on waste disposal per household[2]
- On average, transfers from the National Government account for 52 percent of total funds available to MMDAs to fund sector operations, with the remaining 48 percent coming from internally generated funds at the MMDA level[3]
- Data shared on payments made to private operators by Central Government does not contain sufficient information to understand the period of service or service area(s) the payments cover.

2.3 Reduction and reuse

The responsibility for encouraging reduction, reuse, and recycling has partly been taken on by the Environmental Service Providers Association (ESPA), particularly the Ghana National Cleaner Production Centre (GNCPC), which is an initiative of the Environmental Protection Agency, which is attached to the Ministry on Environment, Science, Technology, and Innovation. However, the GNCPC is responsible for working with small and medium-sized companies, connecting material producers with end users rather than with the public directly.

2.4 Collection

MMDAs are responsible for managing all waste produced in their area, including municipal solid waste (MSW), commercial and industrial waste, and institutional waste (i.e., waste generated at municipal buildings or educational establishments).

2.4.1 Private sector

Collection is predominantly carried out by private sector companies, who bid for franchise contracts within each MMDA. The MMDAs are split into solid waste management zones, and each private-sector collection company bids for particular zones. Some MMDAs stated that there is a policy[4] requirement for each MMDA to have the capacity to collect up to 20 percent of the waste

[2] MSWR Socio-Economic Survey Report -Revised (November 2019) Page 59

[3] Internally generated funds are generated from property tax, business licences, market fees and various user charges.

[4] National Environmental Sanitation Policy, 1999.

in the area in-house. Some larger MMDAs do collect waste and have the relevant vehicles and equipment to fulfill this requirement. Others, particularly smaller ones, do not have this capacity.

MMDAs do not pay private companies to collect waste. Instead, the companies win contracts based on criteria such as previous experience, the number and type of vehicles owned, and financial standing. Collection companies collect payments from householders and businesses in the zones they serve. In theory, only one company collects from any area, and the MMDA sets the fees for the collection through largely political processes that are not clearly linked to the costs of service.

Formal waste collection is mainly carried out using refuse collection vehicles, which would typically use compaction. Payloads for these vehicles typically range between 3 and 12 tons. Collection from communal collection points does not involve any compaction other than manually pushing waste into the container.

MMDAs evaluate the private sector collection companies regularly[5]. However, it is not common for service contracts to link remuneration to performance and nor are mechanisms to penalize poor performance used regularly.

2.4.2 Informal sector

The informal sector is much better placed to collect waste from poor/slum areas than formal companies. Informal collectors use small vehicles (borla taxis) or push carts and can charge lower fees. Some reported that people in the informal sector dump waste locally rather than paying to transport the waste to a legitimate disposal site.

Many reported that picking through waste that is left out on the street for valuable items or materials is common. This is reported to be mainly plastic, but the low concentration of metal reported in the waste composition at GAMA's landfills, indicates that metal may also be removed from waste put out for collection, where it is available.

Informal collection is carried out using a mix of hand carts and borla taxis (which are motorized tricycles) with a reported payload of up to 1.5 tons, although there will be some with a significantly smaller capacity.

2.4.3 Communal collection

In poor areas without formal road networks, the Government has installed communal collection points (referred to as sanitary sites[6]) for people to dispose of waste. Communal collection points are also often used at markets where there are multiple waste producers in a small area.

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[5] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana, Section 4.2.3

[6] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana

The payment for this is generally unclear. Some private sector companies report that the payment for this service is not enough to recover the cost of collecting the containers. One MMDA reported that the staff at the site would only request a collection of the container when there was enough money available to cover the cost of fuel to the disposal site, rather than when the container was full.

Under the Sanitation Improvement Package (SIP), some MMDAs have contracted all communal collection points to part of the Jospong Group, which collects containers when it has spare availability within its fleet. The SIP was agreed between the Ministry for Local Government and the Jospong Group, but it was reported during stakeholder engagement that individual contracts need to be entered into between the MMDAs and the relevant company in the Jospong Group. Therefore, although the initial idea was that all MMDAs would be part of the SIP, they are currently not part of it. It is not clear if they all plan to or will eventually have to be part of the SIP.

2.5 Transfer

There are two large transfer stations (TSs)[7], which have been constructed by the private sector: the Teshie Transfer Station in Ledzokuku Krowor Municipal Assembly and the Achimota Transfer Station in Accra Metropolitan Assembly. Both are operated by Zoompak Ltd, a subsidiary of Jospong Group, as Public-Private Partnerships (PPPs)[8]. Achimota was developed through a PPP between Ledzokuku Krowor Municipal Assembly Zoompak, and Teshie was developed through a PPP between Accra Metropolitan Assembly and Zoompak.

Additionally, two small TSs operate in Kokomlemle and Gbawe with capacities of 46 and 90 tonnes per day, respectively. All of the facilities are understood to be operating significantly under capacity, as shown in Table 2.1.[9]

Table 2.1: Transfer facilities in GAMA

Location	Capacity (tonnes/day)	Utilization (tonnaes/day)	Operator
Achimota	1,200	300 - 400	Zoompak
Teshie	1,500	300 - 500	Zoompak
Kokomlemle	46	20 - 22	Waste Landfills
Gbawe	90	25 – 30	Tidy Up

[7] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana

[8] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana, Page 80-109

[9] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana, Page 80-109

Source: Table 4.10 Situational Assessment Report, 2019

Private collection companies communicated that they do not use these transfer stations. The reasons given were:

- The companies must pay for waste delivered to the TS. It was reported by one company that even after a full cost-benefit analysis taking into account the additional travel time to a disposal site and the significant queuing time, it was more expensive to use the TS than a disposal site at the current gate fee. This is compounded by the fact that the collection companies do not pay a gate fee at the disposal sites; and
- The queuing time at the TSs can be long. It was reported that there are not enough haulage vehicles to take waste from the TSs to a treatment or disposal site and that multiple small vehicles use the TSs, so queues mean that there is not a significant saving in time between the TS and a disposal site.

It was reported that TSs are used, in part, by informal sector operators, who would also have to pay directly for disposal. The Situational Assessment Report, 2019, highlights the low throughput of the TSs compared to their design capacity, so there is potential scope for more waste to be captured by these facilities. It is not clear if the MSWR or MoF makes any payment to the TS operator.

2.6 Treatment

There are several treatment facilities in GAMA, although they are not currently processing a significant proportion of the solid waste being produced. They are summarized in Table 2.2.

Table 2.2: Treatment facilities in GAMA

Treatment facility and location	Description	Private sector developer
JVL Fortifier Compost Plant, constructed in 2017, Tema Metropolitan Assembly	The facility is designed to treat source-separated organic waste and has a capacity of 700tpa (tons per annum). At its small capacity, the facility is operating as a prototype plant. The plant is effectively a prototype facility and only accepts source-segregated organic waste (i.e., not from a mixed waste source). This means that the compost produced is likely to be suitable for use as a soil improver. The composting plants producing compost from	Jekora Ventures Ltd

	mixed waste would not meet typical quality standards, such as PAS100 in the UK[10] or Compost Guidance in Australia[11], for a soil improver or compost/fertilizer, due to contaminants in the material.	
Accra Compost and Recycling Plant (ACARP), constructed in 2012, Ga West Municipal Assembly	This is a Materials Recovery Facility (MRF) with composting, consisting of waste sorting and a composting plant. The stated capacity is 300 tons of solid waste per shift (approximately 100,000tpa assuming a single shift). The waste sorting recovers materials such as plastics, glass, and metal cans. The composting section produces about 40 tons of compost daily.	Accra Compost and Recycling Ltd (part of the Jospong Group)
Integrated Recycling and Compost Plant (IRECOP), commissioned in 2019, Accra Metropolitan Area	The facility is designed to separate recyclables and to compost organic waste. It has a stated capacity of 200 tons per day (approximately 70,000tpa).	Integrated Compost and Recycling Plant Ltd (understood to be part of the Jospong Group)

Source: Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana

None of the private sector companies interviewed took waste to the larger treatment facilities. The method for charging a gate fee and who would be responsible for that fee is unclear.

2.7 Disposal

The disposal sites in and around GAMA include the following types:[12]

- **Unmanaged dumpsite:** An undefined area where people have disposed of waste, often in water courses or drainage ditches, which is not designed to accept waste. These may be small local areas or larger points which have developed over time. No fee is paid for dumping.
- **Semi-controlled dumpsite:** No engineering, licensing, or emissions management are in place, but there may be some direction regarding the placement of waste. Fees are

[10] PAS 100 and compost quality specifications (organics-recycling.org.uk)

[11] Compost Guideline (epa.sa.gov.au)

[12] Integrated Urban Environmental Sanitation Master Plan: Final Design Criteria Report, 2020.

sometimes paid for waste deposition. These are typically not in areas of heavy footfall but are unlikely to have been planned initially.

- **Controlled dumpsite:** No engineering, licensing, or emissions management are in place, but the site is managed, with the location of tipping directed and possibly compaction of waste.
- **Engineered landfill:** A lined site to prevent leachate from escaping from the waste. Infrastructures such as roads and a weighbridge may be present. Typically, there would be leachate treatment and gas management, although these are likely to be passive. Daily cover of waste is usually used.
- **Sanitary landfill**[13]: An engineered landfill with full leachate treatment and infrastructure on-site, with gas extraction from the landfill with either flaring or gas clean up and used in a combined heat and power engine to produce electricity. Along with daily cover, there is a plan for capping when the site is full, as well as aftercare, including monitoring.

The Nsumia site had an initial capacity of 680,000 m^3, but currently, both Nsumia and Kpone have only six months of remaining capacity.[14] [15] [16] The Adepa dumpsite has a capacity of 1,500 tpd and an estimated remaining 20-years of useful life.[17] None of these sites are engineered, and they do not include mechanisms for emissions management. All three sites are operated privately, with tipping fees reportedly paid by the Government.[18] [19] It is also understood that the sector's incumbent monopoly operator is developing three new disposal sites. Multiple requests for information on these sites were not responded to, so it is not possible to state: what standard they will be constructed to; the capacity of the facilities; or the potential locations of these facilities.

2.7.1 Disposal site usage

MMDAs direct the private collection companies to tip waste at specific sites. However, in practice, private sector companies do not follow these directions and tip at whichever sites are suitable to them.[20]

[13] The sector does not have any sanitary landfill currently. The sanitary facility at Kpone closed in 2019.

[14] IUESMP Sanitation and Drainage Survey Report: Solid Waste Volume I: Main Report, Page 89

[15] IUESMP Sanitation and Drainage Survey Report: Solid Waste Volume I: Main Report, Page 202

[16] World Bank-provided data

[17] World Bank-provided data

[18] MoF claims to make payments for tipping fees only when MMDAs are not able to, but MMDAs claim that the Central Government pays all tipping fees

[19] Stakeholder interviews

[20] Stakeholder interviews revealed that operators tip waste where it is more operationally or financially beneficial, such as in cases where the operator owned a private disposal site

At present, Accra disposes of most waste formally at dumpsites at Kpone, Adepa, and Nsumia. These sites accept the nearly 1 million tons per year of waste requiring treatment or disposal in the GAMA[21]. The remaining generated waste of approximately half a million tons per year is either collected by the informal sector or disposed of by illegal dumping or burning.[22]

Box 2.1: Kpone's sanitary landfill: a project that did not meet its goals

A sanitary landfill was developed and operated from 2013 to 2019 at Kpone, next to the location of the current non-engineered site. It is understood that the World Bank funded the Capex for this project, as it intends to do for Ayidan. The site was developed with tipping fees to be paid by users. However, as users were often unable to pay, these fees were later paid by the Government.[23]

The site was designed to receive 500 tons per day of waste for 10 years[24], but the sector's incumbent operated this site above capacity, accepting and disposing of 300 to 1,500 tons per day more than planned.[25] This increase in usage resulted in unsustainable growth in waste on the site, reduced project engineering and controls, and contributed to a significant fire, leading to the site's closure.[26]

Not all MMDAs have accurate records of the amount of waste tipped, as formal weighbridge records are not consistently available. Therefore, some invoices from disposal sites could not be verified for accuracy by the relevant MMDA. The MMDAs reported that the invoices are passed on to the MoF, as the fees which the collection companies can charge do not cover the cost of tipping. However, the MoF reported that this is not an agreement and that local governments' funds should pay tipping fees. The MoF states that it has only paid invoices in extenuating circumstances, such as the ongoing Covid-19 pandemic.

2.7.2 The informal sector's role in disposal

All disposal points are reported to have pickers—people in the informal sector sorting through waste to remove materials or items of value. These people typically live on the site during the week in makeshift accommodations and return to their homes on the weekend. Men and women are reported to work on the site, and it was reported that children are predominantly not on the site.

[21] Consultant's Technical Report, January 2021

[22] Ibid

[23] Stakeholder Interviews

[24] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana, Page 80 (Stakeholder interviews also quoted the figure of 600-800 tpd and a planned life of 8 years)

[25] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana, Page 82

[26] Consultant's Technical Report, January 2021

The Kpone site has a system for charging people for the right to pick waste from the site as it is dumped, but it is understood that this does not happen at the other dumpsites in Greater Accra. It is understood that approximately 180 waste pickers operate daily at Kpone.[27] Pickers are most likely to target plastics, which are then sold to on-site aggregators, who sell the material to larger aggregators, from where the material is sold to factories or for shipment internationally. There is clearly a market for plastics to be recycled, but as much of it is currently in the informal sector, the capacity and standards are not clear.

3 The Project's role in the sector and considerations for Government

The Greater Accra Metropolitan Area does not have any sanitary final solid waste disposal capacity, and Government intends for the Ayidan Project to meet that need. The Project is expected to add sanitary landfill capacity for up to 3.6 million tons over its life to the sector.

For the Project to operate over the longer term, Government will need to choose how to limit the quantity of waste it receives each year. This choice means that a greater proportion of GAMA's total waste needing final disposal (around 63% in 2022) would continue to be disposed of in non-sanitary ways, at least for the short term. If the Project were structured with a shorter life, it could accept more waste in the short term, and reduce the waste flowing to non-sanitary sites.

3.1 The state of the sector and considerations for Government

The sector faces key issues related to the state of the market, control of waste flows, and regulation that will impact the Project. These issues and opportunities for change in these areas are discussed below.

3.1.1 State of the market

The Project's competitive position depends, to some extent, on the role that Government assigns it. However, its position vis-à-vis the incumbent monopolist may significantly impact its ability to compete in the sector.

One firm owns and operates most transfer, treatment, and final disposal sites in the GAMA, and also operates in collections and thus has significant monopoly power in the sector. In principal, it has the power to set tipping fees above the costs of service at existing landfill sites. However, the

[27] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana – Page 2

Consultant could not secure a meeting with this firm to confirm fees charged or revenues recovered. Stakeholders in the sector also expressed that political influence plays a role in awarding contracts and payments towards this primary operator. The firm received the sole rights to secondary waste collection under the Sanitation Improvement Package (SIP), and the terms and conditions of the contract are undisclosed.[28]

Theory suggests that an incumbent vertically integrated monopoly could affect the success of new projects like Ayidan. A monopolist's control over collections and final disposal means that it could direct collection vehicles to dispose of waste at its own sites only. A monopolist could, in principal, affect the Project from a competitive angle as a monopolist could undercut a new project by pricing disposal at its landfills below its cost of service.

3.1.2 Control of waste

The Government has limited instruments to control waste flows, which contributes to higher costs across the sector. For landfill operators who receive more waste than facilities are designed to process, maintenance costs exceed expectations. This has implications on cost recovery for these operators, with gaps being covered by the Government.[29] The history of the Kpone landfill site demonstrates this.

Designing disposal zones for specific landfill sites could alleviate some of these problems, but the Government does not have any proven methods to effectively designate and enforce service areas. The Government currently uses collection zones, which are allocated to specific waste collection operators for waste collection. The Government could structure disposal zones, from which waste must flow to a designated landfill or transfer station, which would provide greater control on the flow of waste. Collection contracts are not standardized, and service areas for collection companies are often undefined and overlap, with collection companies able to choose where to tip waste. Some dispose of waste at sites that are the most profitable for them, rather than at sites that are operationally efficient for the sector. Some operators choose to travel to dumpsites that are further away than transfer stations to tip waste because the cost to tip waste at a transfer station exceeds the additional fuel costs incurred to travel and queue. Disposal of waste at transfer stations could help reduce queues at dumpsites, but waste collectors have limited incentives to change behavior.

While the current operations model for the sector presents a long-term challenge to sustainability for the sector and the Project, opportunities to improve exist. The Government could designate certain zones or Metropolitan, Municipal, and District Assemblies (MMDAs) to deliver waste directly to specific landfills or transfer stations, to regulate waste flows to the Project and institute

[28] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 213

[29] MoF claims to make payments for tipping fees only when MMDAs are not able to, but MMDAs claim that the Central Government pays all tipping fees

best practices for the sector. A second option is to first increase the use of, and then optimize, the operations of existing transfer stations. An initial step could begin with introducing incentives to use the transfer stations and material recovery facilities (MRFs), thus disincentivizing operators from bypassing them. The change in process could help to reduce wait times and improve collection efficiency across the sector.

3.1.3 Regulation and finance

Inconsistent regulation and the absence of regular and predictable payments across the value chain have prevented the sector from improving service provision. Regulation in the sector has gaps, especially in the overall monitoring and enforcement of standards. These gaps allow service providers to provide lower quality services, as there are few standards set and few enforcement mechanisms available to the Government, like withholding of payments to operators.

Further, financial flows to the sector are also unpredictable and inconsistent. At various points across the value chain, it appears that users may pay less than the cost of service, creating viability gaps and revenue shortfalls.[30] For medium to large-scale formal waste collection and transport service providers, profitability is highly variable. Previous studies have found that collection and transport providers have not been able to operate profitably consistently.[31]

Though regulatory and payment uncertainty is a clear barrier to the sector's sustainability, the sector has several steps it could take to make progress in these areas. One step is to increase payment certainty by providing guarantees to landfill operators, which would reduce risks and increase the attractiveness of the Project. Another step is to develop a clear set of KPIs for the Project, which could help a monitoring agency assess operators' performance and would enable effective and consistent enforcement of standards.

Consistency in payments is also required to ensure continued service. A contract structured following best practice will include mechanisms such as a minimum revenue / quantity or service guarantee. A detailed market sounding conducted during a full feasibility study will inform which type of guarantee will be most attractive to the market. Given that the Government does not have a strong track record of making consistent payments to operators, these guarantees may be required in addition to other credit enhancement mechanisms. A survey of international and domestic operators conducted during this study confirmed that some form of guarantee on the quantities of waste would be required, as well as a guarantee on payments, ideally from an external party.

[30] This statement could not be confirmed through data though, as described in Section 2.2.

[31] Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 10

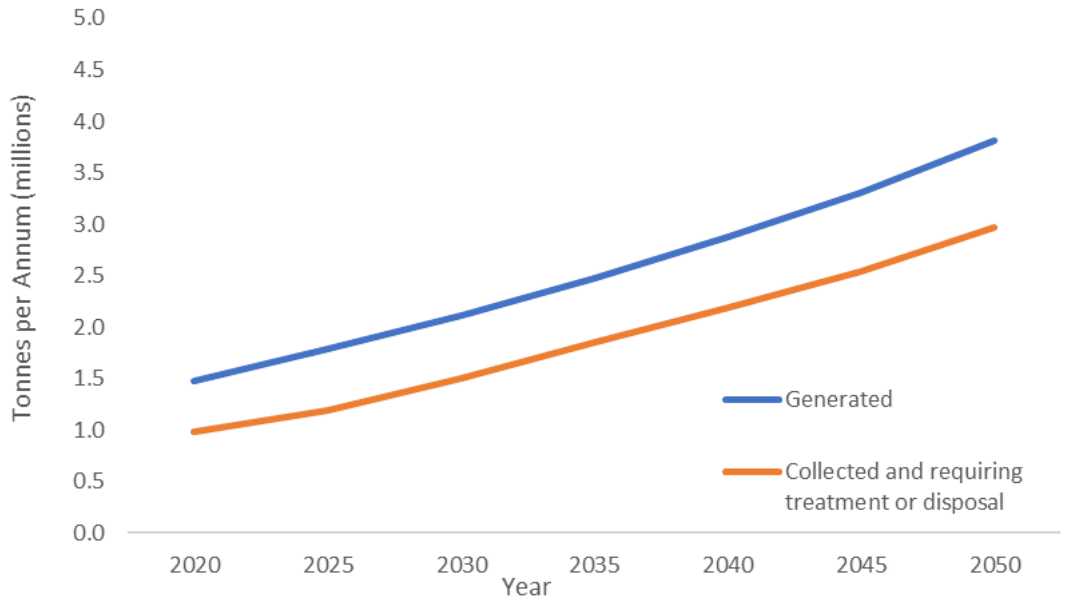
3.2 The Project's market share

To enable the Project to act as a long-term solution, it will need to accept only some of the waste available for disposal in the GAMA every year, meaning the sector will continue to dispose of the remaining waste at existing semi-controlled sites. Regulating waste flows to the Project would reduce annual operational costs, increase overall affordability, and lengthen the Project's life. For the Project to achieve a useful life of 10-years, aligning the Project life with the useful life of mobile equipment (also referred to as operating equipment), waste flows to the Project would need to be regulated to approximately 360,000 tons per year, or 37 percent of total waste available for final disposal in the GAMA.

3.2.1 Sector waste flows

Figure 3.1 shows the waste forecast for the sector in the GAMA. The sector currently generates around 1.5 million tons of waste per year, of which approximately 1 million tons require treatment or disposal. The quantity available for treatment or disposal is expected to rise to 1.2 million tpa by 2025 and 1.9 million tpa by 2035.

Figure 3.1: GAMA waste projection



Source: Mott MacDonald

The types of waste covered include municipal waste, non-hazardous commercial and industrial (C&I) waste, and institutional waste. The estimates of the current and future waste arisings in GAMA rely on assumptions about the population size and the waste generated per capita. Table 3.1 shows the estimates of waste arisings by MMDA.

Table 3.1: GAMA 2020 waste arisings data, Mott MacDonald model

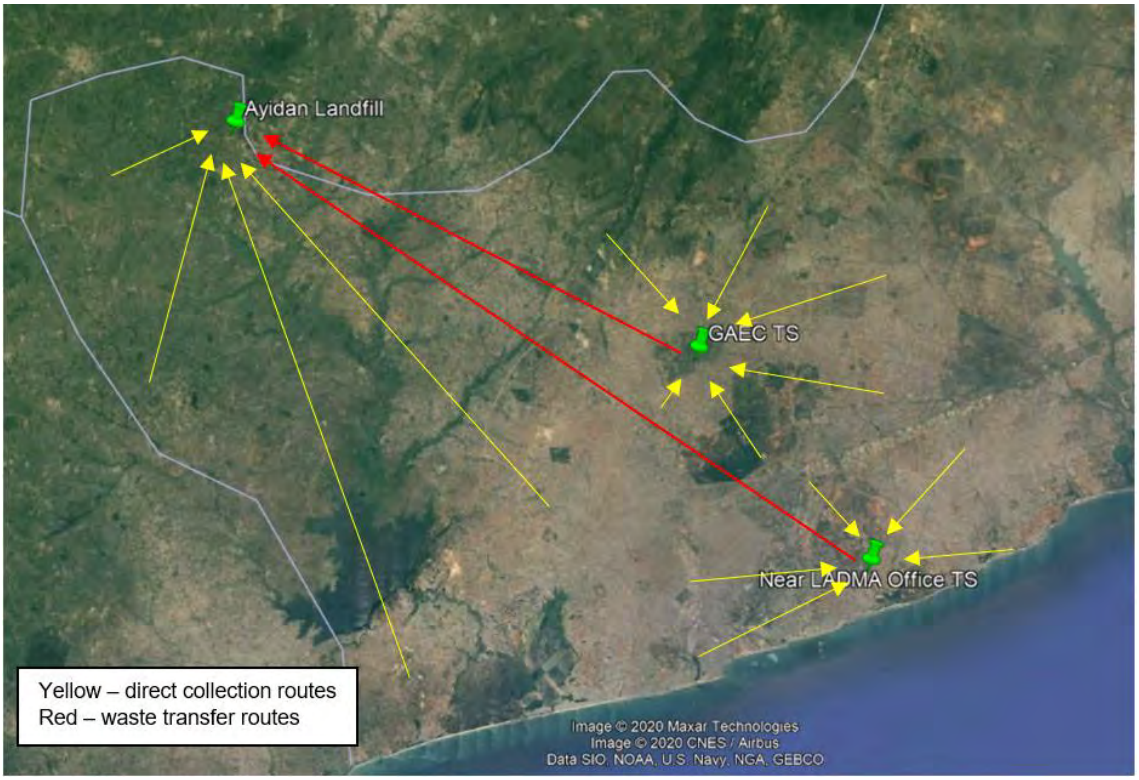
MMDA	Waste	Collected (%)	Collected (tpa)	Not collected	Not collected

	generated (tpa)			(%)	(tpa)
ADENTA	30,449	72%	21,923	28%	8,526
AMA	684,980	74%	506,885	26%	178,095
ASHMA	75,620	91%	68,815	9%	6,806
GCMA	46,136	60%	27,682	40%	18,454
GEMA	58,618	50%	29,309	50%	29,309
GSMA	170,489	35%	59,671	65%	110,818
GWMA	87,949	73%	64,202	27%	23,746
LADMA	72,394	70%	50,675	30%	21,718
LANMA	44,102	70%	30,871	30%	13,230
LEKMA	90,050	80%	72,040	20%	18,010
TEMA	115,509	80%	92,407	20%	23,102
GAMA	1,476,295	69%	1,024,481	31%	451,814

Source: Mott MacDonald

The way the market responds to the Project will likely reflect a proximity principle. This principle suggests that each transfer station or landfill would receive waste from the MMDAs closest to it. Figure 3.2 shows how this may look, highlighting the possible flows of waste from MMDAs to transfer stations and the landfill, and from transfer stations to the landfill.

Figure 3.2: MMDA movement of waste



Source: Mott MacDonald, waste flow model

Waste available for transfer, recovery, and disposal has been calculated based on projected waste generation and accounts for system losses associated with the current collection system and informal recycling market. The forecasts also reflect expectations about increased collection rates expected to begin in 2025 from the current 69 percent to a maximum of 85 percent by 2050.[32] [33] The forecasts also assume that the waste collection system will organically improve over time due to systematic intervention and improvements in the way that waste collection contracts are structured. The assumption that collection rates will reach 85 percent in the majority of MMDAs considers that there are sanitation plans in development, which suggests that there will be some improvement. Some MMDAs are already collecting higher percentages than others. So, with support, it should be possible for other MMDAs to improve. Table 3.2 presents the waste flow model summary.

[32] The highest performing MMDA is ASHMA with a capture rate of 91 percent. However, this is a statistical outlier when compared with other MMDAs as there are no other MMDAs with a stated collection capture rate of higher than 80 percent.

[33] This was modeled based on data from the GAMA ES Strategy and Action Plan, 2018.

Table 3.2: GAMA waste flow model summary

Category	2020	2025	2030	2035	2040	2045	2050
Population	5,055,805	5,646,833	6,189,612	6,771,641	7,380,213	7,977,997	8,700,125
Kg (per capita per day)	0.800	0.867	0.933	1.000	1.067	1.133	1.200
Waste generated (tpa)	1,476,295	1,786,282	2,108,594	2,471,649	2,873,363	3,300,231	3,810,655
Average collection rate	69%	70%	75%	79%	80%	81%	82%
Informal recovery (tpa)	46,102	56,437	70,846	87,326	103,063	119,743	139,908
Waste collected and requiring treatment or disposal (tpa)	978,379	1,197,718	1,503,500	1,853,246	2,187,225	2,541,204	2,969,152
Project waste intake[34]		390,000	390,000				

Source: Mott MacDonald

The estimated systemic waste loss, not including the recovery of recyclable materials by the informal sector, is estimated to have approached 500,000 tons in 2020 and is forecast to exceed 840,000 tons per year by 2050. This waste is largely associated with informal collection (not for recovery), open burning, and illegal dumping and will need to be managed.

At present, the operational dumpsites in the GAMA are Kpone, Nsumia, and Adepa. Kpone and Nsumia have operating capacities of 700 and 1000 tons per day, respectively, and an estimated remaining life of six months. The Adepa dumpsite has an operating capacity of 1,500 tons, and an estimated remaining life of 20 years. It is also understood that the sector's incumbent operator is developing three new disposal sites. Multiple requests for information on these sites were not responded to, so it is not possible to state: what standard they will be constructed to; the capacity of the facilities; or the potential locations of these facilities.

3.2.2 Strategic scenario and its implications

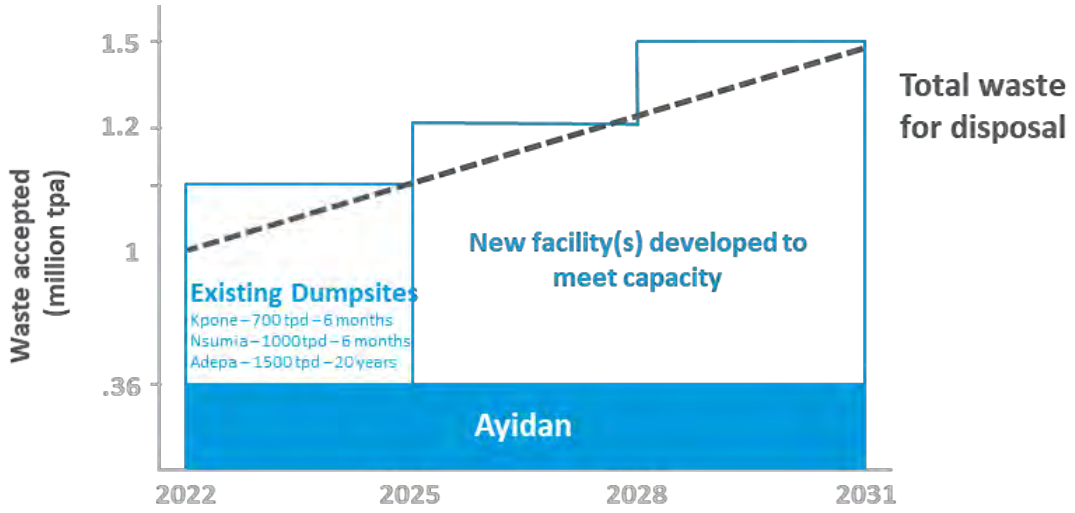
The Ayidan Project is intended to deliver a portion of the final waste disposal capacity that the sector requires and the Project is positioned to catalyze long-term improvements in the sector, including to planning, regulation, cost recovery, and contracting. It could become the first piece in a longer-term strategy to address the GAMA's final waste disposal problem. To make this possible, the sector must regulate waste flows to the Project to 360,000 tons per annum to bring its operational life in line with its equipment's economic life. While the GAMA would still require additional capacity, implementing the changes necessary to make the Ayidan Project successful would put the sector on the pathway to sustainability. Waste that the Project does not accept

[34] This assumes the Project starts operations in 2022 and operates until 2031.

would be sent to temporary solutions, such as semi-engineered sites, providing the sector time to develop additional long-term sites to build capacity later.

Figure 3.3 illustrates the part the Project can play in a long-term solution.

Figure 3.3: The Project's role in a broader strategy



Note: Under Existing Dumpsites, facilities' operating capacity in tons per day and available operational life are shown.

The Government may need to designate disposal zones for specific landfill sites to deliver this scenario.[35] Implementing this scenario could bring some stability to the sector, as it could move the sector away from short-term solutions and toward well-planned, sustainable operations. Some advantages of this scenario include:

- The choices required to make this solution viable will demonstrate the benefits of long-term planning and put the sector on the pathway towards sustainability. Developing the capacity to plan long-term will help the Government be proactive and develop projects to meet future demand before needs become critical.
- The Project would be structured to last a minimum of 10 years, and this term aligns more closely to the lifecycle of the equipment, which could make bundled private-sector participation models possible, including some with significant risk transfer.
- This scenario could reduce costs over the long term through greater integration of project functions and the ability to engage in whole-of-life costing.[36]

[35] To note, the market may limit waste that flows to the Project because of price competitiveness or monopoly power, which could have a similar effect.

[36] "PPP Reference Guide 3.0" International Bank for Reconstruction and Development / The World Bank, 2017. Page 18

- Improved risk management as the envisaged structure will transfer risks that a private firm is well-placed to handle, like cost overruns or delays, reducing the Project's total costs.
- It increases opportunities to maximize economic benefits through the environmental treatment, management, and disposal of waste and reducing illegal dumping and burning.

As the Project would take up not all waste, additional capacity must be found. Engineered landfill capacity will not be available immediately, so waste must continue to be disposed of in semi-engineered, semi-controlled, and uncontrolled landfills.

4 Project funding and business models

This section discusses the potential sources of funding for the Project, as well as the business models that could be used to structure the Project, and the risks and advantages of each of them.

4.1 Funding for the Project

The Project must be fully funded across its entire life to maintain its intended level of service. It is understood that the World Bank Group will fund the Project's Capex. Payments for Opex will come from Government payments, or user fees, or a combination of the two. The Government will likely make most payments and cover most, if not all, of the Project's costs in the short term. The sources for funding may include general funds and tax revenues, user charges and tipping fees, and internally generated funds at the MMDA level. However, as discussed in Section 2.2, no clear estimation of funds available to the sector was possible. Therefore, there is also no clarity on funds that will likely be available to the Project.

The Project's ultimate sources of revenue will depend on how the Government allocates risks and structures the Project. For example, the Government may choose to transfer availability risk to the operator and take quantity risk. Availability risk is the risk of bringing the facility online and running it to the level needed to accept a certain daily quantity of waste. In this model, the Government would make availability payments to the operator. Alternatively, the Government could transfer quantity risk to the operator, which means that the operator would receive revenues and earn profits from user charges based on the quantity of waste delivered to the landfill. Models that share these risks also exist, combining fixed availability payments with variable payments based on waste treated.

4.2 Business models suitable for the GAMA's context

Given the Project's challenges, only a few possible business models exist, each of which will affect the size of the annual payment that the Government makes to the operator, as well as the cost per ton of disposal. The Government's ultimate choice of a business model could enable the Project to set an example for the sector of how to engage the private sector while achieving significant risk transfer. It could also choose a model with minimal risk transfer and no bundling of functions, which is likely to perpetuate the problems that exist in the sector today.

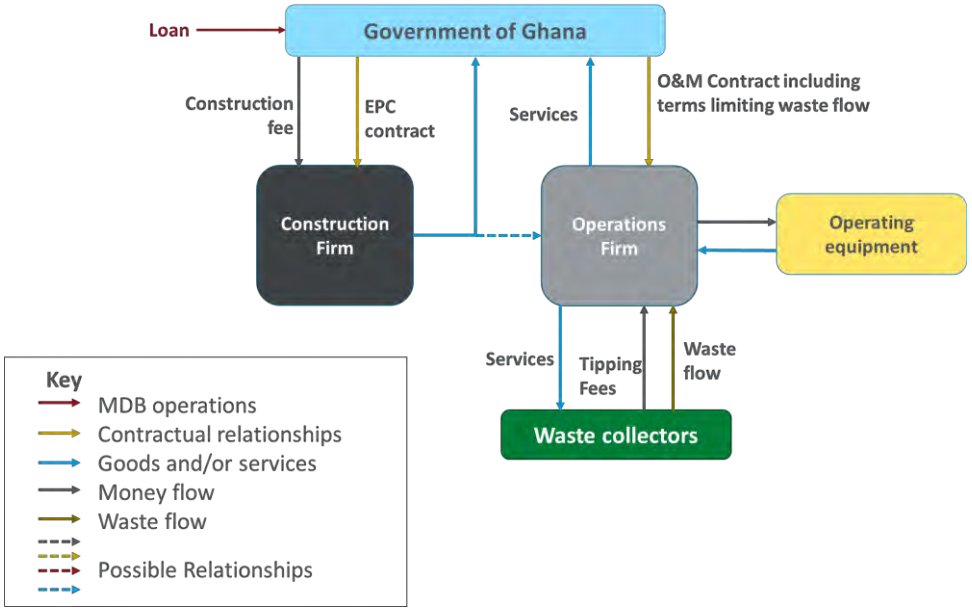
Appendix A shows the process flow diagrams that illustrate waste flows for 2022, 2025, and 2030.

4.2.1 Possible business models

An unbundled Engineering, Procurement, and Construction (EPC) with a long-term[37] Operations and Maintenance (O&M) contract and a bundled Build-Operate-Transfer (BOT) project both have pathways to commercial viability and sustainability. Both models could align the economic life of operating equipment with the life of the landfill, which would enable a private operator to optimize costs and mitigate risks over the anticipated 10-year life of the Project. The EPC with long-term O&M and the BOT can deliver similar benefits, except for the additional benefits achievable through the bundling of functions in the BOT model. These additional benefits include cost reductions and greater efficiency achieved through whole of life costing. Both models could provide value for money as private investment in the project and alignment of useful lives incentivize firms to practice whole-of-life costing and maximize efficiency.

Figure 4.1 shows the unbundled model in which the O&M firm finances the purchase of operating equipment. The O&M contract could be structured as a long-term, 10-year contract, which ensure the provision of services of a high standard. The O&M firm recovers its investment and operating and maintenance costs through the tipping fees paid by waste collectors or Government. The EPC company would be contracted with an EPC fee which includes a profit margin for the operator. It is anticipated that the World Bank would provide a loan to fund this Capex.

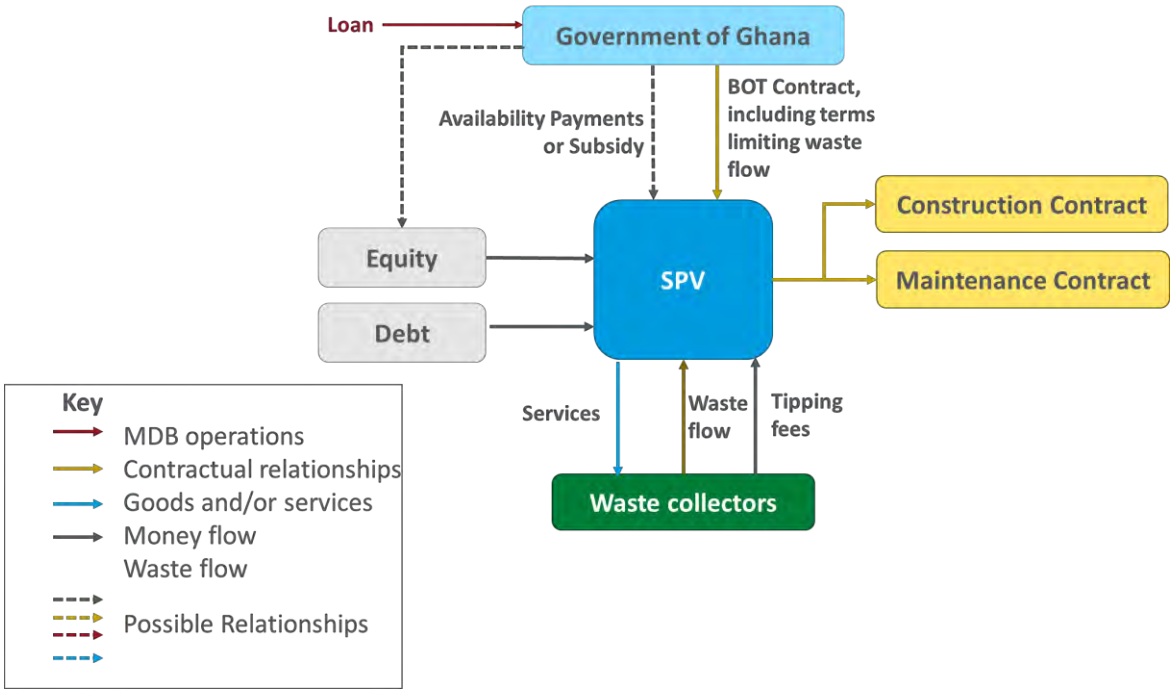
Figure 4.1: EPC & O&M with private investment in operating equipment



[37] Long-term in this case means 10-years, in order to align the contract length with the planned landfill life.

Figure 4.2 illustrates a bundled PPP model based on a BOT contract. Private investors, and potentially multilateral development banks (MDBs), place equity and debt in a special purpose vehicle (SPV). The SPV signs a contract with the Government to build, operate and maintain the Project. The SPV, directly or through subcontracts, executes the functions agreed within the contract and delivers services at agreed standards. The Government funds the construction of the Project, but the SPV finances the operating equipment. It recovers its costs through tipping fees, and if it fails to provide service at the contracted standard, faces financial penalties. It is also anticipated that the World Bank would provide a loan to the Government to finance Capex.

Figure 4.2: Build - Operate -Transfer



This bundled model is only likely to be viable under certain conditions. During a detailed market sounding at the feasibility stage, investors may indicate that a guarantee on waste flows would be required for them to feel comfortable participating in the project. Also, the contract term is most likely to be attractive if it covers a period of 10 or so years. This view was supported by the market survey, in which most operators indicated that they would prefer a term of 10 years or less, though some were open to extensions. A term of greater than 10 years is unlikely to be viable as a

longer project would put added pressure on the Government to limit waste flows to the Project. Further, though industry-standard contracts are 20-25 years[38], the Government does not have a track record of delivering long-term agreements, which means investors would likely perceive the deal as unnecessarily risky.

4.2.2 Models not considered

A full design-build-finance-operate-maintain (DBFOM) model does not appear to be a realistic option. The Government has already begun the procurement process for selecting the design consultant, making integration of all components challenging. This model is unlikely to be commercially sustainable. Given the Government's credit and fiscal positions, this model is not likely to attract competitive or affordable bids.

4.2.3 Summary of realistic business models and risks associated with each

Table 4.1 describes the various models that could be successful along with the payment mechanisms and risks associated with each of them.

Table 4.1: Summary of realistic business models

Name	Functions and roles	Description	Payment mechanism	Risks
Unbundled model - EPC of fixed infrastructure and private finance of mobile equipment along with a long-term O&M	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	▪ The Government or World Bank funds capital expenditure. The Government awards an EPC contract for the Project facilities and a separate agreement to another company to operate and maintain the Project ▪ The O&M contract has a term of 10-years and is written to industry standards ▪ The O&M firm finances mobile operating equipment	The Government pays a fixed fee for EPC, with cost overruns and delays dealt with through change orders. The O&M firm finances mobile equipment and collects tipping fees to recover those equipment costs and the costs of maintenance and operations.	▪ Government still takes cost overrun risks ▪ This will require implementing measures to control waste flows to the site to restrict waste flows to approximately 360,000 tpa

[38] Waste management contracts involving landfills and other treatment or transport infrastructure in African and Middle Eastern markets

Bundled model - Build-Operate-Transfer (10 years or less)	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	▪ A private company builds and operates the Project and transfers the facilities back to the Government after 10-years. ▪ The private partner finances the cost of mobile equipment.	The Government/World Bank finances capital costs, except for mobile equipment. Operator finances private equipment and collects user fees to recover these costs.	▪ This will require implementing measures to control waste flows to the site ▪ Over or under-delivery of waste could trigger contingent liabilities ▪ Private sector interest may be low given contract length and challenges in controlling waste flows

5 Key cost considerations

The costs associated with the Project include capital costs (Capex), operational costs (Opex), and the cost of capital. These are described below.

5.1 Capex

The table below provides a list of the Project's capital expenditures. These estimates are based primarily on benchmarks taken from two integrated waste management projects in Africa and informed by professional engineering evaluation of the situation in the GAMA. The configuration of each benchmark project broadly aligns to that of the technical concept for the Project.[39] The range presented is based on estimations from Mott MacDonald and from the World Bank Group and will need to be refined based on design choices at a later stage.

The benchmark data has been adjusted to reflect the Project's tonnage profile and sizing (footprint). These costs include profit and design and delivery contingencies but do not include contract or risk allocation margins.

Table 5.1: Capital Expenditures

Capital expenditure	Description	Million US$

[39] One benchmark is located in Northern Africa, the other in Sub-Saharan Africa. The source data is based on quoted or actual values from the operators of these projects, and both feature engineered landfills and/or semi-automated MRF and/or transfer stations. Source: Mott MacDonald Proprietary data.

Landfill	Civil infrastructure, gas, leachate	17.5 - 25.6
Transfer Station	All civil infrastructure and plant costs excluding haulage)	8.0 - 10.8
Landfill Mobile Plant	Compactors, dozers	2.7 - 3.7
MRF	Civil infrastructure and equipment	12.2
MRF Mobile Plant	Forklifts, diggers, transport for residues to landfill	2.5
Haulage	Vehicles moving waste between the transfer stations and landfill but not including those moving waste from the MRF to the landfill	4.1
Total		**47.0 - 58.9**

Note: All costs calculated in 2021 US$.
Source: Mott MacDonald and WBG estimates

The drivers of these costs include:

- Physical size of the facilities,
- Projected throughput, and
- Technological capabilities. For example, an MRF that captures a higher percentage of recyclables would be more expensive.

5.2 Opex

Like Capex, the Project's Opex is broken down across each of the Project's components. These estimates are based primarily on the same benchmark projects. These costs exclude operating margins.

Table 5.2: Operating costs

Cost item	Description	Unit cost per ton – margins not included US$/ton (GHS/ton)	Unit cost per ton – 33% operating margin included US$ (GHS)	Annual costs on O&M (without margin) US$ (GHS)	Cumulative O&M costs (without margin) US$ (GHS)
Landfill	Waste transfer, daily covering of waste, and maintenance	3.3 (19.4)	4.4 (25.8)	1,177,742 (69,278,937)	11,777,419 (6,927,894)
Transfer Station	Movement of waste and maintenance	1.5 (8.8)	2.0 (11.7)	450,000 (26,470,588)	4,500,000 (2,647,059)
Haulage	Includes haulage of waste between the transfer stations and landfill, but does not	1.2 (7.1)	1.6 (9.4)	348,000 (20,470,588)	3,480,000 (2,047,059)

	include movement of waste from the MRF to the landfill				
MRF	Reception of waste, waste capture, and maintenance	2.3 (13.5)	3.1 (18.0)	867,652 (51,038,338)	8,676,518 (5,103,834)

Note: All costs calculated in 2021 US$
Source: Mott MacDonald

These costs are driven by the scale of operations and the composition of waste flows. The number of vehicles that deliver waste to facilities also affects costs, as a higher number of vehicles on the site increase operational costs.

5.3 Cost of capital

Two costs of capital are used for the financial analysis. For the EPC and O&M scenario, the margins that typical EPC and O&M contracts add are considered. For the return on private financing of equipment, a real weighted average cost of capital (WACC) has been calculated and used in the analysis. These are shown in Table 5.3.

Table 5.3: Cost of capital and profit margin assumptions

Cost	Value (%)	Source
Government cost of debt[40] - Real (US$)	6.50%	Government of Ghana cost of borrowing in US$, February 2020 14-year US$ Bond Issuance[41]
EPC margin[42]	14.00%	NYU Stern – Environmental and Waste Gross Margin
O&M margin[43]	33.00%	NYU Stern – Environmental and Waste Gross Margin
Weighted average cost of capital - Real (US$)	11.98%	Consultant calculations[44]

[40] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount - 14-year bond issuance of February 2020

[41] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount

[42] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[43] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[44] For the purpose of this analysis, it is assumed that the costs of capital under the privately financed options include the margins of EPC and O&M providers. These margins are spread across the SPV's total costs, which are then recovered at the WACC. In practice, it is likely that some of these margins would be passed on to Government, though the extent of which cannot be determined at this stage of analysis.

A post-tax WACC has been calculated using the following formula:

$$WACC = R_{e*}\left(\frac{E}{E+D}\right) + R_d\left(\frac{D}{E+D}\right) * (1-T)$$

Where:

- R_e is the cost of equity
- R_d is the cost of debt
- (E / (E + D)) is the proportion of equity
- (D / (E + D)) is the proportion of debt
- T is the corporate tax rate

The cost of equity has been calculated using the Capital Asset Pricing Method (CAPM):

$$R_e = R_f + \beta_{levered} * (R_m - R_f) + CRP$$

Where:

- R_f is the risk-free rate, which is the interest rate an investor can expect to earn on an investment that carries zero risk.
- $\beta_{levered}$ is the levered beta for environmental and waste services

$$Levered\ beta = Unlevered\ beta * (1 + (1 - Corporate\ Tax\ rate) * Debt/Equity\ Ratio)$$

- $R_m + R_f$ is the market risk premium for the US, which is the excess return earned by an investor when they invest in the stock market (R_m) over a risk-free rate (R_f).
- CRP is the country risk premium for Ghana

The cost of debt is given by:

$$R_e = R_f + Country\ default\ risk\ spread$$

The country default risk spread reflects the debt investor's perception of the default risk. The values and sources for each of these inputs follow in Table 5.4.

Table 5.4: Components of the WACC

Component	Term	Value	Source
Gearing	D / (E +D)	75.00%	International Finance Corporation (IFC) Benchmark figure within the range of

			acceptable gearing levels for the sector[45]
Risk-free rate, United States (nominal US$)	$R_{f\,(US)}$	2.30%	U.S. Treasury 20-year yield[46]
Risk-free rate, Ghana (nominal US$)	$R_{f\,(Ghana)}$	7.9%	Government of Ghana cost of borrowing in US$, February 2020 14-year US$ Bond Issuance[47]
US inflation		1.4%	Trading economics[48]
Unlevered beta	$\beta_{unlevered}$	0.85	NYU Stern - Environmental and Waste Services
Levered beta	$\beta_{levered}$	2.76	Consultant calculations
Market risk premium (US)	$R_m + R_f$	5.60%	NYU Stern[49]
Corporate income tax rate	T	25.00%	Ghana Corporate Income Tax Rate[50]
Country default risk spread (Ghana)		5.75%	NYU Stern[51]
Country risk premium (Ghana)	CRP	6.30%	NYU Stern[52]

[45] Ranges provided by the IFC for a similar project evaluated in the GCC. As a range of potential gearing percentages is possible, sensitivity analysis has been conducted on the WACC.

[46] US Treasury "Daily Treasury Yield Curve Rates" 20 year https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield. Date: 25 February 2021

[47] Government of Ghana, Ministry of Finance. See: https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount. Accessed 26 February 2021

[48] See: https://tradingeconomics.com/united-states/inflation-cpi

[49] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html Accessed: 26 February 2021

[50] See: https://tradingeconomics.com/ghana/corporate-tax-rate

[51] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html. Accessed: 26 February 2021

[52] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html Accessed: 26 February 2021

6 Financial analysis

This section presents the performance of the business models. Section 6.1 compares the performance of models described in Section 4.2 of this report to each other. Section 6.2 explores how changes in cost drivers— including Opex, Capex, and the cost of capital—will have impacts of varying degrees on the performance of the business model.

6.1 Financial analysis of the business models

The table presents two business models: An unbundled and a bundled model that include private financing of operating equipment. For each of the models, the annual capacity of the transfer stations (300,000 TPA) and the MRF (400,000 TPA) are expected to be the same, as is the total capacity of the landfill (3,600,000 tons).

Table 6.1 presents the outcome of the financial analysis on each of these models. First, the table shows the operational costs per ton in US dollars for each project component. These costs include contractor margins in the EPC + O&M models and the return on capital for the privately financed models.[53] Next, the table presents the PV of all payments to the Project over its term. All payments are discounted at the Government of Ghana's borrowing cost in US dollar terms[54]. The annual payments in real US dollar terms to the contractor follow, and the last two rows present the PV of cumulative 10-year O&M cash flow per ton of waste processed for each of the business models.

Table 6.1: Analysis of business models

	Unbundled model: EPC & O&M + private finance of equipment	Bundled model: BOT
Project Life (Years)	10	10
Degree of Capital Cost Recovery	Capital costs of mobile equipment are recovered	Capital costs of mobile equipment are recovered
Source of mobile equipment	Funded by private operator	Funded by private investor
Outputs		

[53] It is expected that contractors would assign margins to both EPC and O&M contracts executed within the BOT project structure as they would in the unbundled structure. However, as the BOT contractor would be expected to manage costs of all inputs, these margins have been omitted. Detailed analysis of these margins and costs should be conducted during a full feasibility study.

[54] Government of Ghana cost of borrowing in US$ (7.9%), February 2020 14-year US$ Bond Issuance Government of Ghana, Ministry of Finance. See: https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount. Accessed 26 February 2021

Landfill O&M cost (US$/ton)	7.13	5.71
MRF O&M cost (US$/ton)	4.70	3.75
Transfer Station O&M cost (US$/ton)	7.11	5.91
PV of payments (US$ Million)	44.34	35.69
Annual Payment to Contractor (US$ Million)	**6.55 (GHS 39)**	**5.27 (GHS 31)**
PV of cumulative 10-year O&M cash flow per ton of waste processed (US$/ton)	**6.64 (GHS 39)**	**4.99 (GHS 29)**

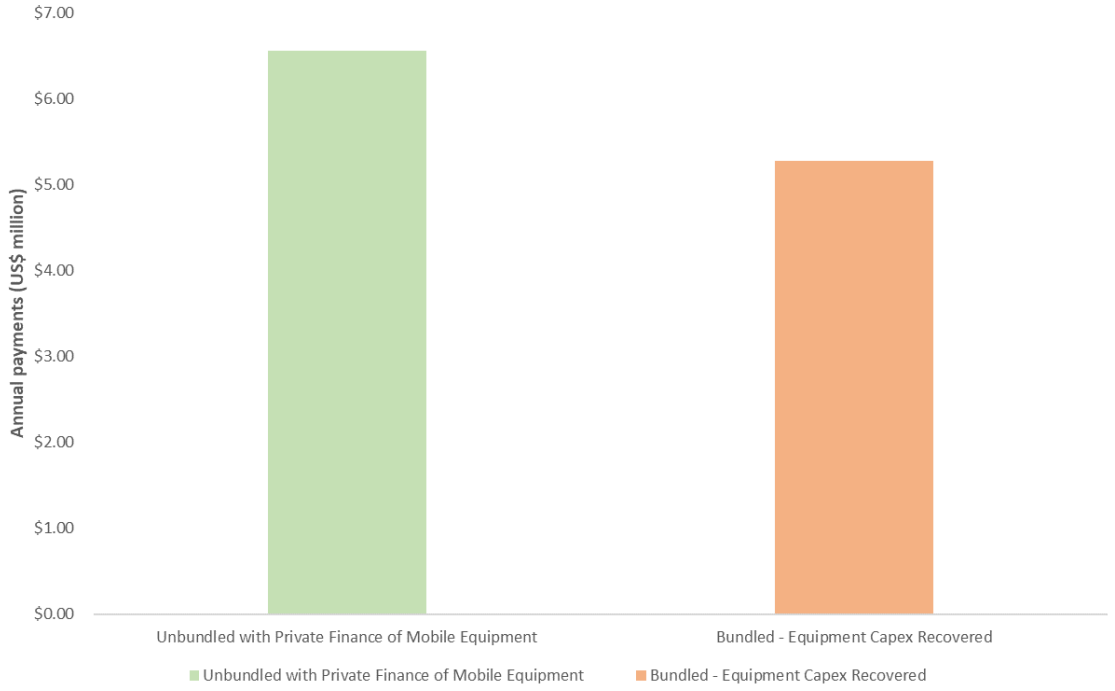
The two models show significant differences in performance. The figures that follow compare the:

- Annual payments required to the Project in real terms (Figure 6.1)
- Levelized O&M costs for each option in US$/ton (Figure 6.2)
- The present value of payments to the Project in each option in real terms (Figure 6.3).

Analysis suggests that each model will face an annual viability gap based on forecasts of the money that may be available to fund the Project. However, as discussed, the data gathered provides conflicting estimates of Government funds that could be available, so it is not possible to quantify the viability gap. Analysis suggests that to earn the required returns, the unbundled model with private financing of equipment requires an annual payment of US$6.55 million, while the bundled option requires an annual payment of US$5.27 million.[55]

[55] Annual revenue requirements reflect the net revenue a firm would require to recover all costs, including a reasonable rate of return.

Figure 6.1: Annual payments to Project, US$ million (real)



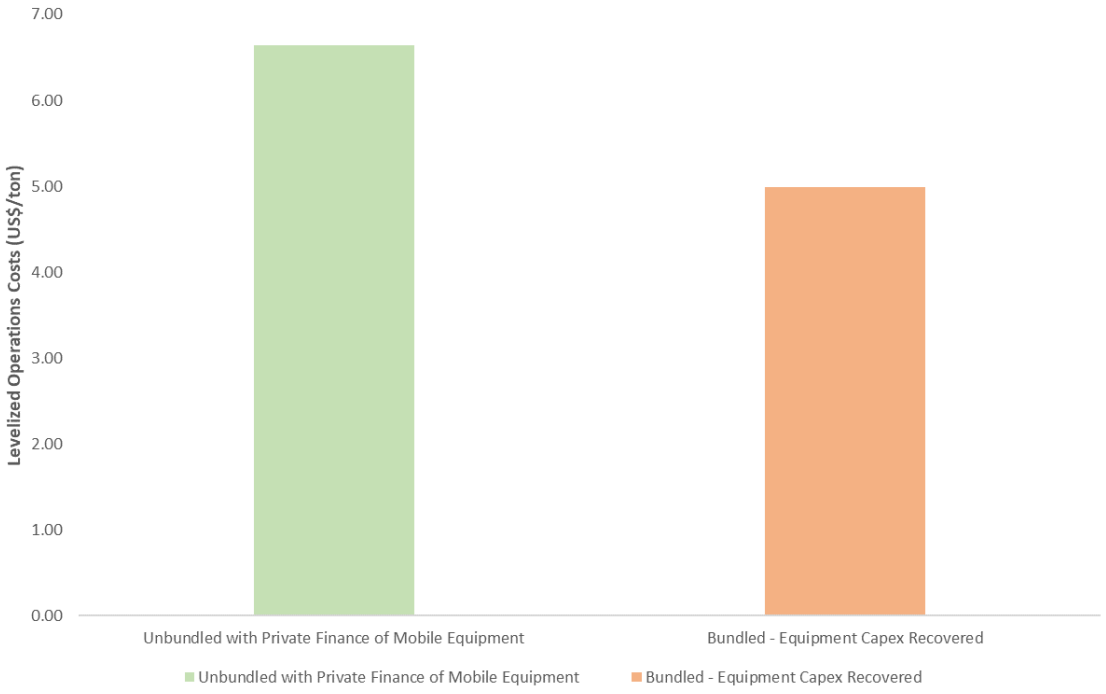
A key driver of the differences in the performance of the two models is how the private operator profits or earns a return on capital. In the unbundled business model, average EPC and O&M margins are applied to the unadjusted Capex and Opex. In the bundled model, a different approach is taken. Rather than markup Capex and Opex at the contractor margins, it is assumed that the private company earns a return equal to its weighted average cost of capital, which has been estimated following the approach set out in Section 5.3.

Implicitly, the conditions simulated for the bundled model represent a transfer of risk from Government to the private operator, such that the management of costs associated with the EPC and O&M contracts within the bundled model are internalized and fall to the private operator. In practice, the transfer of risk, and subsequently costs, is likely to be less complete, such that the total cost of providing services under the BOT model are likely to be higher than the costs presented in this study. The degree of difference cannot be known at this stage and should be studied in detail during the full feasibility study.[56]

[56] The extent of the private company's ability to manage subcontractor margins and to internalize them with its own cost of capital will vary from operator to operator. These costs can be reduced by introducing competition into the selection of EPC and O&M contractors.

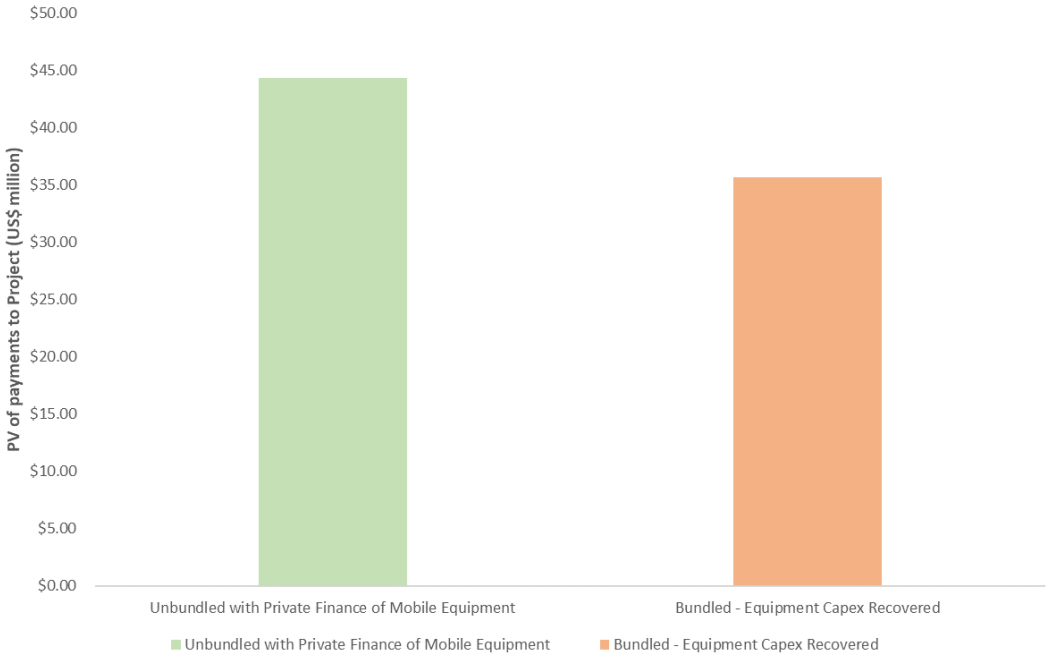
The unbundled model has a PV of cumulative 10-year O&M cash flow per ton of waste processed cost per ton of US$6.65/ton while the bundled model has a cost of US$4.99 per ton.

Figure 6.2: PV of cumulative 10-year O&M cash flow per ton of waste processed (levelized operational costs), US$/ton



The unbundled model has the higher PV of payments (US$44.34 million), while the bundled option is lower at US$35.69 million.

Figure 6.3: Present value of payments to the Project, US$ million (real)



6.2 Sensitivity analysis

As the Project is currently at the pre-feasibility stage, key cost drivers will change along with a clear definition of the Project's scope and business model. Changes in these cost drivers—including Opex, Capex, and the cost of capital—will have impacts of varying degrees on all the models presented. While these impacts will change between options, the extent of the change across options will remain relatively constant. Therefore, sensitivity analysis has been conducted only on the bundled BOT option with private financing of operating equipment (Base Case), which is the best performing model for balancing cost reductions and risk transfer.

Table 6.2 compares the impact of (+/-) 15 percent change in Capex and Opex to the results presented previously for the Base Case. It also compares changes of (+/-) 1.5 percent in the cost of capital affect the Project's financial performance. The table presents the PV of cumulative 10-year O&M cash flow per ton of waste processed' as agreed for the presentation to government, including Capex and the O&M costs, to enable a fair comparison of the impacts of changes in Capex and the cost of capital across the sensitivities.

Table 6.2: Sensitivity Analysis

	Base Case	Capex +15%	Capex (-15%)	O&M +15%	O&M (-15%)	Cost of Capital +1.5%	Cost of Capital (-1.5%)
Landfill (US$/ton)	5.71	6.07	5.34	6.20	5.22	5.86	5.56

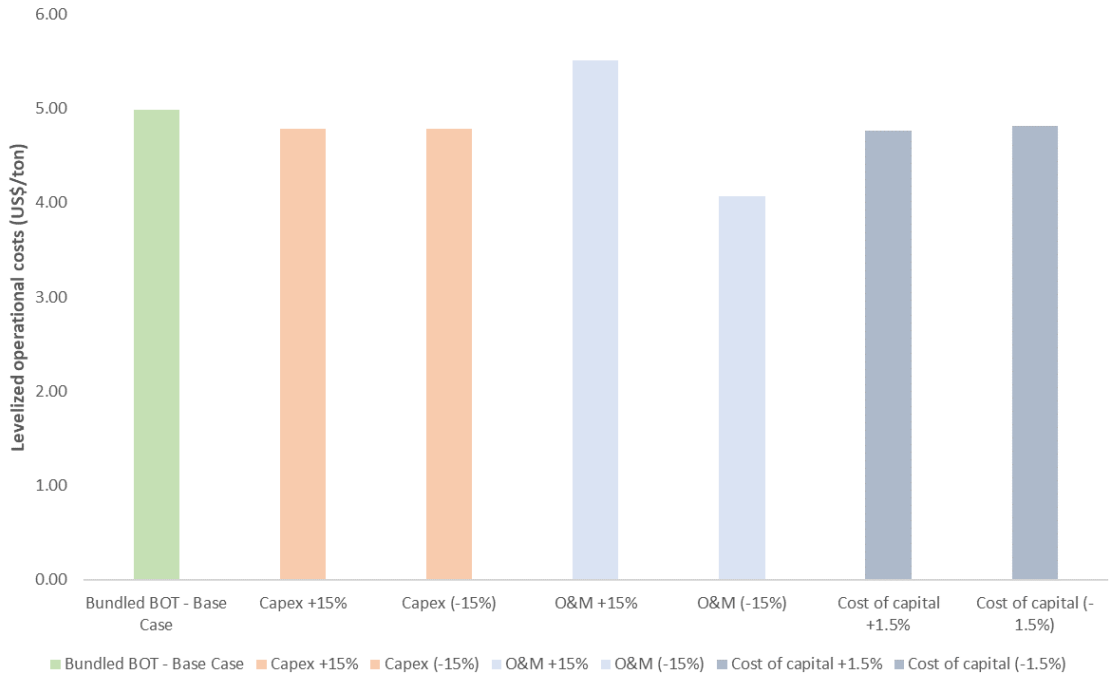
MRF (US$/ton)	3.75	3.97	3.52	4.08	3.41	3.84	3.66
Transfer Station (US$/ton)	7.24	6.41	5.43	6.31	5.51	6.11	5.72
PV O&M cost per ton, *excluding Capex* (PV O&M costs / PV tons) (US$/ton)	4.99	4.79	4.79	5.51	4.07	4.76	4.81
PV costs, *including Capex* (PV all costs / PV tons) (US$/ton)	19.36	18.87	15.19	17.75	16.31	16.99	17.07
Annual Payment to Contractor US$ Million	5.27	5.64	4.91	5.70	4.85	5.42	5.13

Figure 6.4 below compares the PV of cumulative 10-year O&M cash flow per ton of waste processed (Levelized O&M costs) (US$/ton) across each of the sensitivity scenarios. Box 6.1 suggests additional analysis required to deepen the understanding of the drivers of O&M costs and affordability to the Government.

Box 6.1: Additional considerations for analysis – the economic case for the MRF

It is recommended that Government study the impact that removing the MRF from the Project scope would have on the affordability of the Project to Government and on the Project's useful the life. While the MRF is expected to reduce the final disposal of waste at the landfill by 7 percent, it requires almost 25 percent of the total Capex. Removing the MRF could have several outcomes on the Project. However, at this stage of analysis, it is not possible to determine the ultimate impact. Neither the magnitude of the impact, nor the direction of that impact, can be quantified because the relationships between the cost and benefit drivers is not fully understood. For example, removing the MRF would reduce Capex and increase the airspace of the site available for final disposal, allowing the Project to take additional waste, which would likely reduce costs and extend its life. The additional airspace available may require investment in additional operating equipment to process the additional waste the site could take, which would increase the financing required for equipment and the total O&M costs. Additional study is required as part of the feasibility assessment to determine which of these effects would prevail.

Figure 6.4: PV of cumulative 10-year O&M cash flow per ton of waste processed (levelized operational costs), US$/ton



7 Challenges to sector and Project development

The GAMA's solid waste sector faces challenges to sustainable operations, while the Project itself faces specific challenges to development. The sector must overcome technical constraints, gaps in regulations and poor institutional performance, and obstacles to profitable operations and cost recovery in the sector. This section describes these barriers.

7.1 Technical challenges

Technical challenges relate to practices and physical constraints that limit the Project and sector's efficiency and long-term sustainability. These include challenges related to waste quantities, its collection, transportation, and final disposal. This section deals with the physical aspects and does not cover issues with regulations and institutions, or the financial implications of these issues, as these are covered in later sections. Table 7.1 describes the sector's technical challenges

Table 7.1: Technical challenges

Project Challenges	Sector Challenges

▪ The potential market share the Project will capture is uncertain as it is unclear whether the Government has the ability to limit waste flows ▪ The Project will not have direct control over the amount of waste delivered to the facilities	▪ Source segregation is limited ▪ Existing final disposal sites receive waste beyond designed capacity ▪ Large queues at waste disposal sites reduce operational performance ▪ Limited usage of transfer stations contributes to large queues at dumpsites ▪ There is a need for greater coordination with the informal sector ▪ Decentralized and short-term collections contracts reduce the efficiency of waste collection systems. ▪ Waste collection frequency is inconsistent, and this causes increased illegal dumping

These challenges are discussed in detail below.

The potential market share the Project will capture is uncertain as it is unclear whether the Government has the ability to limit waste flows. The GAMA generates around 1.5 million tons per annum (tpa), of which around 1 million tons (66 percent) is formally collected and available for final disposal. If Government chooses, this amount of waste could flow to the Project to address a critical need though it would limit the Project's capacity to accept waste to a period of approximately 3-years.[57] Further, the total volume of waste requiring management would be larger than any existing facilities have managed historically.

Under a longer-term option, the Project's lifespan could increase to 10 years, assuming it accepts around 360,000 tons of waste per annum. The challenge here is to ensure sufficient waste flows to the Project, as other semi-engineered landfills expected to be developed by the incumbent could attract a significant quantity of the waste in the GAMA on account of lower tipping fees or monopoly control. All else equal, tipping fees at the incumbent's sites would likely be significantly lower than the Project's due to limited environmental and engineering controls, assuming that the level of service of existing facilities of the incumbent would be achieved in any new facility. A clear challenge to the success of this model is that it is uncertain whether the Government can effectively designate and enforce disposal zones for specific landfill sites.

Source segregation is largely absent. Currently, only one provider (Jekora Ventures) practices source segregation within its operational areas.[58] Segregating even a modest proportion of the organic waste from the mixed waste at source will reduce demands on both the Project and on

[57] Consultant's Technical Report, January 2021

[58] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 188

future projects. This reduction in demand will lengthen all projects' useful lives. Organic waste that is source segregated can be used to form compost or soil improver. Organic waste treated from a mixed waste source cannot be used as compost or soil improver, as it will contain impurities that could leach into the soil. However, even in the absence of source segregation, treatment of organic wastes received commingled with general wastes is still considered technically viable given the high percentage of organic waste in GAMA. Technically viable options include biostabilization and drying of organic waste to reduce volume, reducing methane production on the landfill, and generating a material suitable for a daily cover.

Existing final disposal sites receive waste in excess of design capacities. Final disposal sites such as Nsumia, Adepa, and Kpone have exceeded their capacities. This has depleted their useful lives in advance of their expected lifetimes. If waste flows are greater than plants were designed to accept, it is difficult to place waste as planned and to build up the right landfill profile. Compactor capacity is also limited at disposal sites. Additionally, the bigger the tipping face, the greater the potential for environmental impacts from litter, odors, and fires. As landfill operators cannot control waste inflows, they may incur more significant maintenance costs than anticipated and would therefore be unable to recover costs given current charging structures and practices in the sector. Further, the absence of sufficient final disposal capacity increases illegal and uncontrolled dumping of waste. If waste collectors do not have geographically accessible and affordable landfill capacity, they will likely dispose of waste illegally.

Large queues at waste disposal sites reduce operational performance. Both MMDAs and private collection companies reported significant queues at dumpsites. Stakeholders have said that vehicles often wait up to two days to unload at some locations.

These long queues are inefficient and:

- Prevent the waiting vehicle from undertaking further waste collections
- Remove staff from useful waste management work
- Prevent robust route planning as it is uncertain how long vehicles will be out of use
- Increase the release of vehicle emissions as trucks idle.

Further, borla taxis and other small vehicles deliver waste to dumpsites, increasing the number of vehicles unloading.[59] Reliance on borla taxis and other small vehicles is inefficient and increases the number of vehicles on the road.

Two transfer stations already operate in the GAMA, neither of which are fully utilized. Transfer stations collect waste from small vehicles and transfer this waste to larger vehicles, which then

[59] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 221

travel to final disposal sites. The use of vehicles with greater volumes reduces the number of vehicles tipping at final disposal sites and helps reduce queues.

Limited usage of transfer stations contributes to large queues at dumpsites. Disposal of waste at transfer stations could help reduce queues at dumpsites, but waste collectors have limited incentives to tip at transfer stations. Currently, waste collectors dispose of waste at sites that are the most profitable for them, rather than at sites that are operationally efficient for the sector. Disposal at a regulated dumpsite has limited direct costs for private collection companies apart from fuel costs as collection vehicles are not charged a tipping fee to dispose of wastes. During stakeholder consultation, waste collectors communicated that the additional cost of fuel and queuing for disposal at distant dumpsites was lower than the cost of tipping fees at transfer stations. This disincentivizes waste collectors from using transfer stations.

If consumers were to pay cost-recovering tariffs, waste collectors would be able to pay the cost of transport to landfill sites and tipping fees at the landfill sites. In such a scenario, accompanied by enforcement of anti-dumping laws and hefty fines, waste collectors would be less likely to dump waste illegally as they could afford to pay tipping fees at disposal sites. This scenario does not appear terribly farfetched as more than 60 percent of the population of Greater Accra would be willing to pay more for improved collection services.[60]

There is a need for greater coordination with the informal sector. Although the informal sector currently collects around 52 percent of waste in the GAMA and is an integral part of the system, there is a lack of coordination between formalized and informal waste collectors.[61] In some instances, the informal sector does coordinate or operate under the private sector[62], but the practice is not widespread. This lack of coordination leads to congestion at landfill sites and transfer stations and overlapping collection routes.

Decentralized and short-term collection contracts reduce efficiency. The scale and tenure of waste collection contracts limit private operators' ability to implement cost-efficient solutions over the long term, make capital investments, and achieve economies of scale. Existing collection contracts are set over varying periods, with some as 3 years and others as 5 years.[63] Short-term contracts reduce the incentives for firms to invest in transit fleets, leading to poor service delivery and reduced collection rates.

At present, the approach to waste collection is highly fragmented as each MMDA is split into waste collection zones with different private sector companies collecting waste from each zone.

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[60] "Household Willingness-to-Pay for Improved Solid Waste Management Services in Four Major Metropolitan Cities in Ghana"(2019) Kwame Nkrumah University of Science and Technology, Kumasi, Ghana (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6334316/)

[61] Stakeholder interviews

[62] This usually occurs in low-income locations that do not have suitable road access for the private sector's collection vehicles. The informal sector can access these households as their vehicles are smaller and more agile.

[63] Stakeholder interviews

Decentralizing municipal entities, which increased the total number of MMDAs from 11 to 26 (or 29 according to some sources), has increased this problem's complexity. As service areas are constantly changing, it is difficult to plan for long-term waste collection and to maximize collection rates. Current practices prevent effective waste collection, leading to reduced waste flows to landfill sites, and uncertainty around quantities of waste flows that these sites will receive, which impedes effective logistical and financial planning of the sector.

Waste collection frequency from communal collection points is inconsistent, and this causes increased dumping. Collection frequency is inconsistent and can lead to periods where waste is not collected. If waste containers from communal collection points are not collected when full, people dispose of waste by dumping it illegally. This illegal dumping could cause reduced waste flows to the Project.

7.2 Institutional and regulatory challenges

Institutional roles and policies must be clear and comprehensive to drive long-term sustainability in the solid waste sector. Institutional challenges in the sector relate to the regulations and institutions that govern the waste management sector and limitations that prevent the sector from becoming sustainable, and include institutions' roles, enforcement of laws, determination of fees, and management of contracts. Table 7.2 presents the sector's institutional challenges.

Table 7.2: Institutional and regulatory challenges

Project Challenges	Sector Challenges
▪ All of the sector challenges listed alongside affect the Project, as it is part of the sector and subject to the same institutional and regulatory regime	▪ Institutional roles are not clearly defined ▪ The sector lacks a comprehensive regulatory framework and existing regulations are not well enforced ▪ Private waste collectors are unable to manage collection risk effectively, resulting in reduced revenue collection to fund waste transit and disposal operations ▪ Metropolitan, Municipal, and District Assemblies (MMDAs) do not have tools to enforce contractual terms effectively, enabling poor performance from private operators ▪ Contracts do not always define KPIs or service standards and are not standardized across MMDAs ▪ Fee-fixing resolutions are non-uniform and do not consider costs explicitly

These challenges are discussed in detail below.

Institutional roles and responsibilities are not clearly defined. The laws governing solid waste management do not clearly allocate responsibility for essential functions to specific institutions. This lack of clarity has led to poor coordination and left crucial functions such as sector-wide monitoring and evaluation unfulfilled. For example, the Government has not consolidated the responsibility for collecting information on the sector's financial flows within a single entity. As this

function is not consolidated within one agency, it is difficult to understand what the costs are, who bears them, and how they are covered. Further, the Government has not made a single agency responsible for oversight of the implementation of the Integrated Urban Environmental Sanitation Master Plan (IUESMP).[64] Without a centrally responsible body, and under the current approach, the Government cannot ensure the efficient allocation of resources and coordination to meet the plan's goals.[65]

The sector lacks a comprehensive regulatory framework and does not enforce the existing regulations consistently. Gaps in the overall monitoring and enforcement of the sector enable inconsistent service provision. These gaps allow service providers to provide sub-par services, as there are few standards set and few enforcement mechanisms like withholding of payment available to the Government.

Further, despite being mandated to do so, MMDAs do not consistently enforce environmental sanitation bylaws and contracted service standards either due to lack of capacity, resources, or accountability to other branches of government that they will actually do so. The failure to enforce these increases costs for the Government, reduces service quality, limits funding for the sector, and increases illegal dumping of solid waste.[66] Monitoring and enforcement of MMDAs to achieve their mandate by a central government agency, such as the Ministry of Local Government and Rural Development (MLGRD) or the MSWR, appears to be lacking. MMDAs self-report on performance and do not appear to be penalized for failure to meet expectations or performance goals. This is further complicated by a lack of transparency on the roles of oversight and enforcement between MLGRD and MSWR.

The informal sector operates with limited restrictions in the GAMA, meaning it can compete in areas officially licensed to the formal sector.[67] For illustration, in Kpone, the informal sector collects approximately 52 percent of all waste collected.[68] In addition to operating without regulation, informal operators have lower costs, and therefore are able to attract customers away from formal service providers by offering lower prices.[69]

Contracts do not always define KPIs or service standards and are not standardized across MMDAs. In order to achieve consistency and better service quality, contracts must be standardized and should clearly list performance indicators and enforcement mechanisms in case

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64 "Conditional Assessment Report (Solid Waste)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 14

65 Consultant's Enabling Environment Report, 19th February 2021

66 "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 242

67 "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 238

68 Stakeholder interviews

69 "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 238

of contract breaches. Standardization of contracts would ensure that Waste Management Departments (WMDs) of MMDAs include key contractual terms and utilize complete contracts.[70]

Private waste collectors are unable to manage collection risk effectively, resulting in reduced revenue collection. Private collectors have limited means for forcing customers to make payments. When customers stop paying for services, collectors can take consumers to sanitation courts, which exist to settle such disputes. However, interviews with stakeholders showed that local members of parliament prevent enforcement of sanitation laws for political reasons.[71]

MMDAs cannot enforce contractual terms effectively, enabling poor performance from private operators. The terms of collection contracts limit MMDAs' powers to enforce the contracts through standard and accepted processes like withholding payments. If formal service providers do not perform to standard, assemblies can eventually reduce concession areas or rescind contracts. A more effective method of control is to withhold payments if services are not performed. However, service providers' fees are paid directly by the Ministry of Finance, and there is no mechanism for assemblies to withhold payments for non-performance.[72] [73]

Fee-fixing resolutions are non-uniform and do not explicitly consider costs. The process to determine waste collection fees for consumers that is used by the MMDAs is informal and lacks transparency.[74] Further, the process is managed by elected officials, making it political. Members of the district assemblies charge their constituents lower rates to try and improve their chances of re-election.[75] Further, the process does not consider the cost-of-service provision. In some instances, the fees fixed are not sufficient for service providers to fully recover costs.[76]

As fees differ across MMDAs, the fee-fixing process leads to an imbalance in service providers' profitability. Two waste service providers servicing the same amount of waste across equivalent-sized service areas could have different profitability levels, despite their costs being the same. This imbalance leads to differences in waste collectors' capacity to pay transfer station or landfill tipping fees.

7.3 Commercial challenges

The sustainability of Accra's solid waste management sector from a commercial perspective is limited. While options to attract private sector participation to the Project exist, these options are unlikely to deliver the long-term benefits of private investment and operations without substantial

[70] Consultant's Enabling Environment Report, 19th February 2021

[71] Stakeholder interviews

[72] Ibid

[73] Ibid

[74] Ibid

[75] Ibid

[76] Ibid

changes in the sector. Significant reforms and financial support from the Government will be needed to ensure the sector's long-term sustainability. At present, key constraints exist in relation to solid waste management service providers' capacity to operate profitably, manage risks they are allocated, and compete with large service providers (See Table 7.3).

Table 7.3: Commercial Challenges

Project Challenges	Sector Challenges
▪ Uncertainty in the competitive landscape ▪ Monopoly influence	▪ Monopolists limit competitive outcomes and increase sector costs ▪ The culture of cost-recovery is largely absent in the formal sector ▪ The Government does not consistently meet its payment obligations ▪ There are limited PSP models which can be sustainable and commercially viable in the long-term ▪ Risks are not allocated to the party best capable of managing them ▪ The informal sector prevents formal operators from recovering the full value from a franchise area

The remainder of the section discusses the challenges outlined above in detail.

Monopolists limit competitive outcomes and increase sector costs. A single firm currently operates (either solely or in partnership with another firm) the two existing materials recovery and recycling facilities and the two largest waste transfer stations.[77] It also owns disposal sites and has a considerable influence over the entire value chain in some areas. Stakeholders expressed the view that political influence plays a role in awarding contracts and payments towards the incumbent. The firm was allocated the sole rights to secondary waste collection under the Sanitation Improvement Package (SIP), and the terms and conditions of the contract are undisclosed.[78] [79]

The Government does not consistently meet its payment obligations. The Government's history of missing payments to the private sector will make it difficult to attract new private investors to the sector.[80] It was reported that the World Bank-supported Kpone landfill did not receive payments from the Government for 5 years. Additionally, the ACARP plant was shut down for

[77] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 80 - 108

[78] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 213

[79] Consultant's Enabling Environment Report, 19th February 2021

[80] Stakeholder interviews

some time in 2014 because the Government defaulted on its payment for services rendered to the MMDAs.[81]

Most transfer, treatment, and final disposal activities currently in operation in the GAMA are owned and/or managed by subsidiaries of the sector's incumbent operator. This provides the commercial entity greater bargaining power and capacity to buffer delinquent payments across facilities. This will not be the case for newcomers that the Government would like to attract to operate the Ayidan landfill. Therefore, the Government will need to provide security for operational payments to overcome this track record, such as government guarantees or maintaining an escrow account for the transaction.

There are limited PSP models that can be sustainable and commercially viable in the long-term. With the levels of risk around the Project and the highly dysfunctional nature of the sector, a private operator will be unlikely to participate in a fully integrated PPP model (such as design-build-operate-transfer) without significant reforms and credit support.

Under current sector management, an operator would not have the ability to limit waste flows to the Project. The Government could pursue two options to increase attractiveness, but both have challenges. One is to transfer quantity risk to the operator. Given current uncertainty and the sector's history, the cost of taking quantity risks on waste flows would be quite high, which would translate to a higher gate fee. The Government would need to guarantee this payment and make these payments reliably for an investor to accept this risk. This structure also presents a significant risk for the Government. If waste volumes exceed the forecast levels as they did at Kpone, its liabilities to the Project could balloon and rapidly become unsustainable.

The other option is to limit waste to the Project. This option also has its challenges as the Government has not established a precedent for this, nor has it created a credible enforcement mechanism to ensure that only waste from a specific area flows to the site. At Kpone, the landfill reached capacity quickly, in part because the operator did not have control over waste flows. The facility no longer operates as a sanitary landfill and is now considered a semi-engineered dumpsite.[82]

The uncertainty introduced by the incumbent's proposal to develop three semi-engineered dumpsites in the GAMA further limit PSP options. Investors would be unlikely to accept any risk regarding waste flows without significant subsidy contributions and Government guarantees. As the Project is to be developed to a fully engineered, sanitary standard, the cost per ton of disposal will be higher than a semi-engineered site operated at a lower standard. This means that it is possible that the Project's future operator may not be able to compete on price with the new

[81] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 96

[82] Stakeholder interviews

sites. The geographic locations of the competitive sites, which are currently unknown, could also affect the amount of waste delivered to them.

The culture of cost-recovery is largely absent in the formal sector. At various points across the value chain, users may pay less than the cost of service, creating viability gaps and revenue shortfalls. For medium to large-scale formal waste collection and transport service providers, profitability is highly variable. Previous studies have found that collection and transport providers have not been able to consistently operate profitably.[83] In addition, several transfer stations do not collect enough revenue to cover the costs of operations.[84]

There is also a view that the Government lacks commitment to honoring contracts or facilitating competition, making further investment unattractive.[85] Government stakeholders also confirmed this view, noting that firms in some instances are making profits but are not willing to invest additional capital.[86]

Risks are not allocated to the party best able to manage them. Private waste collectors, currently responsible for collecting fees from households[87], often face payment defaults and must either (a) cease collections or (b) collect waste without payment.[88] Option (a) reduces the quantity of solid waste captured in the formal system, and option (b) causes direct financial harm to the companies. Neither option is attractive as they do not facilitate the collection of payments owed. Waste collectors' inability to collect fees creates considerable risks given that in some areas, 40 to 50 percent of waste collectors' fees remain uncollected, impacting their ability to operate profitably.[89] The Ministry of Finance noted that it was required to pay service providers GHS 120 million in 2020 due to late and non-payment of fees.

The informal sector prevents formal operators from recovering the full value from a franchise area. The informal sector operates without regulation on its services and can charge lower prices than the formal sector because it avoids municipal levies and has lower operating and capital costs. A formal provider awarded a contract in a specific area cannot always service all households because the informal sector captures some households' waste by charging lower prices. This reduced market share lowers revenue available to the formal sector operators.

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83 "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 10

84 Consultant's Enabling Environment Report, 19th February 2021

85 "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 10

86 Stakeholder interviews

87 Stakeholder interviews

88 While sanitation courts exist to resolve such disputes and to prevent this risk from materializing, these courts do not appear to be effective means of enforcement for most providers.

89 Stakeholder interviews

8 What must be in place for the Project to work?

In order to deliver a sustainable Project, the sector must develop mechanisms to control waste flows as well as operator's performance. It also needs clarity around financial flows and must take steps to improve cost recovery. The sector also would benefit from a shift toward a more competitive market that creates market-driven incentives. The sections below explore the specific steps that the sector could take in each of these areas.

8.1 Managing waste flows to the Ayidan Project

Operators require predictable volumes and compositions of waste to manage costs. For the 26-hectare Ayidan facility to operate effectively and in a financially viable manner, it is critical to ensure the flow of waste to the site is controlled throughout its projected useful life. This control can be achieved through a set of reforms. Choices about the design and scope of the Project can also impact the flow of waste throughout GAMA, as well as the amount of waste that requires final disposal at Ayidan and other sites. A set of possible choices include:

- Defining disposal zones that require waste to flow to specific sites and perhaps through specific transfer stations. In addition to limiting waste flows to the Project, introducing disposal zones across GAMA can deliver additional benefits, including reducing travel time of waste trucks and the sector's carbon footprint.

  In considering whether and how to set these zones, thought will need to be given to the tradeoffs required and their implications. Some MMDAs, or areas within MMDAs may need to be excluded because they do not fit within an optimized model, while others may need to be included for various policy objectives. Choices like these will impact the total cost of the Project to Government and may create additional challenges.

- Refining the scope of the Project to achieve a balance between costs, level of service, and complexity of the deal. Reducing the number of transfer stations required for the Project would reduce costs and increase its affordability Government. Likewise, so would descoping the MRF.

  The analysis undertaken in this study suggests that the Project can be delivered with one transfer station and without an MRF, but further analysis is necessary to verify these preliminary findings. These changes are possible, in part, due to how waste is collected in GAMA and to the composition of the that waste. Interviews with operators and data on waste composition indicate that segregating waste at the source would have the most significant impact on the quantities of waste for final disposal. Segregating waste at source represents a fundamental change to collections, and while valuable, is unlikely to be possible within the development period of the Project. As such, project structures that maximize affordability while achieving a desired level of service within the current environment should be assigned higher importance.

Further, technical analysis shows that a suitable MRF for Ayidan would only reduce waste for final disposal by approximately 7 percent while accounting for 25 percent of Capex. The choice to include the MRF or not should be framed around its ability to extend the useful life of the Project such that the marginal cost of processing another ton of waste at the MRF does not exceed the marginal benefit achieved from doing so. At this stage, analysis suggests that the marginal costs will exceed the marginal benefits of including the MRF, which should be confirmed during a full feasibility study.

8.2 Transparency in financial management, performance, and cost recovery

The sector must have clarity over all financial flows across the value chain, which is important for several reasons, such as:

- Transaction structuring,
- Soliciting market interest,
- Assessing risk premiums and,
- Driving performance of Projects by demonstrating whether it is performing and, where not, enabling that performance is corrected.

The challenges faced in gathering data for this study demonstrate that significant room for improvement exists. The United States Environmental Protection Agency (US EPA) recommends that policymakers, especially in developing countries, know the true costs of providing solid waste management within a service area. Once those are known, the US EPA suggests that policymakers identify untapped sources of revenues that can be raised, the barriers that exist to raising them, and the actions that policymakers can take to removing them.[90]

One step to bringing transparency around these costs and financial flows to the sector is for the Government to assign responsibility for collecting and managing sector data to one central agency, like the National Sanitation Authority. Under such an arrangement, the NSA could collect and report on all sector financial flows, waste quantities and flows, sector contracts, and fiscal commitments and payment arrears.

A second step to improving transparency and certainty around financial flows is to change how users pay for services. The Government could include a solid waste fee on utility bills to bring consistency to how users pay for services across the GAMA. These charges can be set at cost recovery or could be set lower and supplemented by other internal revenues or charging

[90] Best Practices for Solid Waste Management: A Guide for Decision-Makers in Developing Countries. United States Environmental Protection Agency. Page 39. EPA 530-R-20-002. October 2020. See: https://www.epa.gov/sites/default/files/2020-10/documents/master_swmg_10-20-20_0.pdf

mechanisms. In Maputo, Mozambique, the government charges a variable rate to users, using a proxy for economic status. It levies the fee on electricity bills, charging users who consume more electricity more for waste collection services, assuming that households and businesses that consume more power generally have achieved higher economic status than those that consume less.[91] The Government of Ghana could use a similar approach, but should only do so with a clear plan and communication strategy to bring stakeholders on board.

Even with additional clarity around the sector's finances, private investors and operators may still require credit enhancement on contracts and payments to manage the risk of payment defaults. These enhancements could take the form of:

- Escrow accounts, which can be used to hold funds until payments are due
- Multilateral development bank guarantees, which also helps the Project's creditworthiness through the bank's reputation
- Minimum revenue guarantees/assurance on waste inflows.

With clear processes for cost reporting and price setting, the sector's attractiveness to private investors would also increase.

8.3 Competition in procurements and regulation of services

Government can further improve the sector's efficiency by introducing greater competitive tension in procurements and through more effective, consistent, and credible regulation of current operators. Balancing these objectives can bring lower costs of service and higher-quality services across the sector.

Should the Government continue the path it has set for the Project, it would represent an appropriate step towards delivering a competitively procured project with credible regulation, both of which are necessary to achieve a 10-year operational life for Ayidan. A well-run procurement for Ayidan will have the following characteristics:

- *Clear project scope*. While the temptation to let bidders decide the full scope of the Project exists, the procurement is more likely to meet the sector's current need and deliver value for money if the role that any private partner is to play is clear, fit-for-purpose, and achievable given current and near-term market conditions. Before launching the transaction, Government should decide on technical aspects of the Project (i.e., number of transfer stations; whether to include an MRF; service area for the Project) and be clear on the Project's affordability vis-à-vis expected costs and revenue requirements.
- *Credible payment mechanisms and revenue sources.* These will be defined by contract, but will need to be supported by data, which can be consolidated in a central agency, or

[91] Ibid.

compiled prior to the operationalization of the agency to communicate with potential bidders, and to ensure that Government is likely to be able to afford the Project.

- *An engagement or marketing strategy to attract the interest of bidders both domestically and internationally*. After finalizing the scope of the Project, Government should conduct outreach to suitable domestic and international partners to inform them of the pending transaction.
- *Transparent and open processes*. Following the processes set out in either the Public Procurement (Amendment) Act of 2016 and the PPP Act of 2020, as the final structure of the Project dictates, will reinforce the Government's credibility to the market and help to deliver outcomes that are more likely to achieve value for money than directly negotiated projects.

In the short-term, running the procurement for Ayidan following these principles is more likely to:

- Deliver bids at a lower cost per ton to the Government than could be achieved otherwise
- Build credibility with the market
- Add capacity within Government for running complex transactions in the sector
- Create a model to follow for future transactions.

The success of this strategy is contingent on regulation being clear, costs being understood, and the consistent enforcement of clear service standards. No single step can deliver these objectives, though. Instead, it is advised that the Government start with necessary items like the definition of disposal zones for Ayidan as a precursor to a larger package of reforms. Likewise, clarity around costs and the eventual affordability of the Project is necessary to understand and achieve the long-term benefits expected from the Project.

After agreeing to disposal zones, regulation for the Project is most likely to be set by contract. Ensuring that the Project delivers services at contractually mandated standards will represent an important step towards improved regulation in the sector. The Government can then use the contract and its enforcement as a model for future contracts in the sector with incumbents and new operators alike to deliver high-quality services across the GAMA.

Appendix A: Description of Approach to Calculating Sector Cash Flows

Table A.1 shows the funds received by each MMDA as transfers from the National Government, internally generated funds, and the waste management expenditure registered in each assembly's budget. Internally generated funds are generated from property tax, business licences, market fees and various user charges.[92] On average, transfers from the National Government account for 52 percent of total funds available, with the remaining 48 percent are internally generated funds at the MMDA level. The data includes inputs received from MMDAs and estimations of the funds available to each MMDA (highlighted *yellow*). An explanation of the figures follows the table.

Table A.1: MMDA Sources of funds

MMDA	Population	Monies received from the central budget for waste management (GHC/year)	Internally generated funds used for waste management (GHC/year)	Cost of waste management on Assembly budget (GHC/year)
ABCMA - Ablekuma Central	352,664	1,184,133	400,000	1,600,000
ABNMA - Ablekuma North	251,846	845,618	580,011	2,612,984
ABWMA - Ablekuma West	185,520	259,930	144,353	404,283
AMA - Accra	424,654	1,425,852	2,911,259	3,804,000
ADMA - Adenta	121,096	800,000	600,000	40,000
ASHMA - Ashaiman	285,891	869,000	315,000	1,000,000
AYCMA - Ayawaso Central	142,322	477,872	371,295	1,476,637
AYEMA - Ayawaso East	126,280	424,008	126,000	923,293
AYNMA - Ayawaso North	128,463	431,338	136,113	852,000

[92] Mobilisation of Internally Generated Funds In The Awutu Senya East Municipal Assembly; Realities, Prospects And Challenges', University of Ghana Institute Of Statistical, Social And Economic Research (ISSER), 2014, Page 27. (Retrieved from http://ugspace.ug.edu.gh/bitstream/handle/123456789/22765/Mobilisation%20of%20Internally%20Generated%20Funds%20in%20the%20Awutu%20Senya%20East%20Municipal%20Assembly%3b%20Realities%2c%20Prospects%20and%20Challenges.%20-%20Ama%20Aku%20Aboagye.pdf?sequence=1&isAllowed=y)

AYWMA - Ayawaso West	93,013	312,308	242,656	965,040
GCMA - Ga Central	194,382	408,670	10,000	299,200
GEMA - Ga East	184,509	414,000	350,000	764,000
GNMA - Ga North	149,248	103,500	36,000	1,548,497
GSMA - Ga South	388,000	1,302,780	1,012,229	4,025,626
GWMA - Ga West	106,057	207,000	139,314	9,884,861
KKMA - Korley Klottey	148,903	2,040,000	1,069,207	155,040
KorMA - Kowor	169,000	567,448	440,894	1,753,430
KoKMA - Kpone Katamanso	129,000	433,141	336,540	1,338,417
LANMA - La Nkwantanang Madina Municipal	137,350	310,500	456,878	456,878
LEKMA - Ledzokuku	186,522	206,000	60,000	628,000
ONMA - Okaikwei North	300,454	1,008,828	783,836	3,117,308
TMA - TEMA	353,086	506,000	4,050,000	5,839,500
TMWA - Tema West	150,720	566,000	180,000	1,300,000
WGMA - Weija-Gbawe	233,155	782,860	181,369	181,369
TOTAL population	**5,177,319**			
TOTAL GHC/year		**15,886,783**	**14,932,953**	**44,970,364**
TOTAL US$/year		**2,700,753**	**2,538,602**	**7,644,962**

MMDAs state that waste management budget deficits are covered by payments from the Central Government.[93] If the funding from Government transfers to MMDAs grows at the same rate as inflation, it will rise from approximately GHC 15.8 million (US$2.7 million) in 2020 to GHC 27.0 million (US$4.6 million) in 2031. In the same way, internally generated funds are estimated to rise

[93] Consultant Interviews with MMDAs

from approximately GHC 14.6 million (US$2.5 million) in 2020 to GHC 25.3 million (US$4.3 million) in 2031.

The dataset used to create the forecasts has several gaps that have been filled using proxy calculations. The population of MMDA's where data is incomplete is multiplied by an average of the per capita values for each column to complete the dataset. The calculation of averages from available information is shown in Table A.2.[94]

Table A.2: Per capita calculations

MMDA	Monies received from the central budget for waste management (GHC/capita)	Internally generated funds used for waste management (GHC/capita)	Cost of waste management on Assembly budget (%)	Cost of waste management on Assembly budget (GHC/capita)
ABCMA - Ablekuma Central		1.1	40%	4.5
ABNMA - Ablekuma North		2.3	5%	
ABWMA - Ablekuma West	1.4	0.8	3%	2.2
AMA - Accra		6.9		9.0
ADMA - Adenta	6.6	5.0	10%	0.3
ASHMA - Ashaiman	3.0	1.1	5%	3.5
AYCMA - Ayawaso Central				
AYEMA - Ayawaso East		1.0	20%	7.3
AYNMA - Ayawaso North		1.1	7%	6.6
AYWMA - Ayawaso West				
GCMA - Ga Central	2.1	0.1		1.5
GEMA - Ga East	2.2	1.9	15%	4.1
GNMA - Ga North	0.7	0.2		
GSMA - Ga South				
GWMA - Ga West	2.0	1.3	4%	93.2
KKMA - Korley Klottey	13.7	7.2	8%	1.0
KorMA - Kowor				

[94] Grey cells are intentionally blank.

KoKMA - Kpone Katamanso				
LANMA - La Nkwantanang Madina Municipal	2.3	3.3	10%	3.3
LEKMA - Ledzokuku	1.1	0.3	4%	3.4
ONMA - Okaikwei North				
TMA - TEMA	1.4	11.5	10%	16.5
TMWA - Tema West	3.8	1.2	10%	8.6
WGMA - Weija-Gbawe		0.8	40%	0.8
Average (% of budget)			**13%**	
Average (GHC/capita/year)	**3.36**	**2.61**		**10.38**
Average (US$/capita/year)	**0.57**	**0.44**		**1.76**

Another source of funding to the sector is fees paid by households for waste collection. These are paid to waste collection firms but still provide insight into funds available to the sector. Based on broad estimations from survey data of expenditure on waste disposal per household[95], the range of these fees could be between US$47 million and US$204 million. Table A.3 shows detailed calculations of collection fees.

Table A.3: Estimations of collection fees from households

Group	Percentage of total	Number of households[96] (thousands)	HH cost low (GHS/month)	Monthly fee (GHS Million)	Annual in GHS Million)[97]	Annual in USD Million
Lower estimate						
Top segment	54%	803	30	24.09	289.07	49.14
Middle segment	44%	654	5	3.27	39.26	6.67

[95] MSWR Socio-Economic Survey Report -Revised (November 2019) Page 59

[96] Population in 2020 – 5,055,805 – Consultant's Technical Report.

Average household size – 3.4 - MSWR Socio-Economic Survey Report -Revised (November 2019) Page 17. Note: HH size of sample is 4. Lower range in calculations shows the estimate based on larger HH side.

Total number of households – 1,487,001- Calculated

[97] 1 GHS = 0.17 US$ - Approximate current exchange rate

Bottom segment	2%	30	0	-	-	-
Total	**100%**	**1487**		**27.36**	**328.33**	**47.44 – 55.82**
Higher Estimate						
Top segment	54%	803	100	80.30	963.58	163.81
Middle segment	44%	654	30	19.63	235.54	40.04
Bottom segment	2%	30	5	0.15	1.78	0.30
Total	**100%**	**1487**		**100.08**	**1200.90**	**173.53 – 204.15**

A second bottom-up approach used estimates of funds paid to facilities and waste flows at these facilities to estimate sector cash flows. The key assumption for this approach is that, given that waste management facilities in the sector continue to operate, is that the facilities receive payments—though these are likely often delayed—sufficient to maintain operations, though possibly at a lower standard than contracted to do so.

Known and estimated per ton tipping fees paid at various points of the value chain and estimates of waste flows through these points have been used for the calculation and are shown in Table A.4. This analysis suggests that the total sector cash flows for transfer, treatment, and disposal approached US$8.8 million in 2020.

Table A.4: Estimations of Government outflows to the sector

Assumed Tipping Fees	Transfer station	Materials Recovery Facility(MRF)	Landfill	Total	Data Source
Waste Flows (in thousand tons per annum)	291	182	978		Transfer Station and Landfill - Technical Report MRF – Situational Assessment Report[98]
Fees (GHS/ton)	30.00	20.82	40.00		▪ Transfer station – Situational Assessment Report (Revised) - Volume II – Appendices - Page 89 ▪ MRF – Consultant financial model

[98] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana – Page 99

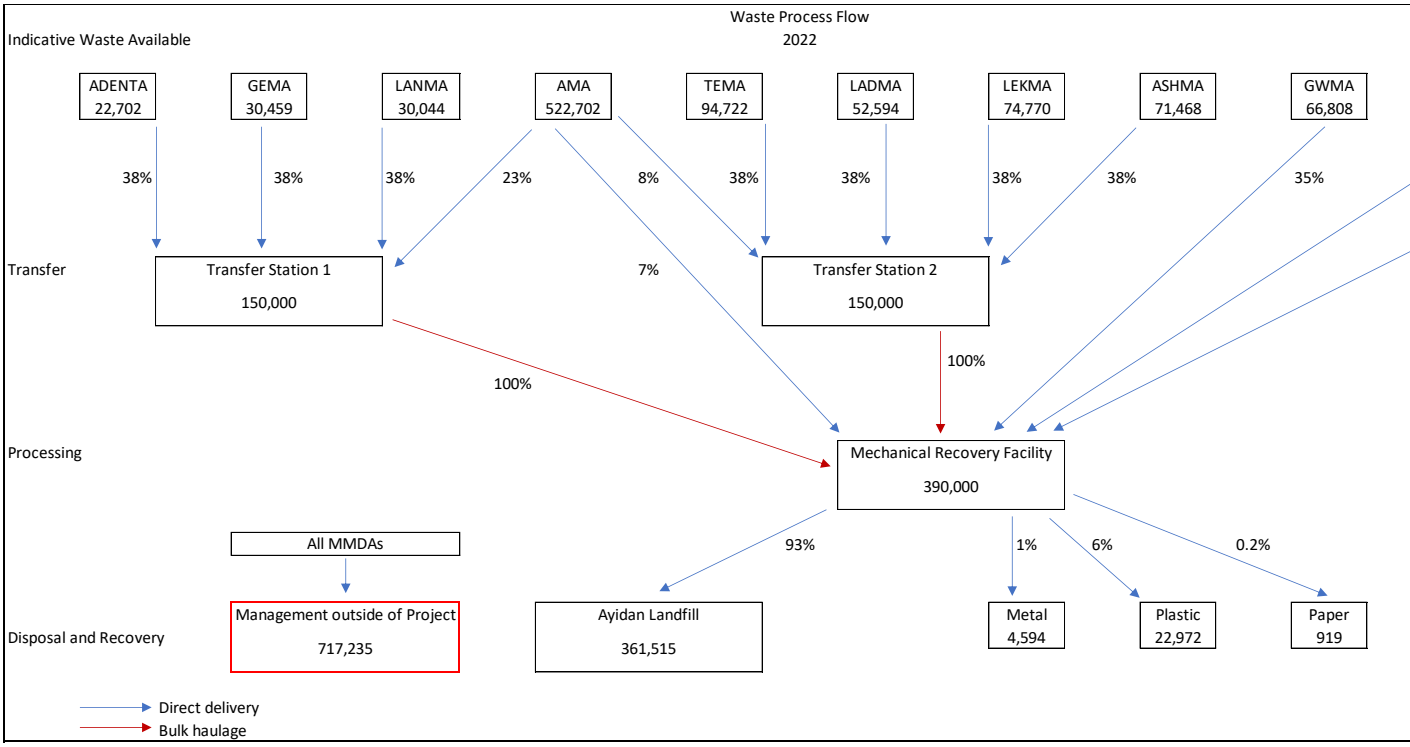
					▪ Landfill – WB team; consultant team[99]
Fees (US$/ton)	5.10	3.54	6.80		▪ Same as above
Total fees (GHS Million)	**8.76**	**3.82**	**39.12**	**51.71**	
Total fees (US$ million)	**1.49**	**0.65**	**6.65**	**8.79**	

Lastly, payments from the MSWR to operators of approximately US$7 million were recorded in 2020, but there was no clarity on what services and time periods those payments covered.

[99] Reporting from the sector indicates that operators pay between GHS 30 and GHS 60 per ton to tip waste, depending on the size of the vehicle. Bola taxis pay less, large trucks pay more.

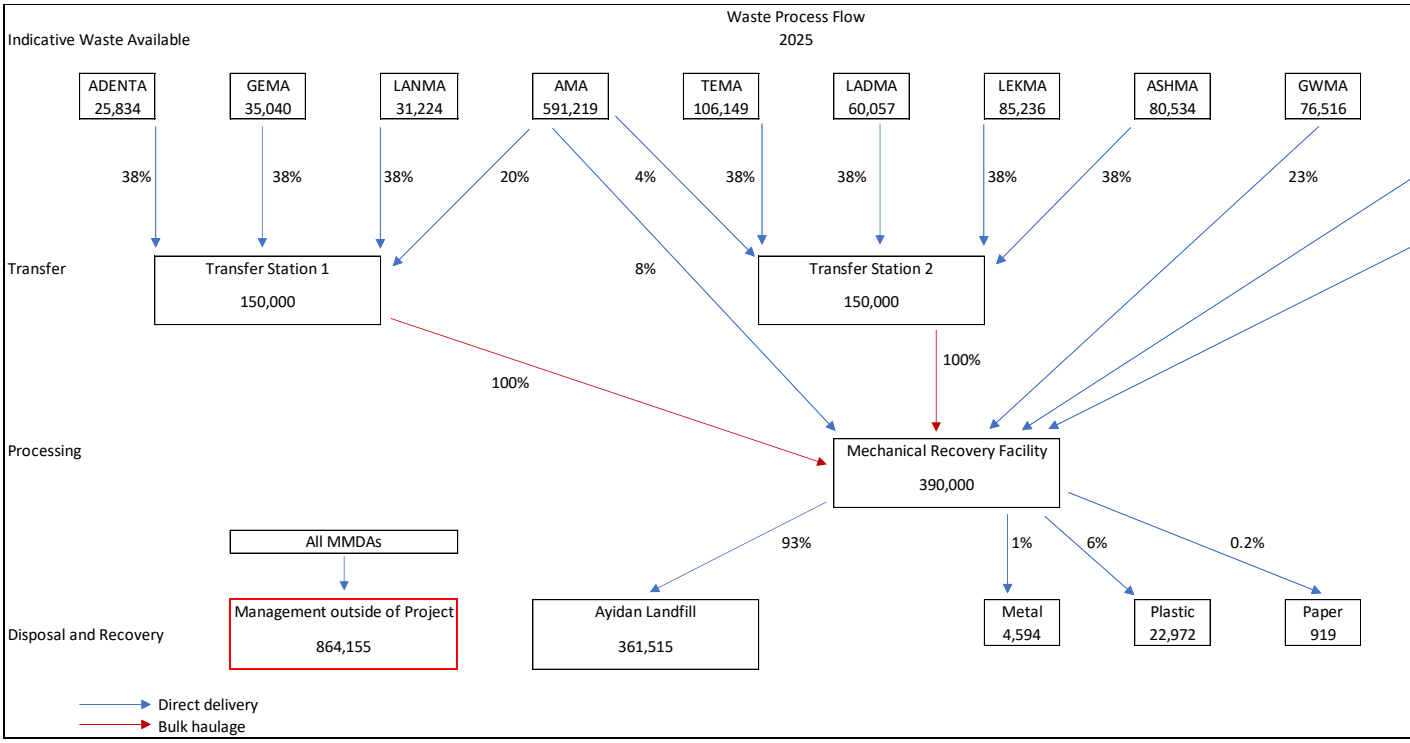
Appendix B: Process Flow Diagrams

Figure B.1: GAMA waste process flow diagram (2022) tpa



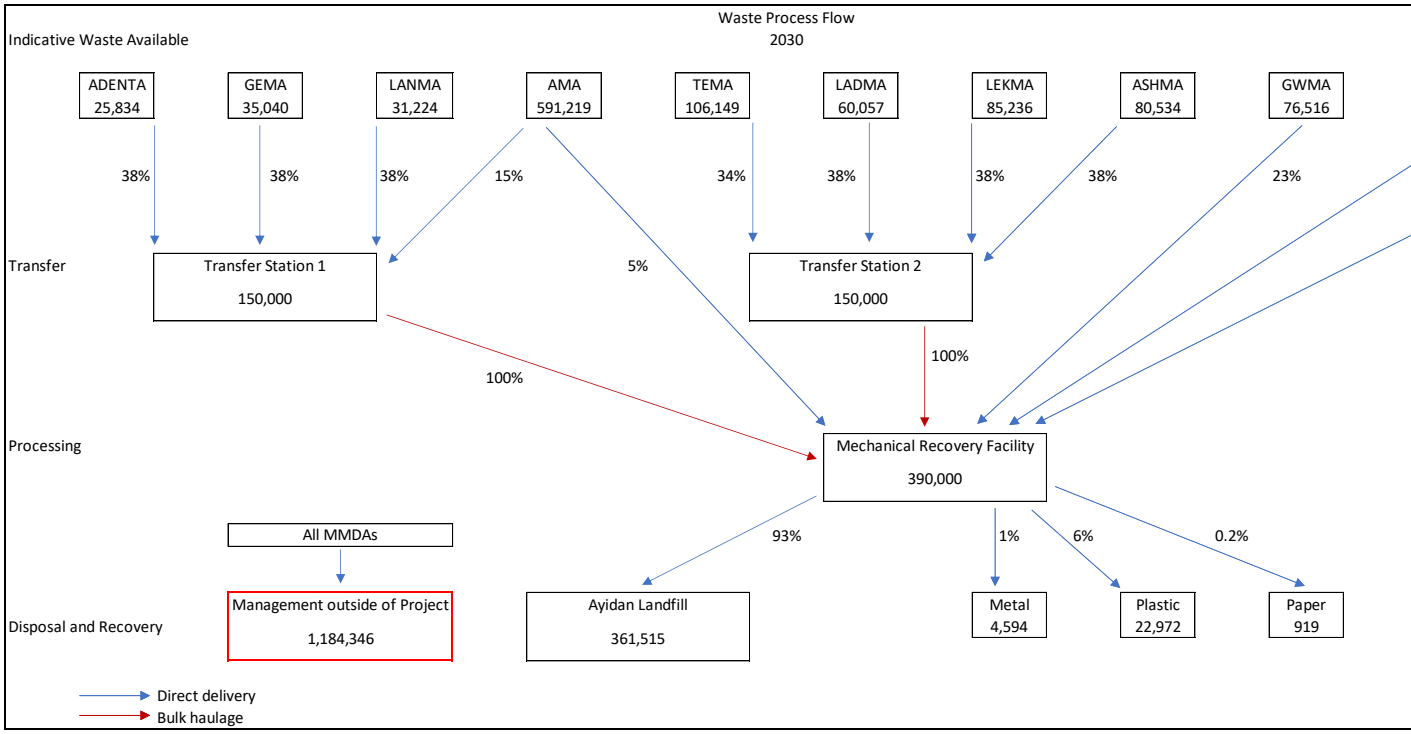
Source: Mott MacDonald

Figure B.2: GAMA waste process flow diagram (2025) tpa



Source: Mott MacDonald

Figure B.3: GAMA waste process flow diagram (2030) tpa



Source: Mott MacDonald

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Technical Analysis Report

Financial and Economic Advisory for a Solid Waste Management Project in the Greater Accra Region, Ghana

May 2021

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Definitions

C&I	Commercial and industrial
CHP	Combined heat and power
ESIA	Environmental and Social Impact Assessment
ESPA	Environmental Service Providers Association
GAEC	Ghana Atomic Energy Commission
GAMA	Greater Accra Metropolitan Area
MoF	Ministry of Finance
MMDA	Metropolitan, Municipal, and District Assemblies
MRF	Materials recovery facility
MSW	Municipal solid waste
MSWR	Ministry of Sanitation and Water Resources
PPP	Public Private Partnership
SIP	Sanitation Improvement Package
SWM	Solid waste management

1 Introduction

1.1 Scope

The World Bank has provided a US$200 million loan facility for the Greater Accra Resilience and Integrated Development (GARID) project, which will finance, among other activities, the proposed Ayidan landfill, MRF, and transfer station project in Accra, Ghana (the Project). The Project aims to improve service quality and reduce capacity gaps in transfer stations, waste treatment, and sanitary landfill volumes.

Castalia, with Mott MacDonald as technical advisors, has been engaged by the World Bank to:

- Determine the viability of potential business models for the Project (including options for private sector participation);
- Evaluate the potential market to be captured; and
- Comment on any key barriers to the Project's long-term success.

To achieve this, the financial and technical viability of the Project will be evaluated through data analysis, benchmarking, and high-level technical and financial modeling. The deliverables under this assignment include:

1. **Inception Report** that includes the list of documents received; interviews completed; and any initial findings. The final version of the Inception Report was submitted on 23rd September 2020;

2. **Technical Report** that describes market volume, expected market share, a critique of preliminary designs, and visually observable environmental and social issues (this report);

3**. Commercial Report** that presents potential business models, revenue mechanisms, a validation of financial modeling assumptions (CAPEX, OPEX, revenues), financial modeling results, and initial risk matrix;

4. **Enabling Environment Report** that describes the analysis of key regulatory and institutional issues, along with the proposed timeline and action plan to commercial close;

5. **Final Report**, which will be a compilation of three reports (deliverables 2 to 4) plus an Executive Summary of the entire study; and

6. **Financial Model** to follow best practices in calculating investment and operating cash flows associated with various PPP models, prepared in Excel.

The purpose of this Technical Report is to:

- Summarize the findings from desktop research and stakeholder analysis undertaken;
- Present the available information utilized to produce a waste flow model which estimates current waste arisings and potential future waste produced;
- Define the waste type(s) and volumes to be included as part of the Project; and

- Specify the interfaces with existing waste management and outline areas where the sector would need to develop.

This information will feed into the commercial analysis and the review of the required enabling environment.

In addition, our Terms of Reference included a review of the preliminary designs for the Ayidan site and transfer stations (TS). The design contractor is in the process of being procured, and we understand that the designs are due to be completed in June 2021. Therefore, we have not been able to comment on the preliminary designs within this report. We have been provided with the Terms of Reference for the design contractor and have provided comments on this in Appendix C.

2 Overview of the sector

Considerable amounts of work have previously been carried out (by others) in the Greater Accra Metropolitan Area (GAMA) to understand the current solid waste management situation and to propose solutions for the future. The Situational Assessment Report1, 2019, which was produced for the Ministry of Sanitation and Water Resources (MSWR) contains a detailed review of solid waste management in GAMA and a series of recommendations for improving the current situation. Improvements have largely not yet been implemented. It was stated by MSWR that the issue of the final version of the report has been delayed, with recommendations not being taken forward until the final report is issued. Therefore, there may be improvements to solid waste management soon, which we do not cover in our summary of the situation and future project planning.

Waste collection, treatment, and disposal services are highly fragmented and managed by several different bodies. MSWR has overall responsibility for solid waste management, with devolved responsibility allocated to the Metropolitan Municipal and District Assemblies (MMDAs). Also, the Ministry of Finance (MoF) pays for some waste disposal costs, and the Ministry for Local Government and Rural Development, which used to be responsible for solid waste management, may still be involved in some elements.

Waste management is split predominantly into reduction/reuse, collection, transfer, treatment and/or disposal. We have provided a summary of our understanding of each of these in the sections that follow.

2.1 Reduction and Reuse

It is not fully clear, but it appears that the overarching responsibility for communications and education about solid waste management lies with the MSWR. However, from discussions with MMDAs and private sector companies, it is reported that day-to-day communications are either

[1] Integrated Urban Environmental Sanitation Master Plan

not being fully undertaken, being led by the MMDAs, or being undertaken by individual private companies.

The MSWR indicated that MMDAs are responsible for allocating funds for public awareness and community participation. However, it is not clear how many of the planned activities have occurred and if their effectiveness has been monitored.

The responsibility for encouraging reduction, reuse, and recycling has partly been taken on by the Environmental Service Providers Association (ESPA) and the Ghana National Cleaner Production Centre (GNCPC), which is an initiative of the Environmental Protection Agency of the Ministry on Environment, Science, Technology, and Innovation. However, the GNCPC is responsible for working with small and medium-sized companies, connecting material producers with end users, rather than with the public directly.

2.2 Collection

MMDAs are responsible for managing all waste produced in their area, including municipal solid waste (MSW), commercial and industrial waste, and institutional waste (i.e., waste generated at municipal buildings or educational establishments).

Private sector

Collection is predominantly carried out by private sector companies, who bid for franchise contracts within each MMDA. The MMDAs are split into solid waste management zones, and each private-sector collection company bids for particular zones, which are allocated following an evaluation process. Some MMDAs stated that there is a policy2 requirement for each MMDA to have the capacity to collect up to 20 percent of the waste in the area in-house. Some of the larger MMDAs do this and have the relevant vehicles and equipment to fulfill this. Others, particularly smaller ones, do not have this capacity. From discussions with MMDAs, it appears that some would welcome the ability to bring a higher proportion of waste collection in-house. Others do not want or would not be able to carry out additional collection activities.

An analysis of fiscal flows is carried out in the commercial report; however, MMDAs do not pay the private companies to collect waste. Instead, the companies win contracts based on criteria such as their previous experience, the number and type of vehicles they own, and their financial standing. They are then required to collect payment from householders and businesses in the zones which are allocated to them. In theory, only one company collects from any area, and the fees for the collection are set by the MMDA through largely political processes that are not clearly linked to the cost of services. All of the private sector companies interviewed said that collecting fees can be a challenge and that there are instances of being undercut by the informal sector.

Formal waste collection is mainly carried out using refuse collection vehicles, which would typically use compaction. Their payload range is usually between 3- 12 tons. Collection from communal

[2] National Environmental Sanitation Policy, 1999.

collection points does not involve any compaction other than manually pushing waste into the container.

MMDAs evaluate the private sector collection companies regularly, as outlined in section 4.2.3 of the Situational Assessment Report, 2019. However, most MMDAs3 we engaged reported that performance-related key performance indicators (KPIs) and methods to penalize poor performance within waste collection service agreements are not widely used. The private sector companies reported that their challenges include the fact that 'complaints made' was one of the items that they were scored against, but that if they did not collect waste from an individual (as a result of the individual not paying for collection), there was no method for the complaint to be discounted. The MMDAs are responsible for following up on missed payments, and in theory, have the ability to prosecute people or organizations who fail to pay. However, it was reported that this does not regularly occur, and this was attributed to a lack of resources and political pressure. It is understood that the private sector cannot directly prosecute people but rather must do so through the MMDAs.

Informal sector

The majority of the private sector companies communicated that the informal sector is much better placed to collect waste from poor/slum areas as they use small vehicles (borla taxis) or push carts and can charge lower fees. Some reported that people in the informal sector dump waste locally, rather than paying for/taking the time to transport the waste to a legitimate disposal site.

Some stakeholders mentioned an MMDA led trial of the provision of local disposal sites for the informal sector, although the specific details of the trial were not available. The local disposal sites were similar to communal collection points but specifically for the informal sector to deliver waste to. It was reported that a key finding was to make them very local so that the time taken to get to them was not too significant, otherwise waste continued to be illegally dumped. The trial was not reported to have been particularly successful as the informal sector did not utilize them regularly. The reason suggested was that they were less easy to physically get to than illegal dumpsites.

Although there is very little information about it, most private-sector collection companies and people working with the informal sector said that there is picking through waste that is left out on the street for valuable items or materials. This is reported to be mainly plastic, but the low concentration of metal reported in the waste composition, as discussed in section **3.5**, indicates that metal may also be removed from waste put out for collection, where it is available.

Informal collection is carried out using a mix of hand carts and borla taxis (which are motorized tricycles) with a reported payload of up to 1.5 tons, although there will be some with a significantly smaller capacity.

While it is not possible to corroborate, several stakeholders opined that the relationship between the MMDAs, the private sector, and the informal sector around waste collection is complex. The private sector companies interviewed communicated a willingness to work with the informal

[3] A contract shared with the consulting team by GA West municipality does include a penalty schedule, but it does not link the penalties directly to KPIs.

sector, particularly in collection areas that are not accessible by larger vehicles, but that it would need to be in agreement rather than as competition to deliver a positive solution. In addition, it was reported that whilst the MMDAs publicly state that the informal sector should not be competing with the private sector, there are instances where the informal sector has been supported in purchasing vehicles or other equipment to enable the informal collection of waste.

Communal collection

A common form of waste collection in many MMDAs is the use of communal collection points (referred to as sanitary sites in the Situational Assessment Report, 2019), which are places where a large, open container is left for people to put their waste. The payment for this is generally unclear; some private sector companies interviewed said that the payment for this service, often from money collected by staff stationed by the container, is not enough to recover costs of collecting the containers. One MMDA reported that the staff at the site would only request a collection of the container when there was enough money available to cover the cost of fuel to the disposal site, rather than when the container was full.

It is understood that some MMDAs have contracted all their communal collection points to a single operator, part of the Jospong Group, which then collects when there is spare availability within their fleet. This is called the Sanitation Improvement Package (SIP). The SIP was agreed between the Ministry for Local Government and Rural Development and the Jospong Group, but it was reported during stakeholder engagement that individual contracts need to be entered into between the MMDAs and the relevant company in the Jospong Group. Therefore, although it was reported that the initial idea was that all MMDAs would be part of the SIP, they are not yet. It is not clear if they all plan to or will have to. It should be noted that the Jospong Group includes Zoomlion and is often referred to by stakeholders as Zoomlion, although we understand that there are multiple companies within the group. We have not yet been able to arrange a meeting with the Jospong Group to understand the SIP in more detail.

Communal collection points are also often used at markets where there are multiple waste producers in a small area. We understand that collecting and maintaining these sites happens more frequently as it is more straightforward to collect payment from the local waste producers.

It is noted that money is meant to be paid to a local supervisor at each communal collection point. So it is likely that in the poorest communities, even communal collection skips are not provided, and waste is dumped or burned. It is also reported that waste pickers (informal sector) work at the collection points, removing recyclable materials with a resale value.

2.3 Transfer

There are two large Transfer Stations (TSs) referred to in the Situational Assessment Report, 2019, which have been constructed by the private sector: the Teshie Transfer Station in Ledzokuku Krowor Municipal Assembly and the Achimota Transfer Station in Accra Metropolitan Assembly. Both are operated by a subsidiary of the Jospong Group, Zoompak Ltd. In addition, two small TSs were listed, in Kokomlemle and Gbawe, with a capacity of 46 and 90 tons per day, respectively. All of the facilities are understood to be operating significantly under capacity, as shown in **Table 2.1**, taken from the Situational Assessment Report.

Table 2.1: Transfer facilities in GAMA

Location	Capacity (tons/day)	Utilization (tonnaes/day)	Operator
Achimota	1,200	300 - 400	Zoompak
Teshie	1,500	300 - 500	Zoompak
Kokomlemle	46	20 - 22	Waste Landfills
Gbawe	90	25 – 30	Tidy Up

Source Table 4.10 Situational Assessment Report, 2019

Private sector collection companies interviewed communicated that they did not use these transfer stations. The reasons given were:

- The companies must pay for waste delivered to the TS. It was reported by one company that even after a full cost-benefit analysis considering the additional travel time to a disposal site and the significant queuing time, it was more expensive to use the TS than a disposal site at the current gate fee. This is compounded by the fact that the collection companies do not pay a gate fee at the disposal sites; and
- The queuing time at the TSs can be long. It was reported that there are not enough haulage vehicles to take waste from the TSs to a treatment or disposal site and that multiple small vehicles use the TSs, so queues mean that there is not a significant saving in time between the TS and a disposal site.

It was reported that TSs are used, in part, by the informal sector, who would also have to pay directly for disposal, as this is not invoiced to the MMDAs or MSWR. The Situational Assessment Report, 2019, highlights the low throughput of the TSs compared to their design capacity, so there is potential scope for more waste to be captured by these facilities. However, the TSs are privately operated and outside of the scope or control of the new Project. It was reported in the Situational Assessment Report, 2019, that PPP arrangements were used to develop the Achimota and Teshie TSs. Achimota TS was developed through a PPP between Ledzokuku Krowor Municipal Assembly and Zoompak; Teshie TS was developed through a PPP between Accra Metropolitan Assembly and Zoompak. We are not clear if any payment is made to the TS operator from MSWR or MoF.

2.4 Treatment

There are several treatment facilities in GAMA, although they are not currently processing a significant proportion of the solid waste being produced. They are summarized in **Table 2.2**.

Table 2.2: Treatment facilities in GAMA

Treatment facility and location	Description	Private sector developer
JVL Fortifier Compost Plant, constructed in 2017, **Tema Metropolitan Assembly**	The facility is designed to treat source-separated organic waste and has a capacity of 700tpa (tons per annum). At	Jekora Ventures Ltd

	its small capacity, the facility is operating as a prototype plant.	
Accra Compost and Recycling Plant (ACARP), constructed in 2012, **Ga West Municipal Assembly**	This is a mixed waste / wet Materials Recovery Facility (MRF with composting), consisting of waste sorting and a composting plant. The stated capacity is 300 tons of solid waste per shift (approximately 100,000tpa assuming a single shift). The waste sorting recovers materials such as plastics, glass, and metal cans. The composting section produces about 40 tons of compost daily.	Accra Compost and Recycling Ltd (part of the Jospong Group)
Integrated Recycling and Compost Plant (IRECOP), commissioned in 2019, **Accra Metropolitan Area**	The facility is designed to treat MSW, separate recyclables and to compost organic waste. It has a stated capacity of 200 tons per day (approximately 70,000tpa).	Integrated Compost and Recycling Plant Ltd (part of the Jospong Group)

Source: Situational Assessment Report, 2019

None of the private sector companies interviewed took waste to the larger treatment facilities. The method for charging a gate fee, and who would be responsible for that fee, was not clear. The JVL Compost Plant is small-scale, effectively a prototype facility, and only accepts source segregated organic waste (i.e., not from a mixed waste source). This means that the compost produced is likely to be suitable for use as a soil improver. The composting plants producing compost from mixed waste would not meet typical quality standards, such as PAS100 in the UK4 or Compost Guidance in Australia5, for a soil improver or compost/fertilizer, due to contaminants in the material.

2.5 Disposal

There are a number of disposal sites in and around GAMA. For clarity, the terms used are defined here, continuing and expanding on the terminology used in the Final Design Criteria Report6, 2020.

- **Unmanaged dumpsite** – An undefined area where people have disposed of waste, often in water courses or drainage ditches, which is not designed to accept waste. These may be small local areas or larger points which have developed over time. No fee is paid for dumping.
- **Semi-controlled dumpsites** – no engineering, licensing, or emissions management will be in place, but there may be some direction regarding the placement of waste. Potentially a fee is paid for waste deposition. Typically, not in an area of heavy footfall, but unlikely to have been planned initially.

[4] PAS 100 and compost quality specifications (organics-recycling.org.uk)

[5] Compost Guideline (epa.sa.gov.au)

[6] Integrated Urban Environmental Sanitation Master Plan

- **Controlled dumpsite** - no engineering, licensing, or emissions management will be in place, but the site will be managed, with the location of tipping directed and possibly compaction of waste.
- **Engineered landfill** – a lined site to prevent leachate escaping from the waste, infrastructures such as roads and a weighbridge may be present. Typically, there would be leachate treatment and gas management, although these are likely to be passive. Daily cover of waste would usually be used.
- **Sanitary landfill** – as for an engineered landfill with full leachate treatment and infrastructure on-site. Gas extraction from the landfill with either flaring or gas clean up and use in a combined heat and power engine to produce electricity. As well as daily cover, there will be a plan for capping when the site is full and aftercare, including monitoring.

Disposal site usage

The MMDAs and the private sector collection companies responded with mixed statements about who was responsible for identifying which disposal site waste should be sent to. The majority of the responses were that the MMDA directs the private-sector collection company to tip waste at a specific site. However, there may be instances of private sector companies finding alternative sites (e.g., where is it is more operationally or financially beneficial, such as if they owned a private disposal site). It was not clear if the MMDAs follow up and monitor where waste is disposed of, if they have directed where it should be taken.

The MMDAs do not all have accurate records of the amount of waste tipped as formal weighbridge records are not consistently available. Therefore, some invoices from disposal sites would not be able to be verified for accuracy by the relevant MMDA. The MMDAs reported that the invoices are passed on to the MoF, as the fees which the collection companies can charge do not cover the cost of tipping. However, the MoF reported that this is not an agreement and that local governments' funds should pay tipping fees. The MoF historically only has paid invoices in extenuating circumstances, such as the ongoing Covid-19 pandemic.

Kpone site

MMDAs and private sector operators, for the most part, indicated that the final disposal site that they utilized was the Kpone site. This site was designed and constructed through a PPP to be an engineered landfill in 2010, including a hazardous waste cell. It was designed to receive approximately 500 tons per day. However, it was reported to have received over 1,200 tons per day. The site was not managed as an engineered landfill and was filled much more quickly than expected, meaning requirements such as daily cover and separation of hazardous waste were not met. There was a significant fire at the site in 2019, and it has now been closed. An adjacent piece of land is currently being used as a semi-controlled dumpsite, with no environmental controls. It is reported that there is very little capacity remaining.

Both the MMDAs and collection companies highlighted an issue that the queuing time at the Kpone site (stated to be more than 24 hours in some cases) is unsustainable. This is significantly higher than we have seen on any other project on which we have worked. For a landfill contract with a local authority in the EU a typical turnaround time limit (from the in-weighbridge to the out-

weighbridge) would be in the region of 15 – 20 minutes, with queuing prior to weighing prohibited in some contracts, or limited to 10 – 15 minutes.

Queuing for long periods is unsustainable as it removes collection vehicles from beneficial use for a long period, which means that the staff in the vehicles are not able to carry out other duties and therefore means either more vehicles and staff are required to operate the service than should be, or that service levels fall as there are no available vehicles for collection.

The Situational Assessment Report, 2019, states that three-wheeled borla taxis deliver directly to the landfill. This is not typical for waste management systems and means that a large number of vehicles, each delivering relatively small quantities of waste, congest the site. Borla taxis are typically not designed for easy tipping, so the waste from the taxi must be manually removed. The use of a large number of small vehicles creates additional health and safety issues because they are not designed for use on a disposal site tipping waste. Further, the informal sector operatives are highly unlikely to have suitable footwear and personal protective equipment to reduce health and safety risks through being on the site.

Informal sector

All of the disposal points are reported to have pickers (people in the informal sector sorting through waste to remove materials or items of value). These people typically live on the site during the week, in makeshift accommodation, and return to their homes on the weekend. Men and women are reported to work on the site, and it was reported that children are predominantly not on the site. At Kpone, there has been a system of charging people for the right to pick waste from the site as it is dumped, but it is understood that this does not happen at the other dumpsites in Greater Accra. The Kpone site operator is part of the Jospong Group, with who we have not been able to speak to understand the value of the charge to the informal sector and whether this money is used to support the informal sector or elsewhere. It was reported approximately 500 waste pickers operate at Kpone, although this number cannot be confirmed and is likely to vary week by week.

The materials which are targeted are plastics, which are then sold to on-site aggregators, who then sell the material to larger aggregators, from where the material is sold to factories or for shipment internationally. There is clearly a market for plastics to be recycled, but as much of it is currently in the informal sector, the capacity and standards are not clear.

2.6 Review of stakeholder consultation

To help develop our understanding of the solid waste management sector in GAMA, we have conducted interviews and meetings with stakeholders from across the public, private, and informal sectors. For this report, our analysis includes findings from stakeholder engagement activities carried out between 11 September 2020 and 20 October 2020. The meetings carried out are summarized in Appendix B.

The purpose of the stakeholder consultation was to:

- Raise awareness of the Project;

- Obtain insight into existing technical and operational challenges, barriers, and opportunities;
- Establish an understanding of governance, including arrangements for collection, transport, and disposal;
- Determine the allocation of responsibility between the public and private sectors;
- Consider the role of the informal sector; and
- Gather anecdotal feedback to support or dismiss technical assumptions.

A summary of the key themes identified during the stakeholder consultations is included in **Table 2.3**. The opinions and recommendations identified in this table are those that have been expressed by the stakeholders consulted.

Table 2.3: Summary of stakeholder consultation findings

Sector	Governance	Collection	Transport/Transfer	Disposal/Treatment
Public	There is a high level of sector knowledge within many MMDAs but a lack of institutional capacity to drive forward improvements. MSWR is still in transition; a clear top-down approach to SWM governance and allocation of responsibility needs to be set out in legislation.	The capacity for waste collection services to be delivered in-house by MMDAs is limited. Data on C&I waste generation and composition is scarce. Service providers are evaluated, and contracts awarded against a broad set of technical and operational requirements. However, the duration of each contract varies from 1 to 5 years.	Access to waste transfer infrastructure is extremely limited. The provision of new transfer stations that meet high sanitary standards should be a priority.	Land for new waste infrastructure tends to exist on the fringes of the Accra region and is not close to the main centers of population. MMDAs direct collection contractors to specific disposal points but inconsistently enforce or penalize in the event of non-compliance. Long-term treatment solutions should incorporate recovery of materials and not solely focus on landfill provision.
Private	There are elements of political influence in the award of waste service contracts. Contracts have monitoring specifications, but these do not include typical KPIs and are not always things the contractor has direct control over.	Service providers are not able to fully recover the cost of collection due to shortfall in payments from householders (20-40 percent do not pay and the fees set are reported to be below cost recovery) and delays in payments.	The tipping fee at transfer stations is prohibitive and not recoverable.	Private collectors are unable to afford tipping fees at formal disposal sites leading to dumping at informal sites. There are reported delays in MSWR payments to some disposal site operators. Distance to and delays at existing disposal points reduce

				the affordability of service delivery and impact operations. The local market for recycling and sale of materials is undeveloped in the formal sector.
Informal	There is a desire to integrate the informal sector into service delivery more robustly. There is little tracing and documenting of informal sector activities.	The informal sector is heavily relied upon for segregation and recovery of materials. Competition between the informal sector and service providers in low-income areas causes challenges.	The informal sector is reported to use the transfer stations more than the private sector.	Disposal of collected waste is often at unapproved sites. Informal picking of materials at disposal sites is a key income source; important that this is not displaced. Market intelligence on outlets for recyclable materials could be utilized if recycling increased through the formal sector.

Source: Stakeholder consultations

It should be noted that extensive efforts have been made to arrange a meeting with the Jospong Group (whose subsidiaries account for a significant proportion of the private sector market across the waste management value chain – collection, transfer, treatment, and disposal). As of the date of this report, a meeting has not yet been arranged. The findings set out in this report are, therefore, not representative of their feedback.

3 Waste generation

3.1 Waste generation and model scope

The purpose of the waste flow model is to forecast the total quantity of waste generated, collected, recovered, and requiring treatment and/or disposal in GAMA from 2020 to 2050. Estimating these figures based on assumed waste trends and population growth allows for analysis and discussion of the total waste expected to be captured, which could potentially require management through the Project. It also allows for the estimation of the potential capacity requirements for new infrastructure.

This section focuses on the outputs of the modeling process and explains the figures and key assumptions used in the development of the model. For further details on the assumptions and a step-by-step description of the modeling process, please refer to Appendix A.

3.2 Geographic scope

The geographic scope of the Project is GAMA (Greater Accra Metropolitan Area). As of 2019, GAMA comprises 24 MMDAs, the full list of these MMDAs has been provided in Appendix C. These MMDAs have not been formally mapped and are described as being based on landmarks or area demarcations, which are understood by residents rather than formal legislation, although as there are Environmental Health Officers for each of the new MMDAs there are clearly new management structures being put in place. Furthermore, robust waste generation data does not currently exist for the previous GAMA MMDAs, so it is unlikely to be available in the short term from the new, smaller MMDAs.

For these reasons, the MMDAs which have utilized for modeling purposes are the previous GAMA divisions. These are presented in **Table 3.1**.

Table 3.1: MMDA / MMA geographic scope

MMDA / MMA	In Scope	Reference
Adenta Municipal Assembly	Yes	ADENTA
Accra Metropolitan Assembly	Yes	AMA
Ashaiman Municipal Assembly	Yes	ASHMA
Ga Central Municipal Assembly	Yes	GCMA
Ga East Municipal Assembly	Yes	GEMA
Ga South Municipal Assembly	Yes	GSMA
Ga West Municipal Assembly	Yes	GWMA
La Dadekotopon Municipal Assembly	Yes	LADMA
La Nkwatanang Madina Municipal Assembly	Yes	LANMA
Ledzokuku - Krowor Municipal Assembly	Yes	LEKMA
Tema Metropolis	Yes	TEMA
Kpone Katamanso	No	
Ada East	No	
Ada West	No	
Ningo Prampram	No	
Shai Osudoku	No	

Source: Situational Analysis Report, 2019

There are four MMDAs (Ada East, Ada West, Ningo Prampram, and Shai Osudoku) that have been identified as being in Greater Accra but outside of GAMA. It should be noted that previously Kpone Katamanso was not included in GAMA and was not included in our modeling. The revised list of

MMDAs in GAMA includes Kpone, but it is geographically distant from Ayidan and was outside of the scope of the Project, so it has not been added.

As the total population of GAMA has not changed due to the reallocation of MMDAs and the new MMDAs are sub-areas of the old MMDAs, the changes do not impact the total tonnage within the scope of the Project.

3.3 Scope of waste types

The analysis covers the types of solid wastes which fall under the responsibility of the MMDAs, including:

- Municipal solid waste,
- Non-hazardous commercial and industrial (C&I) waste, and
- Institutional waste.

Sewage related waste is not part of the solid waste classification for this Project. Medical waste and e-waste are also excluded as these are managed through separate contracts and are not considered suitable for handling at the facilities within scope of the Project.

The Integrated Urban Environmental Sanitation Master Plan reports, including the Final Inception Report 2018, Situational Assessment Report 2019, and the GAMA Environmental Sanitation Strategy Report, 2019, have been reviewed. No current legislative definition of municipal or C&I waste in GAMA[7] has been identified as part of this review. Instead, the MMDAs are responsible for the waste arising in a specified geographical area. For the purposes of this Project large-scale, heavy C&I waste is excluded, as this waste is typically of a different composition to MSW, and therefore managed separately.

3.4 Current waste arisings

We have analyzed several published reports which cover the estimated values of waste arisings in GAMA. These reports often list waste tonnages but frequently provide unclear sources and methodology for their data. The most complete data source identified is within the GAMA Environmental Sanitation Strategy and Action Plan, 20188. The document includes waste generation and collection rate values for each MMDA, set out in **Table 3.2** below.

Table 3.2: Waste arisings data, GAMA ES Strategy and Action Plan, 2018

MMDA	Per capita generation (kg / day)	Waste generated (tpa)	Collected (%)	Collected (tpa)	Not collected (%)	Not collected (tpa)
ADENTA	0.84	32,850	72%	23,725	28%	9,125

[7] Ministry of Sanitation and Water Resources and Integrated Urban Environmental Sanitation Master Plan.

[8] GAMA Environmental Sanitation Strategy and Action Plan (GESSAP), Consulting Services for the Preparation of IUESMP & Preliminary Engineering Design of Proposed Prioritized Interventions for Immediate Implementation in GAMA.

AMA*	0.71	631,450	74%	467,200	26%	164,250
ASHMA	0.61	54,750	91%	49,640	9%	5,110
GCMA	0.75	46,720	60%	28,105	40%	18,615
GEMA	0.75	48,180	50%	24,090	50%	24,090
GSMA	0.60	101,835	35%	35,770	65%	66,430
GWMA	0.50	38,325	73%	28,105	27%	10,220
LADMA	0.60	40,150	70%	28,105	30%	12,045
LANMA	0.70	45,990	70%	32,120	30%	13,870
LEKMA	0.75	62,415	80%	50,005	20%	12,410
TEMA*	2.00	292,000	80%	233,600	20%	58,400
GAMA		1,394,665	72%	1,000,465	28%	394,565

*Source: GAMA ES Strategy and Action Plan, 2018, Table 2.10. *The source document states that "Figures for TEMA and AMA are derived by including floating population estimates." No further information is provided.*

The source of the data above is listed as MMA Environmental Health and Sanitation Directorate and Waste Management Department officials. The source year of this data is unclear, as well as exactly which waste streams are included in the figures. Although additional information on data collection methodology is desirable, this dataset corresponds to the most complete waste tonnage and collection percentage data available for each MMDA. The data has also been anecdotally supported by findings from the stakeholder consultation exercise, where individual MMDAs have reported similar collection percentages. For these reasons, these values have been partly utilized as starting assumptions for waste calculations.

We have produced a waste flow model that estimates the current and future waste arisings in GAMA. The key assumptions in our model are the population size and the waste generated per capita, rather than waste arising tonnages which have been identified in some reports, such as the GAMA ES Strategy and Action Plan, 2018, because the reported data is:

- Unable to be verified
- Exclusive of waste that is not formally collected, and
- Based on assumptions (as the majority of disposal sites that waste may be taken to do not have reliable weighbridges or weighbridge data).

Our model uses several sources of data9. The results of the model for the year 2020 follow in **Table 3.3**.

Table 3.3: GAMA 2020 waste arisings data, Mott MacDonald model

[9] Step-by-step guidance on the model assumptions and workings is provided in Appendix A.

MMDA	Waste generated (tpa)	Collected (%)	Collected (tpa)	Not collected (%)	Not collected (tpa)
ADENTA	30,449	72%	21,923	28%	8,526
AMA	684,980	74%	506,885	26%	178,095
ASHMA	75,620	91%	68,815	9%	6,806
GCMA	46,136	60%	27,682	40%	18,454
GEMA	58,618	50%	29,309	50%	29,309
GSMA	170,489	35%	59,671	65%	110,818
GWMA	87,949	73%	64,202	27%	23,746
LADMA	72,394	70%	50,675	30%	21,718
LANMA	44,102	70%	30,871	30%	13,230
LEKMA	90,050	80%	72,040	20%	18,010
TEMA	115,509	80%	92,407	20%	23,102
GAMA	1,476,295	69%	1,024,481	31%	451,814

Source: Mott MacDonald

These estimates of waste arisings differ from those from the GAMA ES Strategy and Action Plan, 2018 for two reasons:

- Our model utilizes the figure of 0.8kg per person per day for all MMDAs within GAMA. This is based on an estimated baseline figure of 0.74kg per person per day from 2015 (Miezah et al., 201510) and has been adjusted to reflect expected per capita waste arising increases between 2015 and 2020; and
- Our model utilizes population figures from the Housing Census Report, 2014, whereas the source of the population utilized in the GAMA ES Strategy and Action Plan, 2018 has not been identified. Data from the 2020 census is not available yet.

Heavy commercial and industrial (C&I) waste data is lacking for GAMA, as light C&I waste is collected through the contracts with MMDAs. The developed model has utilized Miezah et al. figures as a basis, which have been analyzed as the most reliable data source, but correspond to household quantities only. Although it is likely that additional C&I waste is generated, our estimated 2020 figures are in line with the GAMA ES Strategy and Action Plan, 2018, and are supported by the stakeholder consultations, which did not raise significant C&I waste generation as a source of concern.

[10] Municipal solid waste characterization and quantification as a measure towards effective waste management in Ghana. May 2015.

3.5 Waste composition

The quality of waste composition data available for GAMA varies. There are several sources that specify household waste composition across scientific papers and recent reports, although these almost exclusively refer to household waste composition, with little information on C&I waste. The waste composition source which has been consistently utilized across several reference documents is that from the Miezah et al., 2015 study. The results of this study are provided in **Table 3.4**.

Table 3.4: Accra household waste composition

Category	Accra
Organic	66%
Paper	5%
Plastic	10%
Metal	3%
Glass	3%
Leather & rubber	2%
Textile	2%
Inert	5%
Miscellaneous	4%

Source: Miezah et al, 2015 and Situational Assessment Report, 2019

The figures above are for Accra, which Miezah et al., 2015 lists as having a population of approximately 2 million people. This source was considered to be the most reliable as it is from a peer-reviewed paper and provides fractions for all primary material categories. It is understood that this waste composition is reflective of the central part of GAMA (e.g., AMA district). In general, waste composition information identified in reference documents for GAMA, Accra, and Ghana are very similar and vary only marginally.11

Accra's waste composition features a high organic waste fraction and is broadly comparable to what is seen in many developing countries with emerging economies. This is expected as it is representative of economies where food is sold with less packaging, and there is less disposable income for the purchasing of other packaged goods or single-use items. The high organic content reported in the composition studies was corroborated by the private sector collection companies interviewed.

Compositional data exclusively for C&I waste has not been identified. It is understood—based on stakeholder feedback—that the C&I fraction may equal approximately 20 percent of total waste.

[11] Other waste composition information is available and is discussed in Appendix A.

As bulky and heavy processing waste is not included within the scope of the Project, we have assumed that the composition of the C&I waste is the same as the MSW. Further information on the composition analysis is in Appendix A. It is possible that due to the nature of C&I wastes, the fraction of recyclable materials, such as paper and plastics, could be higher than for household waste, but there are not specific data sources to corroborate this.

3.6 Population and waste growth

Several population forecasts and growth models have been identified as part of this study. The population growth data that we have used for the GAMA waste flow model is provided in **Table 3.5**.

Table 3.5: GAMA population projection and growth

Projection	2020	2025	2030	2035	2040	2045	2050
Population	5,055,805	5,646,833	6,189,612	6,771,641	7,380,213	7,977,997	8,700,125
Growth relative to 2020	0%	12%	22%	34%	46%	58%	72%

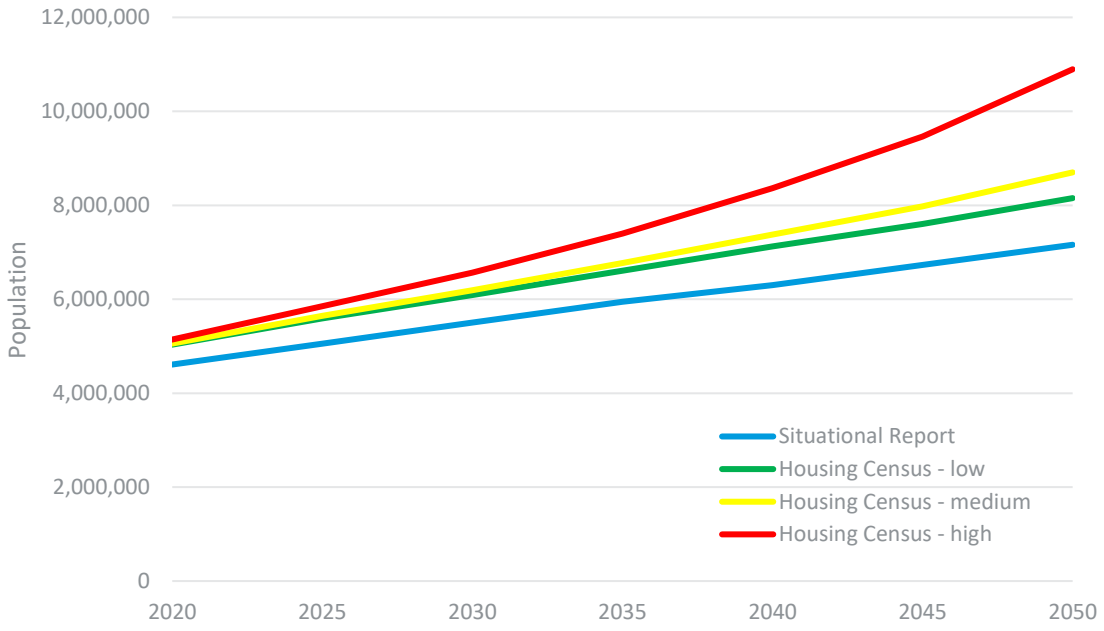
Source: Housing Census Report, 2014

This population projection is sourced from the Housing Census Report, 201412, which provides a high, medium, and low growth variant for GAMA. We have used the medium population growth variant for our waste modeling as it assumes a moderate increase in population and is broadly aligned with the World Bank's Ghana13 estimate. These projections are provided in **Figure 3.1**.

[12] Ghana Statistical Service."2010 Population and Housing Census Report". Page 10. Accessed September 28, 2020. https://www2.statsghana.gov.gh/docfiles/2010phc/Mono/Ghana%20Population%20Prospects.pdf

[13] The World Bank. "Population Estimates and Projections". Accessed October 21, 2020. https://datacatalog.worldbank.org/dataset/population-estimates-and-projections

Figure 3.1: GAMA population projections



Source: Situational Assessment Report, 2019 and Housing Census Report, 2014

Waste growth has been calculated based on the population growth data as well as an expected increase in the per capita waste generation figure for GAMA. The per capita waste generation figure we have used is 0.8kg per person per day in 2020, rising to 1.2 kg per person per day in 2050. The increase in per capita waste generation is based on the assumption that consumption (and therefore waste) will increase as the economy continues to grow.

These values have been benchmarked against the data from Miezah et al., 2015, which suggests an average of 0.74 kg per person per day in 2015 for Accra, as well as against data for other African capitals and nations. This assumption is corroborated by the constant gross domestic product (GDP) per capita growth, which has been estimated at approximately 3.6 percent per year based on the past 20 years of data14. Additional details are provided in Appendix A.

Table 3.6 shows the results of the waste growth projection based on the values above.

Table 3.6: GAMA waste projection and growth

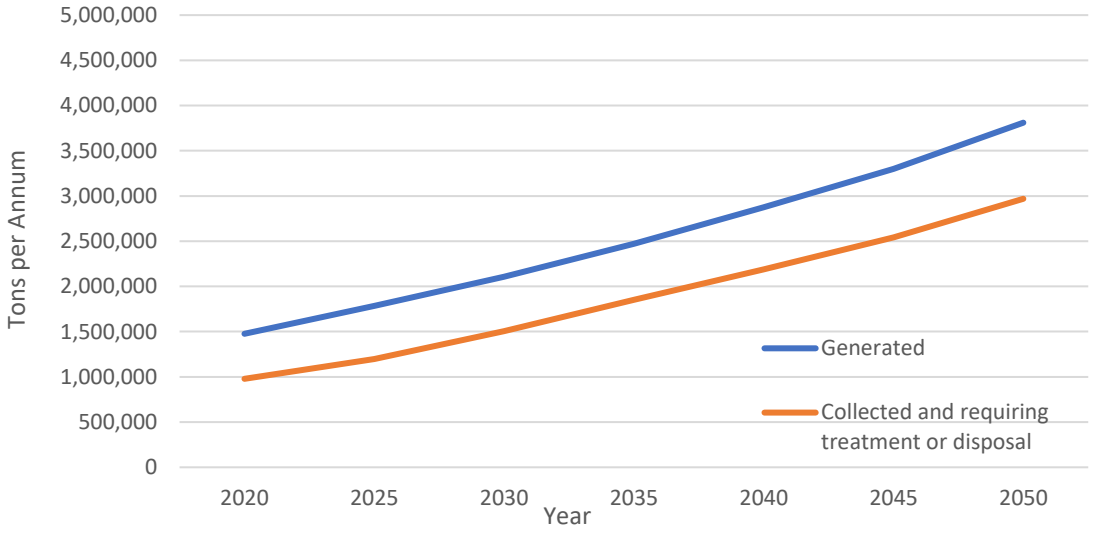
Projection	2020	2025	2030	2035	2040	2045	2050
Waste generation (tpa)	1,476,295	1,786,282	2,108,594	2,471,649	2,873,363	3,300,231	3,810,655
Waste per capita (kg)	0.800	0.867	0.933	1.000	1.067	1.133	1.200

[14] https://tradingeconomics.com/ghana/gdp-per-capita, accessed 29/10/2020

Cumulative growth relative to 2020	0%	21%	43%	67%	95%	124%	158%

Source: Mott MacDonald

Figure 3.2: GAMA waste projection



Source: Mott MacDonald

3.7 Waste capture analysis

Waste available for transfer, recovery, and disposal has been calculated based on projected waste generation and accounts for system losses associated with the current collection system and informal recycling market. Furthermore, an increased collection rate starting in 2025 (from the current 69 percent to a maximum of 85 percent by 205015) was modeled based on data from the GAMA ES Strategy and Action Plan, 2018. An overarching assumption that the waste collection system will organically improve over time due to systematic intervention and improvements in the way that waste collection contracts are structured has also been included. The assumption of reaching 85% in the majority of MMDAs is based on the fact that there are sanitation plans in development, suggesting improvements are going to be made, and some MMDAs are already collecting higher percentages than others, so with support it should be possible for other MMDAs to improve.

It is noted that the Government's ambition is to reach universal coverage between 2036 and 2050. Therefore, these projections would need to be reviewed and adjusted in the future in accordance with developments in the sector.

[15] The highest performing MMDA is ASHMA with a capture rate of 91 percent. However, this is a statistical outlier when compared with other MMDAs as there are no other MMDAs with a stated collection capture rate of higher than 80 percent.

We have assumed that a small proportion of waste available for collection will be recovered by the informal sector. This includes 10 percent of paper waste, 25 percent of plastic waste, and 50 percent of metal waste arisings. As there is very little quantitative data available on the performance of the informal sector, these assumptions have been made based on qualitative feedback from the stakeholder consultations held with GAMA MMDAs, private contractors, and informal sector experts, along with our knowledge from other countries. Based on these assumptions, the total waste estimated to be captured by the Project is 978,379 tons in 2020, rising to 2,969,152 tons by 2050. This is presented in **Table 3.7**.

Table 3.7: Waste flow model summary

Category	2020	2025	2030	2035	2040	2045	2050
Population	5,055,805	5,646,833	6,189,612	6,771,641	7,380,213	7,977,997	8,700,125
Kg (per capita per day)	0.800	0.867	0.933	1.000	1.067	1.133	1.200
Waste generated (tpa)	1,476,295	1,786,282	2,108,594	2,471,649	2,873,363	3,300,231	3,810,655
Average collection rate	69%	70%	75%	79%	80%	81%	82%
Informal recovery (tpa)	46,102	56,437	70,846	87,326	103,063	119,743	139,908
Waste collected and requiring treatment or disposal (tpa)	978,379	1,197,718	1,503,500	1,853,246	2,187,225	2,541,204	2,969,152

Source: Mott MacDonald

The estimated systemic waste loss, which does not include the recovery of recyclable materials by the informal sector, totals 497,916 tons in 2020, rising to 841,503 tons by 2050, and will still need to be targeted through future waste management. This waste is currently largely associated with informal collection (not for recovery), open burning, and illegal dumping.

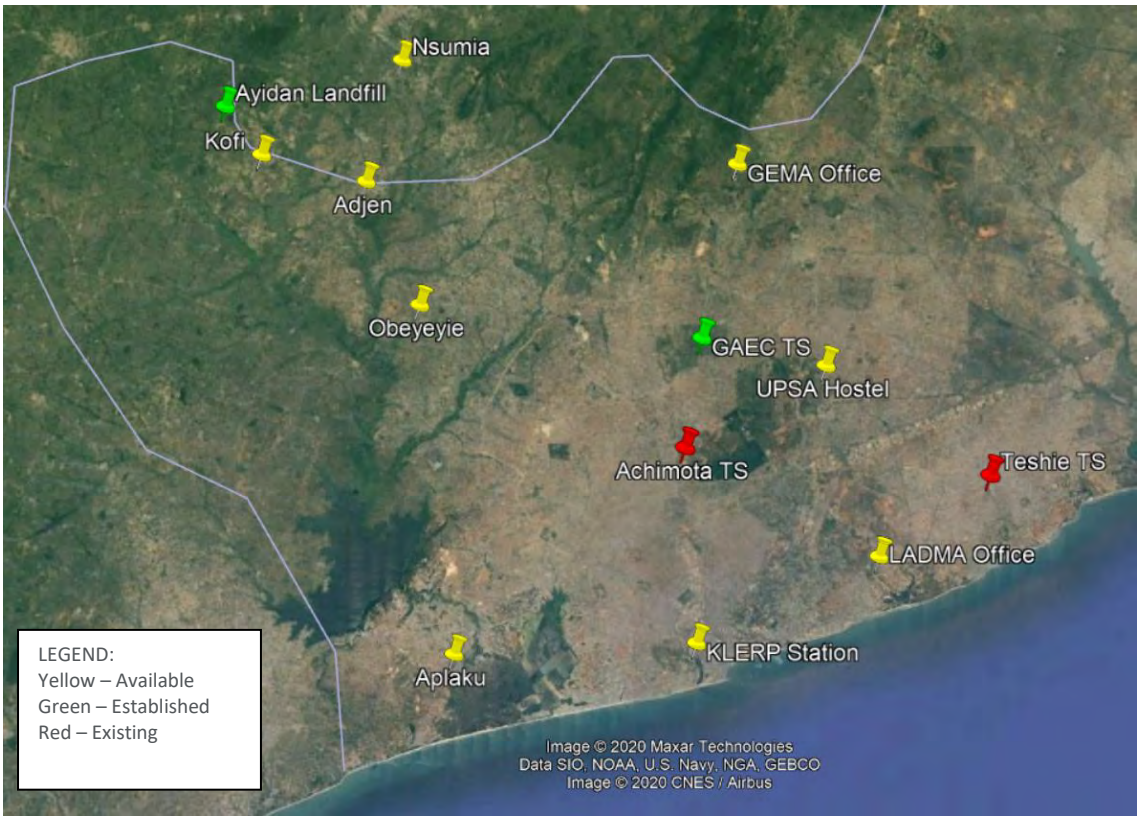
4 Project sites and capacities – Waste Capture Scenario

There are three sites which are relevant to the Project scope; these are:

- The Ayidan landfill site, which is currently in the process of being acquired by the MSWR for this Project. This is a 26.2-hectare site in the northwest of GAMA, in the GA West MMDA.
- Transfer station 1 (TS1), to be located on a site currently owned by the Ghana Atomic Energy Commission (GAEC). It is also currently in the process of being acquired by the MSWR for this Project.
- Transfer station 2 (TS2), in an undetermined location within GAMA. This site has not been selected or purchased yet.

To carry out the modeling exercise across GAMA, we have referenced the Solid Waste Survey Report16, 2018, and identified a preferred site from the list of suitable locations. The selected site has been referred to as the "Near LADMA Office" site within the Solid Waste Survey Report, 2018. Further details on the site and why it was selected for modeling are detailed within 4.3.2. The geographic overview of the available and selected sites for this model is provided in **Figure 4.1**.

Figure 4.1: Available, existing, and selected sites in GAMA



Source: Mott MacDonald, using Google Earth

4.1 Approach

The approach we have taken with regards to sizing the landfill and associated facilities is to provide a landfill in GAMA which accepts all waste which is collected and requiring treatment or disposal, as specified in **Table 3.7**. This approach has been taken because of the history of the Kpone disposal site, where waste deliveries to the site far exceeded the expected daily capacity requirements. The Kpone site was developed as a PPP, with an expectation of 600 to 800 tons per day of waste being delivered for eight years17. Instead, it was reported that between three to four

[16] Integrated Urban Environmental Sanitation Master Plan

[17] Information acquired through stakeholder consultations.

times more waste was typically delivered daily. This increase in usage resulted in unsustainable growth, reduced project engineering and controls, and contributed to a significant fire which led to the closure of the site. Without full control over where each MMDA's waste is delivered to, the use of the Project's transfer stations (and multiple other operational disposal sites available to accept waste), there is little certainty that a set amount of waste could be delivered to the Ayidan site daily. The developments needed in the solid waste management sector are further discussed in the Enabling Environment Report.

In order to avoid a repeat of the over tipping experienced at Kpone and provide MSWR and MMDAs with an engineered landfill facility (rather than a dumpsite), as an interim step allowing time to develop further facilities, this scenario is to build a facility which can accept all of the expected waste in GAMA.

A risk of designing a landfill for a smaller daily capacity is that if more waste is delivered than expected, it may be hard to manage the site, preventing effective depositing of waste, compaction, and formal recycling. A further scenario, whereby a reduced tonnage of waste is delivered to the landfill each day, is discussed in Chapter **5**.

4.2 Ayidan site

The Ayidan site being provided by MSWR is required to provide a landfill and a waste treatment facility (referred to as a materials recovery facility (MRF) in the Terms of Reference (ToR) for the procurement of a design contractor for the site). The term MRF would usually refer solely to the separation of materials for recycling (locally referred to as a dry-MRF). However, it is understood that in this context, and based on background work carried out on the GAMA Project, the MRF may also include the treatment of the organic fraction of the waste (locally referred to as a wet-MRF).

This scenario has not been specified to the design consultant, as the ToR for the Ayidan design is not specific. It will, therefore, not be directly comparable to the approach that is chosen through the design consultant work. Comments on the Ayidan ToR are included in Appendix D.

4.2.1 Assumptions about the site

Detailed information about the site is not yet available. Therefore, for the purposes of estimating the available void space (total capacity), and therefore cost and capacity, the following assumptions have been agreed upon between us, the World Bank, and MSWR.

- The land is not flat but gently sloping;
- The new facility will be a land raise rather than a landfill. This is because the site is not currently a void, such as an old quarry. The waste which is tipped will form a hill;
- There are no complex ground conditions. This means we are assuming there is no contaminated land and that the bearing capacity of the basal geology will not constrain the height of the landfill;
- There is no running water (such as rivers or streams) across the site;

- The requirement is to meet standard containment for a non-hazardous (municipal waste) landfill. The landfill will not be permitted to accept hazardous waste unless it has been stabilized and is non-reactive. If hazardous waste is to be deposited, then a cell would need to be developed with additional containment engineering;
- The access road is under construction to the edge of the site. The finish is a bituminous surface dressing. Any improvement required would be part of the new Project;
- The ESIA is a separate process, and any costs of rehousing people or other activities will be managed separately; and
- Water supply to the site currently is by borehole, electricity is already available with a transformer, and the cost of additional services required for the site would be part of the new Project.

4.2.2 Site footprint

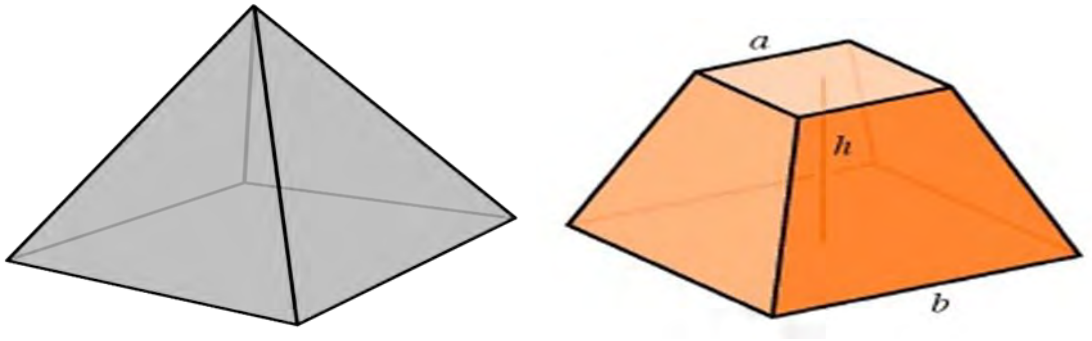
The total site available is 26.2 hectares. We understand that the Greater Accra Region's initial and urgent requirement is engineered or sanitary landfill capacity, as there is none available in the region. Therefore, the majority of the site will be used for landfilling. However, recycling removes waste from landfill moves waste up with waste hierarchy, has wider economic and environmental benefits, and should increase the waste density, increasing the tonnage of waste that can be landfilled. Therefore, we have proposed that a small part of the site be used as an MRF.

4.2.3 Landfill capacity and specification

It is understood that the site is 26.2 hectares in area. Additional features at the site, such as access roads, reception buildings, other waste infrastructure, and infrastructure associated with the landfill (leachate treatment, gas compounds, etc.) are likely to require approximately 4 to 6 hectares of area. Therefore, the space available for the landfill is likely to be between 20 to 22 hectares.

We have estimated the capacity of the landfill based on the volume of simple geometric shapes. The base is described by a truncated, four-cornered prism, and the top is based on a 4-cornered pyramid. The final design of the landfill will be based on the actual shape of the site, using a 3D volumetric tool, so the volume of waste which can be received will need to be refined.

Figure 4.2: Four-cornered pyramid and truncated prism geometric shapes



The maximum slope angle used for the truncated prism base is 1:4. This should allow the waste and cover materials to remain stable while maximizing the waste that can be deposited. A slope of 1:4 also means that post-settlement, it should be feasible to drive over the surface. The minimum slope for the upper pyramid is based on a 1:20 profile. This slope is chosen as, following the significant settlement that would occur as municipal waste degrades, there should still be sufficient gradient to allow for rainwater to run off the site and not pond.

The density of the waste has been considered over a range of 0.8t/m^3 to 1.0t/m^3. The lower density is typically found for mixed municipal waste where the material is subject to standard or light compaction. The higher value is typically observed for municipal waste where the waste is subjected to heavy compaction. The higher value has been considered as the waste composition is predominantly organic. This means that it will also degrade more rapidly with significant mass loss through gas generation. The rapid nature of the degradation means that it is likely that more waste can be deposited to meet the profiles proposed.

More extensive modeling would be required to forecast the anticipated impact of upfront mass loss and, therefore, to account for this effect. However, for the purposes of this analysis, it has been assumed that a reasonable estimate for the final density is 1.0t/m^3, which is at the higher end of the range typically seen.

A 10 percent factor has also been applied to the waste deposited to allow for engineering materials and daily cover.

Waste flow modeling, presented in chapter 3 and Appendix A, has identified the following waste totals that could be delivered to the landfill. The design contract for the Ayidan site was in the process of being procured in October 2020. The deadline for the completion of design works was reported to be June 2021. Therefore, assuming mobilization could happen immediately, the earliest possible date that a new sanitary landfill could be operational and able to receive waste would be the beginning of 2022. In reality, it would be likely to require more time, but there are no dates yet set in contract documentation.

Table 4.1: Landfill capacity calculations (excluding MRF)

	2022	2023	2024	2025	2026	2027
Total waste available for deposition (tpa)	1,057,409	1,098,042	1,139,421	1,197,718	1,255,717	1,315,548
Cumulative		2,155,451	3,294,872	4,492,590	5,748,308	7,063,855
Landfill capacity required assuming 1t/m^3 plus engineering material		1,163,150	2,326,300	3,534,146	4,787,509	6,104,999
Landfill capacity required assuming 0.8t/m^3 plus engineering material		1,453,937	2,907,875	4,417,683	5,984,386	7,631,249

Source: Mott MacDonald

As the landfill area of the site is to be restricted to 20 hectares, then a 46-meter-high landfill with profiles identified above would be expected to have a total capacity of 3,450,000m^3. Assuming 10 percent of the site's volume is reserved for engineering materials, the capacity available for waste would be 3,150,000m^3. This equates to 2,520,000 tons if a density of 0.8t/m^3 or 3,150,000 tons if a density of 1t/m^3 is used. This suggests that there is sufficient capacity for the landfill to receive approximately 2 years and 4 months (i.e. mid-2024 if deposition commences at the beginning of 2022) using a density of 0.8t/m^3 or 2 years and 10 months (i.e. by the end of 2024) using a density of 1t/m^3.

Landfill sizing for all waste

To provide a single site that could take all wastes up to 2050 (55Mt), in order to match the typical useful life of waste treatment technologies, and using the same profiles, the area required would be 1,310m x 1,310m x 64m high for a density of 1t/m^3. This equates to a site of 171 hectares. In all likelihood, over this period, there would be significant mass losses through the degradation of organic matter leading to gas and leachate loss. The overall settlement is typically greater than 30 percent of the waste deposited at municipal waste landfills. Therefore, the area identified is probably conservative. However, the area required for a single site would still be significantly larger than the site at Ayidan.

Assuming a final density of 1t/m^3 and assuming a reduction of waste mass of 30 percent, the landfill required would be 1,180m x 1,180m x 61m high. This equates to a site covering 139 hectares. Assuming that the MRF is implemented and operational for the same duration, then the landfill would need to be 1,155m x 1,155m x 61m high. This equates to a site covering 133 hectares.

If two equal-sized landfills were provided, including 30% losses and the diversion of material from an MRF, the site would be 865m x 865m x 53m high. This equates to 75ha, which for two landfills would be 12.8% more area required than a single site of an equivalent capacity.

These dimensions are represented in **Table 4.2**.

Table 4.2: Dimensions of a single landfill for wastes generated up to 2050

Capacity of landfill	Density	Dimensions	Height	Area
50,000,000t excluding losses	1 t/m^3	1,310m	64m	171ha
50,000,000t including 30% losses	1 t/m^3	1,180m	61m	139ha
50,000,000t including 30% losses and MRF	1 t/m^3	1,155m	61m	133ha
2 x 25,000,000t including 30% losses and MRF	1 t/m^3	865m (x2)	53m	150ha (2 x 75ha)

Source: Mott MacDonald

It is not typical sector practice to manage all wastes arising from a major capital city at one site, and it would be expected that other landfills would be required and that measures be employed, such as material recovery, composting, etc., to divert waste from landfilling. Where more than one site is provided, the overall footprints of the sum will exceed the area required for a single site as providing a single large site is more efficient in terms of void capacity generation compared to several smaller sites.

4.2.4 MRF specifications

The ToR for the Ayidan design includes recycling, so an MRF has been included as one of the facilities on the site. The ToR does not include specifications for the MRF, and there are clear challenges due to the large amount of waste likely to be delivered to the site on a daily basis. Therefore, we have reviewed options which could move waste up the waste hierarchy, divert waste from landfill and use innovative solutions (e.g., by featuring an element of organic waste treatment) given the constraints in GAMA. The review of MRF options is not exhaustive but was undertaken to determine if the life of the landfill could be extended, while moving waste up with hierarchy.

The landfill footprint requirement has been limited to 20 hectares. Our early estimation is that up to 2 hectares of footprint may be unusable given its shape. This leaves a maximum of approximately 4.2 hectares for access roads, reception buildings, and the MRF. Access roads to the site will need to be longer than for a typical landfill due to the large number of vehicles that will be delivering waste at any one point. It has been assumed that the weighbridges, queuing space, and parking will take a maximum of 0.3 hectares.

We propose for the reception area for the MRF to also have the capacity to act as a TS, to prevent vehicles from queuing directly to tip on the landfill site. It could also serve as a contingency for waste being delivered from other TSs in the event of long queues to dispose of waste in the landfill. Therefore, the tipping hall is designed to allow for as much directly delivered waste as possible to be delivered to the MRF rather than directly to the landfill. This has the benefit of reducing the number of vehicles on the landfill as the collection vehicles will have a lower capacity than the haulage vehicles, as discussed in sections 4.4 and 4.5.

As the capacity of the MRF will not be enough for all waste arising in GAMA to be treated, the waste from the TSs will be direct delivered to the landfill (see section 6.2 for further details).

Treatment Overview

Reception and screening

The waste would be delivered to the tipping hall by the collection vehicles and moved to a number of simple conveyor belts for manual separation of recyclables. The main material to be targeted would be plastic, which is what is currently removed from the waste, which is dumped at the landfill site by informal waste pickers. In addition, any metal which is available in the waste would be targeted. However, there is not expected to be a lot of metal, as much of this is likely to have been removed by informal waste pickers prior to collection. Clean paper and cardboard could also be targeted, although this will be a small amount as the bulk of paper and card will be contaminated by organic waste.

It is assumed that members of the informal sector who currently pick waste out of the landfill could be employed to do manual separation of the waste within the MRF. This has the following benefits:

- Employing skilled people who know what materials to target and who are able to work at speed;
- Providing a safer working environment away from heavy vehicles, unsafe ground conditions, and the wider hazards of walking on a landfill or dumpsite;
- Providing a livelihood to people who would otherwise be in precarious employment; and
- Giving a stronger platform to prevent people from picking waste from the landfill, which is both dangerous and not suitable for an engineered landfill using daily cover.

Whilst the landfill would receive waste during the day only, it is assumed that the MRF would operate for 2.5 shifts per day, with the remaining part shift for maintenance. This would allow as much material as possible to be processed through the facility, which is important given the tonnage of waste which will be delivered to the landfill. It would, however, rely on near 24-hour operation, which would need to be approved, as it is understood that this is not standard practice currently for waste management in GAMA.

We have assumed that up to 7 percent of the material arriving at the MRF can be separated for recycling. This is based on discussions surrounding materials that are targeted by the informal sector and the performance of other MRFs processing a mixed municipal waste (of similar composition), which typically separate in the region of 5 – 9 percent of input material by mass. Clearly, if the amount separated reduces, additional landfill capacity would be required. The assumptions used are shown in **Table 4.3**.

Table 4.3: Material recovery assumptions

Material	Paper	Plastic	Metal	Organic	Other
MRF input composition	5%	8%	2%	69%	16%
Percentage of material category which can be recovered	5%	75%	75%	0%	0%
Recovery estimate*	~1ktpa	~23ktpa	~5ktpa	80ktpa	0tpa

Source: Mott MacDonald

** Recovery estimate based on an MRF with a total waste throughput of 400ktpa, including 80ktpa of organic treatment*

The total recovery estimated, which is typical for a dirty MRF, totals approximately 7%. This is based on the individual recovery efficiencies utilized, which are 5% recovery of paper (5% of MRF input), 75% recovery of plastic (8% of MRF input), and 75% recovery of metal (2% of MRF input). Note that the MRF input fraction of recyclates is lower than the corresponding fraction generated in Accra due to the presence of an informal material recovery sector, which also targets these material streams.

Front end process summary

Waste would be received into a reception from collection vehicles, and from haulage vehicles from the TS if there is available capacity. The reception hall operators would be responsible for removing large or dangerous items from the waste, using loading shovels. Waste that would damage the downstream equipment, such as gas canisters or large electronics, would need to be removed. This protects the equipment and also staff working in the waste separation lines.

The waste would be loaded into mechanical bag openers to pull apart any plastic bags and partially reduce the size of the material. The material would be then loaded onto conveyors, which would move slowly down picking lines for staff to manually remove targeted materials. It would be important to load the conveyors evenly, spreading waste out as much as possible.

Once the remaining material reached the end of the conveyors, it would be shredded to reduce the particle size so that the material is more suitable for organic treatment. It is envisaged that the shredder would be set at 80mm, but this would need to be decided based on a detailed analysis of the waste.

The capacity of each stage, and the corresponding amount of plant and equipment needed, would depend on the configuration of the MRF. This is discussed further in the section.

Organic treatment process summary

The organic fraction would be loaded into bays on a concrete floor, with concrete separation walls every 5 meters. A breathable moisture-resistant membrane (see) would be placed over the pile to reduce odors and issues from vermin.

Figure 4.3: Membrane composting

Source: https://www.recovery-worldwide.com/imgs/1/3/1/8/9/4/7/CONVAERO-e671f1bc4d17b7ed.jpeg

The concrete walls allow material to be stored at a greater depth than it would if left in open windrows, increasing the capacity of the facility. The floor of the piles would require an aeration system to force air up through the organic material to aid aerobic degradation. Elevated temperatures develop within the material, which promotes higher rates of degradation and aids the reduction of pathogenic organisms. The material would need to be turned periodically using specialist turning equipment to promote mixing and effective gas exchange. We are aware that this type of system is being implemented elsewhere in northern Africa.

Treatment approach options

As there are a significant number of approaches which could be used on the Ayidan site we have investigated the following three options for the MRF and organic treatment, or no treatment:

- **Option A** – Maximize recyclable separation with no further treatment. In this option, all waste accepted into the MRF would have dry recyclables removed, with the remainder of the waste being sent to the landfill. All waste delivered to the site could be processed through the MRF;
- **Option B** – Maximize organic waste partial biodrying to increase potential compaction in the landfill. In this option the total capacity of the MRF would be reduced, with all of the organic waste being bio-dried to reduce organic activity prior to landfilling. Up to approximately 400,000tpa could be processed through the site in the area available;
- **Option C** – Produce a material from the organic fraction of the waste, which is suitable for use as a daily cover within the landfill. A fraction of the organic waste would be placed into covered windrows and left for a period of at least six weeks to allow for a more complete organic degradation, so that the material could be used as daily cover at the landfill. This would, in effect, increase the capacity of the landfill as daily cover would not need to be brought into the site from elsewhere; or
- **Option D** – No treatment, reception only. In this option, there would still be a reception facility in order to accept waste from collection vehicles, including borla taxis, avoiding them driving and tipping on the landfill.

These options, along with their main positives and negatives, have been summarized in a decision matrix in **Table 4.4**.

Table 4.4: MRF decision matrix

Option	Capacities	Positives	Negatives	Conclusion
Option A – Maximize recyclable separation, no further treatment	MRF approximately 1,000,000 tpa	Maximizes recyclable material removed from the waste, moving waste up the waste hierarchy and diverting it from landfill. Could benefit the recyclables markets	Requires significant end-markets for recyclates (outside of the control of the Project). The largest proportion of the waste, the organic fraction, would not be used in any way.	Not feasible in the short term as the size (approx. 1million tons per annum is larger than existing facilities), and landfill diversion is limited.

		as there would likely be a steady stream of similar materials that could be marketed and sold in bulk. Simpler technology (i.e. without organic treatment). Optimum flexibility regarding changes in waste composition.	This fraction is the one which decomposes most in a landfill, producing methane and leachate. Very large MRF, which could present logistical and operational challenges. If other facilities were developed in the future (after the landfill is full), it may be difficult to continue to get beneficial use from the remaining MRF, as all of the non-recyclable material would need to be transferred to another facility, effectively requiring double handling, and the Ayidan site is in the far north of the GAMA. Other operational facilities in GAMA also have some level of organic treatment.	
Option B – Maximize organic waste biodrying, increasing compaction;	MRF approximately 400,000tpa, organic treatment of all organic waste entering the MRF	Allows the organic fraction of the waste to be treated in the windrows for two weeks, which would partially reduce the organic activity and particle size of the waste – increasing landfill capacity as material should compress more readily. Allowing degradation to occur under aerobic conditions produces carbon dioxide, rather than methane when decomposition occurs in anaerobic	Practically complex to load and unload large amounts of waste into a series of composting tunnels for a short residence period. High-level calculations suggest that 154 bays would be needed. This is higher than seen on other simple organic treatment facilities. Reduced amount of waste would be able to be processed through the material separation part of the MRF (in comparison to	Not feasible given the complex operations required to load and unload the organic waste into treatment tunnels, and that the footprint available would make the site operation more cramped than ideal.

		conditions (which is 21 times more potent as a greenhouse gas). Waste accepted into the MRF would have recyclables separation, moving waste up the hierarchy.	Option A) due to space constraints. Reduced recyclables recovery. The organically treated material would not be suitable for daily cover.	
Option C – Produce a material suitable for daily landfill cover; or	MRF approximately 400,000tpa, organic treatment of approximately 80,000tpa	Removes daily cover requirement and produces a usable product (diverting material from landfill and moving waste up the hierarchy). Uses the organic fraction of the waste in a beneficial way, as it could not be used as a compost, given it is from a mixed waste source. Once the landfill is closed the facility would be stand alone, to produce a daily cover for a new landfill. The facility is similar to the existing facilities in GAMA (with different outputs). Facility could be adapted in the future to produce compost, if source segregated organic waste collection was introduced.	Reduced recyclate recovery as the capacity of the site would be reduced in comparison to option A. The MRF would have a capacity of approximately 400,000tpa, with approximately 80,000tpa undergoing organic treatment. The facility would use all available space at the Ayidan site. Once Ayidan landfill is closed a new outlet would need to be found for the daily cover material, reliant on a commercial agreement with future landfill developers.	Feasible, giving some dry recyclables and a daily cover as products, (similar to currently operational facilities in GAMA) and provides flexibility on options for future use.
Option D – no treatment, reception only.	No treatment capacity, largest landfill capacity available, 4 million meters cubed. Increases landfill lifespan by approximately 4 months (12% increase in capacity).	Maximizes volume of landfill capacity. No technology operation required. Large scale landfill with a stand-alone reception facility could alleviate issue of long (>24 hour)	No recyclable or organic material recovery, meaning no improvement of waste management regarding the waste hierarchy. Does not meet the outline specification	This does not move waste up the hierarchy, although it would provide additional capacity for disposal. However, in order to avoid multiple small vehicles from depositing waste on the landfill, a

	queues for waste collectors.	in the Ayidan site ToR. Does not meet aspirations to improve waste management sustainability. No treatment or removal of recyclable materials could reduce the level of compaction of waste which is achievable.	reception facility, which would be large due to the volume of waste being delivered and the number of small vehicles likely to deliver waste, would still require development.

Source: Mott MacDonald

The suggested approach based on the options identified in the table above is Option C, an MRF of 400,000tpa, as well as organic treatment of 80,000tpa, which would provide a material suitable for usage as daily landfill cover. In addition, the facility would be most similar to those already in operation in Accra and could potentially be used after the landfill is closed.

4.2.5 Capacity

The maximum material being sent to the landfill during the operational period of the site is approximately 1,200,000tpa (assuming that the landfill is full by the end of 2025). A standard assumption for the volume which is taken up with engineering material or daily cover is 10 percent of the void space, of which approximately 8 percent is the engineered basal and capping layers, and the remaining 2 percent is the daily cover. Typically, the daily cover is stripped and reused, which is why it only constitutes approximately 2 percent of the capacity. The purpose of daily cover material is to provide a layer that reduces environmental nuisance, such as litter, odor, flies, vermin, and other scavenging animals.

Organically treated waste can be used as a replacement to the daily cover. However, in this instance, it would not be stripped but would remain in place. Although an exact figure cannot be determined until a full design was undertaken, we have assumed that a product from the organic treatment of a maximum of 80,000tpa of waste could be used within the landfill. This figure would need to be refined through the design of the landfill and the development of operational plans.

While using the organically treated material as daily cover, it is important to note that there is a risk that some light plastics will be in the organic fraction of the waste, along with items not removed for recycling. Therefore, it will not look like a compost type material, and there is a risk of light plastics being blown across the site. This can be mitigated using fencing and netting, along with regular clearing of the areas around the fences. The material produced in the organic treatment will not be suitable for top cover, to cap the landfill, once the landfill is full.

In order to process 80,000tpa of organic waste, with an assumed density of 450kg/m^3 and a residence time of at least six weeks, a minimum of 82 bays would be required. This assumes bays

that are 5 meters wide, with a length of 20 meters and a depth of waste of 2.5 meters on average. This is a large organic treatment facility, in comparison to source-segregated organic treatment facilities, but is in line with other mechanical biological treatment facilities that are in operation and we are aware of. The processing of 80,000tpa of predominately organic waste is likely to produce approximately 60,000tpa of daily cover material.

Including space for loading and unloading and equipment for aeration of the bays, this would require a footprint of approximately 1.3 hectares. This leaves about 2.7 hectares for material separation and site operation.

With this area of land, approximately 400,000tpa of waste could be processed, with recyclables removed from all of the waste. This would mean that the material reaching the end of the conveyors would all be shredded, with only a fraction taken to the organic treatment part of the facility. The remainder would be transferred to the landfill. As it would have been shredded, its density should have increased, allowing for better compaction in the landfill.

Table 4.5: Capacity summary

Facility	Annual Capacity (tpa)
Maximum waste to landfill during the operational period (approximately)	1,200,000
MRF reception and material separation	400,000
Recyclable materials separated	29,200
Material separated for organic treatment	80,000
Daily cover material	60,000

Source: Mott MacDonald

Allowing for the implementation of the MRF within the Project (and based on Option C as identified in section 4.2.4), resulting in the diversion of some recyclable material and using waste subject to organic treatment as the daily cover material, this would extend the life of the landfill by a further four months, taking it to 2 years 8 month (based on 0.8t/m^3) or to 3 years 2 month (based on 1t/m^3).

4.2.6 Other GAMA facilities

Additional data regarding the current daily operational capacity of other waste infrastructure servicing GAMA has been provided by the World Bank in December 2020. This information has been presented in **Table 4.6**. We have extrapolated the information to estimate the annual capacity of each site, assuming 300 days of operation for each facility.

Table 4.6: GAMA facilities summary

Facility	Daily Operating Capacity	Annual Capacity at 300 days (tpa)	Estimated Life Remaining (years)	Ownership
Adepa Dumpsite	1,500 tons	450,000**	20 years	Private

Accra Compost and Recycling Plant (ACARP)	600 tons 1,200 tons*	180,000** 360,000* **	20 years	Public / Private
Integrated Recycling and Compost Plant (IRECOP)	400 tons	120,000**	20 years	Private

Source: Ministry of Sanitation and Water Resources
**Capacity is being expanded to 1,200 tons per day.*
***Annual capacity estimated based on 300 operational days*

Alternative data sources suggest conflicting processing capabilities of the ACARP and IRECOP. These have been listed below:

- ACARP – similar maximum capacity, but has been stated to operate at approximately 300 tons per day18 (90,000tpa).
- IRECOP – the site opened in June 2019 and is designed to treat 400 tons per day of mixed municipal wastes. This study was not able to confirm actual waste received, treated or tonnage of residual material sent for disposal.

Neither the ACARP, IRECOP, or Adepa dumpsite have been included as part of our baseline model as sufficient evidence of actual performance of waste diversion of GAMA has not been verified. Further details on the quality of the outputs of these sites, as well as what percentage of treated waste requires further treatment or landfilling, has also not been identified.

If all three sites were to operate at their full capacity, and none of the treated waste required landfilling, the expected waste managed in GAMA would total 3,100 tons per day (approximately 930,000 tpa at 300 days per annum of operation). These tonnages would have significant impacts in extending the duration of the Ayidan landfill, as the total amount of waste requiring landfilling would be reduced from 1,057,409 tons per annum to 127,409 tons per annum in 2022, rising to 573,500 tons per annum by 2030. This alternation would be directly linked to a significant increase in useful landfill life; it is estimated that the Ayidan landfill could last for approximately eight years and one month, assuming a density of 0.8t/m^3 and nine years and three months utilizing a density of 1.0t/m^3.

4.3 Transfer station sites

4.3.1 GAEC transfer station site

The GAEC is a large site, not all of which would be available for use. The site is shown in **Figure 4.4**. The exact ownership boundaries and specific area being purchased are not known.

[18] Solid Waste Assessment Report, 2019.

Figure 4.4: Ghana Atomic Energy Commission site

Source: Google maps *https://www.google.com/maps/@5.6745559,-0.223356,1840m/data=!3m1!1e3*

Assumptions about the site

We have made assumptions about the location of the TS within the wider site and the footprint of the site which would be used. These are detailed below.

- The site has significant urban development around its perimeter on three sides, with the fourth side being a major road. Therefore, we have assumed that the TS can be at the south of the site, with direct access from the major road, the Haatso-Atomic Road. This avoids the need to disturb local residents and is likely to save significant time driving more complex routes to the site;
- The traffic around the site is reported to be generally bad. It is outside of the scope of our work to analyze traffic and road networks, but we have assumed additional time periods for vehicles getting to and leaving the site in estimating the number of haulage vehicles needed; and
- We have limited the site of the TS to a capacity that is considered reasonable based on the size of facilities of which we are aware, as the amount of land available is larger than needed for a TS alone. The limit for many TSs which have surplus land is a reasonable number of vehicle movements for the site and surrounding road network to cope with. A traffic survey or traffic plan is outside of the scope of this project.

4.3.2 Near LADMA office transfer station

The second TS, which is to be developed as part of the Project, has not yet been assigned a specific site by the MSWR. We have therefore reviewed the sites which have been listed as being potentially suitable for the development of solid waste management facilities within the Solid Waste Survey Report, 201819.

We have identified the site known as “Near LADMA Office” as being the most suitable for the second TS for the following reasons:

- It is the site that is located furthest away from the Ayidan landfill and would maximize benefit to collection contractors in those MMDAs that would otherwise have the longest distance to travel;
- Most of the other proposed sites were located in close proximity to the Ayidan site or the GAEC TS site and would therefore not maximize geographic coverage of the Project;
- The footprint available for the site would comfortably accommodate a large TS (although this is the case for most of the sites reviewed);
- It would be capable of serving MMDAs within the south and south-eastern areas of the GAMA, close to the main waste-producing centers of population; and
- It is within a reasonable distance of the major road network (N1 and N6)

[19] Integrated Urban Environmental Sanitation Master Plan

The aerial view of the selected site is available in **Figure 4.5**.

Figure 4.5: Near LADMA Office site

Source: Mott MacDonald, using Google Earth

The site area is 1.2 hectares, and it is understood that the site is flat. As with the Ayidan site, we have assumed no complex ground conditions, and that an ESIA would be carried out separately, with the implications of any findings outside the scope of this analysis. Specific access and egress arrangements would need to be determined.

4.4 Transfer station capacity

The limiting factor for the capacity of waste which can be managed through the TSs is not expected to be the amount of land available, given that there is a stated area of 1.2 hectares for the Near LADMA Office site, and the area available for the GAEC TS site is not yet specified. Instead, the limiting factor will be the number of vehicles that can be accepted onto the site, unloaded, and safely driven off the site. Therefore, assumptions have been made about the potential capacity for the site's practical management, using a full weighbridge system where all vehicles are weighed on entry to and exit from the site.

Typical requirements in operational TS contracts are for a total turnaround time (from weighbridge on entry to weighbridge on exit) of 15 to 20 minutes. We have used this as a basis for the specification and size requirements. The assumptions used are shown in **Table 4.7**.

Table 4.7: Transfer station assumptions

Assumption per TS	Category	Reason	Comments
400,000tpa (1,300 tons per day)	Total site capacity	This capacity is at the larger end of typical TSs. While it is possible to have a larger capacity, it would require very specialist management and ideally control over the timing of deliveries from waste collection contractors.	If deliveries of waste were to be spread evenly over a longer period, with the addition of new haulage vehicles, the capacity could be increased.
8 tons	Average delivery vehicle capacity (in)	Formal large collection vehicles will have a payload of 10 to 12 tons, but smaller vehicles are currently used in some of the collection areas.	This assumes some deliveries from smaller vehicles and potentially borla taxis (with a payload of 1 to 1.5 tons). However, if a large number of vehicles delivering waste are small (for example, with a payload <6 tons), it would significantly reduce the capacity of the TS as the time taken to unload each one is larger than for an equivalent amount of waste from a large collection vehicle to help maximize efficiency.
20 tons	Average haulage vehicle (out)	A typical payload for haulage of waste from a well-operated TS in Europe would be 23 to 24 tons. However, this assumes vehicles are loaded with some compaction and that roads are all able to support vehicles of up to 44 tons.	It is outside the scope of this project to determine if roads are able to support heavy goods vehicles of up to 44 tons. If not, there would be additional vehicle movements and time required to load them.
6 days per week	Number of working days per week at the TS and for collection	This is typical for a large-scale TS.	In order for the TS to operate for six days per week, it requires waste collection to be undertaken for at least 5.5 days a week (with the remaining half day to empty bays of waste at the end of the week to be sent for treatment or disposal).
9 hours per day	Operational hours of the TS per day	This is shorter than seen at large TSs in other countries, which may operate for over 12 hours per day, but there is no control over when waste is collected, and it is understood from discussions with waste collectors in Accra that	If the site could be operated for longer each day, the capacity would increase, and the Opex per ton would decrease. However, this would rely on collections being carried out throughout the day and the

		waste collection is not done very early in the morning or at night.	treatment or disposal facility being open for corresponding hours to allow for deliveries.
16 deliveries per hour (average), 32 deliveries per hour (peak)	This corresponds to 32 vehicles movements per hour as the empty vehicles will need to leave the site	The peak deliveries per hour are assumed to be 20 percent of the daily capacity. This is because most waste collection companies will try to start their daily collections with empty vehicles, and they will fill them up at roughly the same time of day, so they deliver to the facility at similar times. Likewise, at the end of the day, they will want to empty their vehicles to be ready to start collections in the morning. Therefore, there will be peaks and troughs for delivery times.	If the TS operator has input into collection company practices or routing, there may be opportunities to smooth delivery times. But, assuming this is not the case, the facility needs to be designed for peak delivery loads.
6 loads for haulage to treatment or disposal per hour (average)	This corresponds to 12 vehicles movements per hour as the empty vehicles will arrive at the site	Haulage vehicles will be loaded in parallel and sent out as soon as they are full.	We have assumed a layout of four separate waste unloading bays in order to allow multiple vehicles to be filled at the same time. It will take strong management of the facility to ensure safety with high numbers of vehicle and mobile plant movements.
The average density of the waste delivered to the TSs will be 400kg/m^3		This is higher than seen for typical MSW internationally. However, due to the high organics content (>60 percent), it is considered reasonable.	
The waste storage volume required is 3,200m^3	The storage volume has been divided into eight unloading bays, each 20 meters wide, with a maximum height of 3 meters of stored waste. Each bay will have waste with a depth of approximately 6 meters.	An unloading area has been selected, rather than bunkers or raised tipping, as this is easier to keep clean and manage. A loading shovel will be needed to lift the waste from the bays into haulage vehicles. The storage requirement is based on one full day's capacity.	It would be beneficial to increase storage capacity, as this provides a buffer if disposal or treatment sites close for several hours, but this is harder to manage, so it has not currently been assumed.

With the given assumptions, the peak delivery rate is 32 vehicles per hour. This equates to a peak of one vehicle arriving at the site and being weighed, recorded, and directed to an entry door every 1.9 minutes. Therefore, we do not recommend modeling a TS capacity more than 400,000tpa as the management of the TS would be complex and require a highly automated system to be safe and effective.

A TS facility of 400,000tpa would be able to comfortably fit on a site of 1.2 hectares. The basis of the calculations assumes a simple TS, all on one level, with four separate tipping areas, each with two or three doors for vehicles to maneuver into for tipping. Additional space could be provided for informal sector deliveries using borla taxis, using a simple ramp and tipping floor below. The designer of the TS will need to make assumptions about the proportion of space needed, as the unloading time for a borla taxi will be longer than for a refuse collection vehicle. Therefore, queuing for formal sector vehicles, which are larger, would be segregated from smaller vehicles.

4.5 Haulage

The TS capacity calculations described in section 4.4 assume that waste is removed from each TS by haulage vehicles within one day of being delivered by collection vehicles. To facilitate effective system management and avoid a backlog of waste at each TS, solid waste will need to be transported efficiently from each of the two TSs to the Ayidan site. In most well-developed waste management systems, bulk haulage vehicles are used to transport waste in high volume between stations and the final treatment or disposal point. The intention is to maximize the volume of waste transported in one single load and reduce the total number of waste vehicles on the road network. **Table 4.8** provides a summary of different bulk haulage options.

Table 4.8: Bulk haulage options

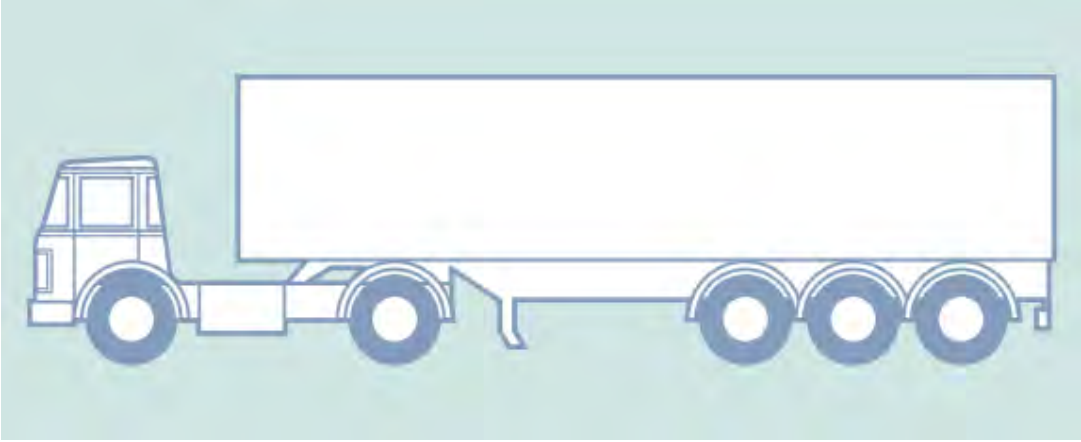
Type of vehicle	Key specifications	Suitable waste types	Comments
Articulated (tipper/ejector)	44-ton max. gross weight 24-ton max. payload Six axle wheelbase 11m tip height	Mixed solid waste	Able to transport large volumes of mid to low-density waste. Requires loading using fixed plant or mobile equipment. Waste ejected quickly using hydraulic tipper or ejector action.
Articulated (walking floor)	44-ton max. gross weight 24-ton max. payload Six axle wheelbase	Mixed solid waste	Able to transport large volumes of mid to low-density waste. Requires loading using fixed plant or mobile equipment. Waste ejected using an automated walking floor within the trailer.
Rigid tipper	32-ton max. gross weight 20-ton max. payload Four, six, or eight axle wheelbase	Inert waste and aggregates	Robust haulage option used to transport high-density waste.

Curtainsider	Three axle wheelbase (excluding vehicle cabin)	Segregated dry recyclables	Trailer with curtain along the side to allow loading and unloading by pallet trucks, used to transport baled recyclables.
Roll-on-roll-off (RORO)	30-ton max. gross weight 14-ton max. payload Fitted with hooklift to load and unload waste containers Two or three axle wheelbase	Mixed solid waste	Capable of transporting pre-loaded 20m^3, 30m^3, or 40m^3 waste containers. Typically used to haul waste over short distances or for pre-segregated waste types.

Source: Mott MacDonald

We have assumed that waste will be hauled in articulated tipper/ejector vehicles as this form of haulage facilitates the maximum volume of waste to be transported when compared against other options, reducing the total number of haul trips required. The tipper/ejector style vehicle has been selected as it enables more efficient unloading of waste at the final disposal point when compared against the walking floor option (which can take up to 20 minutes to complete one unloading cycle). We would recommend that all bulk haul vehicles should be fitted with retractable sheeting and lockable trailer doors to ensure waste is secure to prevent waste from escaping during transport.

Figure 4.6: Example side profile of articulated tipper vehicle



Source: Department for Transport: Truck Specification for Best Operational Efficiency

As described in section 4.4, we have assumed that each bulk haulage vehicle will carry an average of 20 tons per load. We would expect an experienced TS and logistics operator to achieve a higher average payload (e.g., by using basic compaction at the TS). However, we have made an allowance for the Accra road network not being fully able to support vehicles operating at or very near to their maximum gross weight.

To calculate the estimated total haulage fleet required, we have assumed that each vehicle will be able to make two trips per day from either TS to the Ayidan site on the basis of a nine-hour operational day. This has been calculated using the trip time and vehicle route assumptions set out in **Table 4.9** and **Table 4.10**. Where practical, we have assumed that haulage vehicles will use major or arterial roads, which are more likely to be suitable for the proposed form of haulage. A review of the assumed haulage routes using Google Streetview indicates that the routes are predominantly well surfaced, wide enough for articulated vehicles, and dualled in many places. It should be noted that trip times accommodates a buffer (e.g., in the case of traffic and operational delays) of 0.5 hours for TS1 but no buffer for TS2, and that the specific access and egress locations for each TS have not yet been defined. If traffic conditions were particularly bad additional time would be required for the trips, this is usually avoided by waste management companies planning routing outside of peak hours where possible. If good practice could not be followed there is a risk that additional vehicles could be required.

Table 4.9: Haulage trip time assumptions

TS	Return Trip Time (hrs)	Unloading Time (hrs)	Loading Time (hrs)	Buffer (hrs)	Total Trip Time (hrs)
1	2.5	0.5	1	0.5	4.5
2	3	0.5	1	0	4.5

Source: Google maps

Table 4.10: Haulage route assumptions

TS	Route from TS to Ayidan Site
1	Hatso Atomic Rd (west), N6 (north), Juaso – Nsawam Rd (west)
2	Giffard Rd (north), N1 (west), N6 (north), Juaso – Nsawam Rd (west)

Source: Mott MacDonald, Google Streetview

If a total of 54 loads are required to be hauled each day from each TS (based on the assumptions described in section 4.4), and each vehicle is able to make two trips per day, a total of 27 haulage vehicles will be required to serve each TS, or 54 in total across the network. This is a sizeable fleet; however, it makes sense to include a 10 percent contingency allowance for fleet unavailability in the event of breakdowns, servicing, or routine maintenance. We have therefore estimated a total haulage fleet requirement of 60 vehicles for the Project.

Nine roll-on, roll-off (RORO) vehicles will be required for the internal movement of materials at the Ayidan site, as set out in **Table 4.11** below.

Table 4.11: Ayidan site internal vehicle requirements

Movement	ROROs	Spare
MRF to Organic Treatment	1	1*

Organic Treatment to Landfill	1	
MRF to Landfill	5	1
Total	7	9

**Note: If source segregated organic waste was treated in the future, additional spare vehicles would be needed, as mixed waste and source segregated, and pre-treatment and post-treatment material would all need to be kept apart.*

This includes one vehicle to move material from the mechanical separation part of the MRF to organic treatment and one vehicle to move material from organic treatment to the landfill (for use as daily cover), with one spare vehicle across both activities. For each vehicle, excluding the spares, a maximum of two containers will be needed so that one can be loaded while the other is being transported. This assumes that a total of 18 loads are taken into and out of organic treatment each day. It also includes five vehicles to move the shredded waste from the MRF to the landfill, assuming a total of 88 loads are taken from the MRF to the landfill each day. Both activities assume a 30-minute turnaround time per load. RORO vehicles are more suitable for this type of activity as they can be loaded more quickly than articulated tippers and are more maneuverable, given typical operational conditions.

We have assumed that recyclable materials recovered in the MRF will be removed from the site by third parties (i.e., off-takers).

Our waste modeling assumptions have not allowed for any manual recovery or sorting of materials at the TSs. If this was to be implemented, then other forms of bulk haulage (e.g., RORO or rigid tipper vehicles) are likely to be required subject to the specific form of segregation and storage.

A mobile plant will be required at each of the TSs to move waste around the tipping bays and load haulage vehicles. They will also be needed within the MRF reception hall to maneuver waste and load conveyor belts and to load the treated organic material for transfer to the landfill. Our recommendations for mobile plant provision are included in **Table 4.12** below.

Table 4.12: Mobile plant requirements

Facility	Loading Shovels	Spare
TS1	4	1
TS2	4	1
MRF	6	1
Organic Treatment	3	1
Total	17	4

Source: Mott MacDonald

We have assumed that four loading shovels will be required at each TS on the basis that one loading shovel is provided for each tipping bay. Given the high number and frequency of vehicle movements within each TS, it will be important that waste piles are constantly managed. We have assumed that six loading shovels will be required in the MRF and three for organic treatment, although there is likely to be an element of flexibility between the two, given they are collocated at the same site.

5 Project sites and capacities – Lifecycle Scenario

5.1 Scope

We have suggested in Chapter 4 that the Ayidan landfill is designed to accept all the collected waste requiring treatment and disposal in GAMA. This is to avoid some of the issues which arose at the Kpone site, where more waste was delivered to site that designed for, resulting in the site operating as a dumpsite rather than an engineered landfill.

Without significant change to the waste management sector, there is the risk that a similar pressure would be put on the Ayidan landfill. However, construction of an engineered landfill to accept all of the waste expected to require disposal in GAMA would result in a landfill with an operational life of approximately two and a half to three years, depending on the density of waste compaction achieved. This is far shorter than would typically be expected for regional infrastructure and could cause commercial and operational issues. Therefore, an alternative scenario has been investigated, of developing the landfill with a set life of 10 years, in line with the expected life of the bulk of the operating equipment required.

In order for the landfill not to be filled at a higher capacity, significant changes would be needed to the waste management sector. These are discussed in the Enabling Environment Report.

5.2 Ayidan site

The approach to the Lifecycle Scenario has been to set the life of the landfill at 10 years, and then back calculate the amount of waste that can be accepted per annum over that period. As the capacity has been limited to less than the amount of waste collected and requiring treatment or disposal in the first year of operation, the amount of waste delivered to the site has been modeled as being the same for each of the ten years of operation, rather than growing annually.

5.2.1 Lifecycle considerations

The landfill life has been set at 10 years as this is the typical life for the heavy machinery, such as the compactors and dozers, which operate at an engineered landfill. This means that they would not need to be replaced during the life of the landfill and that they would have reached the end of their typical useful economic life by the time the landfill was filled.

5.2.2 Site footprint

A footprint review of the Ayidan site has identified that the total area suitable for landfilling, taking into account the amount of land needed for the MRF, is approximately 21 hectares.

The tonnages and volumes for the site have been calculated utilizing an area of 21ha, a maximum height of approximately 45m, and slopes of 1:4 ratio. The available void space for landfilling waste based on these figures, including a 10% allowance for engineering materials, is approximately 3.6 million m^3. This is equal to 2,890,000 tons when utilizing a density of 0.8t/m^3 and equal to 3,600,000 tons with a density of 1t/m^3. We have modeled 360,000tpa of waste being landfilled, and used the figure to calculate the capacity of the MRF and TSs.

Based on the 1t/m^3 figure, the landfill would be able to accept 34% of GAMA's "collected waste requiring treatment and disposal" in 2022, with 3% diverted as recyclates. In 2031, the last year of landfill operations, these figures decrease to 23% and 2% respectively, due to growth in total waste.

5.2.3 MRF specifications

The suggested MRF for the Lifecycle Scenario is a simple recyclables separation facility, using predominantly manual separation. The more innovative solutions (i.e., those featuring organic waste treatment) reviewed in Chapter 4 have not been considered, as there is less pressure to increase the life of the landfill. The MRF would be used to remove metals, plastic, and paper. This facility will not separate organic material, nor provide any organic processing. The MRF will process all waste delivered to the Ayidan site. The rejected material from the MRF will all be sent to the landfill. The MRF has been sized by back calculating the amount of material which can be accepted by the landfill and the proportion of waste which would be diverted from landfill.

The recovery rates for the Lifecycle Scenario MRF are identical to those of the Waste Capture Scenario, as presented in section 4.2.4 , although with no organic recovery. Based on the input waste composition identified, an expected recovery of 7% of input material is expected for the site. The remaining 93% of rejected material will be sent to landfill. Therefore, the MRF has a capacity of approximately 390,000tpa, with approximately 360,000tpa being transferred on to the landfill site.

All waste received at the site will be unloaded at the MRF reception hall, preventing refuse collection vehicles (along with any borla taxis arriving at the site) from entering the landfill, reducing operational risks and preventing queueing on the landfill.

5.3 Transfer station capacity

The GAEC site, and the Near LADMA site will be used as transfer stations for the Project. The sites will both receive waste from nearby MMDAs, in accordance with the proximity principle. As there is a limit on the total annual Project tonnage, the relevant MMDAs and MSWR will need to decide upon and then ensure that only a proportion of collected waste is sent to the Project's facilities. For the purpose of modeling, we have assumed that each MMDA will deliver waste to the same disposal points as in the Waste Capture Scenario. However, the proportion of collected waste

delivered to each Project site has been proportionately reduced. This means that each TS has a capacity of 150,000tpa.

Both transfer stations will exclusively supply waste to the Ayidan site. This means that waste delivered to the MRF from the TSs will account for 300,000tpa of the MRF's 390,000tpa capacity. The remaining 90,000tpa capacity of the MRF will be supplied directly by nearby MMDAs.

The operational requirements for the TSs are assumed to be the same as for the Waste Capacity Scenario, in particular the standard requirement for a total turnaround time (from weighbridge on entry to weighbridge on exit) of 15 to 20 minutes. We have used this as a basis for the specification and size requirements. The assumptions used are shown in **Table 5.1**.

Table 5.1: Transfer station assumptions

Assumption per TS	Comments
150,000tpa (490 tons per day)	Total site capacity
8 tons	Average delivery vehicle capacity (in)
20 tons	Average haulage vehicle (out)
6 days per week	Number of working days per week at the TS and for collection
9 hours per day	Operational hours of the TS per day
6 deliveries per hour (average), 12 deliveries per hour (peak)	This corresponds to 12 vehicles movements per hour as the empty vehicles will need to leave the site
2.3 loads for haulage to treatment or disposal per hour (average)	We have assumed a layout with three separate waste unloading bays in order to allow multiple vehicles to be filled at the same time. This is higher than would be seen at a facility of this size without deliveries from borla taxis.
400kg/m^3	Average density of the waste delivered to the TS
The waste storage volume required is 1,200m^3	The storage volume has been divided into three unloading bays, each 15 meters wide, with a maximum height of 3 meters of stored waste. Each bay will have waste with a depth of approximately 8 meters.

A TS facility of 150,000tpa would be able to comfortably fit on a site of 1.2 hectares. The basis of the calculations assumes a simple TS, all on one level, with three separate tipping areas, each with two or three doors for vehicles to maneuver into for tipping. Three separate tipping areas is more than would usually be needed for a TS of this size, so would allow for inefficient unloading from small vehicles. The designer of the TS will need to make assumptions about the proportion of space needed, as the unloading time for a borla taxi will be longer than for a refuse collection vehicle.

5.4 Haulage

Assuming that each of the TSs operate at maximum capacity (150,000tpa), and on the basis that each haulage vehicle carries a maximum load of 20 tons, a total of 7,500 loads will need to be moved in bulk from each TS to the Ayidan site per annum. A total of 24 loads will need to be hauled from each TS per day, assuming that each TS is operational for nine hours per day, six days per week. This is the equivalent of 480 tons per day.

Assuming that each haulage vehicle can perform two return trips each day (as with the Waste Capture Scenario and as described in section 4.5), 12 haulage vehicles will be required to serve each TS, or a total of 24 across the network. Including a minimum 10 percent contingency allowance for fleet unavailability in the event of breakdowns, servicing, or routine maintenance a total of 27 haulage vehicles would be required in the Lifecycle Scenario.

Based on the same assumptions as outlined in section 4.5 and as outlined in **Table 4.11,** seven RORO vehicles would be required for the internal movement of waste at the Ayidan site. This includes six vehicles to move shredded material from the MRF to the landfill, plus one spare. The difference between option C in the Waste Capture Scenario and the Lifecycle Scenario being that there will be no double handling of organic material in the Lifecycle Scenario and a marginal reduction in annual MRF capacity, meaning that one less RORO is required. This also reduces the requirement for spare vehicles from two to one.

Table 5.2: Ayidan site internal vehicle requirements, Lifecycle Scenario

Movement	ROROs	Spare
MRF to Landfill	6	1
Total		7

Source: Mott MacDonald

Our recommendations for mobile plant provision in the Lifecycle Scenario are included in **Table 5.3** below:

Table 5.3: Mobile plant requirements, Lifecycle Scenario

Facility	Loading Shovels	Spare
TS1	3	1
TS2	3	1
MRF	6	1
Total	14	3

Source: Mott MacDonald

One loading shovel would be required for each tipping bay per TS, with one spare. Six loading shovels would be required for the MRF with one spare.

5.5 No MRF option

If the MRF was removed from the project, there would still be a requirement for a reception building on site to prevent borla taxis and other unsuitable vehicles from driving on a working landfill site. Therefore, the maximum land available for landfilling would be approximately 23.7ha, meaning up to approximately 2,922,000 tons of waste, assuming a density of 0.8m^3/t, or 3,652,000 tons at a density of 1m^3/t.

6 Process flow diagrams

6.1 Approach

We have developed a series of process flow diagrams to illustrate the potential movement of captured waste within GAMA. The purpose of this is to demonstrate which MMDAs will deliver waste into each of the new waste management facilities and to show what will happen to the waste when it reaches the Ayidan site. For the Waste Capture Scenario, we have included:

- A conceptual map to illustrate the philosophy for the movement of waste from each MMDA to the new facilities (**Figure 6.1**);
- A process flow diagram for 2022 (**Figure 6.2**). This is the year that we have assumed that the new facilities will become operational;
- A process flow diagram for 2025 (**Figure 6.3**). All of the new waste management facilities are assumed to have been operational for a period of three years by this time;
- A process flow diagram for 2030 (**Figure 6.4**). The Ayidan landfill is estimated to become full prior to this point in time; however, we have included a diagram for this year to illustrate the quantity of waste that will need to be sent to a new landfill or another treatment facility if the TSs, MRF and organic treatment remained operational.

We have not specified waste sent to other existing facilities (i.e., those referred to in section 2.4) within our modeling or the process flow diagrams. This is because we have not been able to conduct a meeting with the operator of those facilities to determine the current and expected future throughput of the facilities and where the residues and products will be sent to.

6.2 Movement of waste

The objective of developing a network of new TSs is to reduce journey times associated with current waste disposal practices, to improve operational efficiency, and maximize formal network capacity and coverage. Our approach to determining which MMDAs deliver waste into which new waste management facility is based on the proximity principle, with the intention that each MMDA is able to deliver waste directly into its closest disposal point, whilst taking into account the

capacity of the new TSs and proximity to the major road network. Our justification for the selection of the Near LADMA Office site for TS2 is included in section 4.3.2.

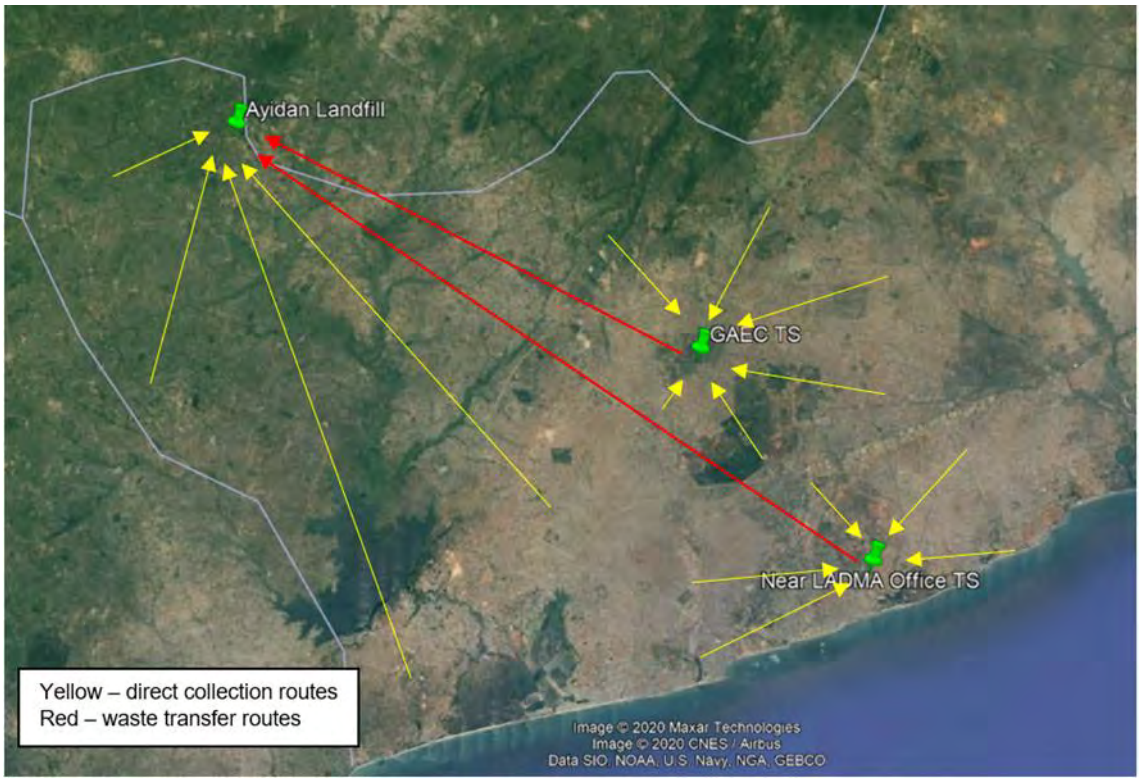
The movement of waste from each MMDA is summarized in **Table 6.1** and **Figure 6.1**. The intention is to provide one dedicated disposal point for each MMDA. However, waste from AMA has been split between each of the three new waste management facilities, given the large volume of waste generated within this MMDA.

Table 6.1: MMDA waste delivery points, Waste Capture Scenario

MMDA	Delivery 2022	Delivery 2025	Delivery 2030
ADENTA	TS1	TS1	TS1
AMA	TS1 / TS2 / Ayidan	TS1 / TS2 / Ayidan	TS1 / Ayidan
ASHMA	TS2	TS2	TS2
GCMA	Ayidan	Ayidan	Ayidan
GEMA	TS1	TS1	TS1
GSMA	Ayidan	Ayidan	Ayidan
GWMA	Ayidan	Ayidan	Ayidan
LADMA	TS2	TS2	TS2
LANMA	TS1	TS1	TS1
LEKMA	TS2	TS2	TS2
TEMA	TS2	TS2	TS2 / Ayidan

Source: Mott MacDonald, waste flow mode

Figure 6.1: MMDA movement of waste



Source: Mott MacDonald, waste flow model

6.3 Waste Capture Scenario process flow

The limiting factor in the movement of waste within the system is the capacity of the TSs and MRF. We have estimated that the capacity of each TS will be 400,000tpa and that the capacity of the MRF will be 400,000tpa. As the capacity of these facilities is fixed, but the quantity of captured waste is estimated to grow, there are points in time at which MMDAs may need to deliver a proportion of their waste to other facilities or directly to the landfill.

6.3.1 2022

In 2022, we have assumed that all MMDAs will deliver waste to the disposal points, as specified in **Table 5.1**. AMA would be required to deliver 61 percent of its waste to TS1, 20 percent to TS2, and the remaining 19 percent to the Ayidan MRF.

The MRF would also treat wastes delivered directly from GWMA, GSMA, and GCMA. We have assumed that it will recover 7 percent of waste inputs. Assuming that organic treatment will be fully utilized (80,000tpa), a balance of 948,195tpa is estimated to be landfilled. This would include 100 percent of the waste hauled from TS1 and 64 percent of waste hauled from TS2.

6.3.2 2025

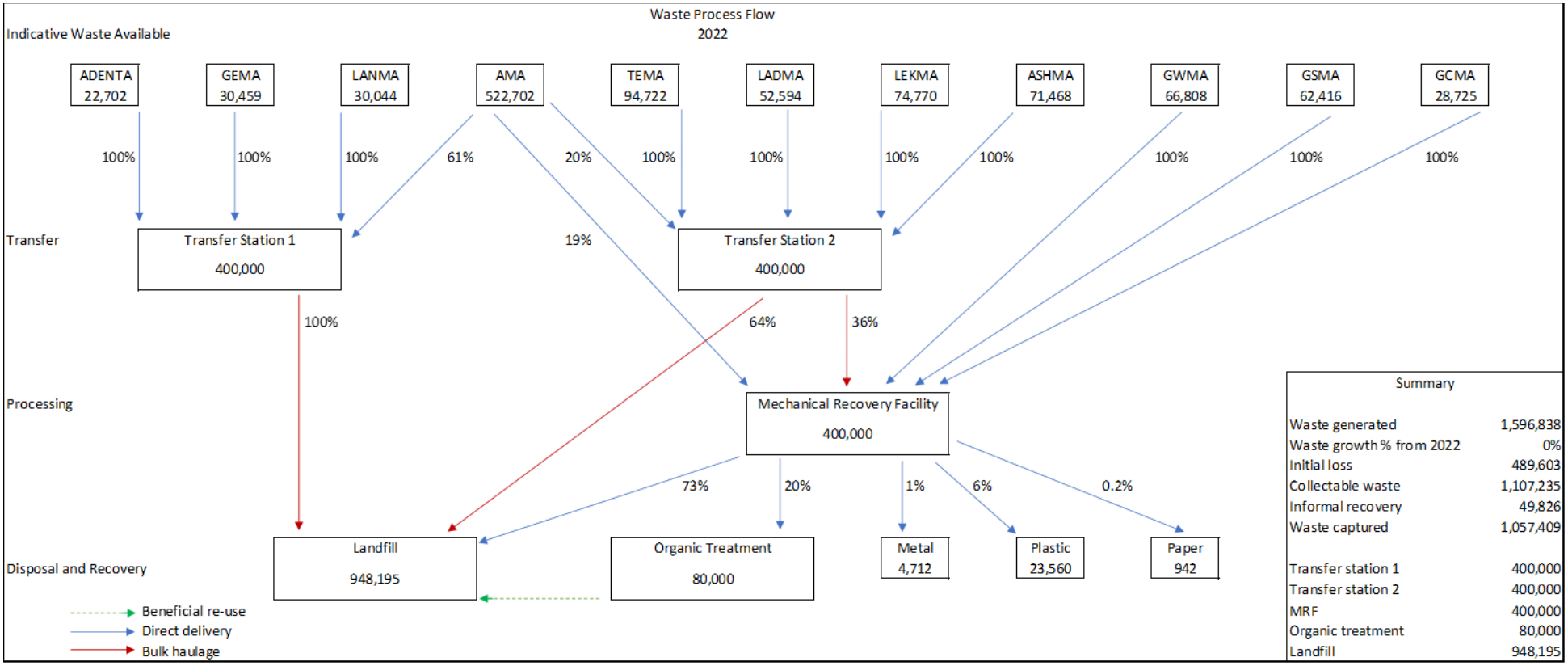
By 2025, the proportion of waste requiring direct delivery from AMA to the Ayidan MRF increases from 19 percent to 36 percent as more of the TS capacity is used for waste from other MMDAs

due to waste growth. Assuming that MRF recovery performance remains fixed at 7 percent and organic treatment remains fixed at 80,000tpa, an estimated balance of 1,088,504tpa would be sent to landfill, included an increasing proportion of waste hauled from TS2 (99 percent).

6.3.3 2030

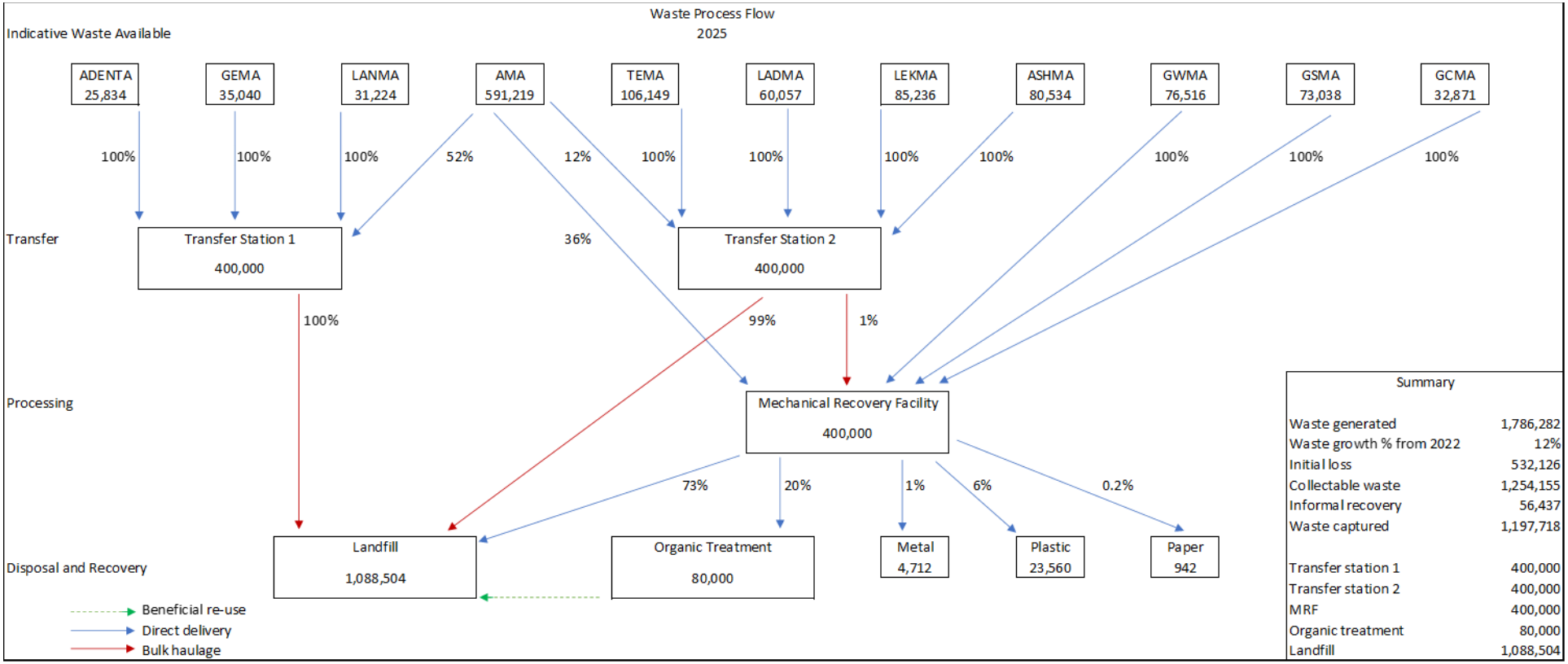
By 2030, we have assumed that the Ayidan landfill has reached full capacity as is no longer available for waste disposal. This would mean that an alternative disposal point would need to be found for all of the waste hauled from TS1 and TS2 and the residues from the Ayidan MRF (73 percent). AMA would no longer be able to deliver directly into TS2 as capacity would be utilized fully by other MMDAs. A proportion of AMA waste could continue to be delivered to TS1 (39 percent), with 22 percent delivered directly to the Ayidan MRF. The balance (40 percent) would need to be disposed of elsewhere. Further, 10 percent of waste from TEMA would need to be directly delivered to an alternative disposal point due to the capacity limit on TS2.

Figure 6.2: GAMA waste process flow diagram (2022) tpa



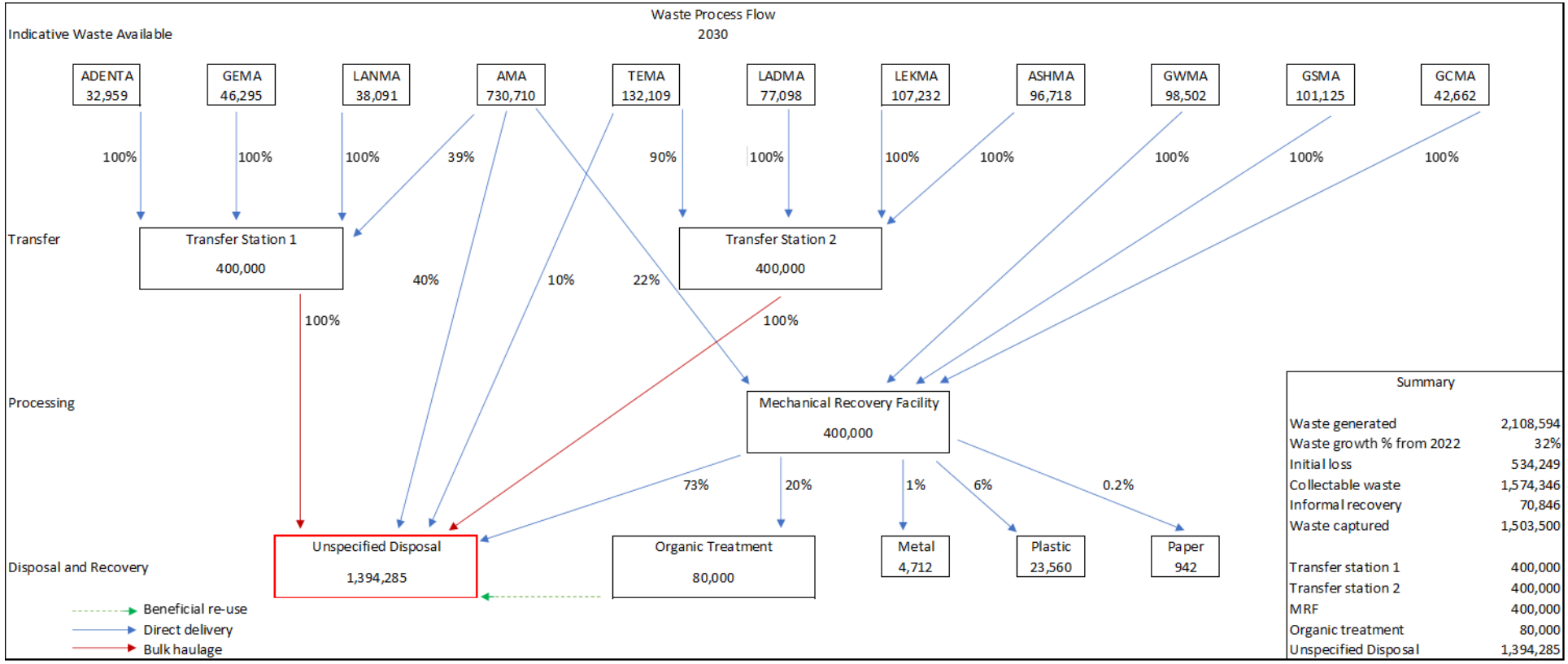
Source: Mott MacDonald

Figure 6.3: GAMA waste process flow diagram (2025) tpa



Source: Mott MacDonald

Figure 6.4: GAMA waste process flow diagram (2030) tpa



Source: Mott MacDonald

6.4 Lifecycle scenario process flow

Three PFDs have also been developed for the Lifecycle Scenario, showing the reduced amount of waste which will be managed through the Project. They show the tonnage flows, and also the amount of waste which will require treatment and/or disposal through other contracts.

Table 6.2: MMDA waste delivery points, Lifecycle Scenario

MMDA	Delivery 2022	Delivery 2025	Delivery 2030
ADENTA	TS1	TS1	TS1
AMA	TS1 / TS2 / Ayidan	TS1 / TS2 / Ayidan	TS1 / Ayidan
ASHMA	TS2	TS2	TS2
GCMA	Ayidan	Ayidan	Ayidan
GEMA	TS1	TS1	TS1
GSMA	Ayidan	Ayidan	Ayidan
GWMA	Ayidan	Ayidan	Ayidan
LADMA	TS2	TS2	TS2
LANMA	TS1	TS1	TS1
LEKMA	TS2	TS2	TS2
TEMA	TS2	TS2	TS2

Source: Mott MacDonald, waste flow model

6.4.1 2022

In 2022, all MMDAs are modeled as disposing of 35-38% of their waste with the Ayidan site.

TS 1 is supplied by 38% of the waste from ADENTA, GEMA, LANMA, as well as 23% of AMA's waste. TS 2 is supplied by 38% of the waste from TEMA, LADMA, LEKMA, and ASHMA, as well as 8% of AMA's waste. The MRF is supplied by 100% of both transfer station tonnages, 35% of GWMA, GSMA, and GCMA, and 7% of AMA's waste. The remainder of the waste arising from each MMDA, totaling 717,235tpa will require management outside of this Project.

For all years, the 390,000tpa MRF facility has been modeled to divert 28,485tpa of waste, whilst landfilling 361,515tpa to the Ayidan landfill.

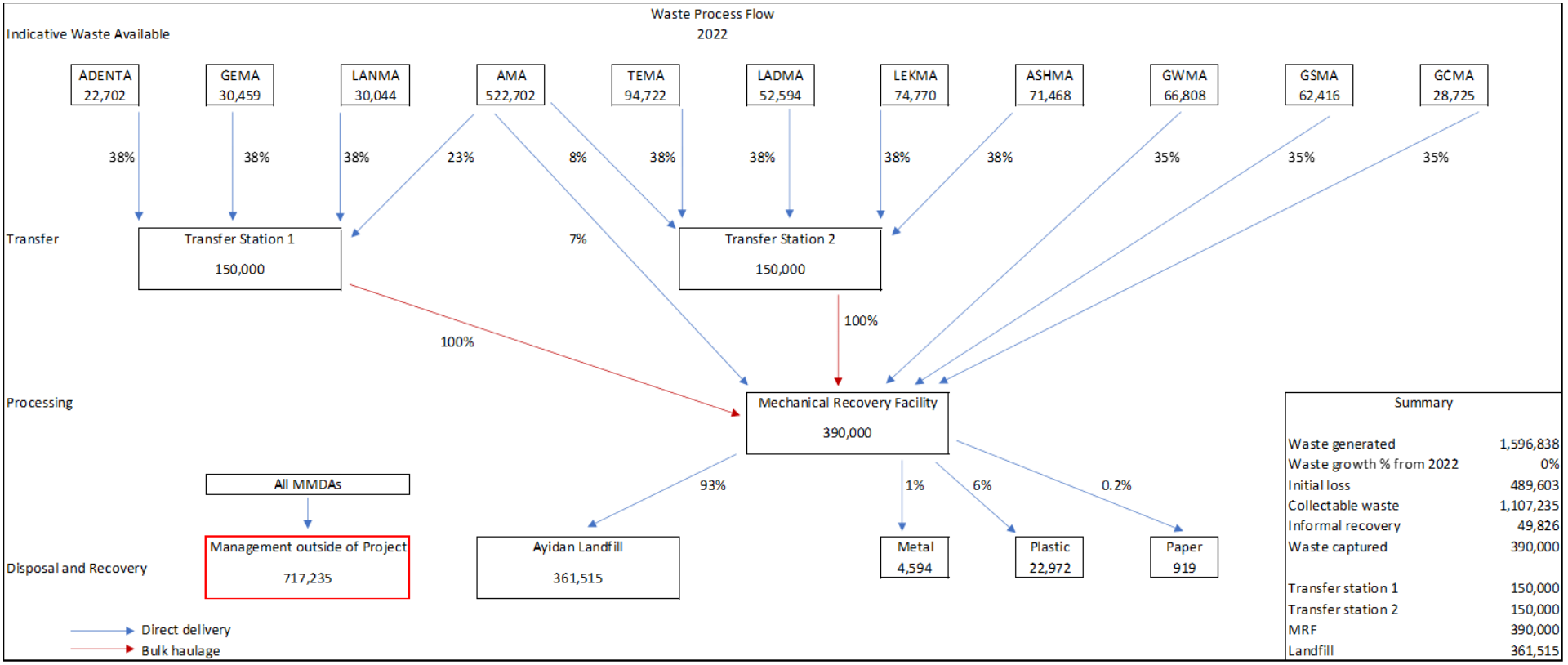
6.4.2 2025

In 2025, TS 1 is supplied by 38% of the waste from ADENTA, GEMA, LANMA, with a reduction to 20% of AMA's waste. TS 2 is supplied by 38% of the waste from TEMA, LADMA, LEKMA, and ASHMA, as well as 4% of AMA's waste. The MRF is supplied by 100% of both transfer station tonnages, 23% of GWMA, GSMA, and GCMA, and 8% of AMA's waste. The remainder of the waste arising from each MMDA, totaling 864,155tpa, will require management outside of this Project.

6.4.3 2030

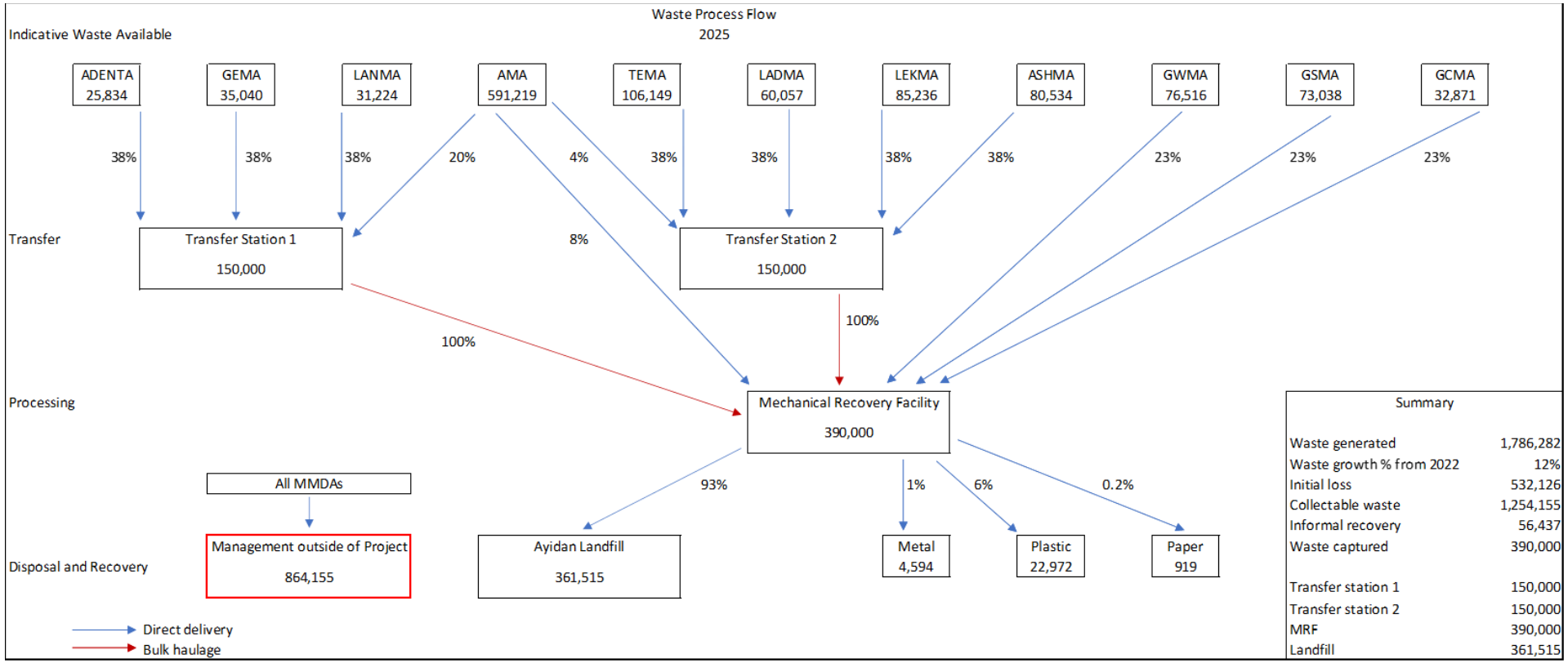
By 2030, transfer station one is supplied by 38% of the waste from ADENTA, GEMA, LANMA, with a reduction to 15% of AMA's waste. Transfer station two is supplied by 38% of the waste from LADMA, LEKMA, and ASHMA, as well as 34% of TEMA's waste. The MRF is supplied by 100% of both transfer station tonnages, 23% of GWMA, GSMA, and GCMA, and 5% of AMA's waste. The remainder of the waste arising from each MMDA, totaling 1,184,346tpa, will require management outside of this Project.

Figure 6.5: GAMA Lifecycle Scenario waste process flow diagram (2022) tpa



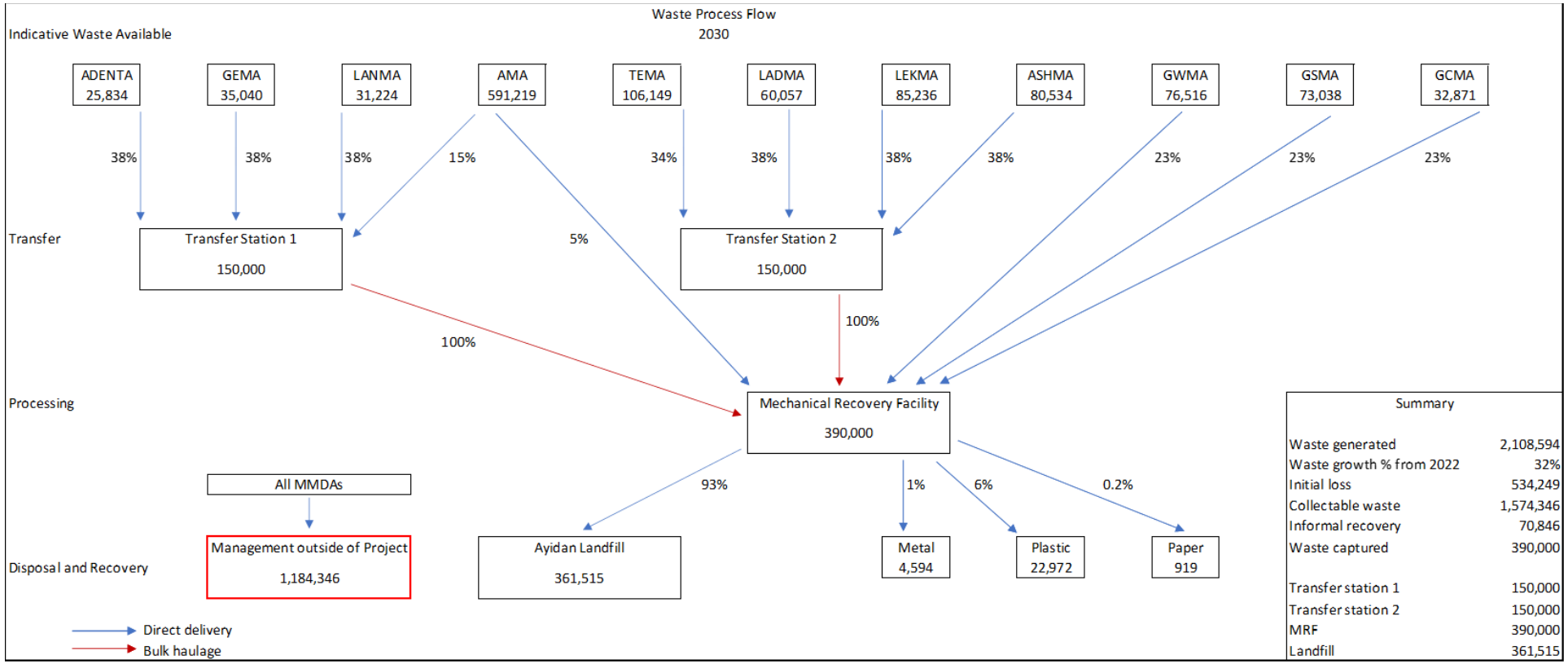
Source: Mott MacDonald

Figure 6.6: GAMA Lifecycle Scenario waste process flow diagram (2025) tpa



Source: Mott MacDonald

Figure 6.7: GAMA Lifecycle Scenario waste process flow diagram (2030) tpa



Source: Mott MacDonald

7 Conclusions

A summary of the key findings of the technical review of the sector and the new Project follows.

7.1 Overview of the sector

Across four elements of the value chain, we find:

- **Collection** – collection in GAMA is conducted by the formal private sector and the informal sector. Private sector operators bid and are granted short-term contracts that service specific areas of each MMDA. Additionally, communal collection sites are utilized to service markets and many medium- and low-income communities. These act as disposal points for those areas, although the collection frequency has been reported to be insufficient at some of the sites.
- **Transfer** – two large transfer stations have been developed in GAMA with a total stated capacity of 2,700 tons per day, both operated by the Jospong Group. It is understood that these are significantly underutilized, with a throughput of between 600 and 900 tons per day.
- **Treatment** – there are two sites in GAMA (ACARP with a capacity of 100,000tpa and IRECOP with a capacity of 70,000tpa). These facilities are both operated by the Jospong Group, and it is understood that they are operating significantly below capacity.
- **Disposal** – there are currently no engineered landfills operating within the GAMA waste management system. There are several semi-controlled dumpsites sites, the primary one currently adjacent to the old Kpone disposal site, which was shut down due to a fire. The current site has been reported to have very long queues (stated to be over 24 hours at times) and has informal waste pickers removing recyclables, predominantly plastics, from the areas where waste is disposed of.

7.2 Waste generation

The summary of the outputs of the waste flow model has been provided in **Table 7.1**.

Table 7.1: Waste flow model summary

Category	2020	2025	2030	2035	2040	2045	2050
Population	5,055,805	5,646,833	6,189,612	6,771,641	7,380,213	7,977,997	8,700,125
Kg (per capita per day)	0.800	0.867	0.933	1.000	1.067	1.133	1.200
Waste generated (tpa)	1,476,295	1,786,282	2,108,594	2,471,649	2,873,363	3,300,231	3,810,655

Average collection rate	69%	70%	75%	79%	80%	81%	82%
Informal recovery (tpa)	46,102	56,437	70,846	87,326	103,063	119,743	139,908
Waste collected and requiring treatment or disposal (tpa)	978,379	1,197,718	1,503,500	1,853,246	2,187,225	2,541,204	2,969,152

Source: Mott MacDonald

The waste flow model projects the expected waste to be captured in GAMA for the next 30 years. The significant growth in estimated waste collected and requiring treatment or disposal (from approximately 980,000tpa in 2020 to 2,970,000tpa in 2050) is based on several key observations and figures:

- A significant increase in population (approximately 72%20) is expected for GAMA during the period of the model;
- A continuous increase in the waste generated per person per day is expected; this value has been estimated at 50%21;
- Waste collection rates are expected to increase with continued investment into the GAMA waste management systems. The expected improvement is from a current average collection rate of 69% to 82% by 2050.

There is currently insufficient waste management and disposal infrastructure in GAMA, hence the need for new facilities. The rise in total waste generated, as well as waste captured in the GAMA area, will increase the pressure on waste management infrastructure, as well as the collection network.

7.3 Project sites and capacities

The Ayidan Project comprises of two new transfer stations, a materials recovery facility, and an engineered landfill site. Two scenarios have been investigated:

- The Waste Capture Scenario where all of the waste collected and requiring treatment or disposal is managed as part of the Project; and

[20] Housing Census Report, 2014

[21] Per capita waste generation is expected to continuously increase as GAMA develops economically and people are able to increase their consumption of goods.

- The Lifecycle Scenario where the volume of waste managed through the Project is limited, so that the Ayidan landfill site can operate for a period of 10 years.

7.3.1 Waste Capture Scenario

The Waste Capture Scenario has been developed in order to avoid the issues which arose at the Kpone disposal site, where more waste was delivered to the site than it was designed for, partly due to lack of other facilities or a robust waste management sector. As there are currently no other engineered landfills in GAMA that MSWR has control over, it was recommended that the Ayidan facility was designed to accept all collected waste requiring treatment and disposal as an interim solution, while the waste sector can be developed. Requirements for strengthening the sector are set out in the Enabling Environment Report.

The total volume of waste requiring management in GAMA is larger than a single facility could manage, so estimates have been made of feasible capacities for the transfer stations and Ayidan site. In particular, the Ayidan site is approximately 26.2 hectares and would have the capacity to accept waste from across GAMA for less than 3 years.

In addition to the landfill, both a dirty 400,000tpa MRF and an 80,000tpa organic treatment facility have been modeled. The MRF would be expected to divert approximately 7 percent of inputs as recyclate recovery, whilst the composting plant could provide stabilized material to be used as daily cover for the landfill. The inclusion of the organic treatment facility increases the lifespan of the Ayidan landfill by approximately two months. Although the increase in lifespan is modest, it would allow waste to be recycled or recovered for beneficial use and could extend the life of future landfills as well as the Ayidan site.

Two transfer stations have been modeled as part of the GAMA waste collection and transfer system; these are at the Ghana Atomic Energy Centre, which is already on a selected and available site, and the “Near LADMA Office” site, selected based on the list of suitable available sites provided. Each transfer station has been modeled to support 400,000tpa of waste movements, as this is the largest recommended capacity for a TS in the given context due to operational complexities of larger sites.

7.3.2 Lifecycle Scenario

In order to develop a project which has a longer lifespan, and therefore is more typical of a publicly procured waste management contract, the landfill life was set at 10 years. This corresponds to an annual capacity of 360,000tpa. This figure was used to scale down the MRF and the TSs, resulting in an MRF with a capacity of 390,000tpa, and two TSs of 150,000tpa. Smaller facilities mean that operational requirements are likely to be less complex, subject to specific design considerations (e.g., accommodating borla taxis).

The total annual tonnage that the Project could accept under this scenario is therefore limited to the total MRF capacity (390,000tpa), as all waste, whether direct delivered or via TSs would be treated by the MRF. This is the equivalent of 37% of collected waste requiring treatment and disposal in GAMA in 2022, decreasing to 26% in 2030 (due to overall waste growth).

In order for the Lifecycle Scenario to be developed, each MMDA would need to be able to direct exactly where collected waste is delivered to and to ensure that only waste allocated to this Project is delivered to the TSs or MRF.

Appendix A: Waste Flow Model

The full waste flow model developed is available as an Excel file and has been issued in parallel with this report. This appendix presents the assumptions and explanations of each element of the model.

A.1 Household waste composition

Household waste composition data for Accra has been identified across several documents. The breakdown of the data is provided in **Table A.1**.

Table A.1: Waste composition sources

Category	New Town	Ghana	Accra	GAMA	Average
Organic	63%	61%	66%	66%	64%
Paper	6%	5%	5%	5%	5%
Plastic	10%	14%	10%	10%	11%
Metal	2%	3%	3%	3%	3%
Glass	2%	3%	3%	3%	3%
Leather & rubber		1%	2%	2%	1%
Textile	5%	2%	2%		2%
Inert	12%	6%	5%	5%	7%
Miscellaneous		5%	4%	6%	4%

Source: Miezah et al, 2015 and Situational Assessment Report, 2019

The sources of the data are as follows:

- New Town – from Miezah et al, 2015. Figures are quoted as being from a 2008 study on household waste composition. New Town is part of Greater Accra.
- Ghana – from Miezah et al, 2015. These figures refer to the household waste composition of all ten regions of Ghana.
- Accra – from Miezah et al, 2015. These figures correspond to Accra, with a listed population of approximately 2 million. The source of this data is listed as “this survey,” and it is labeled as municipal solid waste, although based on the methodology, it is understood that this is solely corresponding to household waste.
- GAMA – from Figure 4.1 of the Situational Assessment Report, 2019. No further information on the source of this data or methodology is provided. This data is listed as material fraction components for the GAMA waste stream.

Figures from all of these sources are very similar and deviate only by a small range. Whilst there are anomalies, a general consensus on the makeup of waste composition is established.

For modeling purposes, the "Accra" composition has been utilized when splitting total waste quantities into individual material categories. This source was considered to be the most reliable as it is from a peer-reviewed paper and provides fractions for all primary material categories.

Prior to the development of any waste treatment facilities, it would be beneficial to carry out additional waste audits, ideally over a period of a year, sampling in the wet and dry seasons. Whilst no waste audit can be fully representative, the most up-to-date data available allow for more robust plant design.

A.2 Population growth

Forecasts on waste generation and growth are largely based on population projections, which estimate the expected population for different areas and years. Several population projections have been identified for GAMA; these are presented in **Table A.2**.

Table A.2: GAMA population forecast sources

Projection	2020	2025	2030	2035	2040	2045	2050
Situational Report	4,609,693	5,051,292	5,502,072	5,942,471	6,303,241	6,729,923	7,158,589
Housing census low	5,033,153	5,593,658	6,090,698	6,607,135	7,124,167	7,598,870	8,152,331
Housing census medium	5,055,805	5,646,833	6,189,612	6,771,641	7,380,213	7,977,997	8,700,125
Housing census high	5,141,881	5,848,900	6,565,679	7,399,055	8,365,466	9,461,065	10,895,228

Source: Situational Assessment Report, 2019 and Housing Census Report, 2014

The sources of these population forecasts are as follows:

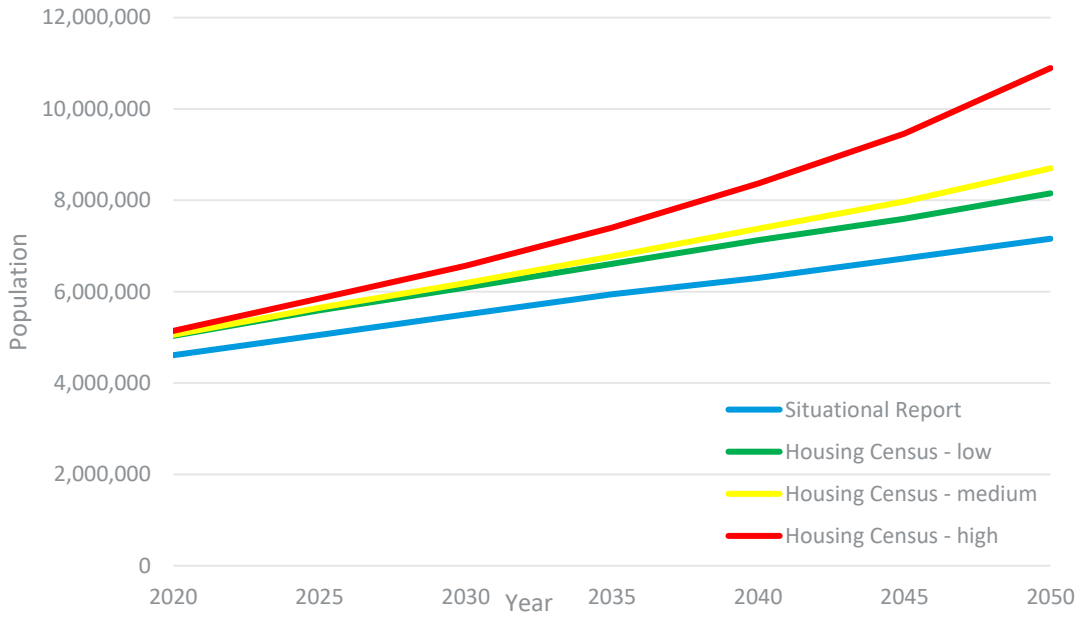
- Situational Report – from Table 3.15 of the Situational Assessment Report 2019. This information has been listed as having been obtained from the Ghana Statistical Service (GSS), although this could not be verified, and the same figures were not obtained whilst searching the GSS archive.
- Housing census – from the Housing Census Report, 2014[22]. This document provides data for a low, medium, and high population projection variant for Ghana, as well as a medium variant for Greater Accra. In the medium variant, the population of Greater Accra is equivalent to 16% of the population of Ghana. This same percentage was utilized in order

[22] https://www2.statsghana.gov.gh/docfiles/2010phc/Mono/Ghana%20Population%20Prospects.pdf, accessed 28/09/2020

to calculate the Greater Accra population for the high and low variants, which was calculated as 16% of the Ghana population forecast.

This data has also been provided in **Figure A.1**.

Figure A.1: GAMA population projections



Source: Situational Assessment Report, 2019 and Housing Census Report, 2014

Additional population forecast data is available for Ghana at a national level from the World Bank23. This data is not directly comparable to the GAMA figures from **Table A.2**, but a comparison with the Ghana population forecast available in the Housing Census Report, 2014, suggests that World Bank estimates (47 to 57 million people by 2050) are generally lower than those estimates from the Housing Census Report, 2014 (49 to 66 million people by 2050).

The population forecast utilized for further waste growth modeling was the housing census medium scenario. The population growth percentage for this scenario in comparison to 2020 figures is provided in **Table A.3**.

Table A.3: Housing census medium scenario, population growth compared to 2020

Projection	2020	2025	2030	2035	2040	2045	2050
Housing census medium	0%	12%	22%	34%	46%	58%	72%

Housing Census Report, 2014

[23] The World Bank. "Population Estimates and Projections". Accessed September 29, 2020. https://datacatalog.worldbank.org/dataset/population-estimates-and-projections

A.3 Waste growth scenarios

Waste growth has been calculated based on the population growth data provided and a series of waste generation figures and assumptions. In total, four different waste growth scenarios were initially developed for GAMA, these were as follows:

- Baseline scenario: devised with the same projection methodology and population growth figures as that of the Situational Assessment Report, 2019. This scenario utilized a 0.8kg per capita per day generation rate, which was based on the 0.74kg figure from Miezah et al., 2015 and adjusted to account for an assumed increase in per capita waste generation between 2015 and 2020. The 0.8kg figure was then utilized as a constant to 2050.
- Projection 1 – This scenario utilizes the medium population variant of the Housing Census Report, 2014, as well as the 0.8kg per capita per day estimate for 2020. This figure is linearly increased to 0.86kg per capita per day by 2050 to reflect an increase in affluence across GAMA, to bring it in line with the generation rate currently associated with the richer areas of Accra.
- Projection 2 – This scenario utilizes the medium population variant of the Housing Census Report, 2014, as well as the 0.8kg per capita per day estimate for 2020. The generation per capita is linearly increased to 1.2kg per capita day by 2050 to reflect the generation rate associated with an increase in wealth across the city, as well as development to more closely reflect other emerging African capital cities and nations. Some examples of other waste generation rates have been extracted from Miezah et al., 2015:
  - Cairo, Egypt, 1.3kg per capita per day;
  - Juba, South Sudan, 1.11kg per capita per day;
  - Cape Town, South Africa, 0.7 to 1.3 kg per capita per day;
- 1.2kg per capita per day was considered a reasonable estimate as it is in line with World Bank forecasts, whereby low and middle-income countries' waste is expected to grow by 40% or more by 205024. Reaching 1.2kg is a 50% growth, taking into account the development in Accra.
- Projection 3 – This scenario utilizes the high population variant of the Housing Census Report, 2014, as well as the 0.8kg per capita per day estimate for 2020. This figure is linearly increased to 1.2kg per capita per day by 2050.

The resulting waste projections from these four models is provided in **Table A.4** and **Figure A.2**.

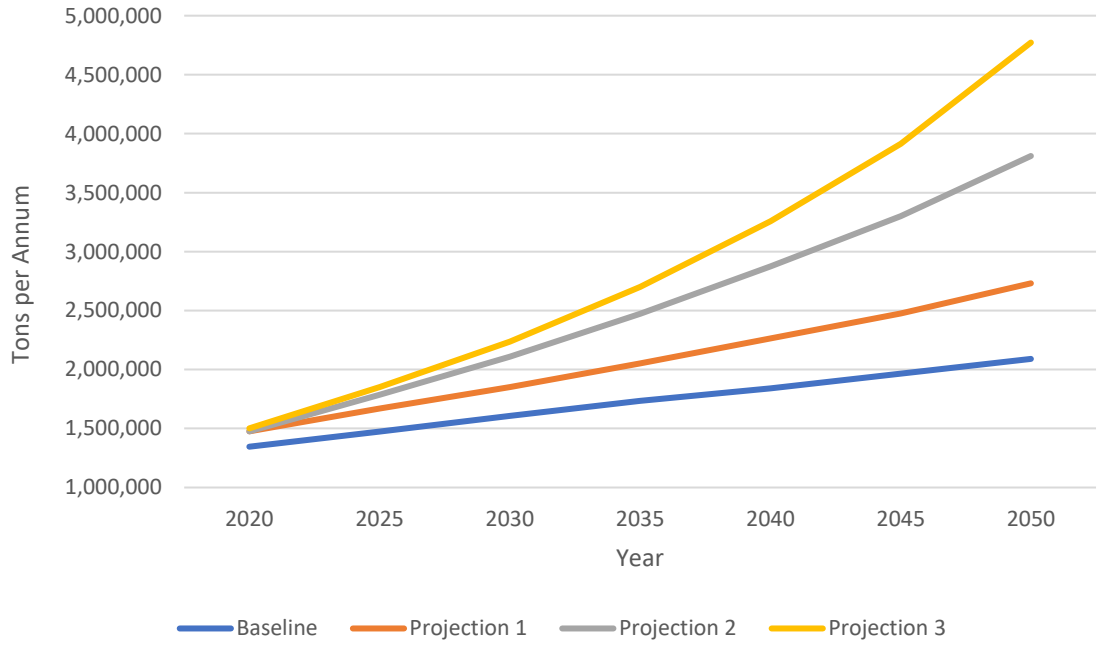
[24] The World Bank. "Trends in Solid Waste Management" http://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

Table A.4: GAMA waste projection results (tons per annum)

Projection	2020	2025	2030	2035	2040	2045	2050
Baseline	1,346,030	1,474,977	1,606,605	1,735,202	1,840,546	1,965,138	2,090,308
Projection 1	1,476,295	1,669,486	1,852,551	2,051,469	2,262,773	2,475,174	2,730,969
Projection 2	1,476,295	1,786,282	2,108,594	2,471,649	2,873,363	3,300,231	3,810,655
Projection 3	1,501,429	1,850,202	2,236,708	2,700,655	3,256,955	3,913,727	4,772,110

Source: Mott MacDonald

Figure A.2: GAMA waste projections



Source: Mott MacDonald

Projection 2 was selected for further analysis in the waste flow model. Both the baseline projection and Projection 1 do not accurately reflect expected trends regarding waste generation, as they provide either static or very minor growth in waste generation per capita. These figures are not viewed as representative of a rapidly developing capital city with a significant GDP per annum growth. Projection 3 is based on the high population growth variant from the Housing Census Report, 2014, which predicts a 2050 population that is significantly higher than other estimates encountered and therefore has not been selected for further modeling.

A.4 Collection and recovery model

The collection rates utilized for the collection and recovery model have been sourced from the Strategy and Action Plan25. This is the only source of data identified for these figures, which in turn lists its source as the MMA Environmental Health and Sanitation Directorate and Waste Management Department officials.

Our collection model utilizes the source collection percentage figures for each MMDA as a static value until 2024. The model has assumed that there will then be an increase of 1% per annum in collection efficiency in each MMDA from 2025 onwards. This growth rate has been selected on the assumption that MMDAs with lower collection rates will slowly and steadily increase their capture efficiency, as would be expected with increased waste awareness, policy, and investments across 30 years. Each MMDA has been capped at a maximum collection fraction of 85% to reflect inevitable losses associated with informal collection systems, which are often challenging to monitor, as well as fly-tipping, burning, etc. The results of modeled collection rates are provided in **Table A.5**.

Table A.5: GAMA waste collection percentages

MMDA	2020	2025	2030	2035	2040	2045	2050
ADENTA	72%	73%	78%	83%	85%	85%	85%
AMA	74%	75%	80%	85%	85%	85%	85%
ASHMA	91%	91%	91%	91%	91%	91%	91%
GCMA	60%	61%	66%	71%	76%	81%	85%
GEMA	50%	51%	56%	61%	66%	71%	76%
GSMA	35%	36%	41%	46%	51%	56%	61%
GWMA	73%	74%	79%	84%	85%	85%	85%
LADMA	70%	71%	76%	81%	85%	85%	85%
LANMA	70%	71%	76%	81%	85%	85%	85%
LEKMA	80%	81%	85%	85%	85%	85%	85%
TEMA	80%	81%	85%	85%	85%	85%	85%
Average	69%	70%	75%	79%	80%	81%	82%

Source: Mott MacDonald, based on data from the GAMA ES Strategy and Action Plan, 2018.

ASHMA currently represents the MMDA with the highest collection rate, which has been listed at 91%. For this reason, the collection rate of ASHMA has been kept unchanged in the model. It is

[25] Integrated Urban Environmental Sanitation Master Plan

believed that other MMDAs can improve their collection rates over time, particularly as ASHMA already showcases that this can be achieved.

Waste was further removed from the generated waste quantities by separating the total tonnages into their respective waste composition fractions and incorporating a recovery element by the informal recycling sector. The recovery fractions estimated have been based on the stakeholder consultations held and our experience of other places with an informal sector separating recyclables from the waste stream. The figures are not supported by quantitative field data. The recovery fractions estimated are as follows:

- 10% informal recovery of paper waste;
- 25% informal recovery of plastic waste; and
- 50% informal recovery of metal waste.

No other material recovery has been included in the waste flow model other than for the MRF.

Based on these assumptions, the final tonnages of waste collected and requiring treatment or disposal for the Project have been calculated. These are presented in **Table A.6**, along with the summary of other key indicators.

Table A.6: Waste flow model summary

Category	2020	2025	2030	2035	2040	2045	2050
Population	5,055,805	5,646,833	6,189,612	6,771,641	7,380,213	7,977,997	8,700,125
Kg / person / day	0.800	0.867	0.933	1.000	1.067	1.133	1.200
Waste generated (tpa)	1,476,295	1,786,282	2,108,594	2,471,649	2,873,363	3,300,231	3,810,655
Average collection rate	69%	70%	75%	79%	83%	84%	85%
Informal recovery (tpa)	46,102	56,437	70,978	88,116	107,260	125,127	146,114
Waste collected and requiring treatment or disposal (tpa)	978,379	1,197,718	1,503,500	1,853,246	2,187,225	2,541,204	2,969,152

Source: Mott MacDonald

The performance data for new facilities is discussed in section 4 of the report.

Appendix B: Summary of Stakeholder Consultation

Table B.1: Stakeholder consultation meeting schedule

Stakeholder	Sector Focus	Date
GA West Assembly	Public	11/09/2020
GA East Assembly	Public	14/09/2020
Ministry of Sanitation and Water Resources	Public	15/09/2020
Accra Metropolitan Assembly	Public	16/09/2020
J Stanley Group Private Contractor	Private	16/09/2020
Asedu Private Contractor	Private	18/09/2020
Tema Metropolitan Assembly	Public	18/09/2020
Jekora Ventures Private Contractor	Private	22/09/2020
Elsie Odonkor, Informal Sector and recycling	Informal	23/09/2020
Ghana National Cleaner Production Centre	Public/Informal	23/09/2020
Ministry of Finance	Public	02/10/2020
Kpone Katamanso Assembly	Public	05/10/2020
La Nkwantang Madina Assembly	Public	05/10/2020

Source: Mott MacDonald

Appendix C: List of GAMA MMDAs

The current list of MMAs and MMDAs within the GAMA region is as follows:

- Ablekuma Central Municipal
- Ablekuma North Municipal
- Ablekuma West Municipal
- Accra Metropolitan
- Adentan Municipal
- Ashaiman Municipal
- Ayawaso Central Municipal
- Ayawaso East Municipal
- Ayawaso North Municipal
- Ayawaso West Municipal
- Ga Central Municipal
- Ga East Municipal
- Ga North Municipal
- Ga South Municipal
- Ga West Municipal
- Korle Klottey Municipal
- Krowor Municipal Assembly
- Kpone Katamanso Municipal
- La Dade Kotopon Municipal
- La Nkwantanang Madina Municipal
- Ledzekuku Municipal
- Okaikwei North Municipal
- Tema Metropolitan
- Tema West Municipal

Additionally, the following MMDAs are part of GAR, but not GAMA:

- Ada West District
- Ada East District
- Ningo Prampram District
- Shai Osudoku District

Appendix D: Review of preliminary design concept

The review of the preliminary design will be carried out once it is completed by third parties and made available to us.

We have received a copy of the ToR for the design consultant work and believe that there are a number of areas where further information is needed in order for bidders to be able to respond in detail and to reduce the risk of the design being unsuitable for a sanitary landfill. A high-level review of the ToR is outlined below. A full review of the ToR for the landfill design work is outside the scope of our assignment.

Technical parameters

- It would be beneficial to define the following parameters in order to minimize the risk of the design consultant designing a facility that does not meet the typical standards of a sanitary landfill.
- There are currently insufficient engineering parameters defined – "lining the landfill base with appropriate clay and plastic geomembranes, as needed to protect underground water resources" does not define the system. The EU defines engineering by way of the equivalent of a 1m thick mineral layer with permeability < 1 x 10-9m/s plus a sealing layer (which should be a 2mm thick welded geomembrane).
- Determination of gas extraction (see Task 2.2 – 5th bullet) for utilization would usually be a separate project. This may be better placed outside of the design contract. It would be feasible to address this at a later stage and drill boreholes into waste from above.
- Emission monitoring requirements, i.e., how many monitoring installations – these should ideally be monitored for at least six months prior to waste deposits
- It would be beneficial to define the standards for aspects such as:
  - Gatehouse and administration buildings (e.g., staff numbers, office size, permanent construction or portacabin)
  - Fencing – e.g., 2.1-meter-high with three strands of barbed wire
  - Road construction – length of permanent roads vs. temporary
  - Leachate collection and treatment systems
  - Need for a wheel wash and expectations
  - The proximity of service connections
- The discharge location for surface water and potentially treated leachate needs to be defined. This identifies roughly the length of surface water drainage likely to be required.
- The design would be impacted by the geotechnical and hydrogeological conditions. For instance, there could be a need for an underdrain to be installed under any engineering

containment, and there could be a need for excavation of soft material. This is unknown because a ground investigation would be required prior to design.

Program

The timeline for the project is short, particularly as a site investigation and geophysical study is required. Typically, there would be four to six months to the point of delivery of a concept design and then acceptance. This would be followed by a period of two months to develop the concept to a preliminary design, suitable for use in a tender process. Tender documents would need to be produced concurrently with the development of the preliminary design.

Currently, the ToR has the following timeframes:

- First phase is 13 weeks to the delivery of the draft tender documents
- There is a 4-week period for delivery of the final tender documents

Development of concept

As there is currently no break in the development of the design, it would be beneficial to develop initial information and documentation first to develop a concept. Next, break the program to agree to the concept before developing the project further. The following items would need to be determined and agreed upon:

- Outline of the project boundary, based on land ownership
- Determination of the capacity expected
- An estimate of waste to be deposited each day, based on expectations, material capture, material diversion estimates
- Understanding of the ground conditions, at least described through a walkover of the site
- Identification of preferred access point to the site
- Development of a baseline review, which would include:
  - A literature review of geotechnical conditions,
  - An understanding of the hydrogeological situation
  - Topographic survey (see Task 2.1 – 4th bullet)
  - Weather patterns (see Task 2.1 - 10th bullet)
  - Potential service connections (water, gas, electricity)
  - Traffic studies including as constructed capacities (see Task 2.1 – 9th bullet) – the design consultant would not usually be responsible for improving the road network outside of the site boundary

Task 1.1 should then be to check acceptance of the aspects noted, rather than to develop these:

- Findings of the ESIA, including any significant species and any on-site wetlands (Task 2.1 – 8th bullet) – this should be part of the ESIA and not part of the design consultant's work.

- The socio-economic and cultural background task needs to be defined (Task 2.1 – 11th bullet) - the design consultant could undertake this task, but it needs to be defined.

Key performance indicators

It is recommended that KPIs are included within the contract with the design consultant in order to have the ability to monitor work and set standards. Useful KPIs include:

- Identifying the site investigation required (boreholes), as otherwise, the consultant could do the minimum (see Task 2.1 – 5th bullet and 7th bullet), although further monitoring points are likely to be required (although the ToR is silent on this)
- Define KPI for Task 2.1 – 12th bullet
- Task 2.2 does not have any predefined KPI – these should be defined as the design consultant does not have any indication of what measures need to be met
- Engineering properties of any landfill containment measures
- Discharge parameters to be achieved for treated leachate and if the leachate is to then be subject to further treatment at a water treatment facility or going to be discharged to a river

The following should also be undertaken by the design consultant as part of the first phase:

- Develop the site investigation and then procure it and supervise the installation
- The site investigation should include monitoring points for future monitoring
- Geophysical survey (Task 2.1 – 6th bullet)
- Study slope stability to establish a stable profile, including the stability of restoration materials
- The production of a design report, as indicated in Task 1.5

Once the above is complete and accepted, it would be feasible for the remaining aspects of the ToR to be completed as a second phase of the overall design work.

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Commercial Report

Financial and Economic Advisory for a Solid Waste Management Project in the Greater Accra Region, Ghana

February 2021

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Definitions

ACARP	Accra Compost and Recycling Plant
BOT	Build-Operate-Transfer
CAPM	Capital Asset Pricing Method
EPC	Engineering, Procurement, and Construction
GAMA	Greater Accra Metropolitan Area
GARID	Greater Accra Resilient and Integrated Development Project
GDP	Gross Domestic Product
GHS	Ghanaian cedi
IFC	International Finance Corporation
MMDA	Metropolitan, Municipal, and District Assembly
MRF	Materials Recovery Facility
O&M	Operations and Maintenance
PPP	Public Private Partnership
PSP	Private Sector Participation
SPV	Special Purpose Vehicle
TS	Transfer Station
WACC	Weighted Average Cost of Capital

Executive summary

The World Bank Group, with other partners, is assisting the Government of Ghana with the implementation of the Greater Accra Resilient and Integrated Development Project (GARID Project). Under the GARID Project, the World Bank intends to finance the Ayidan project (the Project) to address immediate gaps in Accra's final waste disposal capacity. The Project is expected to include an engineered landfill, up to two transfer stations, and possibly a materials recovery facility. The Project could also help solve other sector problems by moving toward sustainability through long-term planning and building a cost recovery culture. However, these broader changes are dependent on the Government's choices.

Castalia and Mott Macdonald (the Consultant) has been engaged to evaluate the Ayidan Project's technical and commercial structure, assess potential Private Sector Participation (PSP) models for the Project, and opine on the enabling environment for PSP for the Project. This report presents a potential role for the Project in the sector; business models that have a reasonable potential for succeeding; commercial analysis of these business models; and an assessment of Government funding that could be available to cover the costs of the business models. The analysis presented has been prepared with consideration given to the views of investors and market participants.

The sector can use the Ayidan landfill to create a long-term solution for critically needed landfill capacity

The Project could be developed in a way that will enable it to deliver long-term benefits to the sector. To ensure sustainability and maximize the Project's life, Government will need to make choices about how to organize, manage, and regulate the sector, and then make changes to implement those choices. The first of the choices required to ensure that the Project delivers long-term benefits relates to how the sector manages waste flows to the Project site, and to other sites. For the Project, waste reception must be limited to 360,000 tons per annum (which equates to 37 percent of captured waste in 2022) to extend the landfill's lifespan to 10 years. Defining waste capture zones for specific landfill sites is one way to deliver the change needed.

The Project's performance, costs, and affordability will vary depending on the business model chosen

Table 0.1 describes two types of business models: (1) an unbundled model, which includes an EPC and long-term O&M contract in which the O&M firm finances the purchase of operating equipment; and (2) a bundled model, which is a build-operate-transfer (BOT) model in which private investors, and potentially MDBs, place equity and debt in a special purpose vehicle (SPV). The SPV signs a contract with the Government to build, operate and maintain the Project. Analysis of various options suggests that both the bundled and unbundled structures have pathways to commercial viability and sustainability. Both models could align the economic life of operations equipment with the life of the landfill, which would enable a private operator to optimize costs and mitigate risks over the anticipated 10-year life of the Project.

Table 0.1: Potential Business Models

Name	Functions and roles	Payment mechanism	Risks
Unbundled: EPC of fixed infrastructure and private finance of mobile equipment along with a long-term O&M	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	▪ The EPC contractor's remuneration is the same as the previous model. ▪ The O&M firm finances mobile equipment and collects tipping fees to recover those equipment costs and the costs of maintenance and operations.	▪ Government still takes cost overrun risks ▪ This will require implementing measures to control waste flows to the site
Bundled: Build-Operate-Transfer (BOT) 10 years or less	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	▪ The Government/World Bank finances capital costs, except for mobile equipment. Operator finances private equipment and collects user fees to recover these costs.	▪ This will require implementing measures to control waste flows to the site ▪ Over or under-delivery of waste could trigger contingent liabilities ▪ Private sector interest may be low given contract length and challenges in controlling waste flows

For each of the models, the annual capacity of the transfer stations (300,000 TPA) and the MRF (400,000 TPA) are expected to be the same, as is the total capacity of the landfill (3,600,000 tons). Table 0.2 shows the operational costs per ton in US dollars for each project component. These costs include contractor margins in the EPC + O&M models and the return on capital for the privately financed models.[1] Next, the table presents the PV of all payments to the Project over its term. All payments are discounted at the Government of Ghana's borrowing cost in US dollar terms[2]. The annual payments in real US dollar terms to the contractor follow, and the last row presents the PV of cumulative 10-year O&M cash flow per ton of waste processed for each of the business models.

[1] It is expected that contractors would assign margins to both EPC and O&M contracts executed within the BOT project structure as they would in the unbundled structure. However, as the BOT contractor would eb expected to manage costs of all inputs, these margins have been omitted. Detailed analysis of these margins and costs should be conducted during a full feasibility study.

[2] Government of Ghana cost of borrowing in US$ (7.9%), February 2020 14-year US$ Bond Issuance Government of Ghana, Ministry of Finance. See: https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount. Accessed 26 February 2021

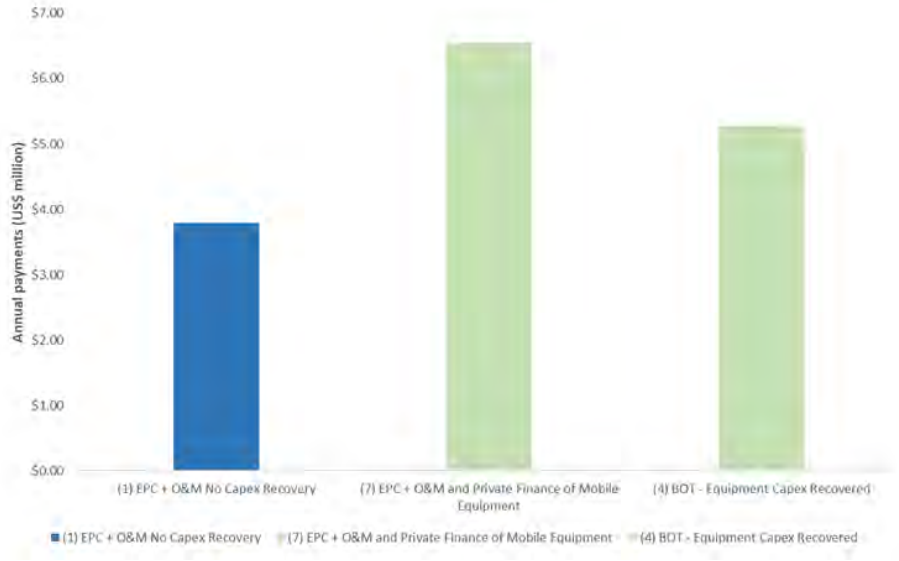
Table 0.2: Business model comparison

	Unbundled EPC & long-term O&M	Unbundled EPC & long-term O&M + private finance of equipment	Bundled BOT
Project Life (Years)	10	10	10
Degree of Capital Cost Recovery	No capital costs recovered within Project	Capital costs of mobile equipment are recovered	Capital costs of mobile equipment are recovered
Outputs			
Landfill (US$/ton)	4.36	7.13	5.71
MRF (US$/ton)	3.00	4.70	3.75
Transfer Station (US$/ton)	3.55	7.11	5.91
PV of payments (US$ Million)	25.65	44.34	35.69
Annual Payment to Contractor (US$ Million)	3.79	6.55	5.27
PV of cumulative 10-year O&M cash flow per ton of waste processed (US$/ton)	6.64	6.64	3.73

It is anticipated that each model will face an annual viability gap based on forecasts of the money that may be available to fund the Project. However, the data gathered provides conflicting estimates of Government funds available, so it is not possible to quantify the viability gap. To earn the required return, the bundled model requires annual payments of US$5.27 million, while the unbundled model with private financing of equipment option requires annual payments of US$6.55 million.[3] The unbundled model with no private financing requires the lowest annual payments of US$3.79 million. Any benefits achieved by reducing payments to the contractor would be offset, to a degree, from the Government needing to repay any loan taken to purchase the operating equipment required for the Project to achieve a higher level of service.

[3] Annual revenue requirements reflect the net revenue a firm would require to recover all costs, including a reasonable rate of return.

Figure 0.1: Annual payments to Project, US$ millions (real)



Sensitivity analysis suggests that the alternatives to the envisaged Project scope should be considered

As the Project is currently at the pre-feasibility stage, key cost drivers will change along with a clear definition of the Project's scope and business model. Changes in these cost drivers—including Opex, Capex, and the cost of capital—will have impacts of varying degrees on all the models. While these impacts will change between options, the extent of the change across options will remain relatively constant. Therefore, sensitivity analysis has been conducted on only the *bundled BOT option with private financing of operating equipment* (Base Case) only, which is the best performing model for balancing cost reductions and risk transfer.

Table 0.3 compares the impact changes in Capex, Opex, and the cost of capital to the Base Case's results. The table also includes a seventh sensitivity that shows the impact of developing the Project without an MRF. The MRF is expected to reduce the final disposal of waste at the landfill by 7 percent but requires almost 25 percent of the total Capex. Therefore, it is worth considering whether the added costs of the MRF justify the 7 percent reduction in final waste disposed at the landfill.[4]

Table 0.3: Sensitivity analysis

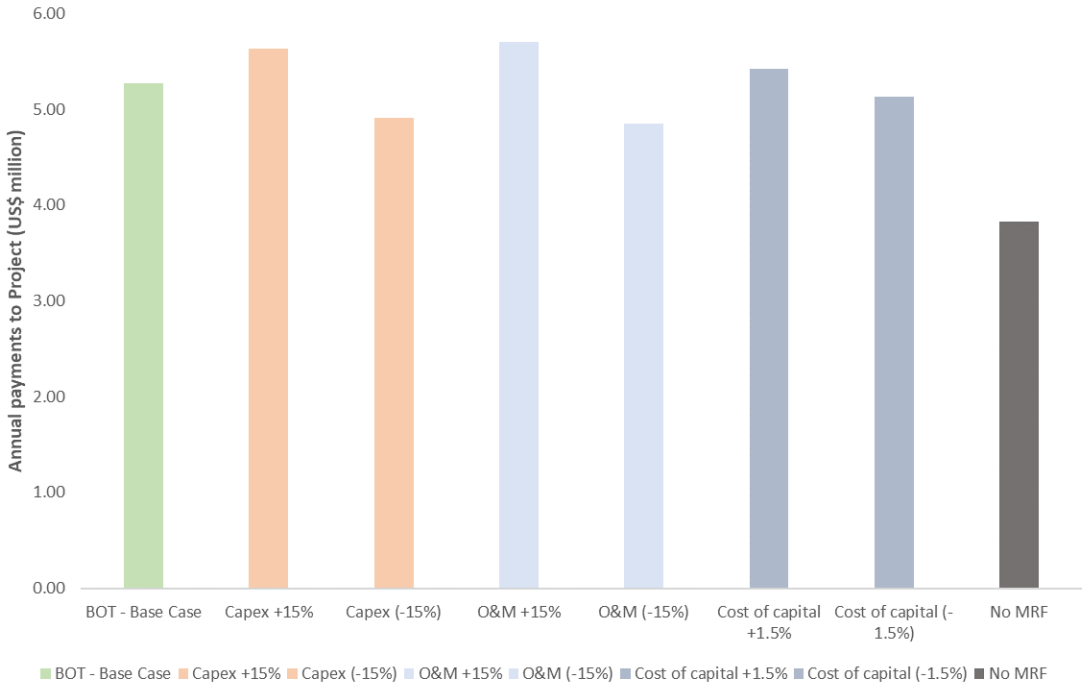
	Base Case	Capex +15%	Capex (-15%)	O&M +15%	O&M (-15%)	Cost of Capital +1.5%	Cost of Capital (-1.5%)	No MRF

[4] Changes in waste flows have not been modeled as part of the sensitivity analysis, because the impact on waste flows is anticipated to be within the margin of error for the Project.

Landfill (US$/ton)	5.71	6.07	5.34	6.20	5.22	5.86	5.56	5.71
MRF (US$/ton)	3.75	3.97	3.52	4.08	3.41	3.84	3.66	0.00
Transfer Station (US$/ton)	7.24	6.41	5.43	6.31	5.51	6.11	5.72	5.91
Levelized O&M cost per ton, *excluding Capex* (PV O&M costs / PV tons) (US$/ton)	4.99	4.79	4.79	5.51	4.07	4.76	4.81	2.75
Levelized costs, *including Capex* (PV all costs / PV tons) (US$/ton)	19.36	18.87	15.19	17.75	16.31	16.99	17.07	10.92
Annual Payment to Contractor US$ Million	5.27	5.64	4.91	5.70	4.85	5.42	5.13	3.83

Excluding the MRF is expected to reduce the annual payment required to the Project in real terms by approximately 27 percent. In dollar terms, excluding the MRF is expected to reduce the annual payment by US$1.45 million per year compared to the Base Case (see Figure 0.2).

Figure 0.2: Annual payments to the Project, US$ millions (real)



Excluding the MRF from the Project is expected to reduce the present value of cumulative 10-year O&M cash flow per ton of waste processed (Levelized O&M costs) by approximately 45 percent

compared to the Base Case and has lower Levelized O&M costs than all options presented in the previous section.

The financial analysis uses inputs for Capex and Opex based on benchmark projects and industry knowledge, and cost of capital inputs based on calculations and industry benchmarks

Capex and Opex estimates are based primarily on benchmarks taken from two integrated waste management projects in Africa and informed by professional engineering evaluation of the situation in GAMA. The configuration of each benchmark project broadly aligns to that of the technical concept for the Project.[5] The benchmark data has been adjusted to reflect the Project's tonnage profile and sizing (footprint). These costs include profit and design and delivery contingencies but do not include contract or risk allocation margins. The range presented reflects estimates from Mott MacDonald as well as the World Bank and will need to be refined based on design choices at a later stage.

Table 0.4: Capex and Opex items (US$)

Cost item	Description	
Capex		**Million US$**
Landfill	Civil infrastructure, gas, leachate	17.5- 25.6
Transfer Station	All civil infrastructure and plant costs excluding haulage)	8.0 - 10.8
Landfill Mobile Plant	Compactors, dozers	2.7 - 3.7
MRF	Civil infrastructure and equipment	12.2
MRF Mobile Plant	Forklifts, diggers, transport for residues to landfill	2.5
Haulage	All vehicles excluding those moving waste from MRF to landfill	4.1
Opex		**US$/ton**
Landfill	Waste transfer, daily covering of waste, and maintenance	3.3
Transfer Station	Movement of waste and maintenance	1.5
Haulage	All haulage costs except those taking those from the MRF to landfill	1.2
MRF	Reception of waste, waste capture, and maintenance	2.3

[5] One benchmark is located in Northern Africa, the other in Sub-Saharan Africa. The source data is based on quoted or actual values from the operators of these projects, and both feature engineered landfills and/or semi-automated MRF and/or transfer stations. Source: Mott MacDonald Proprietary data.

Two costs of capital are used for the financial analysis. For EPC and O&M scenarios, margins that typical EPC and O&M margins add are considered. In cases where private financing of equipment is expected, a real weighted average cost of capital has been calculated and used in the analysis. (See Table 0.5).

Table 0.5: Cost of capital and margin data

Cost	Value (%)	Source
Government cost of debt[6] - Real (US$)	6.50%	Government of Ghana cost of borrowing in US$, February 2020 14-year US$ Bond Issuance[7]
EPC margin[8]	14.00%	NYU Stern – Environmental and Waste Gross Margin
O&M margin[9]	33.00%	NYU Stern – Environmental and Waste Gross Margin
Weighted average cost of capital - Real (US$)	11.98%	Consultant calculations

The next steps include a decision on the Project's scope and its business models

The commercial analysis has shown that excluding an MRF from the Project has financial merits, as would excluding transfer stations. The Government should assess both options' economic impact and weigh these against each option's affordability and the extent to which both deliver against Government's objectives.

Specific steps Government should consider for advancing the Project include:

- Undertaking technical and socio-economic studies to identify and define the potential service area for the Project
- Engage stakeholders, including collection service providers, to understand the willingness and ability to direct waste from specific areas to the Project
- Complete an assessment of the impacts excluding the MRF and transfer stations will have on the Project's operational performance and costs

[6] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount - 14-year bond issuance of February 2020

[7] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount

[8] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[9] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

- Conduct an economic cost-benefit analysis of preferred options as a decision-making tool.

1 Introduction

The World Bank Group, with other partners, is assisting the Government of Ghana with the implementation of the Greater Accra Resilient and Integrated Development Project (GARID Project), which aims to move Ghana's solid waste management sector towards sustainability. The Government of Ghana is working toward changes in the sector and has set out several goals to improve its performance, including:

- Implementing models focused on cost-recovery
- Strengthening capacity for monitoring and evaluation activities
- Evaluating financing mechanisms for priority interventions in the sector; and
- Addressing current gaps in policies, laws, regulations, and standards that are necessary for the implementation of an Integrated Urban Environmental Sanitation Master Plan (IUESMP)

Under the GARID Project, the World Bank intends to finance the Ayidan project (the Project) to address immediate gaps in Accra's final waste disposal capacity. The Project is expected to include an engineered landfill, up to two transfer stations, and possibly a materials recovery facility. The Project could also help solve other sector problems by moving toward sustainability through long-term planning and building a cost recovery culture.

This report evaluates the Project's commercial viability and explores the strategic options and possible business models and the implications of those choices. The analysis presented has been prepared with consideration given to the views of investors and market participants. The structure of the report is set out as follows:

- This report first explores the objectives for the Project, its challenges, and the sector's options to meet its goals (Section 2). These options look at the Ayidan Project's position in Ghana's broader solid waste sector.
- It then describes the different components of the Project's development and operations and discusses realistic business models that can be used for the Project (Section 3).
- The report then analyzes the costs, revenues, results, and fiscal projections under the various business models to show the advantages and disadvantages of each option (Section 4), along with a sensitivity analysis (Section 5)
- Last, the report recommends the steps that must be taken to ensure the chosen business model's success (Section 6).

2 Strategic solution and implications

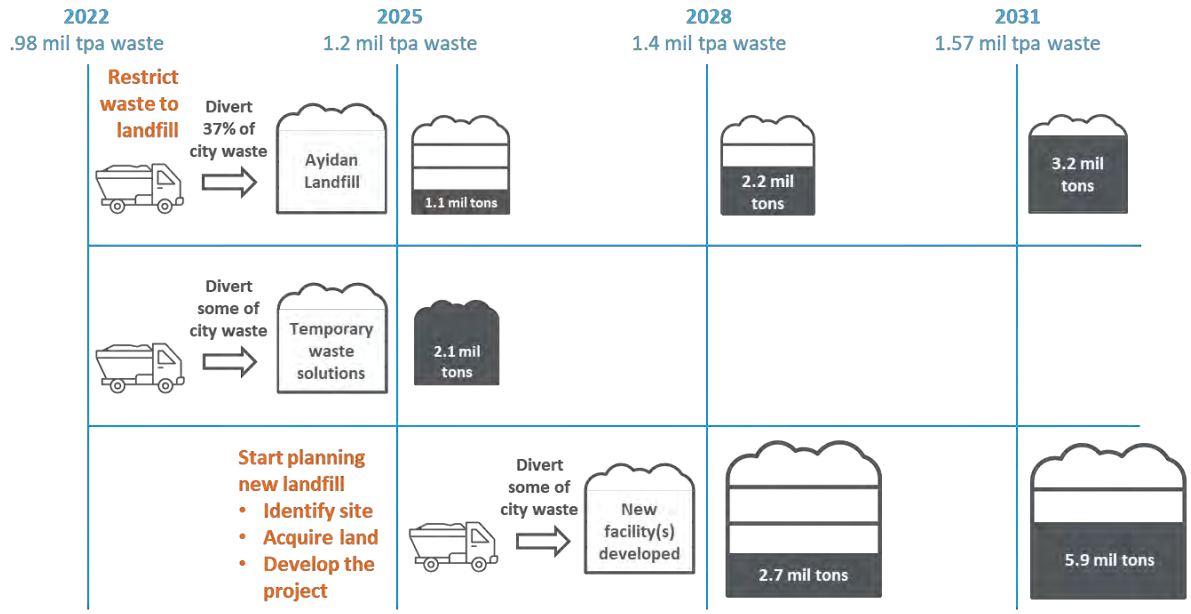
At present, the GAMA does not have any operational engineered solid waste landfills.[10] The sector generates close to a million tons of waste that must be disposed of at landfills annually. The sector has limited options for its disposal, as the region has only uncontrolled and semi-controlled landfill space available. The lack of engineered landfill capacity causes waste to be tipped in unmanaged dumpsites and results in illegal dumping.

The Ayidan Project is intended to deliver the final waste disposal capacity that the sector requires. The Project could act as a solution that will kick-off long-term improvements, including improvements to planning, regulation, cost recovery, and contracting. It could become the first piece in a longer-term strategy to address the GAMA's final waste disposal problem. To make this possible, the sector must limit waste flows to the Project to bring its operational life in line with its equipment's economic life. While the GAMA would still require additional capacity, implementing the changes necessary to make the Ayidan Project successful would put the sector on the pathway to sustainability. Waste that the Project does not accept would be sent to temporary solutions, such as semi-engineered sites, providing the sector time to develop additional long-term sites to build capacity later.

Figure 2.1 illustrates the part the Project can play in a long-term solution, which is explained in more detail in Section 2.2.

[10] The Kpone landfill was an engineered landfill that ceased operations in 2019

Figure 2.1: The Project's role in a broader strategy



This longer-term Project is expected to have several possible business models, including private investment alongside operations and management of the Project.

2.1 Objectives and challenges

This section explores the sector's objectives regarding the Project and the challenges to achieving them. These challenges include technical, economic, and institutional concerns, all of which are explored in detail in *Enabling Environment Report – Financial and Economic Advisory for a Solid Waste Management Project in the Greater Accra Region, Ghana.*[11]

2.1.1 Sector Objectives

Given the status of the solid waste sector in the GAMA, the sector has three high-priority objectives. These include:

- **Developing solid waste disposal capacity.** The sector's main objective is to acquire waste disposal capacity as the sector quickly runs out of landfill capacity. New landfill capacity is necessary to serve an immediate need and reduce illegal dumping.
- **Moving toward a long-term solution for waste disposal.** In 2013, the sector brought the Kpone landfill online with a designed life of 10 years. As a result of poor planning, there were no alternative disposal sites in the GAMA, leading to the Kpone landfill being

[11] Consultant's Enabling Environment Report, submitted 19 February 2021

overutilized and reaching capacity well before its planned life was complete.[12] This failure to realize the entire planned life of Kpone has left the sector in a position where it needs to find more waste disposal capacity very quickly. To avoid the repeat of a situation in which there is no available landfill capacity, the sector must find a long-term solution for final disposal.

- **Creating a sustainable model for PSP for the sector.** The Government aims to create a Project that can serve as a model for future solid waste projects. Previous projects in the GAMA have not realized the benefits of PSP. They have also failed to deliver on other objectives, like delivering waste disposal capacity for the planned period.

2.1.2 Challenges faced by the sector

Developing countries face significant challenges in managing solid waste. As populations move to urban areas and income levels rise, waste generated per capita increases as well.[13] The challenge for solid waste management is amplified by rapid urbanization and greater density, making waste collections more complex. The GAMA faces many of these challenges, as well as the specific issues listed below.

- **The quantity of waste expected to flow to the Project is not known.** Given the uncertainty around future landfill capacity and the sector's ability to limit waste flows to the Project effectively, it is not clear how much waste will flow to the Project. Jospong's proposal to develop three new semi-engineered dumpsites further complicates planning for the GAMA's solid waste sector. Jospong's projects could compete with Ayidan by charging lower fees as they likely will have a lower cost structure than Ayidan, which could jeopardize the financial viability of other projects.
- **The Government has a history of missing payments to the private sector.** Accra Compost and Recycling Plant (ACARP) shut down in 2014 because of non-payment by the Government[14], and the Kpone landfill did not receive payment for 5-years.[15] Some firms can only keep facilities operating as they subsidize operations of waste management facilities from other business lines. These payment failures have established a track record that suggests that any Project delivered by the private sector will require credit support to be commercially viable.
- **At present, users across the value chain pay less than the cost of service, creating revenue shortfalls and viability gaps.** Several transfer stations and landfill sites do not

[12] "Conditional Assessment Report (Solid Waste)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 8

[13] 'What A Waste- A Global Review of Solid Waste Management' IFC, 2012. https://www.ifc.org/wps/wcm/connect/106e528d-ad90-4ef9-9bc4-fddef4a5bb2c/What-A-Waste-Report.pdf?MOD=AJPERES&CVID=ldRsiqP

[14] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 96

[15] Interview C

recover the cost of service from tipping fees and instead have relied on the Government for payments. As described, Government payments are often delayed or not made.

- **Monopoly control creates market failures and deadweight losses.** Jospong Group owns and operates most transfer, treatment, and final disposal sites in the GAMA. Its influence, achieved through market power, could affect the success of new projects including Ayidan. Jospong has an incentive to direct waste collectors to tip at its sites to increase revenues while decreasing revenues to competing sites. This power can manifest in many ways. One issue relevant to the GAMA's current situation is the potential cost and fiscal impacts of Jospong asserting its influence. Costs to the Government could increase if the Government takes on quantity risk and remunerates the operators of Ayidan (or other projects) on an availability basis—which may be necessary for the Project to be bankable—while paying Jospong on a quantity basis.

2.2 Implications of designing the Project as a long-term solution

To create a project that is a long-term solution[16], waste reception must be limited to 360,000 tons per annum (which equates to 37 percent of captured waste in 2022). Defining waste capture zones for specific landfill sites is one way to deliver the change needed. The Project will likely be attractive to the private sector, to varying degrees, and could be structured around different operational and PSP models. These models are explored further in section 3.

Some advantages of this long-term solution include:

- The choices required to make this solution viable will demonstrate the benefits of long-term planning and put the sector on the pathway towards sustainability. Developing the capacity to plan long-term will help the Government be proactive and develop projects to meet future demand before needs become critical.
- The Project would be structured to last a minimum of 10 years, and this term aligns more closely to the lifecycle of the equipment. Thus bundled PSP models are possible, and some with significant risk transfer.
- This solution is likely to reduce costs over the long-term through greater integration of project functions and the ability to engage in whole-of-life costing.[17]
- Improved risk management as the envisaged structure will transfer risks that a private firm is well-placed to handle, like cost overruns or delays, reducing the Project's total costs.
- It increases opportunities to maximize economic benefits through the environmental treatment, management, and disposal of waste and reducing illegal dumping and burning.

Some disadvantages of the solution include:

[16] Meaning at least 10 years.

[17] "PPP Reference Guide 3.0" International Bank for Reconstruction and Development / The World Bank, 2017. Page 18

- As the Project would take up not all waste, additional capacity must be found. Engineered landfill capacity will not be available immediately, so waste must continue to be disposed of in semi-engineered, semi-controlled, and uncontrolled landfills.
- Limiting waste flows to the Project will require fundamental changes to the sector, including collections.

3 Project components and potential business models

Various business models could be applied to the Project to deliver the intended benefits. This section explores the Project's components, the potential business models, and their advantages and disadvantages.

3.1 Components of the Project

The business models that could be followed for the Project are defined by how core functions of project development, construction, financing, and operations are allocated between the public and private sector. For clarity, these functions are:

- **Design—**includes developing the Project from initial concept and output requirements to construction-ready specifications. For the Ayidan project, the Government has completed an initial concept, identified land for the landfill and one transfer station, and has prepared terms of reference to procure a design contractor.
- **Build—**comprises construction of the Project and the installation of equipment on the site. It is envisaged that a contractor will build the facilities based on the outputs of the design consultation. A shortlist of consultants to submit full proposals was approved in December 2020.
- **Finance—**includes raising money to fund the Capex transaction costs and other Project-related fees. It is understood that the World Bank intends to finance all Capex for the Project but may not finance all operating equipment.
- **Operate and maintain—**involves running the day-to-day operations and maintaining the facility to a specified standard over the contract's life. For Ayidan, the Government may select a single operator for the entire Project or multiple operators for the landfill, the transfer station, and the materials recovery facility (MRF).

3.2 Potential business models

The Project requires a business model that is commercially viable, sustainable, and has a high probability of creating value-for-money.[18] Understandably, there will be a choice between various models and project structures. While several models could achieve commercial viability, not all commercially viable models will create value-for-money. Alternatively, some models that could deliver value-for-money may not be commercially viable or sustainable.

An unbundled EPC with a long-term[19] O&M contract and a bundled BOT project both have pathways to commercial viability and sustainability. Both models could align the economic life of operations equipment with the life of the landfill, which would enable a private operator to optimize costs and mitigate risks over the anticipated 10-year life of the Project. The EPC with long-term O&M and the BOT can deliver similar benefits, except for the additional benefits achievable through the bundling of functions in the BOT model. Both could provide value for money as private investment in the Project and alignment of useful lives incentivize firms to practice whole-of-life costing and maximize efficiency.

Figure 3.1 shows the unbundled model in which the O&M firm finances the purchase of operating equipment. The O&M contract could be structured as a long-term, 10-year contract, which would provide services at an international standard. The O&M firm recovers its investment and operating and maintenance costs through the tipping fees paid by waste collectors. The EPC company would be contracted in the same way as the model above, with an EPC fee plus a margin paid to the construction firm. It is anticipated that the World Bank would provide a loan to fund this Capex and could provide a partial risk guarantee or minimum revenue guarantee on the O&M firm's revenue.

[18] Value for money is achieved when the private firm can deliver the project for a lower total cost across the life of the project than the Government can. (World Bank. 2017. Public-Private Partnerships: Reference Guide Version 3. World Bank, Washington, DC. © World Bank. Page 18 - *https://openknowledge.worldbank.org/handle/10986/29052*)

[19] Long-term in this case means 10-years, in order to align the contract length with the planned landfill life.

Figure 3.1: Unbundled model - EPC & O&M with private investment in operating equipment

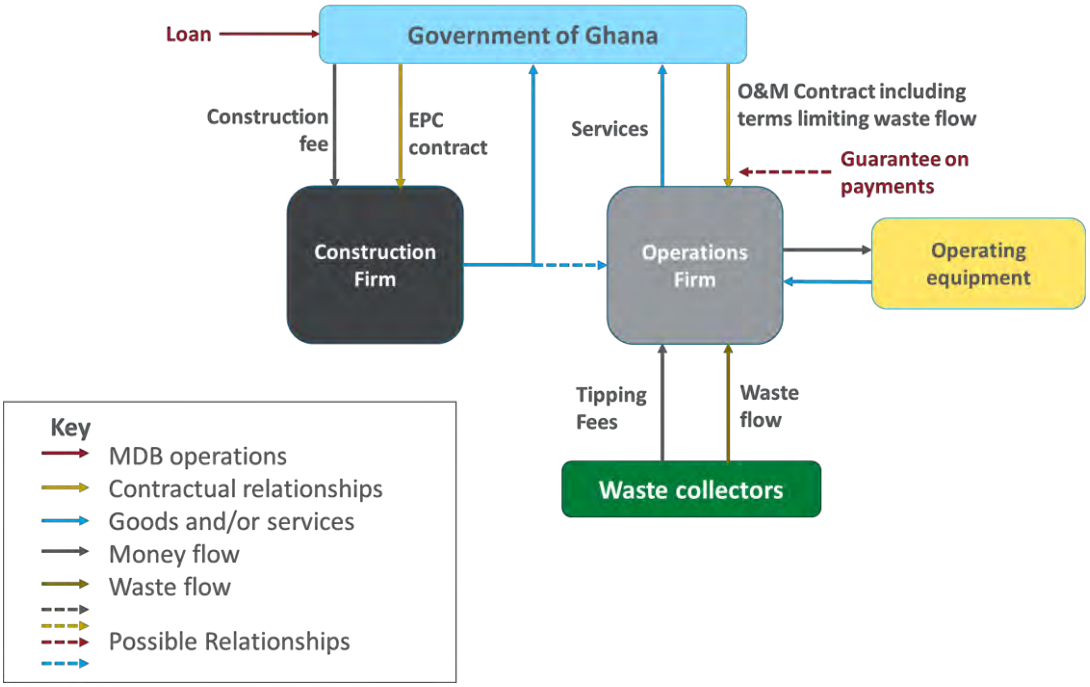
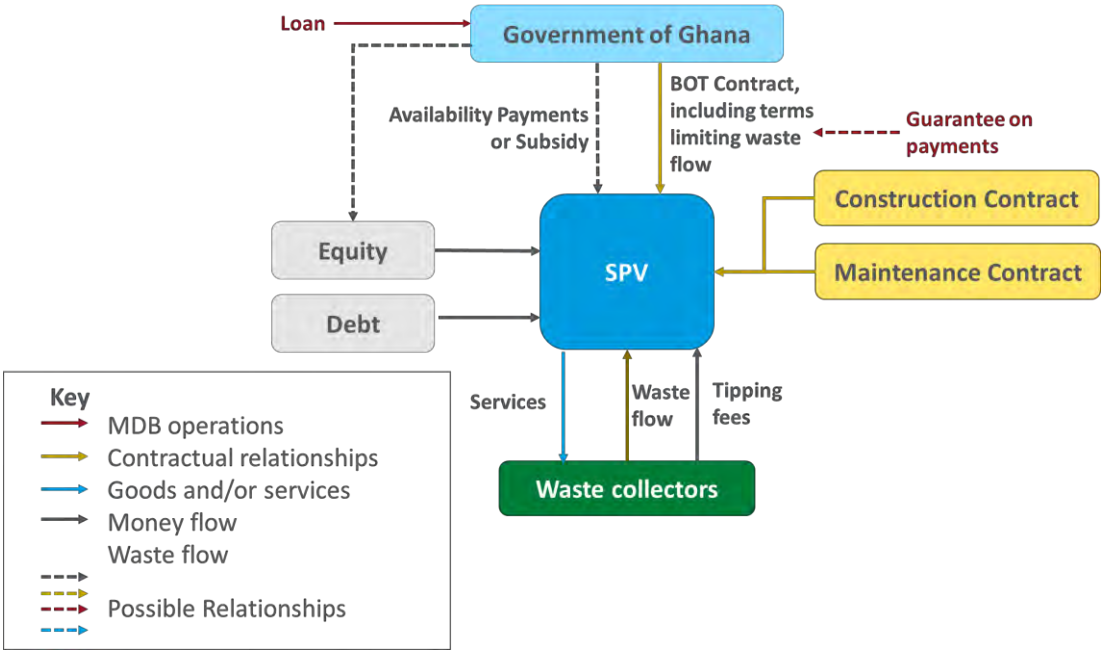


Figure 3.2 illustrates a bundled PPP model based on a BOT contract. Private investors, and potentially MDBs, place equity and debt in a special purpose vehicle (SPV). The SPV signs a contract with the Government to build, operate and maintain the Project. The SPV, directly or through subcontracts, executes the functions agreed within the contract and delivers services at agreed standards. The Government funds the construction of the Project, but the SPV finances the operating equipment. It recovers its costs through tipping fees, and if it fails to provide service at the contracted standard, faces financial penalties. It is also anticipated that the World Bank would provide a loan to the Government to finance Capex.

Figure 3.2: Bundled Model - Build - Operate -Transfer



This bundled model is only likely to be viable under certain conditions. The Government must guarantee waste flows to the Project to enable this model to be viable. Also, the contract term is most likely to be attractive if it covers a period of 10 or so years. A term of greater than 10 years is unlikely to be viable as a longer project would put added pressure on the Government to limit waste flows to the Project. Further, though industry-standard contracts are 20-25 years, the Government does not have a track record of delivering long-term agreements, which means investors would likely perceive the deal as unnecessarily risky.

3.2.1 Models not considered

A full design-build-finance-operate-maintain (DBFOM) model does not appear to be a realistic option. The Government has already begun the procurement process for selecting the design consultant, making integration of all components challenging. This model is unlikely to be commercially sustainable, as it would require payments from the Government, which it is unlikely to afford. Given the Government's credit and fiscal positions, this model is not likely to attract competitive or affordable bids.

3.2.2 Summary of possible models

Table 3.1 summarizes the models described above.

Table 3.1: Summary of realistic business models

Name	Functions and roles	Description	Payment mechanism	Risks
Unbundled model - EPC of fixed infrastructure and private finance of mobile equipment along with a long-term O&M	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	Similar to above, with these exceptions: ▪ The O&M contract has a term of 10-years and is written to industry standards ▪ The O&M firm finances mobile operating equipment.	The EPC contractor's remuneration is the same as the previous model. The O&M firm finances mobile equipment and collects tipping fees to recover those equipment costs and the costs of maintenance and operations.	▪ Government still takes cost overrun risks ▪ This will require implementing measures to control waste flows to the site
Bundled model - Build-Operate-Transfer (10 years or less)	▪ **Design**: Private ▪ **Build**: Private ▪ **Finance**: World Bank (Capex), Private (equipment) ▪ **Operate**: Private ▪ **Maintain**: Private	A private company builds and operates the Project and transfers the facilities back to the Government after 10-years. The private partner finances the cost of mobile equipment.	The Government/World Bank finances capital costs, except for mobile equipment. Operator finances private equipment and collects user fees to recover these costs.	▪ This will require implementing measures to control waste flows to the site ▪ Over or under-delivery of waste could trigger contingent liabilities ▪ Private sector interest may be low given contract length and challenges in controlling waste flows

4 Analysis of business models

This section evaluates each of the business models and their financial performance, considering the costs associated with each model, degrees of capital recovery, and the Project's revenues. These inputs are used to assess each model's performance.

4.1 Costs

The costs associated with the Project include capital costs (Capex), operational costs (Opex), and the cost of capital. These are described below.

4.1.1 Capex

The table below provides a list of the Project's capital expenditures. These estimates are based primarily on benchmarks taken from two integrated waste management projects in Africa and informed by professional engineering evaluation of the situation in GAMA. The configuration of each benchmark project broadly aligns to that of the technical concept for the Project.[20] The range presented is based on estimations from Mott MacDonald and from the World Bank Group and will need to be refined based on design choices at a later stage.

The benchmark data has been adjusted to reflect the Project's tonnage profile and sizing (footprint). These costs include profit and design and delivery contingencies but do not include contract or risk allocation margins.

Table 4.1: Capital Expenditures

Capital expenditure	Description	Million US$
Landfill	Civil infrastructure, gas, leachate	17.5 - 25.6
Transfer Station	All civil infrastructure and plant costs excluding haulage)	8.0 - 10.8
Landfill Mobile Plant	Compactors, dozers	2.7 - 3.7
MRF	Civil infrastructure and equipment	12.2
MRF Mobile Plant	Forklifts, diggers, transport for residues to landfill	2.5
Haulage	All vehicles excluding those moving waste from MRF to landfill	4.1

Note: All costs calculated in 2021 US$.
Source: Mott MacDonald and WBG Estimates

[20] One benchmark is located in Northern Africa, the other in Sub-Saharan Africa. The source data is based on quoted or actual values from the operators of these projects, and both feature engineered landfills and/or semi-automated MRF and/or transfer stations. Source: Mott MacDonald Proprietary data.

These drivers of these costs include the:

- Physical size of the facilities,
- Projected throughput, and
- Technological capabilities. For example, an MRF that captures a higher percentage of recyclables would be more expensive.

4.1.2 Opex

Like Capex, the Project's Opex is broken down across each of the Project's components. These estimates are based primarily on the same benchmark projects. These costs exclude operating margins.

Table 4.2: Operating costs

Cost item	Description	Unit cost per ton – margins not included US$/ton (GHS/ton)	Unit cost per ton – 33% operating margin included US$ (GHS)
Landfill	Waste transfer, daily covering of waste, and maintenance	3.3 (GHS 25.8)	4.4 (GHS 25.8)
Transfer Station	Movement of waste and maintenance	1.5 (GHS 11.7)	2.0 (GHS 11.7)
Haulage	All haulage costs except those taking those from the MRF to landfill	1.2 (GHS 9.4)	1.6 (GHS 9.4)
MRF	Reception of waste, waste capture, and maintenance	2.3 (GHS 18.0)	3.1 (GHS 18.0)

Note: All costs calculated in 2021 US$
Source: Mott MacDonald

These costs are driven by the scale of operations and the composition of waste flows. The number of vehicles that deliver waste to facilities also affects costs, as a higher number of vehicles on the site increase operational costs.

4.1.3 Cost of capital

Two costs of capital are used for the financial analysis. For EPC and O&M scenarios, the margins that typical EPC and O&M contracts add are considered. In cases where private financing of equipment is expected, a real weighted average cost of capital has been calculated and used in the analysis. These are shown in Table 4.3.

Table 4.3: Cost of capital and profit margin assumptions

Cost	Value (%)	Source
Government cost of debt[21] - Real (US$)	6.50%	Government of Ghana cost of borrowing in US$, February 2020 14-year US$ Bond Issuance[22]
EPC margin[23]	14.00%	NYU Stern – Environmental and Waste Gross Margin
O&M margin[24]	33.00%	NYU Stern – Environmental and Waste Gross Margin
Weighted average cost of capital - Real (US$)	11.98%	Consultant calculations[25]

A post-tax WACC has been calculated using the following formula:

$$WACC = R_{e*}\left(\frac{E}{E+D}\right) + R_d\left(\frac{D}{E+D}\right) * (1-T)$$

Where:

- R_e is the cost of equity
- R_d is the cost of debt
- (E / (E + D)) is the proportion of equity
- (D / (E + D)) is the proportion of debt
- T is the corporate tax rate

The cost of equity has been calculated using the Capital Asset Pricing Method (CAPM):

$$R_e = R_f + \beta_{levered} * (R_m - R_f) + CRP$$

Where:

- R_f is the risk-free rate, which is the interest rate an investor can expect to earn on an investment that carries zero risk.
- $\beta_{levered}$ is the levered beta for environmental and waste services

[21] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount - 14-year bond issuance of February 2020

[22] https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount

[23] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[24] NYU Stern Engineering/Construction Gross Margin - http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[25] For the purpose of this analysis, it is assumed that the costs of capital under the privately financed options roll-in margins of EPC and O&M providers, spreading them across the SPV's total costs, which are then recovered at the WACC. In practice, it is likely that some of these margins would be passed on to Government, though the extent of which cannot be determined at this stage of analysis.

$$Levered\ beta = Unlevered\ beta * (1 + (1 - Corporate\ Tax\ rate) * Debt/Equity\ Ratio)$$

- $R_m + R_f$ is the market risk premium for the US, which is the excess return earned by an investor when they invest in the stock market (R_m) over a risk-free rate (R_f).
- CRP is the country risk premium for Ghana

The cost of debt is given by:

$$R_e = R_f + Country\ default\ risk\ spread$$

The country default risk spread reflects the debt investor's perception of the default risk. The values and sources for each of these inputs follow in Table 4.4.

Table 4.4: Components of the WACC

Component	Term	Value	Source
Gearing	D / (E +D)	75.00%	IFC Benchmark figure within the range of acceptable gearing levels for the sector
Risk-free rate, United States (nominal US$)	$R_{f\ (US)}$	2.30%	U.S. Treasury 20-year yield[26]
Risk-free rate, Ghana (nominal US$)	$R_{f\ (Ghana)}$	7.9%	Government of Ghana cost of borrowing in US$, February 2020 14-year US$ Bond Issuance[27]
US inflation		1.4%	Trading economics[28]
Unlevered beta	$\beta_{unlevered}$	0.85	NYU Stern - Environmental and Waste Services
Levered beta	$\beta_{levered}$	2.76	Consultant calculations
Market risk premium (US)	$R_m + R_f$	5.60%	NYU Stern[29]
Corporate income tax rate	T	25.00%	Ghana Corporate Income Tax Rate[30]

[26] US Treasury "Daily Treasury Yield Curve Rates" 20 year https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield. Date: 25 February 2021

[27] Government of Ghana, Ministry of Finance. See: https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount. Accessed 26 February 2021

[28] See: https://tradingeconomics.com/united-states/inflation-cpi

[29] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html Accessed: 26 February 2021

[30] See: https://tradingeconomics.com/ghana/corporate-tax-rate

Country default risk spread (Ghana)		5.75%	NYU Stern[31]
Country risk premium (Ghana)	CRP	6.30%	NYU Stern[32]

4.2 Projections of funds available for the sector

Ghana's solid waste sector receives funding through multiple sources, including money from the central Government, funds internally generated by individual Metropolitan, Municipal, District Assembly (MMDAs), and fees collected through user payments.

The analysis attempted to understand the financial flows using various approaches, including a top-down and two bottom-up approaches. As part of the top-down approach, the Consultant approached the Central Government to understand sector payments. These were not available, largely because there is no single body responsible for tracking these payments. As part of the bottom-up approaches, the analysis built up sector costs using known and estimated tipping fees and estimates of waste flows. The other bottom-up approach estimated funds available to MMDA's through Central Government funds and internally generated funds. All these methods provided different estimates of funding and financial flows to the sector, and therefore, provided no additional clarity on the state of the sector's finances.

The Project's ultimate sources of revenue will depend on how the Government allocates risks and structures the Project. For example, the Government may choose to transfer availability risk to the operator and take quantity risk. In this model, the Government would make availability payments to the operator. Alternatively, the Government could transfer quantity risk to the operator, which means that the operator would receive revenue from fees paid for waste tipped at the landfill. Models that share these risks also exist, combining fixed availability payments with variable payments based on waste treated.

Potential user revenues

Revenues are supposed to be raised at various points in the value chain. Current transfer station tipping fees are GHS 30/ton (US$5.10/ton).[33] Tipping fees at landfills in the GAMA are GHS 18/ton (US$3.00/ton) for domestic waste and GHS 30/ton (US$5.10/ton) for industrial waste.[34]

User fees will not cover the full cost of service for the Project in the short term and are unlikely to be collected in sufficient quantities to cover most Project costs in the medium term. The transfer station and landfill operators report that users do not pay to tip waste on time and that

[31] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html. Accessed: 26 February 2021

[32] NYU Stern School. See: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html Accessed: 26 February 2021

[33] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana – Page 89

[34] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana – Page 80

Government, at times, makes payments to cover recurring shortfalls, though these payments happen irregularly.[35]

Estimates of funding and financial flows

Table 4.5 shows the funds received by each MMDA as transfers from the National Government, internally generated funds, and the waste management expenditure registered in each assembly's budget. On average, transfers from the National Government account for 52 percent of total funds available, with the remaining 48 percent coming internally generated funds at the MMDA level. The data includes inputs received from MMDAs and estimations of the funds available to each MMDA (highlighted *yellow*). An explanation of the figures follows the table.

Table 4.5: MMDA sources of funds

MMDA	Population	Monies received from the central budget for waste management (GHC/year)	Internally generated funds used for waste management (GHC/year)	Cost of waste management on Assembly budget (GHC/year)
ABCMA - Ablekuma Central	352,664	1,184,133	400,000	1,600,000
ABNMA - Ablekuma North	251,846	845,618	580,011	2,612,984
ABWMA - Ablekuma West	185,520	259,930	144,353	404,283
AMA - Accra	424,654	1,425,852	2,911,259	3,804,000
ADMA - Adenta	121,096	800,000	600,000	40,000
ASHMA - Ashaiman	285,891	869,000	315,000	1,000,000
AYCMA - Ayawaso Central	142,322	477,872	371,295	1,476,637
AYEMA - Ayawaso East	126,280	424,008	126,000	923,293
AYNMA - Ayawaso North	128,463	431,338	136,113	852,000
AYWMA - Ayawaso West	93,013	312,308	242,656	965,040
GCMA - Ga Central	194,382	408,670	10,000	299,200
GEMA - Ga East	184,509	414,000	350,000	764,000
GNMA - Ga North	149,248	103,500	36,000	1,548,497

[35] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 85 and 89

GSMA - Ga South	388,000	1,302,780	1,012,229	4,025,626
GWMA - Ga West	106,057	207,000	139,314	9,884,861
KKMA - Korley Klottey	148,903	2,040,000	1,069,207	155,040
KorMA - Kowor	169,000	567,448	440,894	1,753,430
KoKMA - Kpone Katamanso	129,000	433,141	336,540	1,338,417
LANMA - La Nkwantanang Madina Municipal	137,350	310,500	456,878	456,878
LEKMA - Ledzokuku	186,522	206,000	60,000	628,000
ONMA - Okaikwei North	300,454	1,008,828	783,836	3,117,308
TMA - TEMA	353,086	506,000	4,050,000	5,839,500
TMWA - Tema West	150,720	566,000	180,000	1,300,000
WGMA - Weija-Gbawe	233,155	782,860	181,369	181,369
TOTAL population	**5,177,319**			
TOTAL GHC/year		**15,886,783**	**14,932,953**	**44,970,364**
TOTAL US$/year		**2,700,753**	**2,538,602**	**7,644,962**

Forecasts suggest the annual funding from Government for the sector is expected to rise from approximately GHC 15.8 million (US$2.7 million) in 2020 to GHC 27.0 million (US$4.6 million) in 2031. Internally generated funds are estimated to rise from approximately GHC 14.6 million (US$2.5 million) in 2020 to GHC 25.3 million (US$4.3 million) over the same period.

The dataset used to create the forecasts has several gaps that have been filled using proxy calculations. The population of MMDA's where data is incomplete is multiplied by an average of the per capita values for each column to complete the dataset. The calculation of averages from available information is shown in Table 4.6.[36]

Table 4.6: Per capita calculations

MMDA	Monies received from the central budget for waste	Internally generated funds used for waste	Cost of waste management on	Cost of waste management on

[36] Grey cells are intentionally blank.

	management (GHC/capita)	management (GHC/capita)	Assembly budget (%)	Assembly budget (GHC/capita)
ABCMA - Ablekuma Central		1.1	40%	4.5
ABNMA - Ablekuma North		2.3	5%	
ABWMA - Ablekuma West	1.4	0.8	3%	2.2
AMA - Accra		6.9		9.0
ADMA - Adenta	6.6	5.0	10%	0.3
ASHMA - Ashaiman	3.0	1.1	5%	3.5
AYCMA - Ayawaso Central				
AYEMA - Ayawaso East		1.0	20%	7.3
AYNMA - Ayawaso North		1.1	7%	6.6
AYWMA - Ayawaso West				
GCMA - Ga Central	2.1	0.1		1.5
GEMA - Ga East	2.2	1.9	15%	4.1
GNMA - Ga North	0.7	0.2		
GSMA - Ga South				
GWMA - Ga West	2.0	1.3	4%	93.2
KKMA - Korley Klottey	13.7	7.2	8%	1.0
KorMA - Kowor				
KoKMA - Kpone Katamanso				
LANMA - La Nkwantanang Madina Municipal	2.3	3.3	10%	3.3
LEKMA - Ledzokuku	1.1	0.3	4%	3.4
ONMA - Okaikwei North				
TMA - TEMA	1.4	11.5	10%	16.5
TMWA - Tema West	3.8	1.2	10%	8.6
WGMA - Weija-Gbawe		0.8	40%	0.8
Average (% of budget)			**13%**	
Average (GHC/capita/year)	**3.36**	**2.61**		**10.38**
Average (US$/capita/year)	**0.57**	**0.44**		**1.76**

Another source of funding to the sector is fees collected from households for waste disposal. These are paid to waste collection firms, but still provide insight into funds available to the sector. Based on broad estimations from survey data of expenditure on waste disposal per household[37], the range of these fees could be between US$47 million and US$204 million. Table 4.7 shows detailed calculations of collection fees.

Table 4.7: Estimations of collection fees from households

Group	Percentage of total	Number of households[38] (thousands)	HH cost low (GHS/month)	Monthly fee (GHS Million)	Annual in GHS Million)[39]	Annual in USD Million
Lower estimate						
Top segment	54%	803	30	24.09	289.07	49.14
Middle segment	44%	654	5	3.27	39.26	6.67
Bottom segment	2%	30	0	-	-	-
Total	100%					**47.44 – 55.82**
Higher Estimate						
Top segment	54%	803	100	80.30	963.58	163.81
Middle segment	44%	654	30	19.63	235.54	40.04
Bottom segment	2%	30	5	0.15	1.78	0.30
Total	100%					**173.53 – 204.15**

A second bottom-up approach used estimates of funds paid to facilities and waste flows at these facilities to estimate sector cash flows. The key assumptions for this approach is that, given that waste management facilities in the sector are continuing to operate, it is reasonable to assume that the facilities receive payments—though these are likely often delayed—sufficient to maintain operations. Known and estimated per ton tipping fees paid at various points of the value chain and

[37] MSWR Socio-Economic Survey Report -Revised (November 2019) Page 59

[38] Population in 2020 – 5,055,805 – Consultant's Technical Report.

Average household size – 3.4 - MSWR Socio-Economic Survey Report -Revised (November 2019) Page 17. Note: HH size of sample is 4. Lower range in calculations shows the estimate based on larger HH side.

Total number of households – 1,487,001- Calculated

[39] 1 GHS = 0.17 US$ - Approximate current exchange rate

estimates of waste flows through these points have been used for the calculation and are shown in Table 4.8. This analysis suggests that the total sector cash flows for transfer, treatment, and disposal are approximately US$8.8 million in 2020.

Table 4.8: Estimations of Government outflows to the sector

Assumed Tipping Fees	Transfer station	MRF	Landfill	Total	Data Source
Waste Flows (in thousand tons per annum)	291	182	978		Technical Report
Fees (GHS/ton)	30.00	20.82	40.00		▪ Transfer station – Situational Assessment Report (Revised) - Volume II – Appendices - Page 89 ▪ MRF – Consultant financial model ▪ Landfill – WB team; consultant team[40]
Fees (US$/ton)	5.10	3.54	6.80		▪ Same as above
Total fees (GHS/ton)	8.76	3.82	39.12	51.71	
Total fees (US$ million)	**1.49**	**.65**	**6.65**	**8.79**	

4.3 Performance of each business model

This section presents the performance of the business models. Section 4.3.1 compares the performance of models described in Section 3 of this report to each other. Section 4.3.2 compares these models to variations that show the Project's performance over a period of greater than 10 years, where the entire cost of the Project is recovered, and options that exclude transfer stations from the Project.

4.3.1 Comparison of the three main business models

The table presents the three business models. Two versions of the unbundled model are evaluated: one that includes private financing of operating equipment and one that does not. The

[40] Reporting from the sector indicates that operators pay between GHS 30 and GHS 60 per ton to tip waste, depending on the size of the vehicle. Bola taxis pay less, large trucks pay more.

bundled model is also presented. For each of the models, the annual capacity of the transfer stations (300,000 TPA) and the MRF (400,000 TPA) are expected to be the same, as is the total capacity of the landfill (3,600,000 tons).

Table 4.9 presents the outcome of the financial analysis on each of these models. First, the table shows the operational costs per ton in US dollars for each project component. These costs include margins in the EPC + O&M models and the return on capital for the privately financed models. Next, the table presents the PV of all payments to the Project over its term. All payments are discounted at the Government of Ghana's borrowing cost in US dollar terms[41]. The annual payments in real US dollar terms to the contractor follow, and the last row presents the PV of cumulative 10-year O&M cash flow per ton of waste processed for each of the business models.

Table 4.9: Business model comparison

	Unbundled - EPC & long-term O&M	Unbundled - EPC & long-term O&M + private finance of equipment	Bundled - BOT
Project Life (Years)	10	10	10
Degree of Capital Cost Recovery	No capital costs recovered within Project	Capital costs of mobile equipment are recovered	Capital costs of mobile equipment are recovered
Outputs			
Landfill (US$/ton)	4.36	7.13	5.71
MRF (US$/ton)	3.00	4.70	3.75
Transfer Station (US$/ton)	3.55	7.11	5.91
PV of payments (US$ Million)	25.65	44.34	35.69
Annual Payment to Contractor (US$ Million)	3.79	6.55	5.27
PV of cumulative 10-year O&M cash flow per ton of waste processed (US$/ton)	6.64	6.64	3.73

The three models show significant differences in performance. The figures that follow compare the:

- Annual payments required to the Project in real terms (Figure 4.1)

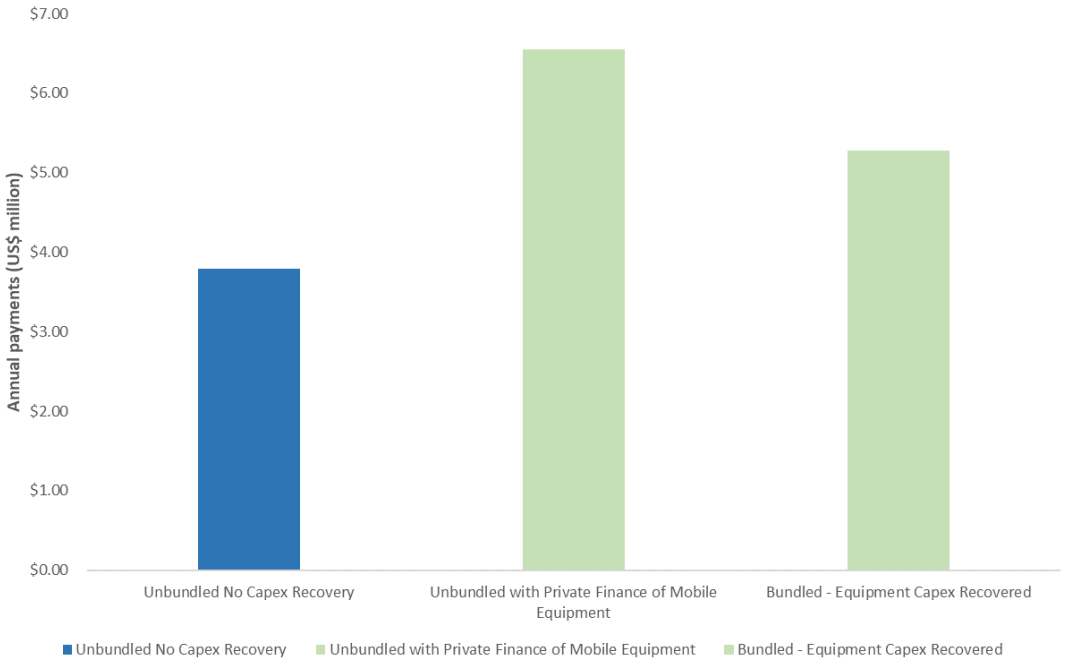
[41] Government of Ghana cost of borrowing in US$ (7.9%), February 2020 14-year US$ Bond Issuance Government of Ghana, Ministry of Finance. See: https://www.mofep.gov.gh/news-and-events/2019-02-05/international-capital-markets-reaffirm-confidence-in-ghana%2C-as-bond-issuance-results-in-order-book-5-times-required-amount. Accessed 26 February 2021

- PV of cumulative 10-year O&M cash flow per ton of waste processed (levelized cost) in US$/ton (Figure 4.2)
- The present value of payments to the Project in each option in real terms (Figure 4.3).

In each figure below, green-shaded bars show results for options with private financing of some part of the Project. Blue shaded bars show results for options without private financing of any kind.

To earn the required return, the unbundled model with private financing of equipment requires an annual payment of US$6.55 million, while the bundled option requires an annual payment of US$5.27 million.[42] The unbundled model with no private financing requires the lowest annual payment of US$3.79 million. Any benefits achieved by reducing payments to the contractor would be offset, to a degree, from the Government needing to repay any loan taken to purchase the operating equipment required for the Project to achieve a higher level of service.

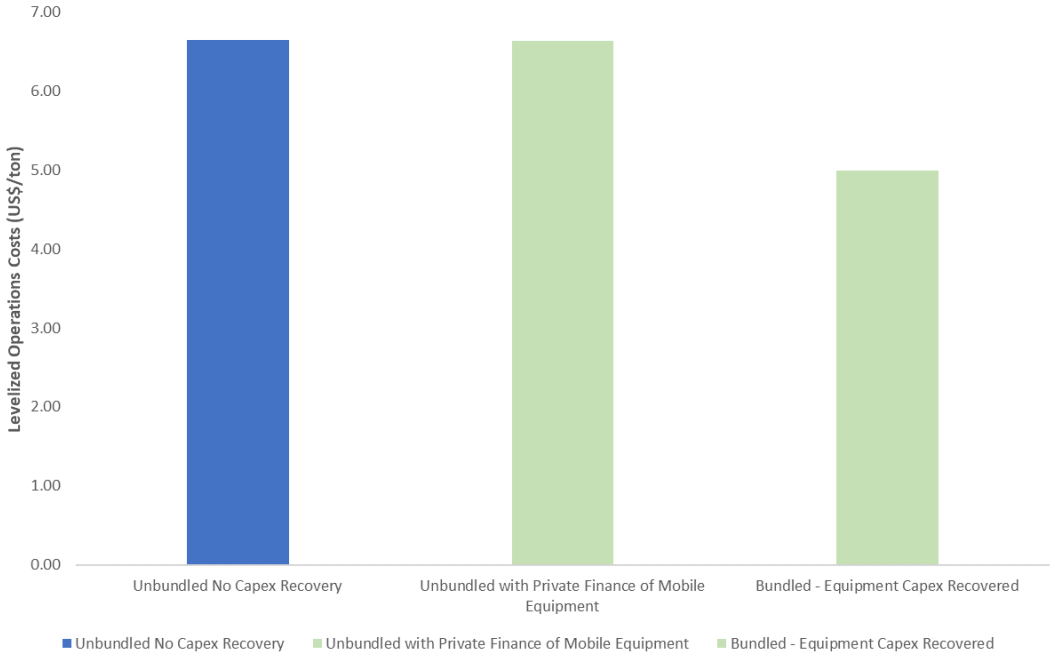
Figure 4.1: Annual payments to Project, US$ million (real)



The unbundled model without private finance and with private finance have the same PV of cumulative 10-year O&M cash flow per ton of waste processed cost per ton (US$6.65/ton). The bundled option has the lowest levelized cost of US$4.99 per ton.

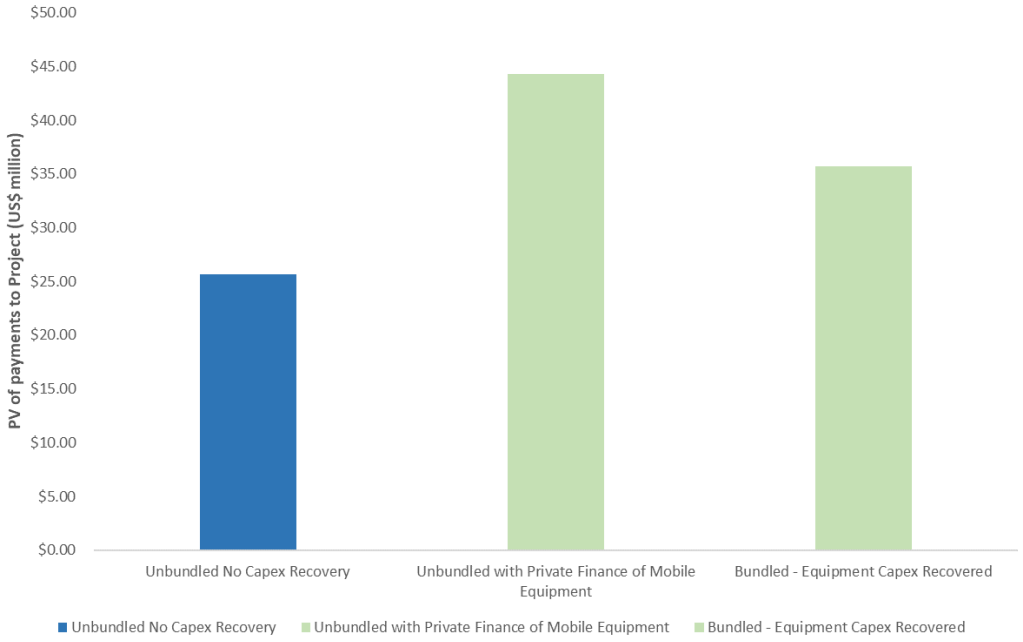
[42] Annual revenue requirements reflect the net revenue a firm would require to recover all costs, including a reasonable rate of return.

Figure 4.2: PV of cumulative 10-year O&M cash flow per ton of waste processed (levelized operational costs), US$/ton



The unbundled option without private finance has the lowest present value of payments to the Project of US$25.65 million. The unbundled model with private finance of mobile equipment has the highest PV of payments (US$44.34 million), while the bundled option is lower at US$35.69 million.

Figure 4.3: Present value of payments to the Project, US$ million (real)



4.3.2 Additional options analysis

In addition to the three options presented, a set of options that include reasonable modifications have also been assessed. The additional options include:

- An unbundled model without private finance that excludes transfer stations. This option shows the reduction in operational costs, change in waste flows, and reduction in capital costs that arise from excluding transfer stations from the Project.
- A bundled model that excludes transfer stations. This option shows the reduction in operational costs, change in waste flows, and reduction in capital costs that arise from excluding transfer stations from the Project.
- A bundled model that allows for full cost recovery. The Project recovers the total Capex, in addition to O&M costs and a return on capital. For this model only, it is envisaged that the private partner finances the entire Project to compare the costs of a PPP that is fully privately financed to those with concessional finance for most project Capex
- A bundled model with a 20-year contract term. For this option, the Project's life has doubled, which means that the amount of waste that flows to the Project each year would need to be halved. As discussed in Section 3, the challenges of implementing this model are unlikely to be overcome easily, and as such, it is not viewed as viable.

Table 4.10 below shows the performance of all options assessed. Removing the transfer stations from the Project, all else equal, leads to the most significant cost savings on both a levelized basis (US$/ton) and in terms of annual payments to the Project. Removing the transfer stations from the

unbundled model without private financing leads to a 28 percent reduction in levelized O&M costs. For the bundled option with private financing of the equipment, removing the transfer stations also reduces levelized costs by 28 percent compared to the bundled option that includes the transfer stations.

Table 4.10: Performance of business models

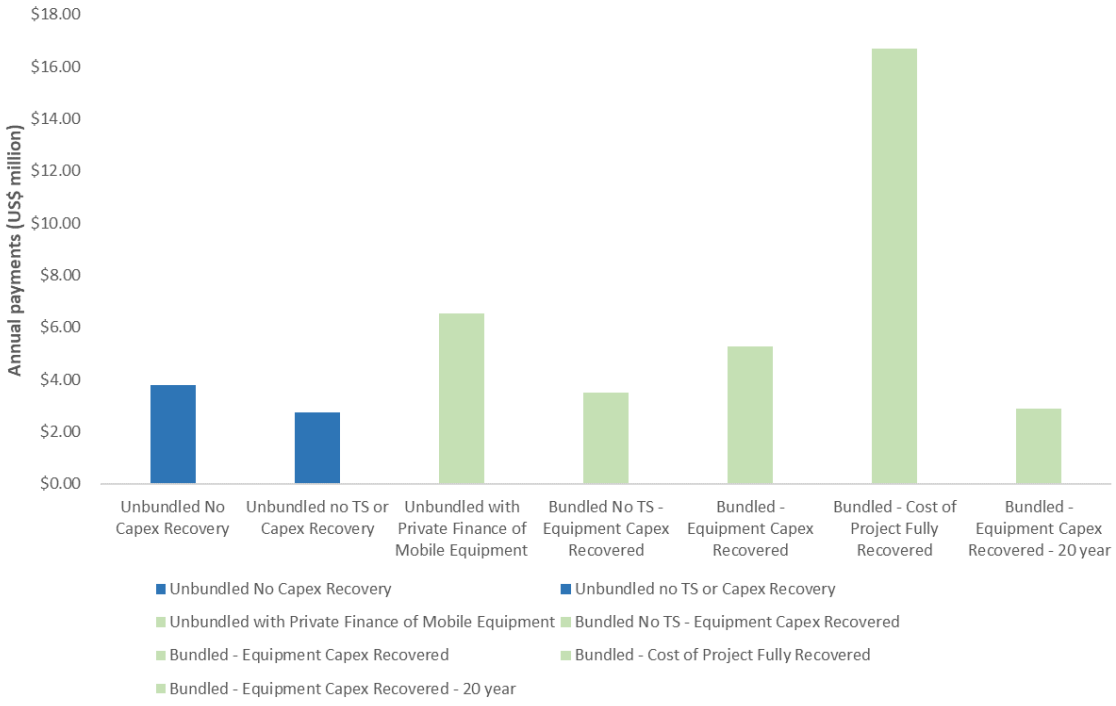
	Unbundled No Capex Recovery	Unbundled no TS or Capex Recovery	Unbundled with Private Finance of Mobile Equipment	Bundled No TS - Equipment Capex Recovered	Bundled - Equipment Capex Recovered	Bundled - Cost of Project Fully Recovered	Bundled - Equipment Capex Recovered - 20 year
Annual Waste Flows to Landfill/MRF (tpa)	390,000	390,000	390,000	390,000	390,000	390,000	195,000
Life (Years)	10	10	10	10	10	10	20
Landfill processing cost (US$/ton)	4.36	4.36	7.13	5.71	5.71	22.44	8.05
MRF processing cost (US$/ton)	3.00	3.00	4.70	3.75	3.75	11.18	3.38
Transfer Station processing cost (US$/ton)	3.55	-	7.24	-	5.91	14.36	5.12
PV of cumulative 10-year O&M cash flow per ton of waste processed (US$/ton)	**6.65**	**4.79**	**6.64**	**3.59**	**4.99**	**4.99**	**4.35**
PV of payments (US$ millions)	**25.65**	**18.46**	**44.34**	**23.70**	**35.69**	**113.02**	**29.82**
Annualized Payment to Contractor (US$ million)	**3.79**	**2.73**	**6.55**	**3.50**	**5.27**	**16.70**	**2.87**

The figures that follow compare the:

- Annual payments required to the Project in real terms (Figure 4.4).
- PV of cumulative 10-year O&M cash flow per ton of waste processed (levelized cost) for each option in US$/ton (Figure 4.5)
- The present value of payments to the Project in each option in real terms (Figure 4.6).

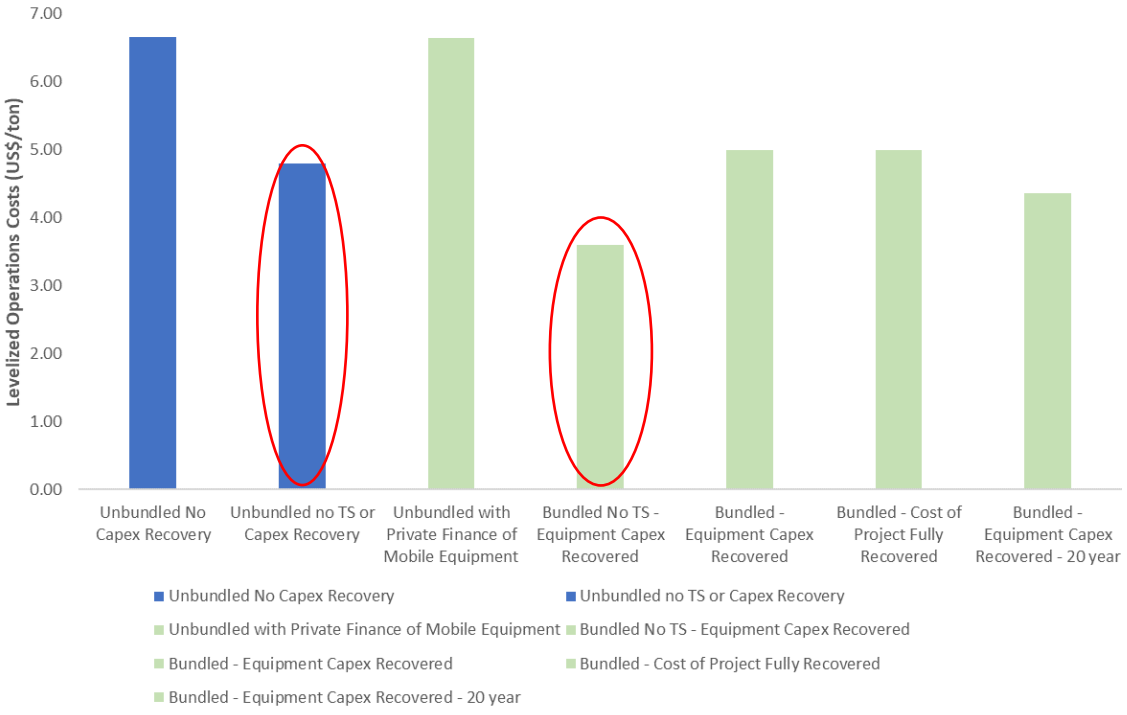
Two options have emerged as clear outliers when comparing the annual payments required for each option to breakeven: the bundled model with full cost recovery and the bundled model with a 20-year contract term. Neither option is realistic given the challenges with implementing both.

Figure 4.4: Annual payments to Project, US$ millions (real) (all options)



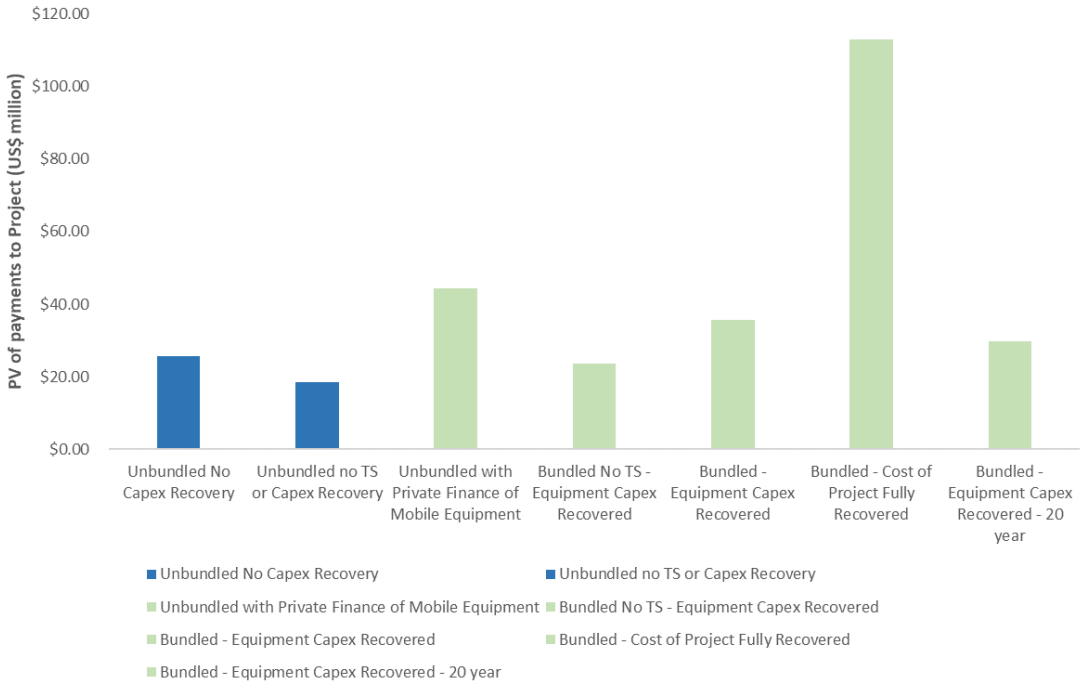
The bundled options have a lower cost per ton compared to similar unbundled options. The two options that exclude transfer stations (circled in red) have lower levelized costs than options with similar financing arrangements.

Figure 4.5: PV of cumulative 10-year O&M cash flow per ton of waste processed (levelized costs), US$/ton (all options)



The present value of payments to the Project required for the bundled model with full Capex recovery exceeds all options by more than US$50 million. The present value of payments necessary for the bundled model with financing for the operational equipment and the unbundled model with private financing of the equipment are higher than those needed for options that exclude the transfer stations.

Figure 4.6: Present value of payments to the Project, US$ million (real) (all options)



5 Sensitivity analysis

As the Project is currently at the pre-feasibility stage, key cost drivers will change along with a clear definition of the Project's scope and business model. Changes in these cost drivers—including Opex, Capex, and the cost of capital—will have impacts of varying degrees on all the models presented in Section 4. While these impacts will change between options, the extent of the change across options will remain relatively constant. Therefore, sensitivity analysis has been conducted on only on the bundled *BOT option with private financing of operating equipment* (Base Case), which is the best performing model for balancing cost reductions and risk transfer.

Table 5.1 compares the impact of (+/-) 15 percent change in Capex and Opex to the results presented previously for the Base Case. It also compares changes of (+/-) 1.5 percent in the cost of capital affect the Project's financial performance. The table presents the Levelized cost including Capex and the Levelized O&M costs, to enable a fair comparison of the impacts of changes in Capex and the cost of capital across the sensitivities

The table also includes a seventh sensitivity that shows the impact of developing the Project without an MRF. The MRF is expected to reduce the final disposal of waste at the landfill by 7 percent but requires almost 25 percent of the total Capex. Therefore, it is worth considering whether the added costs of the MRF justify the 7 percent reduction in final waste disposed at the landfill. Unlike the options presented in Section 4 that exclude Transfer Stations, changes in waste

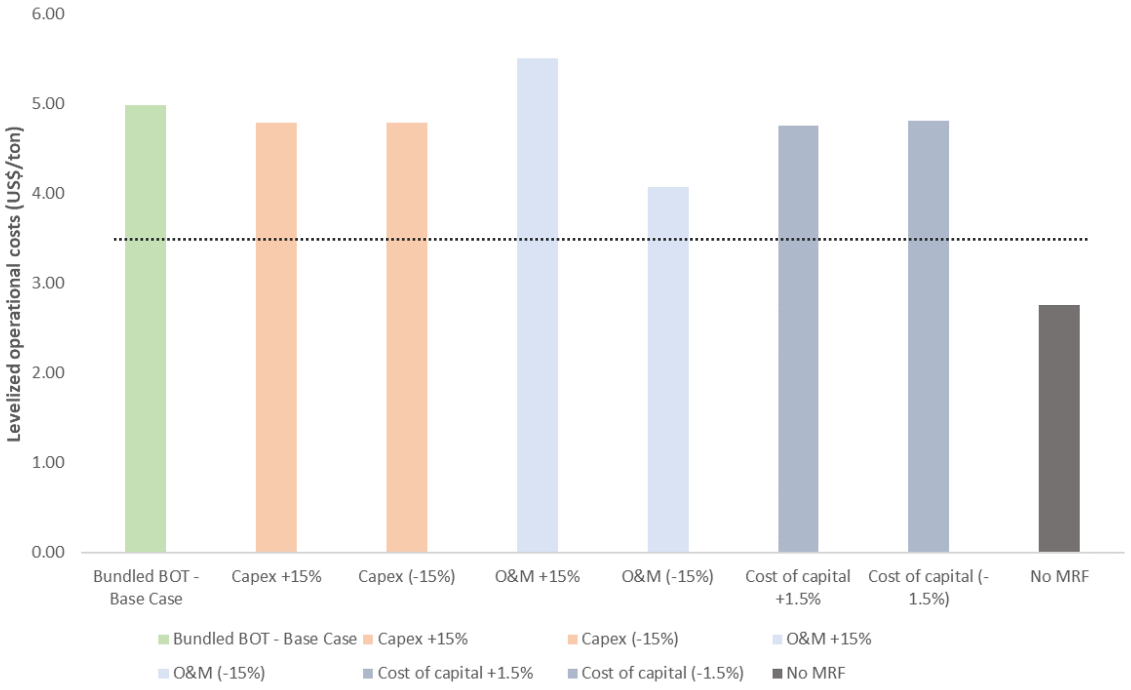
flows have not been modeled as part of the sensitivity analysis. The impact on waste flows is anticipated to be within the margin of error.

Table 5.1: Sensitivity Analysis

	Base Case	Capex +15%	Capex (-15%)	O&M +15%	O&M (-15%)	Cost of Capital +1.5%	Cost of Capital (-1.5%)	No MRF
Landfill (US$/ton)	5.71	6.07	5.34	6.20	5.22	5.86	5.56	5.71
MRF (US$/ton)	3.75	3.97	3.52	4.08	3.41	3.84	3.66	0.00
Transfer Station (US$/ton)	7.24	6.41	5.43	6.31	5.51	6.11	5.72	5.91
Levelized O&M cost per ton, *excluding Capex* (PV O&M costs / PV tons) (US$/ton)	4.99	4.79	4.79	5.51	4.07	4.76	4.81	2.75
Levelized costs, *including Capex* (PV all costs / PV tons) (US$/ton)	19.36	18.87	15.19	17.75	16.31	16.99	17.07	10.92
Annual Payment to Contractor US$ Million	5.27	5.64	4.91	5.70	4.85	5.42	5.13	3.83

Figure 5.1 shows the PV of cumulative 10-year O&M cash flow per ton of waste processed (Levelized O&M costs) (US$/ton) across each of the sensitivity scenarios. Excluding the MRF from the Project is expected to reduce levelized O&M costs of approximately 45 percent compared to the Base Case and has lower Levelized O&M costs than all options presented in the previous section.

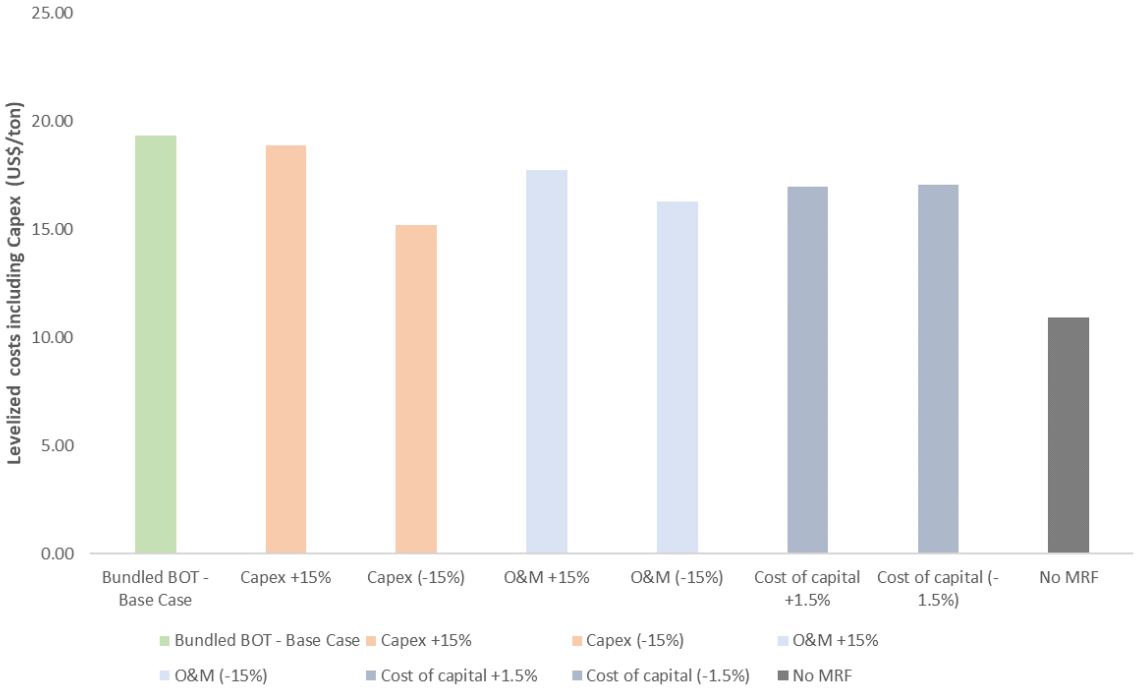
Figure 5.1: PV of cumulative 10-year O&M cash flow per ton of waste processed (levelized operational costs), US$/ton



Note: The dotted sits at US$3.59/ton, which is the levelized O&M cost per ton of the bundled option that excludes transfer stations and is the lowest levelized cost achieved in all scenarios presented in Section 4

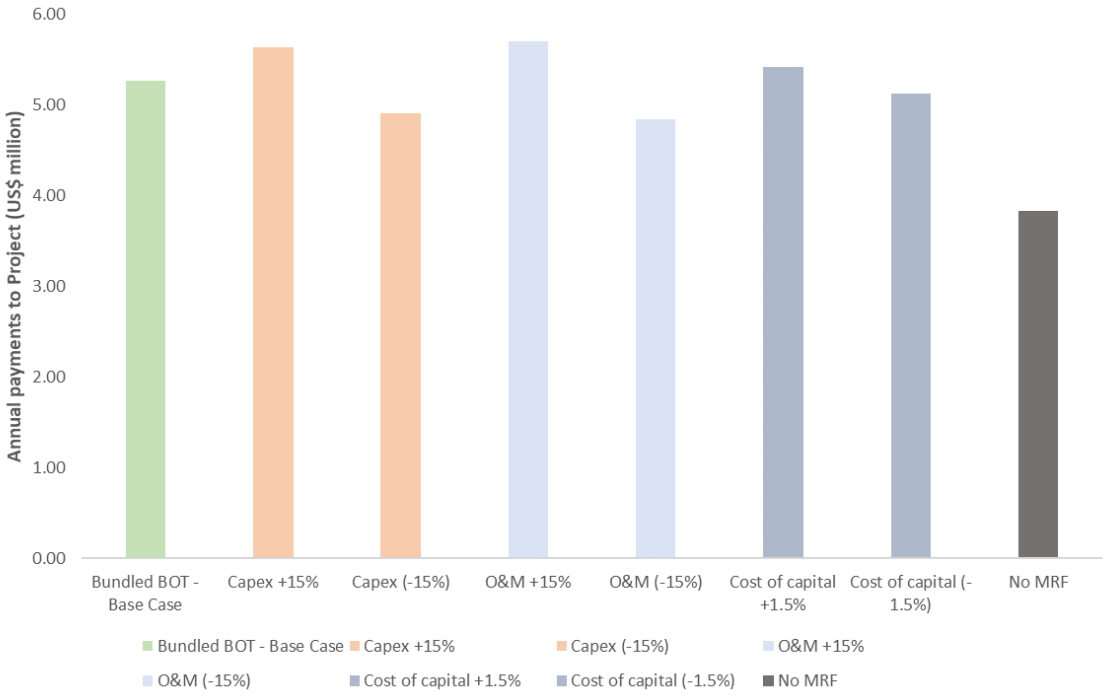
When Capex recovery is included in the levelized cost calculation, excluding the MRF from the analysis again yields the lowest cost (US$10.92/ton) compared to the Base Case and all sensitivity scenarios. Excluding the MRF from the Project would save almost US$8.50/ton compared to the Base Case if Capex were recovered within the Project. Figure 5.2 shows these results.

Figure 5.2: Levelized costs including Capex recovery, US$/ton



Excluding the MRF is expected to reduce the annual payment required to the Project in real terms by approximately 27 percent, which means a real reduction in the estimated viability gap of the same size. Figure 5.3 shows the annual payment requirements for each of the sensitivity scenarios.

Figure 5.3: Annual payments to the Project, US$ millions (real)



6 Next steps

The commercial analysis suggests that the sector has important choices to make as it moves forward with the Project. A choice of business model to employ for the Project is required, as several options exist, each with its advantages and disadvantages.

The commercial analysis has shown that excluding an MRF from the Project has financial merits, as would excluding transfer stations. The Government should assess both options' economic impact and weigh these against each option's affordability and the extent to which both deliver against the sector's objectives.

Specific steps that should be considered for advancing the Project include:

- Undertaking technical and socio-economic studies to identify and define the potential service area for the Project
- Engage stakeholders, including collection service providers, to understand the willingness and ability to direct waste from specific areas to the Project
- Complete an assessment of the impacts excluding the MRF and transfer stations will have on the Project's operational performance and costs
- Conduct an economic cost-benefit analysis of preferred options as a decision-making tool.

Appendix A: Interview Key

Table A.1: Interview Key

Interview Name	Stakeholder
Interview A	Kpone Metropolitan Assembly – October 05, 2020
Interview B	Accra Metropolitan Assembly – September 16, 2020
Interview C	J Stanley-Owusu Group – September 16, 2020
Interview D	Ministry of Finance – October 2, 2020
Interview E	Tema Metropolitan Assembly – September 18, 2020
Interview F	Anthony Mensah, Director of MSWR – September 15, 2020
Interview G	Jekora Ventures Limited – September 22, 2020
Interview H	Ghana National Cleaner Production Center – September 23, 2020
Interview I	Asedu Waste Management – September 17, 2020
Interview J	La Nkwantang Madina Assembly – October 5, 2020

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Enabling Environment Report

Financial and Economic Advisory for a Solid Waste Management Project in the Greater Accra Region, Ghana

February 2021

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Acronyms

ACARP	Accra Compost and Recycling Plant
GAMA	Greater Accra Metropolitan Area
GARID	Greater Accra Resilient and Integrated Development Project
GHS	Ghanaian cedi
GNCPC	Ghana National Cleaner Production Centre
IRECOP	Integrated Recycling and Compost Plant
IUESMP	Integrated Urban Environmental Sanitation Master Plan
KPI	Key Performance Indicator
MMA	Metropolitan and Municipal Assembly
MMDA	Metropolitan, Municipal, and District Assembly
MRF	Materials Recovery Facility
MSWR	Ministry of Sanitation and Water Resources
NSA	National Sanitation Authority
PPP	Public Private Partnership
PSP	Private Sector Participation
SIP	Sanitation Improvement Package
TS	Transfer Station

Executive summary

The Government of Ghana (the Government) has set out to develop an engineered landfill, a materials recovery facility, and up to two transfer stations (the Ayidan Project) to address immediate capacity gaps in Accra's final waste disposal. The Government is considering engaging a private company to operate and maintain the facility and, in doing so, seeks to prove a model for future PPPs in the sector. The World Bank intends to finance the Project and has engaged consultants to opine on potentially viable business models with private sector participation for delivery and operation of the Ayidan Project.

Given the solid waste management sector's extensive structural challenges, investor appetite to enter a public-private partnership (PPP) following international best-practice is likely to be low for the Project. The Government could likely engage an operator following current practices, but the current model is not sustainable. It does not align incentives to deliver technological improvements, operational efficiencies, or reductions in whole-of-life costs.

Reforms are necessary for the Project and the sector to benefit from private sector participation, which can be separated into a set of short-term and long-term actions. The immediate actions are required to create a financially viable and sustainable business model for the Project. Longer-term actions are needed to move the sector toward sustainability.

Table 1.1: Suggested reforms

Short-term actions required to deliver a sustainable Ayidan Project	Longer-term actions required to deliver sustainable sector operations
▪ Agree to risk mitigation and credit enhancement measures ▪ Form a dedicated contract management team to monitor clear KPIs and enforce contractual obligations ▪ Control waste flows to the Project	▪ Develop an integrated resource plan ▪ Reform collections' practices ▪ Empower national regulator to enforce standards ▪ Address gaps in existing monitoring and evaluation of the sector ▪ Develop additional funding sources for the sector to ensure its sustainability

The short-term reforms are designed to deliver the Project in a way that aligns its economic and technical life such that private investors would willingly finance heavy equipment, knowing they could recover costs over a contract term that industry would find acceptable. In Ayidan's case, the contract term should be no less than 10 years. However, a 10-year contract will not be achievable without changes to sector operations. In the absence of the short-term reforms, the Project is likely to reach capacity in 3 to 4 years and will not deliver a sustainable solution to the GAMA's immediate solid waste management needs. An outcome like that of Kpone's would be perceived as a failure by markets and potential investors. This outcome would not be a commercially viable opportunity for foreign private sector investors. The Project must demonstrate to the market how Government can push the sector towards much-needed sustainability.

These reforms are required to address systemic technical, institutional and legal, and commercial challenges to private sector participation and sustainability in the sector. Some of these challenges create immediate barriers to the Project's success while others impede overall sector performance.

Table 1.2: Barriers to the Project's and sector's success

Project	Sector
Technical	
▪ The potential market share that the Project will capture is uncertain as it is unclear whether the Government has the ability to limit waste flows ▪ The Project will not have direct control over the amount of waste delivered to the facilities	▪ Source segregation is limited ▪ Existing final disposal sites receive waste beyond designed capacity ▪ Large queues at waste disposal sites reduce operational performance ▪ Limited usage of transfer stations contributes to large queues at dumpsites ▪ There is a need for greater coordination with the informal sector ▪ Decentralized and short-term collections contracts reduce the efficiency of waste collection systems. ▪ Waste collection frequency is inconsistent. This causes increased illegal dumping
Institutional and regulatory	
▪ All of the sector challenges listed alongside affect the Project, as it is part of the sector and subject to the same institutional and regulatory regime.	▪ The sector lacks a comprehensive regulatory framework, and existing regulations are not well enforced, such as the polluter pays principle and citations for illegal dumping and open burning ▪ Fee-fixing resolutions are non-uniform and do not consider costs explicitly. Similarly, mechanisms for setting gate fees are unknown and do not appear to cover the cost of final disposal. ▪ Private waste collectors are unable to manage collection risk effectively, resulting in reduced revenue collection to fund waste transit and disposal operations ▪ Contracts do not always define KPIs or service standards and are not standardized across MMDAs ▪ Institutional roles are not clearly defined ▪ Metropolitan, Municipal, and District Assemblies (MMDAs) do not have tools to enforce contractual terms effectively, enabling poor performance from private operators
Commercial	

Project	Sector
▪ Uncertainty in a competitive landscape ▪ Monopoly influence	▪ Monopolists limit competitive outcomes and increase sector costs ▪ The culture of cost-recovery is largely absent in the formal sector ▪ The Government does not consistently meet its payment obligations ▪ There are limited PSP models that can be sustainable and commercially viable in the long-term ▪ Risks are not allocated to the party best capable of managing them ▪ The informal sector prevents formal operators from recovering the full value from a franchise area

While the barriers discussed above represent significant shortcomings in Ghana's solid waste sector, there are areas where the sector has made progress and performs comparatively well. The following table describes how the sector has adopted good practices and discusses areas where improvement is needed.

Table 1.3: Overview of Ghana's solid waste sector

Component	Description
	Existing components
Safe treatment	The Government has made efforts to treat waste safely and move it up the value chain. GAMA has several recycling and materials recovery facilities Accra Compost and Recycling Plant (100,000tpa) and Integrated Recycling and Compost Plant (70,000tpa), public agencies like Ghana National Cleaner Production Centre (GNCPC), and a waste-to-energy plant (Safi-Sana). These plants reduce the total waste for final disposal and promote the re-use of waste. However, except for the waste-to-energy plant (Safi-Sana), these plants are operating below design capacity. The quality of outputs and the economic viability of the plants is unclear.
Appropriate legislation and control	While the sector lacks a clear and consistent legal framework, the Government has achieved a level of success in governance and oversight. The implementation of policies and plans is monitored and evaluated at the national and district level.[1] MMDAs collect customer satisfaction surveys from households to monitor the quality of services. The Government is establishing a dedicated National Sanitation Authority (NSA), a single formal regulatory body for waste management.[2] Fee-fixing resolutions have various price bands for large waste producers and smaller waste producers. The differing rates imply that producers are charged based on their capacity to pay rather than total waste generated.

[1] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 240

[2] "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 15

Component	Description
	The Ministry of Sanitation and Water Resources (MSWR) is responsible for the solid waste sector at the national level and is organized into several departments to improve supervision.[3] It is developing standardized service contracts for the sector and procurement guidance. Some of the activities the MSWR is responsible for include: ▪ Coordinating and formulation of environmental sanitation policy (including technical guidelines, monitoring, and evaluation) ▪ Mobilizing funds for government objectives ▪ Developing national legislation and model bylaws Some MMDAs include penalty clauses within contracts for breach of service.[4] For example, waste collectors must pay a fee of 20 GHS for each household from which they fail to collect waste in a week. Further, the Government and United States Agency for International Development are working toward building a harmonized database for the water and sanitation sector. However, it is unclear whether the database will also include financial flows.[5]
Appropriate risk allocation	The Government has transferred to private operators functions that they are well-placed to execute. Despite accepting these responsibilities, the operators often have limited access to appropriate risk mitigation or management tools. For example, private collections companies in the GAMA report that they must provide services even when customers do not pay. While the operators could seek a resolution from sanitation courts, it is reported that political influence in regulation and the courts limits the recourse available to plaintiffs in the courts. Likewise, the Government has taken on some functions it is better placed to (and should) manage, such as land acquisition for final disposal sites. Despite the Government taking on these risks, some functions have not been managed effectively. For example, the Government has neither planned nor acquired sufficient land for final disposal, leaving the sector with a shortage of final disposal capacity.
A degree of funding support	The Government intends to fund parts of the solid waste management system that do not fully recover costs. It has supported the sector by paying tipping fees to landfill operators at Kpone and other sites. However, the Government did not consistently pay the facility's operator for a period of several years. On other occasions, the Ministry of Finance intervened to pay private operators to which MMDAs owed money. The Government has also sought to increase funding to the sector. Ghana implemented an environmental excise tax, which contributed to funding the recycling of plastic waste.[6] Despite progress, the sector has not achieved full funding yet.
	Components that the sector lacks
Economic viability	The sector does not deliver net benefits to society as it does not follow best practices. For illustration: ▪ Government does not have a costed masterplan for the sector. Project selection processes appear reactive, rather than proactive. Projects developed by the private sector do not appear to fit within a broad strategy. This is the case with Ayidan, and it jeopardizes the sustainability of

[3] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 236

[4] Waste Collections Contract Sample provided by Ga West

[5] "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 27

[6] Customs and Excise (Duties and Other Taxes) (Amendment) Act 863, 2013

Component	Description
	projects. It is impossible to have a high level of performance from a project without certainty around the sector's competitive and complementary parts. ▪ Safe treatment of waste is not a consistent practice. While Kpone was developed as an engineered landfill, its operations quickly deteriorated. It is now operated as an unmanaged dumpsite with members of the informal sector picking waste from a live dumpsite. Open dumping of waste is common, as is flooding of waterways during heavy rains.[7] The Nsumia and Adepa dumpsites operate as controlled and semi-controlled sites, respectively.[8] ▪ Services are not consistently delivered to the poorest people, meaning that vulnerable populations often have the fewest options for collection and safe disposal of waste.
Universal access	The Government has not achieved universal access to solid waste management services. Reported collection coverage ranges from 35 percent in Ga South to 93 percent in La-Dade Kotopon Municipal Assembly.[9] Only 72 percent of households in the GAMA have waste collected from their homes.[10]

[7] "Socio Economic Survey Report - Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 41

[8] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 202

[9] "Socio Economic Survey Report - Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 55

[10] "Socio Economic Survey Report - Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 57

1 Introduction

The Greater Accra Resilient and Integrated Development Project (GARID Project) seeks to transition Ghana's solid waste management sector towards sustainability. Among the GARID Project's many objectives, increasing private sector participation (PSP) in solid waste management services is key.

The Government also recognizes that changes are needed in the sector and has set out several goals to improve the sector's performance, including[11]:

- Implementing models focused on cost-recovery
- Strengthening capacity for monitoring and evaluation activities
- Evaluating financing mechanisms for priority interventions in the sector; and
- Addressing current gaps in policies, laws, regulations, and standards that are necessary for the implementation of an Integrated Urban Environmental Sanitation Master Plan (IUESMP)

Under the GARID Project, the World Bank intends to finance the Ayidan project (the Project) to address immediate capacity gaps in Accra's final waste disposal. The Ayidan Project will include an engineered landfill, a materials recovery facility, and up to two transfer stations. Castalia and Mott Macdonald (the Consultant) has been engaged to evaluate the Project's technical structure, assess potential PSP models for the Project, and opine on the enabling environment for PSP for the Project. The objective of this report is to:

- Summarize the status quo of the solid waste management sector environment where the Ayidan transaction is planned
- Discuss the present characteristics and those additionally needed to have a sustainable solid waste sector and implement projects attractive to the private sector
- Outline technical, institutional and regulatory, and commercial challenges faced in Accra's solid waste sector that act as impediments to project and sector sustainability
- Present options to the Government for transitioning the sector towards sustainable operations

This report's delivery was brought forward to communicate the challenges the Project will face prior to an evaluation of the commercial viability of the Project under possible private sector participation models. Given deep uncertainty about the environment under which the Project will be delivered, two possible scenarios are envisaged (detailed in Table 1.1)

[11] "Ghana Environmental Sanitation Strategy Report Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 135-140

Table 1.1: Scenarios for Ayidan Project

Waste Capture Scenario	Lifecycle Scenario
The Project reaches capacity in 3 years, after capturing a market share of 66 percent[12] of total waste generated.[13] While the Project can be developed rapidly and meets an urgent need, this benefit is outweighed by the additional costs Government will incur as it transitions immediately to developing another landfill site within 3 years, to replace Ayidan.	The Project is developed under the same schedule as the Waste Capture Scenario. The Government directs where waste is sent for disposal by assigning service zones or using other quantity management techniques, thus regulating waste flows to Ayidan. The Project's market share reduces because of technical and economic conditions and a changed competitive landscape, while the expected lifespan of the Project increases. If the landfill limits waste reception to 360,000 tons per annum (which equates to 37 percent of captured waste in 2022, reducing to 26 percent in 2030) of the GAMA's waste, the landfill's life will be approximately 10 years.[14]

Under the Waste Capture Scenario, it is anticipated that investor appetite to enter a public-private partnership (PPP) following international best-practice will be low. It is likely that the Government could engage an operator following the prevailing practice of operations and maintenance (O&M) contracts, but this is not sustainable for the Project or sector. Greater value for money and more efficient operations can be achieved by the Government when the private sector is positioned to share part of the risk, such as financing design and equipment for operations, which is difficult to achieve under short-term O&M contracts.

Under the Lifecycle Scenario, other PSP models have varying degrees of potential to succeed. However, without structural reforms to sector operations and management, sustainable long-term options are expected to be limited, and an outcome similar to that of the Kpone Landfill is likely. At the Kpone landfill, an absence of sector control and alternative final disposal sites led to over-tipping, which significantly shortened the landfill's useful life. This report explores these two scenarios, the challenges to developing a sustainable PSP model, and their implications.

The structure of the report is set out as follows:

- This report first presents a definition of sustainability for both an individual project and for the entire sector (Section 2). This discussion is necessary, in large part, to draw a distinction between commercial viability and sustainability.
- Next, it presents challenges to achieving sustainability in the following categories: technical (Section 3), institutional and regulatory (Section 4), and commercial (Section 5).

[12] 66 percent represents the total of the GAMA waste, less collection losses and collections by the informal sector

[13] Consultant's Final Technical Report. February 1, 2020.

[14] Consultant's Final Technical Report. February 1, 2020.

- To conclude, the report recommends changes the Government can and, in some cases, will need to make to achieve sustainable operations for the sector and individual projects (Section 6).

2 Sustainability in Ghana's solid waste management sector

When we speak of sustainability in the solid waste management sector, we mean a sector that provides universal collection, ensures safe treatment of waste, has appropriate legislation and control, appropriate risk allocation, and is fully funded. A sustainable sector ensures that services are available to all members of society.

Sustainability is different than commercial viability. Projects could be commercially viable, but this does not mean that they are sustainable. For example, operations and maintenance contracts are viable in the short term, even following current practices in Ghana, but this is not a model that should be replicated indefinitely. A sustainable sector creates the foundation for commercial and economic viability. The sector must move towards sustainability to prevent projects from falling short of their goals, as they have in the past. Outcomes of projects like the Kpone landfill, which did not serve its whole purpose, must not be repeated.

2.1 What do the components of sustainability mean?

Table 2.1 below details the components of a sustainable sector needed to obtain the desired economic, environmental, and social outcomes.

Table 2.1: Components of sector sustainability

Component	Description
Economically viable	The benefits of the sector must exceed the costs produced by the sector, and the same principle must apply to policies and regulations, such that the benefits of a policy or regulation should exceed the costs of implementing that policy or regulation.
Universal collections	Universal collection is necessary to prevent waste from entering illegal dumpsites, sewers, and rivers or being burnt in the open.[15] To enable universal collection, it is necessary to eliminate duplicate routes, minimize the distance traveled to disposal (including by using transfer stations), ensure disposal takes place at a sanitary landfill, and ensure waste management is adequately resourced. Segregation at source can also support recycling and materials recovery.

[15] "Why every city needs universal waste collection and safe disposal as the foundation for sustainable waste management", C40 Cities Climate Leadership Group, Accessed 1st November 2020, (https://www.c40knowledgehub.org/s/article/Why-every-city-needs-universal-waste-collection-and-safe-disposal-as-the-foundation-for-sustainable-waste-management?language=en_US)

Component	Description
Safe treatment	Safe treatment is essential to prevent health risks, contamination of ground and surface water, and release powerful greenhouse gases such as methane.[16] Some key goals include: ▪ Eliminating open dumping, open burning, and waste leakage ▪ Reducing waste for final disposal by maximizing materials recovery, waste to energy, and recycling, which also creates economic and financial benefits ▪ Encouraging good practice regarding the health and safety of all people involved in waste management, including waste pickers and informal operators
Appropriate legislation and control	Appropriate legislation and control enable the effective management of waste through well-formulated policies, enforcement of legislation, and adoption and implementation of best practices in sector management.[17] A sector must have: ▪ Legislation and policies governing national waste management that are clear, complete, and enforceable ▪ Incentives and enforcement mechanisms for the Government and public institutions responsible for service delivery[18] ▪ Risks allocated to the party best placed to manage them (this will not necessarily always be the private sector)[19]
Fully funded	The sector must be fully funded, which means that its revenues (through user fees or a combination of user fees and government funding) cover its costs, including the cost of capital.
Universal access	Universal access ensures that waste management services are provided to all members of society, with a minimum service standard that protects human health and the environment. A higher service level can be delivered to households that wish for it and are willing to pay for it.

2.2 What else does an individual project need to be sustainable?

While a sustainable sector is essential for environmental and social outcomes, it does not ensure that individual projects will be commercially viable, irrespective of the chosen financing and delivery model. Similarly, a project could be financially viable but not sustainable. For example, an operations and maintenance contract for the Ayidan Project is likely to be financially viable following current practices, but not sustainable. Current practices in the sector limit risk transfer

[16] Ibid.

[17] "Rethinking sustainability: a review of Liberia's municipal solid waste management systems, status, and challenges" David, V.E., John, Y. & Hussain, S., 6th May 2020, Accessed 1st November 2020, (https://link.springer.com/article/10.1007/s10163-020-01046-x)

[18] "Municipal Solid Waste Management" (2018) The World Bank Group. Page 17. (https://openknowledge.worldbank.org/bitstream/handle/10986/30434/130055-WP-P162603-WasteManagement-PUBLIC.pdf?sequence=1&isAllowed=y)

[19] "Risk Allocation, Bankability and Mitigation in Project Financed Transactions" The World Bank Group. (https://ppp.worldbank.org/public-private-partnership/financing/risk-allocation-mitigation)

to the private sector and fail to deliver the true benefits of private sector participation, including technological innovation, operational efficiency, and whole-of-life cost savings

The components of a sustainable project can be assessed in a similar way to that of a sustainable sector. The different aspects that contribute to an individual project's sustainability are outlined below.

Table 2.2: Components of sustainable projects

Component	Description
Economically justified	For every project, the net benefits must be positive, meaning that the benefits delivered by that project exceed the costs of developing and operating that project.
Defined business models	Business models should include: ▪ A clear definition of services ▪ A reliable revenue stream (often secured through credible waste flows) ▪ A transparent dispute resolution process ▪ Allocation of risks with the party most capable of managing them. For example, Government could accept quantity risks at a final disposal site when a landfill operator is unable to influence waste collection, or the choice of final disposal sites. This is in opposition of the current scenario, where the private sector accepts risk from consumer payment defaults although they are not capable of enforcing private citizens to pay service fees, nor are they at liberty to withhold services for non-payment.
Clear key performance indicators	Projects must have clear key performance indicators (KPIs) linked to the payment mechanism. These include defined standards for: ▪ Waste collections, transfers, disposal, and materials recovery ▪ Maintenance timelines, safety, and reporting ▪ Environmental issues related to items such as pollution prevention (air, water, land, ecosystems), adverse impacts to local communities, biodiversity, and natural living resources
Credible enforcement mechanisms	There should be credible enforcement mechanisms available to the Government or private sector for any material breaches of contract by a counterparty.
Financially viable	A project needs to be financially viable, meaning it must receive sufficient revenue to recover its capital and operating expenses and earn a reasonable rate of return. If user fees are not sufficient to cover all costs, Government payments or capital subsidies must close the viability gap. Individual projects may be financially viable, even if the sector as a whole is not.

2.3 What elements of a sustainable sector does Ghana already have?

There are several good practices in Ghana—largely observed in Accra—that can be built upon to develop a sustainable solid waste sector. There are also significant concerns across these areas despite progress made, which are addressed later in this report.

Table 2.3: Overview of Ghana's solid waste sector

Component	Description
	Existing components
Safe treatment	The Government has made efforts to treat waste safely and move it up the value chain. GAMA has several recycling and materials recovery facilities, including the Accra Compost and Recycling Plant (100,000tpa) and Integrated Recycling and Compost Plant (70,000tpa), public agencies like Ghana National Cleaner Production Centre (GNCPC), and a waste-to-energy plant (Safi-Sana). These plants reduce the total waste for final disposal and promote the re-use of waste. However, except for the waste-to-energy plant (Safi-Sana), these plants are operating below design capacity. The quality of outputs and economic viability of the plants is unclear.
Appropriate legislation and control	While the sector lacks a clear and consistent legal framework, the Government has achieved a level of success in governance and oversight. The implementation of policies and plans is monitored and evaluated at the national and district level.[20] MMDAs collect customer satisfaction surveys from households to monitor the quality of services. The Government is establishing a dedicated National Sanitation Authority (NSA), which will be the single formal regulatory body for waste management[21] Fee-fixing resolutions have various price bands for large waste producers and smaller waste producers. The differing rates imply that producers are being charged based on their capacity to pay rather than total waste generated. The Ministry of Sanitation and Water Resources (MSWR) is responsible for the solid waste sector at the national level and is organized into several departments to improve supervision.[22] It is developing standardized service contracts for the sector and procurement guidance. Some of the activities the MSWR is responsible for include: ▪ Coordinating and formulation of environmental sanitation policy (including technical guidelines, monitoring, and evaluation) ▪ Mobilizing funds for government objectives ▪ Developing national legislation and model bylaws Some MMDAs include penalty clauses within contracts for breach of service.[23] For example, waste collectors must pay a fee of 20 GHS for each household from which they fail to collect waste in a week. Further, the Government and United States Agency for International Development are working toward building a harmonized database for the water and sanitation sector. However, it is unclear whether the database will also include financial flows.[24]
Appropriate risk allocation	The Government has transferred to private operators functions that they are well-placed to execute. Despite accepting these responsibilities, the operators often have limited access to appropriate risk mitigation or management tools. For example, private collections firms in the GAMA report that they must provide services even when customers do not pay. While the operators could seek a resolution from sanitation courts, it is reported that political influence in regulation and the courts limits the recourse available to plaintiffs in the courts.

[20] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 240

[21] "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 15

[22] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 236

[23] Waste Collections Contract Sample provided by Ga West

[24] "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 27

Component	Description
	Likewise, the Government has taken on some functions it is better placed to (and should) manage, such as land acquisition for final disposal sites. Despite the Government taking on these risks, some functions have not been managed effectively. For example, the Government has neither planned, nor acquired sufficient land for final disposal, leaving the sector with a shortage of final disposal capacity.
A degree of funding support	The Government intends to fund parts of the solid waste management system that do not fully recover costs. It has supported the sector by paying tipping fees to landfill operators at Kpone and other sites. However, the Government did not consistently pay the facility's operator for a period of several years. On other occasions, the Ministry of Finance intervened to pay private operators to which MMDAs owed money. The Government has also sought to increase funding to the sector. Ghana implemented an environmental excise tax, which contributed to funding the recycling of plastic waste.[25] Despite progress, the sector has not yet achieved full funding.
Components that the sector lacks	
Economic viability	It cannot be said that the sector delivers net benefits to society as the sector does not follow best practices. For example: ▪ Government does not have a costed masterplan for the sector. Project selection processes appear reactive rather than proactive. Projects developed by the private sector do not appear to fit within a broad strategy. This is the case with Ayidan, and it jeopardizes the sustainability of projects. It is impossible to have a high level of performance from a project without certainty around the sector's competitive and complementary parts. ▪ Safe treatment of waste is not a consistent practice. While Kpone was developed as an engineered landfill, its operations quickly deteriorated, and it is now operated as an unmanaged dumpsite with members of the informal sector picking waste from a live dumpsite. Open dumping of waste is common, as is flooding of waterways during heavy rains.[26] The Nsumia and Adepa dumpsites operate as controlled and semi-controlled sites, respectively.[27] ▪ Services are not consistently delivered to the poorest people, meaning that vulnerable populations often have the fewest options for collection and safe disposal of waste.
Universal access	The Government has not achieved universal access or coverage to solid waste management services. Reported collection coverage ranges from 35 percent in Ga South to 93 percent in La-Dade Kotopon Municipal Assembly.[28] Only 72 percent of households in the GAMA have their waste collected from their homes. [29]

[25] Customs and Excise (Duties and Other Taxes) (Amendment) Act 863, 2013

[26] "Socio Economic Survey Report - Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 41

[27] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 202

[28] "Socio Economic Survey Report - Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 55

[29] "Socio Economic Survey Report - Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 57

3 Technical assessment

There are several technical challenges to sustainability that have been identified through stakeholder consultation and desktop research. This section describes these challenges and lists options for addressing them.

3.1 Principal challenges

Technical challenges relate to practices and physical constraints that prevent efficiency and long-term sustainability of the Project and sector. These include challenges related to waste quantities, its collection, transportation, and final disposal. This section deals with the physical aspects and does not cover issues with regulations and institutions, or the financial implications of these issues, as these are covered in later sections.

Table 3.1: Technical challenges

Project Challenges	Sector Challenges
▪ The potential market share the Project will capture is uncertain as it is unclear whether the Government has the ability to limit waste flows ▪ The Project will not have direct control over the amount of waste delivered to the facilities	▪ Source segregation is limited ▪ Existing final disposal sites receive waste beyond designed capacity ▪ Large queues at waste disposal sites reduce operational performance ▪ Limited usage of transfer stations contributes to large queues at dumpsites ▪ There is a need for greater coordination with the informal sector ▪ Decentralized and short-term collections contracts reduce the efficiency of waste collection systems. ▪ Waste collection frequency is inconsistent, and this causes increased illegal dumping

These challenges are discussed in detail below.

The potential market share the Project will capture is uncertain as it is unclear whether the Government has the ability to limit waste flows. Under the Waste Capture Scenario, where no other landfill sites exist, the Ayidan project would likely serve the whole of the GAMA region. The GAMA generates around 1.5 million tons per annum (tpa), of which around 980 thousand tons (66 percent) is formally collected and is projected to flow to the Project due to limited alternative capacity existing in the geographical area. While the Project would address a critical need – availability of final disposal capacity – the volume of waste accepted would limit the Project's

capacity to accept waste to a period of 3 to 4 years.[30] Further, the total volume of waste requiring management would be larger than any existing facilities have managed historically.

Under the Lifecycle Scenario, the Project's lifespan could increase to 10 years, assuming it accepts around 350,000 tons of waste per annum. In this scenario, the challenge is to ensure sufficient waste flows to the Project, as other semi-engineered landfills expected to be developed by Jospong Group could attract a significant quantity of the waste in the GAMA on account of lower tipping fees. These tipping fees at Jospong sites would likely be significantly lower than the Ayidan project due to limited environmental and engineering controls, assuming that the level of service of existing Jospong facilities would be achieved in any new facility. A clear challenge to the success of this model is that it is uncertain whether the Government has the ability to effectively designate and enforce waste capture zones for specific landfill sites.

In both scenarios, a materials recovery facility attached to the Project could divert approximately seven percent of inputs as recyclate recovery, based on modest assumptions for the configuration and performance of the plant. A composting plant could provide stabilized material for use as daily cover for the landfill. Under the Waste Capture Scenario, this seven percent reduction could increase the lifespan of the Ayidan landfill by approximately two months.

Source segregation is largely absent. Currently, only one provider (Jekora Ventures) practices source segregation within its operational areas.[31] Segregating even a modest proportion of the organic waste from the mixed waste at source will reduce demands on both the Ayidan landfill and on future projects. This reduction in demand will lengthen projects' useful lives. Organic waste that is source segregated can be used to form compost or soil improver. Organic waste treated from a mixed waste source cannot be used as compost or soil improver, as it will contain impurities that could leach into the soil. However, even in the absence of source segregation, treatment of organic wastes received commingled with general wastes is still considered technically viable given the high percentage of organic waste in GAMA. Technically viable options include biostablization and drying of organic waste to reduce volume, reducing methane production on the landfill, and generating a material suitable for a daily cover.

Existing final disposal sites receive waste in excess of design capacities. Final disposal sites such as Nsumia, Adepa, and Kpone have exceeded their capacities. This has depleted their useful life in advance of their expected lifetime. If waste flows are greater than plants were designed to accept, it is difficult to place waste as planned and to build up the right landfill profile. Compactor capacity is also limited at disposal sites. Additionally, the bigger the tipping face, the greater the potential for environmental impacts from litter, odors, and fires. As landfill operators cannot control waste inflows, they may incur more significant maintenance costs than anticipated and would therefore be unable to recover costs given current charging structures and practices in the sector. Further, the absence of sufficient final disposal capacity increases illegal and uncontrolled dumping of

[30] Consultant's Draft Technical Report. November 6, 2020.

[31] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 188

waste. If waste collectors do not have geographically accessible and affordable landfill capacity, they will likely dispose of waste illegally.

Apart from Ayidan, three additional landfill sites may become available. However, if new sites do not come online, the lack of additional capacity means that, once operational, the Ayidan site is likely to be the only site available to take waste. In this position, the Project would have a useful life of fewer than 4 years, rather than 10 or more which could be achievable with greater institutional capacity and coordination. Unless additional capacity beyond Ayidan is made available, future projects will repeat the mistakes of Kpone.

Large queues at waste disposal sites reduce operational performance. Both MMDAs and private collection companies reported significant queues at dumpsites. Stakeholders have said that vehicles often wait up to two days to unload at some locations.

These long queues are inefficient and:

- Prevent the waiting vehicle from undertaking further waste collections
- Remove staff from useful waste management work
- Prevent robust route planning as it is uncertain how long vehicles will be out of use
- Increase the release of vehicle emissions as trucks idle.

Further, borla taxis and other small vehicles deliver waste to dumpsites, increasing the number of vehicles unloading.[32] Reliance on borla taxis and other small vehicles is inefficient and increases the number of vehicles on the road.

Two transfer stations already operate in the GAMA, neither of which are fully utilized. Transfer stations collect waste from small vehicles and transfer this waste to larger vehicles, which then travel to final disposal sites. The use of vehicles with greater volumes reduces the number of vehicles tipping at final disposal sites and helps reduce queues.

Limited usage of transfer stations contributes to large queues at dumpsites. Disposal of waste at transfer stations could help reduce queues at dumpsites, but waste collectors have limited incentives to tip at transfer stations. Currently, waste collectors dispose of waste at sites that are the most profitable for them, rather than at sites that are operationally efficient for the sector. Disposal at a regulated dumpsite has limited direct costs for private collection companies apart from fuel costs as collection vehicles are not charged a tipping fee to dispose of wastes. During stakeholder consultation, waste collectors communicated that the additional cost of fuel and queuing for disposal at distant dumpsites was lower than the cost of tipping fees at transfer stations. This disincentivizes waste collectors from using transfer stations.

If consumers were to pay cost-recovering tariffs, waste collectors would be able to pay the cost of transport to landfill sites and tipping fees at the landfill sites. In such a scenario, accompanied by enforcement of anti-dumping laws and hefty fines, waste collectors would be less likely to dump

[32] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 221

waste illegally as they could afford to pay tipping fees at disposal sites. This scenario does not appear terribly farfetched as more than 60 percent of the population of Greater Accra would be willing to pay more for improved collection services.[33]

There is a need for greater coordination with the informal sector. Although the informal sector currently collects around 52 percent of waste in the GAMA and is an integral part of the system, there is a lack of coordination between formalized and informal waste collectors.[34] In some instances, the informal sector does coordinate or operate under the private sector[35], but the practice is not widespread. This lack of coordination leads to congestion at landfill sites and transfer stations and overlapping collection routes.

Decentralized and short-term collection contracts reduce efficiency. The scale and tenure of waste collection contracts limit private operators' ability to implement cost-efficient solutions over the long-term, make capital investments, and achieve economies of scale. Existing collection contracts are set over varying periods, with some as 3 years and others as 5 years.[36] Short-term contracts reduce the incentives for firms to invest in transit fleets, leading to poor service delivery and reduced collection rates.

At present, the approach to waste collection is highly fragmented as each MMDA is split into waste collection zones with different private sector companies collecting waste from each zone. Decentralizing municipal entities, which increased the total number of MMDAs from 11 to 26 (or 29 according to some sources), has increased this problem's complexity. As service areas are constantly changing, it is difficult to plan for long-term waste collection and to maximize collection rates. Current practices prevent effective waste collection, leading to reduced waste flows to landfill sites and uncertainty around quantities of waste flows that these sites will receive, which impedes effective logistical and financial planning of the sector.

Waste collection frequency from communal collection points is inconsistent, and this causes increased dumping. Collection frequency is inconsistent and can lead to periods where waste is not collected. If waste containers from communal collection points are not collected when full, people dispose of waste by dumping it illegally.

3.2 Options to address technical challenges

The sector will require changes to reduce the physical constraints on the system and move it toward sustainability. This section outlines steps that could improve the technical aspects of the sector. Figure 3.1 maps the technical challenges to potential solutions that could be taken to address them.

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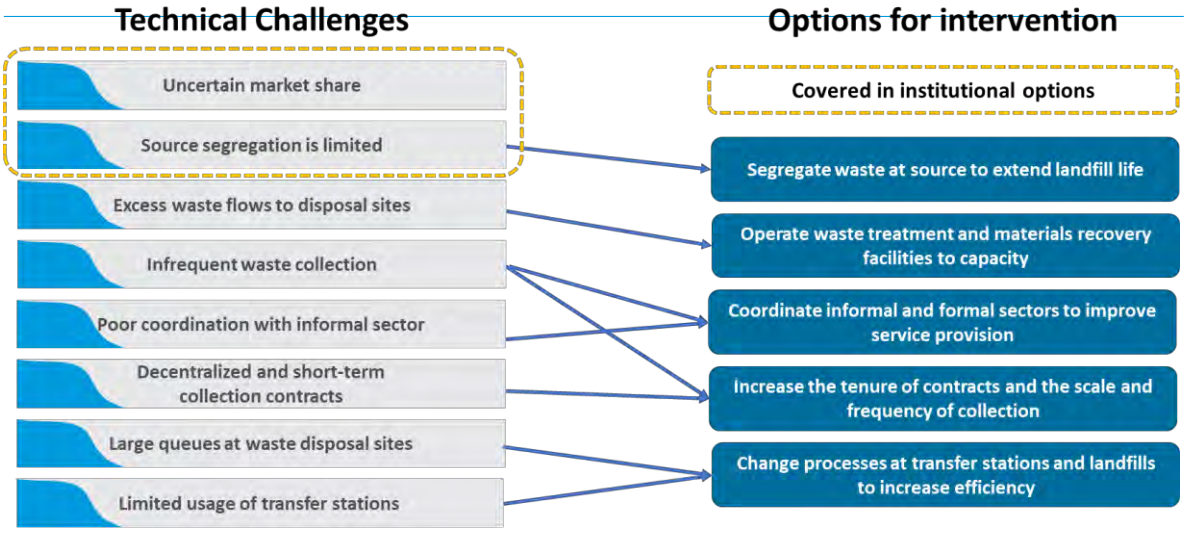
[33] "Household Willingness-to-Pay for Improved Solid Waste Management Services in Four Major Metropolitan Cities in Ghana"(2019) Kwame Nkrumah University of Science and Technology, Kumasi, Ghana (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6334316/)

[34] Interview F

[35] This usually occurs in low-income locations that do not have suitable road access for the private sector's collection vehicles. The informal sector can access these households as their vehicles are smaller and more agile.

[36] Interview I

Figure 3.1: Technical challenges and options to address them



The options are discussed in detail below.

Improve processes for final disposal of waste to increase efficiency. For the Project, the introduction of an MRF and two transfer stations would: increase the number of points at which waste can be delivered, improve sorting and compaction, and reduce queuing times.

To improve efficiency across the sector, operators must have incentives to use existing transfer stations and MRFs, or disincentives to pass them by. This change in process will help to reduce wait times and improve collection efficiency across the sector.

- Increasing the use of transfer stations and using haulage vehicles to move waste from transfer stations to final disposal sites will reduce the overall need for borla taxis. If the opposite occurs, a greater numbers of borla taxis would be required, as they carry smaller volumes of waste, which would cause longer lines at the Project's landfill and MRF. The Government could also designate certain zones or MMDAs to deliver waste directly to specific transfer stations, preventing them from tipping waste at landfill sites, to further ease congestion.
- From a contractual perspective, it is typical to require a maximum turnaround time from weighbridge to weighbridge of 15 or 20 minutes. This measure could be considered for the Project. One way to regulate queuing times is to specify the length of access road from the public highway required on the landfill site. A KPI could then be included to ensure that no vehicles overflow from the access road onto the public highway, thus limiting queue times. The Government could monitor this KPI by asking drivers to take a photo if lines require them to queue on the public highway, subject to following laws about driving and using handheld devices.

- If vehicles could complete two collection rounds in one day, instead of one every other day, they could collect four times more waste. Such an improvement would make the system more efficient and reduce capital and staffing costs for vehicles.
- Under the Lifecycle Scenario, the fundamental approach of reducing the number of small vehicles entering the active landfill tipping area would still apply. The use of an MRF that features a conventional waste reception area would minimize the number of vehicle entries on the landfill site.

Coordinate informal and formal sectors to improve service provision. The informal sector plays a vital role in the sector. Private operators cannot always service all households in areas awarded to them due to limited space and infrastructure in lower-income communities (such as roads suitable for larger vehicles). The informal sector collects waste in these low-income areas, recovers materials at the roadside, and picks materials at landfills and dumpsites. Interventions that may support better integration and acknowledgment of the informal sector include:

- Employing landfill pickers as hand sorters within the Project MRF or offering a fixed subsidy to landfill pickers to separate recyclable waste. These options could yield an additional benefit in reduced congestion at final disposal sites, waste transfer stations, and service costs in some areas by avoiding duplication of effort/trips;
- Developing a licensing system that permits informal workers to collect waste from designated low-income areas (or areas otherwise inaccessible to the formal sector), provided collected waste is taken to transfer stations with the public sector potentially subsidizing tipping fees;[37]
- Designating specific times for informal waste collectors to deliver waste to transfer stations to reduce congestion and conflicts with formal companies;
- Introducing a transparent charging system or including costs for tipping in contracts where the informal sector collectors are using communal collection points to reduce unregulated dumping.

Increase the tenure of contracts to reduce procurement costs and ensure better overall service delivery. Stakeholders communicated that the tenure of collection contracts is between 1 and 5 years and is limited to a single MMDA's service area. These contracts' term and scale reduce operators' ability to implement more cost-efficient solutions and achieve economies of scale. Collection contracts should extend for 5 to 7 years, reflecting the typical lifecycle of a newly purchased collection fleet. A contract term of at least this length would encourage operators to invest in modern waste collection equipment by providing sufficient time to fully recover costs, including a reasonable rate of return. Modern equipment would enable operators to collect waste more efficiently, increasing revenue and reducing operating costs, to ultimately improve service provision in the sector.

[37] "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 37

Segregate waste at source to improve capture rates for recyclables and organic waste to extend landfills' useful lives. Capturing and treating organic waste can reduce the total waste sent to landfills and increase the useful life while producing a useful compost-like product. Adequate waste collection infrastructure and equipment must be implemented and supported by effective education and awareness-raising campaigns to enable high capture rates. Processing source-segregated organic waste with appropriate forms of waste treatment (such as anaerobic digestion, in-vessel composting, or windrow composting) can produce a compost-like product suitable for use as a soil improver or in land remediation.

Overall, whilst resource recovery will have a limited capacity to extend the Project's life, diverting material from the landfill will help establish best practice in Ghana and could serve as a model for future change in the sector. The sale of recyclables could potentially provide additional revenue streams. Resource Recovery will also help to achieve UN Sustainable Development Goals Number 11, 'Make cities and human settlements inclusive, safe, resilient and sustainable' and Number 12, 'Ensure sustainable consumption and production patterns.'

Operate waste treatment and materials recovery facilities to capacity to service more waste. The three existing waste treatment facilities within the GAMA have a total combined capacity of over 170,000 tons per annum (tpa). This could be increased to over 250,000tpa if the ACARP facility operated a second shift.[38] Operating these facilities at or near full capacity would reduce the quantity of waste for capture by the Project and lengthen the life of the landfill. The facilities currently state that they divert almost all treated waste from landfill. This is not typically possible so it is not possible to quantify the amount of waste which would be actually diverted from landfill. If 50 percent of the waste was diverted from landfill (125,000tpa), that would be 11 percent of the amount of material modeled as requiring a treatment/disposal site in 2022.[39]

4 Institutional and regulatory assessment

Institutional roles and policies must be clear and comprehensive to drive long-term sustainability in the solid waste sector. This section describes several challenges which warrant consideration and outlines potential options to overcome them.

4.1 Principal challenges

Institutional challenges in the sector relate to the regulations and institutions that govern the waste management sector and limitations that prevent the sector from becoming sustainable.

[38] The second shift has only been included for ACARP as the 02. Situational Report Vol II Appendices - revised 190819 document states that the design capacity was 600 tons per day, but the 03. Solid Waste Assessment Report – MSWR reports says that it has a capacity of 300 tons per day operating an 8 hour shift

[39] Consultant's Draft Technical Report, 6th November 2020

These challenges relate to institutions' roles, enforcement of laws, determination of fees, and management of contracts.

Table 4.1: Institutional and regulatory challenges

Project Challenges	Sector Challenges
▪ All of the sector challenges listed alongside affect the Project, as it is part of the sector and subject to the same institutional and regulatory regime	▪ Institutional roles are not clearly defined ▪ The sector lacks a comprehensive regulatory framework and existing regulations are not well enforced ▪ Private waste collectors are unable to manage collection risk effectively, resulting in reduced revenue collection to fund waste transit and disposal operations ▪ Metropolitan, Municipal, and District Assemblies (MMDAs) do not have tools to enforce contractual terms effectively, enabling poor performance from private operators ▪ Contracts do not always define KPIs or service standards and are not standardized across MMDAs ▪ Fee-fixing resolutions are non-uniform and do not consider costs explicitly

Institutional roles and responsibilities are not clearly defined. The laws governing solid waste management do not clearly allocate responsibility for essential functions to specific institutions. This lack of clarity has led to poor coordination and left crucial functions such as sector-wide monitoring and evaluation unfulfilled.

For example, the Government has not consolidated the responsibility for collecting information on the sector's financial flows within a single entity. As this function is not consolidated within one agency, it is difficult to understand what the costs are, who bears them, and how they are covered. For illustration, the Ministry of Finance is not aware of payments made to landfills. However, it does have access to information on payments made to solid waste service providers who are owed payments from MMDAs. The MSWR has financial data on payments made to landfills, but is not clear on financial flows from MMDAs.

MMDAs do not share data on waste flows in their areas with any central authority, making it difficult to form a sector-wide view.[40] Centralizing data collection would provide insight on practices across the sector—such as the amount of waste illegally dumped—and enable sector-wide planning.

Further, the Government has not made a single agency responsible for oversight of the implementation of the IUESMP.[41] Without a centrally responsible body, and under the current

[40] Interview F

[41] "Conditional Assessment Report (Solid Waste)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 14

approach, the Government cannot ensure the efficient allocation of resources and coordination to meet the plan's goals.

The IUESMP is unclear on which institutions are responsible for implementing different aspects of the plan. For example, while achieving cost recovery has been identified as a medium-term goal, no specific body is responsible for implementing cost-recovery measures.[42]

The sector lacks a comprehensive regulatory framework and does not enforce the existing regulations consistently. Gaps in the overall monitoring and enforcement of the sector enable inconsistent service provision. These gaps allow service providers to provide sub-par services, as there are few standards set and few enforcement mechanisms like withholding of payment available to the Government.

Further, despite being mandated to do so, MMDAs do not consistently enforce environmental sanitation bylaws and contracted service standards either due to lack of capacity, resources, or accountability to other branches of government that they will actually do so. The failure to enforce these increases costs for the Government, reduces service quality, limits funding for the sector, and increases illegal dumping of solid waste.[43] Further, monitoring and enforcement of MMDAs to achieve their mandate by a central government agency, such as the MLGRD or the MSWR appears to be lacking. MMDAs self-report on performance and do not appear to be penalized for failure to meet expectations or performance goals. This is further complicated by a lack of transparency on the roles of oversight and enforcement between MLGRD and MSWR.

The informal sector operates with limited restrictions in the GAMA, meaning it can compete in areas officially licensed to the formal sector.[44] For illustration, in Kpone, the informal sector collects approximately 52 percent of all waste collected.[45] In addition to operating without regulation, informal operators have lower costs, and therefore are able to attract customers away from formal service providers by offering lower prices.[46]

Contracts do not always define KPIs or service standards and are not standardized across MMDAs. In order to achieve consistency and better service quality, contracts must be standardized and should clearly list performance indicators and enforcement mechanisms in case of contract breaches. Standardization of contracts would ensure that Waste Management Departments (WMDs) of MMDAs include key contractual terms and utilize complete contracts.

Most contracts reviewed did not set out minimum service-level requirements or clear KPIs against which performance could be measured.[47] Ga West Municipal Assembly has contracts with private

[42] "Ghana Environmental Sanitation Strategy Report Revised" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 137

[43] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 242

[44] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 238

[45] Interview A

[46] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 238

[47] "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 9

operators that impose penalties for failing to meet certain service obligations. However, the contract does not show a threshold of service level that the firm must meet to continue operating. Further, collection contracts do not specify where waste collectors should tip their waste.[48] As the central Government pays for final disposal, MMDAs are not concerned with where waste collectors dump waste or whether this is environmentally and operationally efficient.[49]

Private waste collectors are unable to manage collection risk effectively, resulting in reduced revenue collection. Private collectors have limited means for forcing customers to make payments. When customers stop paying for services, collectors can take consumers to sanitation courts, which exist to settle such disputes. However, interviews with stakeholders showed that local members of parliament prevent enforcement of sanitation laws for political reasons.[50]

MMDAs cannot enforce contractual terms effectively, enabling poor performance from private operators. The terms of collection contracts limit MMDAs' powers to enforce the contracts through standard and accepted processes like withholding payments. If formal service providers do not perform to standard, assemblies can eventually reduce concession areas or rescind contracts. A more effective method of control is to withhold payments if services are not performed. However, service providers' fees are paid directly by the Ministry of Finance, and there is no mechanism for assemblies to withhold payments for non-performance.[51] [52]

Fee-fixing resolutions are non-uniform and do not explicitly consider costs. The process to determine waste collection fees for consumers that is used by the MMDAs is informal and lacks transparency.[53] Further, the process is managed by elected officials, making it political. Members of the district assemblies charge their constituents lower rates to try and improve their chances of re-election.[54] Further, the process does not consider the cost-of-service provision. In some instances, the fees fixed are not sufficient for service providers to fully recover costs.[55]

As fees differ across MMDAs, the fee-fixing process leads to an imbalance in service providers' profitability. Two waste service providers servicing the same amount of waste across equivalent-sized service areas could have different profitability levels, despite their costs being the same. This imbalance leads to differences in the capacity of waste collectors to pay transfer station or tipping fees.

[48] View formed from samples of collection contracts from GA West and Interview F

[49] Interview F

[50] Interview C

[51] Interview B

[52] Interview A

[53] Interview B

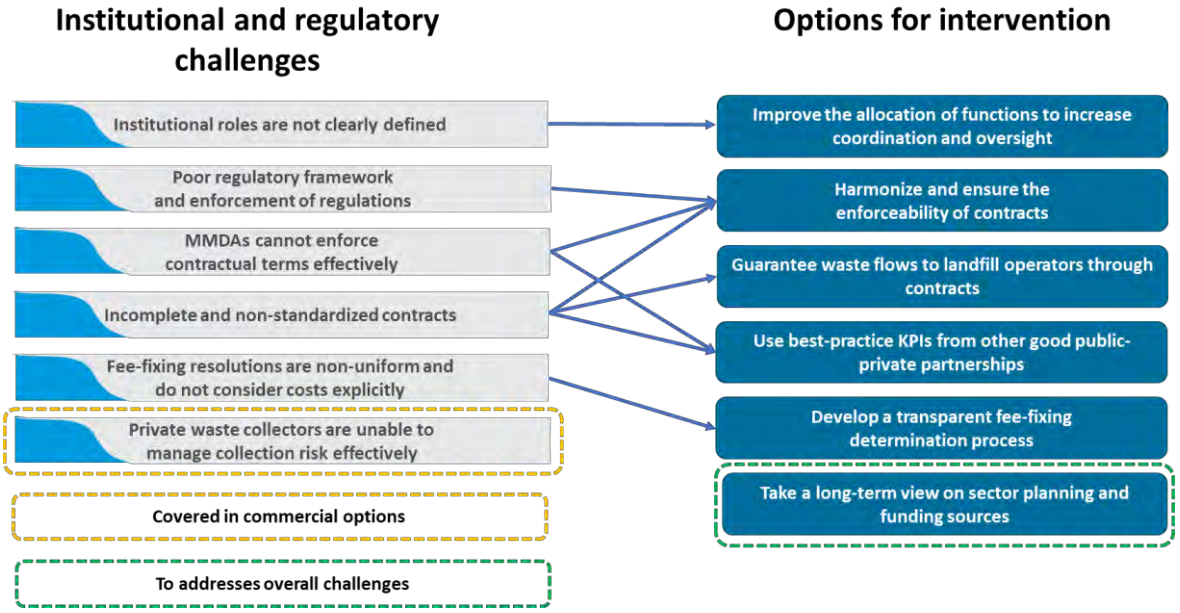
[54] Interview E

[55] Interview E

4.2 Options to address institutional and regulatory challenges

A robust regulatory regime is necessary to ensure competitive and efficient outcomes in Ghana's solid waste sector. This section provides several options to facilitate the movement towards a sustainable institutional environment and to address gaps in the current institutional framework. Figure 4.1 outlines the challenges and options to address them.

Figure 4.1: Options to address institutional and regulatory challenges



The options to address institutional challenges are discussed in detail below.

Define catchment areas for landfills to increase certainty of waste-flows and revenues for landfill operators. Private operators of landfills need a level of certainty regarding waste flows, and therefore revenues to make projects viable, especially in a competitive landscape. Government could provide this certainty by defining catchment areas for individual project sites. Defining catchment areas would prevent competition between final disposal sites and give landfill operators a more confident estimate of waste flows. Monitoring and enforcement will be necessary to ensure that providers comply with these stipulations. One approach would be to certify waste collection vehicles for certain disposal sites, limiting their capacity to dispose outside of the designated facility. However, this approach would not be possible where single waste collectors operate in multiple MMDAs, which could each have different designated disposal sites.

Use best-practice KPIs from other successful public-private partnerships to define performance standards. Contracts should be structured to include key performance indicators with minimum service levels and clear enforcement mechanisms. With clearly defined KPIs, the Government will be capable of assessing whether the private sector has met its contractual obligations and apply enforcement mechanisms (or financial penalties) in the event of breaches.

Possible KPIs for landfill sites and transfer stations include maximum queuing times, a maximum turnaround time from weighing on entry to weighing on exit, and the site's availability during stated opening hours. For transfer stations specifically, additional KPIs include required storage capacity and maximum duration of storage. Waste collectors' contracts may include KPIs that capture the number of missed collections, fleet efficiency, and waste generation from household and commercial activities.

Improve the allocation of functions to increase coordination and oversight. Several steps could be taken to streamline sector operations. For example:

- Creating a waste flow reporting and monitoring systems, with information collection carried out locally by MMDAs and then centralized with an organization such as the NSA. This system would help improve oversight and transparency in the sector.
- Creating a permitting regime where all waste management facilities are required to be registered in compliance with a series of operating conditions. This regime would help improve service quality.
- Centralizing certain functions could improve sector operations. For example, monitoring and oversight of the sector could be strengthened if the Government were to have a centralized database that includes:
  - Reporting on waste quantities and flows
  - Financial flows, including reporting on all payments made by various government agencies
  - Awarded contracts for all waste management companies
  - Fiscal commitments and payment arrears
- Making a specific body (or bodies) responsible for checking standards and enforcement, with the power to impose sanctions if standards are not met for both private operators of disposal sites and collection services, and MMDAs for their mandate to provide planning and oversight. However, applying standards for MMDAs will be challenging, as financial penalties are not likely to work, and government to government sanctions will be difficult to enact and enforce;[56] and
- Ensuring that procurement processes align with the Draft PPP Law[57] and Public Procurement and Disposal Act

Harmonize and ensure the enforceability of contracts to improve the operational performance of waste collection and therefore, reliability of waste flows and revenues to be received at final disposal sites. Developing a standard set of solid waste contracts, particularly in collections and

[56] As there could be conflicts with existing contracts, this change could not be adopted immediately. The terms to allow this would need to be phased into new contracts and any contract extension for existing contracts.

[57] The law is currently under review by Parliament

final disposal, would likely improve sector operations. Contracts could cover, at the least, the entire geographical boundary of each MMDA. This standardization would help to achieve greater consistency in terms of:

- How frequently waste is collected;
- Where it is collected from;
- The method of collection and equipment used;
- The quality and standard of service delivered;
- The cost of collection;
- Fines and sanctions applicable for waste management offenses such as illegal dumping, failure to register or obtain waste management permits;
- Environmental conditions under which new waste management infrastructure is required to be developed and operated.

Standardizing these contracts could deliver additional benefits when two or more municipalities procure services jointly by enabling private providers to achieve economies of scale. Further, developing a strategy to align existing collection contract expiration within or between neighboring MMDAs would help lay the foundations for a more centralized procurement exercise that focuses on this objective.

To further encourage private sector investment in modern waste collection equipment and infrastructure, collection contract terms should extend over 5 to 7 years. While this change will not be achievable immediately, this longer contract lifetime would reflect a newly purchased collection fleet's typical lifecycle and give firms more certainty to invest in better quality equipment.

Such standardization would have direct positive impacts on the financial viability of final disposal sites. It can create transparency and predictability in waste volumes and revenues to be received at final disposal sites over a period of time, which would increase operator’s capacity to plan, and reduce operational and investment risks.

Develop a transparent fee-fixing determination process that considers the cost of service provision to make the service financially viable. Standardized fee-fixing processes that focus on cost-recovery and longer-term fee determinations could attract more private investment to the sector. The regulated fees will also affect how much transfer stations and final disposal sites can charge waste collectors and the potential subsidy required to fully recover costs. One way to achieve a standardized fee rate that covers costs is to allocate the role of fee-fixing across MMDAs to a central agency independent of the political process.

Take a long-term view on sector planning and funding sources to identify and meet long-term needs. To plan for long-term sector needs, the Government could create an integrated resource plan which describes how to develop final disposal capacity, materials recovery and recycling

facilities, and transfer stations.[58] The plan should state a clear time frame and include an analysis of demand for solid waste, disposal costs, and possible constraints over that period.

When planning for the long-term, it is essential to focus on community and stakeholder engagement to minimize opposition to tariff increases. If consumers are to accept higher tariffs, they must clearly see the benefits that an increased fee would bring.

As part of the plan, the National Sanitation Authority and Fund could be operationalized to improve sector outcomes through monitoring, evaluation, and enforcement. The National Sanitation Authority could consolidate funding to the sector via the Fund, which can be used for payments to private operators and fill viability gaps.

Further, the integrated resource plan could map out alternative ways of raising revenue for the sector, including:

- Property taxes, which is the most common source of waste management finance[59]
- A sanitation levy included in water and sanitation bills, as used in some cities in Zambia, Senegal, Mozambique, Madagascar, and Burkina Faso[60]
- Direct taxation from MMDAs
- Taxation on imported waste from outside of Ghana

5 Commercial assessment

The sustainability of Accra's solid waste management sector from a commercial perspective is limited. Further, while options to attract private sector participation to the Ayidan project exist, these options are unlikely to deliver the long-term benefits of private investment and operations in the sector without substantial changes in the sector. Significant reforms and financial support from the Government will be needed to ensure the sector's long-term sustainability. This section explores the challenges facing the sector, like significant counterparty risks, lack of funding, and poor creditworthiness of the Government, and outlines options for addressing these challenges.

5.1 Principal challenges

At present, key constraints exist in relation to solid waste management service providers' capacity to operate profitably, manage risks they are allocated, and compete with large service providers. Table 5.1 provides a list of the key commercial challenges identified.

[58] An integrated resource plan should be an essential part of the IUESMP

[59] "Disposal is Not Free: Fiscal Instruments to Internalize the Environmental Costs of Solid Waste" (2019) Thornton Matheson, Page 10 (https://www.imf.org/en/Publications/WP/Issues/2019/12/20/Disposal-is-Not-Free-Fiscal-Instruments-to-Internalize-the-Environmental-Costs-of-Solid-Waste-48854)

[60] "Sanitation surcharges collected through water bills: a way forward for financing pro-poor sanitation?" (2012) Water and Sanitation for the Urban Poor. Page 1 (https://www.wsup.com/content/uploads/2017/08/DP004-ENGLISH-Sanitation-Surcharges.pdf)

Table 5.1: Commercial Challenges

Project Challenges	Sector Challenges
▪ Uncertainty in competitive landscape ▪ Monopoly influence	▪ Monopolists limit competitive outcomes and increase sector costs ▪ The culture of cost-recovery is largely absent in the formal sector ▪ The Government does not consistently meet its payment obligations ▪ There are limited PSP models which can be sustainable and commercially viable in the long-term ▪ Risks are not allocated to the party best capable of managing them ▪ The informal sector prevents formal operators from recovering the full value from a franchise area

The remainder of the section discusses the challenges outlined above in detail.

Monopolists limit competitive outcomes and increase sector costs. A single firm, Jospong Group, currently operates (either solely or in partnership with another firm) the two existing materials recovery and recycling facilities and the two largest waste transfer stations.[61] It also owns disposal sites and has a considerable influence over the entire value chain in some areas. Stakeholders expressed the view that political influence plays a role in awarding contracts and payments towards Jospong Group. The firm was allocated the sole rights to secondary waste collection under the Sanitation Improvement Package (SIP), and the terms and conditions of the contract are undisclosed.[62]

In principle, monopolies are able to set prices artificially high, creating a deadweight loss and negatively affecting consumers. Jospong Group has the power to charge high tipping fees at landfill sites[63], with the excess costs recovered either directly from user fees or from the Government, which is ultimately funded by taxpayers. The firm's monopoly position makes it harder for smaller firms to retain market share and operate profitably. Smaller waste collectors may be unable to stay in business as their contracts are too small in scale and tenure for them to achieve economies of scale, or to invest in capital that would make them more efficient. Limited competition also means that there are fewer incentives for Jospong to increase efficiency, innovation, or service quality.[64]

[61] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 80 - 108

[62] "Situational Assessment Report (revised) - Volume I – Main Report (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 213

[63] We have been unable to evaluate the fees charged, or revenues received, by Jospong as repeated attempts to meet as part of this study were denied.

[64] "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 8,9.

This monopoly could adversely affect the Ayidan Project. As Jospong Group carries out collections and operates its own landfill sites, it has an incentive to direct its waste collectors to tip at its own sites, thus increasing its revenues. This influence could reduce revenues to the Project in a model where an operator takes quantity risk. Jospong's influence could also increase costs to the Government if the Government takes quantity risk and remunerates Ayidan and other projects on an availability basis while paying Jospong on a quantity basis.

The Government does not consistently meet its payment obligations. The Government's history of missing payments to the private sector will make it difficult to attract new private investors to the sector.[65] It was reported that the World Bank-supported Kpone landfill did not receive payments from the Government for 5 years. Additionally, the ACARP plant was shut down for some time in 2014 because the Government defaulted on its payment for services rendered to the MMDAs.[66]

Most transfer, treatment, and final disposal activities currently in operation in GAR are owned and/or managed by subsidiaries of the Jospong Group of companies. This provides the commercial entitiy greater barganining power and capacity to buffer delinquent payments across facilities. This will not be the case for newcomers that the Government would like to attract to operate the Ayidan landfill. Therefore, the Government will need to provide security for operational payments to overcome this track record, such as government guarantees or maintaining an escrow account for the transaction.

Without credit support, projects that the Government wants to be delivered by the private sector are unlikely to be financially viable. The Government must improve its track record to be seen as a credible partner and reduce the need for guarantees over the long-term.

There are limited PSP models that can be sustainable and commercially viable in the long-term. With the levels of risk around the Project and the highly dysfunctional nature of the sector, a private operator will be unlikely to participate in a fully integrated PPP model (such as design-build-operate-transfer) without significant reforms and credit support.

In the Waste Capture Scenario, the Project's expected lifespan of 3 to 4 years suggests that the most attractive model to the private sector would be one that favors an existing company with its own equipment, likely providing services at the current standard. The Waste Capture Scenario does not support a structure where the private operator finances its own equipment or one where the operator accepts a greater proportion of risk. Recovering the costs of equipment in less than 4 years would require a tipping fee that far exceeds those charged in the sector currently and would be well above stakeholders' willingness to pay. The need for super-normal fees to enable cost recovery suggests that the Project's viability gap would be significant.

Further, under current sector management, an operator would not have the ability to limit waste flows to the Project. The Government could pursue two options to increase attractiveness, but

[65] Interview C

[66] Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 96

both have challenges. One is to transfer quantity risk to the operator. Given current uncertainty and the sector's history, the cost of taking quantity risks on waste flows would be quite high, which would translate to a higher gate fee. Government would need to guarantee this payment and make these payments reliably for an investor to accept this risk.

This structure also presents significant risk for the Government. If waste volumes exceed the forecast levels as they did at Kpone, its liabilities to the Ayidan Project could balloon and rapidly become unsustainable.

The other option is to limit waste to the Project. This option also has its challenges as the Government has not established a precedent for this, nor has it created a credible enforcement mechanism to ensure that only waste from a specific area flows to the site. At Kpone, the landfill reached capacity quickly, in part because the operator did not have control over waste flows. The facility no longer operates as a sanitary landfill and is now considered a semi-engineered dumpsite.[67]

Under the Lifecycle Scenario, the attractiveness to the private sector relies on Government making several key reforms to sector operations. Government would need to:

- Implement mechanisms that enable it to effectively limit the flow of waste to the Project. Without the ability to limit waste to the Project, and absent a significant change in alternative disposal capacity, the Project will not achieve the minimum operational life of 10 years. While the Project scope does not include collections, Government has the ability to make changes to sector operations that would impact Ayidan and future projects.
- Demonstrate to private operators that it will make payments agreed in the contract. Stakeholders communicated that the Ministry of Finance has not consistently made payments.[68] Current operators may accept the inconsistency in payment as Government does not currently enforce service standards.
- Establish a contract management authority to oversee performance against the PPP's service standards and performance indicators. The Government needs this capacity at both a sector and individual project level to achieve value for money and move to sustainable long-term operations.

Making these changes could open the market to best-practice operations and maintenance contracts, or bundled PPP models that include private investment and significantly more risk transfer than the sector currently supports.

The uncertainty introduced by Jospong's proposal to develop three semi-engineered dumpsites in the GAMA further limit PSP options. In both scenarios, investors would be unlikely to accept any risk regarding waste flows without significant subsidy contributions and Government guarantees. As Ayidan is to be developed to a fully-engineered standard, the cost per ton of disposal will be higher than a semi-engineered site operated at a lower standard. This means Ayidan's future

[67] Interview A

[68] Interview C, Interview F

operator would not be able to compete on price with the new sites. In addition, Jospong's monopoly control over collections and final disposal means that it could direct its collection vehicles to dispose of waste at its sites only. The geographic locations of the competitive sites, which are currently unknown, could also affect the amount of waste delivered to them.

The culture of cost-recovery is largely absent in the formal sector. At various points across the value chain, users may pay less than the cost of service, creating viability gaps and revenue shortfalls. For medium to large-scale formal waste collection and transport service providers, profitability is highly variable. Previous studies have found that collection and transport providers have not been able to consistently operate profitably.[69]

Several transfer stations do not collect enough revenue to cover the costs of operations. TidyUp Ghana, which operates in GA West, is unable to recover costs.[70] Teshie and Achimota transfer stations, which are operated by a Jospong Group subsidiary, report that they only recover 50 percent of operations costs.[71] As we have not been able to obtain an interview with the firm, we could not fully understand their operations, particularly in cases where they report 50 percent cost recovery, yet continue to operate and expand.

There is also a view that the Government lacks commitment to honoring contracts or facilitating competition, making further investment unattractive.[72] Government stakeholders also confirmed this view, noting that firms in some instances are making profits but are not willing to invest additional capital.[73] Landfill and transfer station operators may be unwilling to invest, partly because waste collectors who tip waste at these locations do not pay bills on time.[74] Further, discussions with landfill operators indicated that user fees do not fully cover operations and maintenance costs, limiting sector-wide profitability and sustainability. The operator which ran the Kpone landfill did not collect fees from waste collectors and instead relied on the Government for payments.[75]

Risks are not allocated to the party best able to manage them. Private waste collectors, currently responsible for collecting fees from households[76], often face payment defaults and must either (a) cease collections or (b) collect waste without payment.[77] Option (a) reduces the quantity of solid waste captured in the formal system, and option (b) causes direct financial harm to the companies. Neither option is attractive as they do not facilitate the collection of payments owed.

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69 "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 10

70 Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 105

71 As a vertically integrated monopoly, even if individual Jospong entities do not fully recover costs, it is believed that the firm as a whole is fully profitable and that some cross-subsidization of businesses exists. Interview C

72 "Solid Waste Management Model / Strategy for Ghana" (2019) Oxford Policy Management and Maple Consult. Page 10

73 Interview E

74 Situational Assessment Report (revised) - Volume II – Appendices (IEUSMP)" (2019) Ministry of Sanitation and Water Resources, Republic of Ghana. Page 85 and 89

75 Interview C

76 Interview C

77 While sanitation courts exist to resolve such disputes and to prevent this risk from materializing, these courts do not appear to be effective means of enforcement for most providers.

Waste collectors' inability to collect fees creates considerable risks given that in some areas, 40 to 50 percent of waste collectors' fees remain uncollected, impacting their ability to operate profitably.[78] The Ministry of Finance noted that it was required to pay service providers GHS 120 million in 2020 due to late and non-payment of fees.

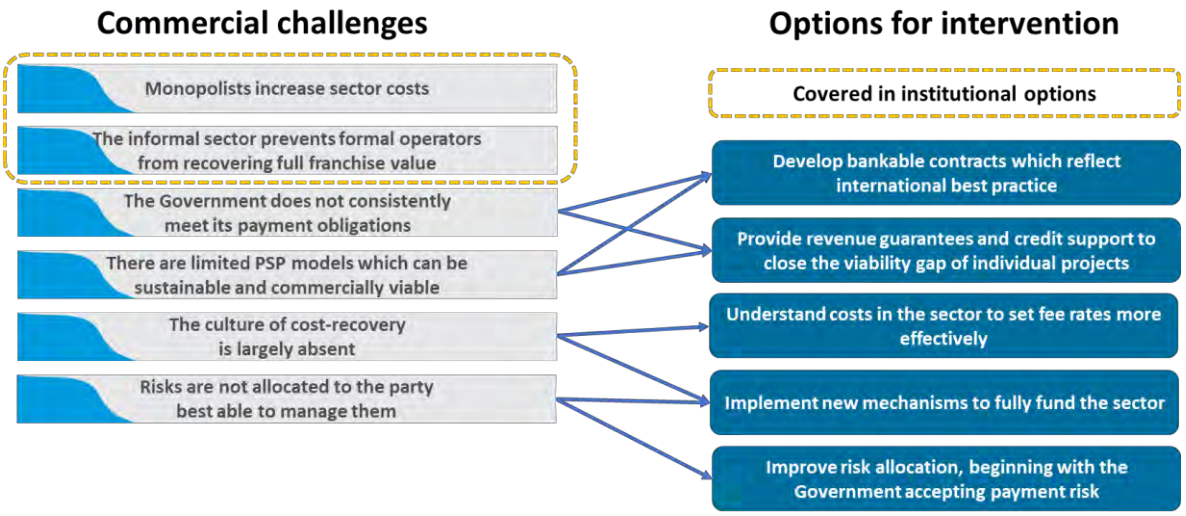
Despite poor fee collections, firms can remain operational as they do not need to pay tipping fees at landfill sites. Some firms are supported by other business lines, which operate outside the solid waste management sector. The long-term implications of this failure are real and will limit the attractiveness of future investments.

The informal sector prevents formal operators from recovering the full value from a franchise area. The informal sector operates without regulation on its services and can charge lower prices than the formal sector because it avoids municipal levies and has lower operating and capital costs. A formal provider awarded a contract in a specific area cannot always service all households because the informal sector captures some households' waste by charging lower prices. This reduced market share lowers revenue available to the formal sector operators.

5.2 Options to address commercial challenges

For a sector to be commercially viable and sustainable, it must allow private sector participants to operate profitably, manage risks, and have appropriate levels of competition. In this section, we discuss the steps that could be taken to create such a sustainable sector. Figure 5.1 maps the commercial challenges with the steps that could be taken to address them.

Figure 5.1: Technical challenges and options to address them



[78] Interview C

Develop bankable contracts which reflect international best practice. By improving the quality of contracts for solid waste PPPs in Ghana, the sector will be more attractive to investors. In emerging economies, successful waste management PPPs have been well structured and included protections for private firms within contracts. For example:

- Guarantees on the minimum quantity of waste delivered to the facilities – In the scenario that there are no additional landfills, this is unlikely to be a risk for the private sector in Accra given the volume of waste within the Project's scope and future projections for waste generation. If additional sites are developed and are competing, such a guarantee could be crucial.
- Guarantees on the composition of waste – This is likely to be more of an issue if the contractor is required to commit to performance guarantees on the proportion of materials recovered in the MRF. The contractor would also not expect to agree to unilateral changes in waste collection frequency or the types of waste collected, where it impacts on the operation and technical assumptions made for the new facilities;
- Exclusivity to all municipal waste within the scope of the PPP – this would provide the contractor with confidence that collection contractors would not deliver waste to other (potentially cheaper or nearer) facilities or dumpsites; and
- The ability for the contractor to reject specific types of waste that are not suitable for the MRF or landfill (e.g., medical waste, e-waste)

Given the challenges outlined in this report, such mechanisms are likely necessary to achieve bankable PPPs in Ghana's solid waste sector.

Understand costs in the sector to set fee rates more effectively and move toward cost-recovery. Conducting a cost-of-service study for the sector would help to better understand the true costs of waste collections, transfers, disposal, and recovery facilities. Developing a more informed view on capital and operational costs will help in creating long-term plans and in understanding the required cashflows to allow a private operator to recover these costs via a PPP. Once costs are understood, phasing in cost-recovering tariffs over time through fee-fixing resolutions, transfer fees, and gate fees would move the sector towards sustainability and improve the investment climate. Additionally, knowing costs would enable the Government to understand the quantum of the viability gap across the value chain. Closing this gap through a transparent subsidy regime would further improve the investment climate.

Implement new mechanisms to fully fund the sector. As outlined in Section 4.2, the implementation of various mechanisms such as a property tax, sanitation levy, or direct taxation from MMDAs on households could help increase funding for the sector. The Government should also consider methods for cross-subsidizing waste collection fees. For example, it could charge higher prices to larger waste producers to subsidize waste collections for low-income households. Tax waivers on capital investments made by the private sector could also improve viability.

Improve risk allocation, beginning with the Government accepting payment risk. A more typical payment method is for collection companies to be paid for services provided by the entity that

appointed them to provide such services (i.e., the MMDA), with responsibility for fee collection sitting with the public sector (e.g., through taxation or utility payments). A payment method where the Government makes payments to collection firms would provide security of revenue for the collection company, supporting a more consistent level of service delivery and maximizing revenue rates. Also, it gives the public sector a more effective method of monitoring and incentivizing the private sector, as MMDAs can withhold payment if KPIs are not met, such as when operators miss collections.

Provide revenue guarantees, credit support, and subsidies to close the viability gap of individual projects. Given the unpredictable landscape and the risks and potential returns of projects in Ghana's solid waste sector, PSP models that require significant investment are unlikely to attract high-quality operators. The costs of a technically and environmentally sustainable project will be significant, yet such projects are necessary to shift the culture of the sector towards sustainability. For these projects to take hold, the Government could subsidize costs to make sustainable projects more competitive and more attractive to users, while proving a new model future investment.

As projects lack certainty about waste flows, and therefore also about revenues, the Government may wish to consider including minimum revenue or service guarantees in contracts. These guarantees entail the Government paying the operator a certain fee if it does not receive a set amount of waste or revenue in a certain period, usually defined around a specific target. Given that Government does not have a strong track record of making consistent payments to operators, these guarantees may be required in addition to other credit enhancement mechanisms. Additional credit enhancement could include cash flow stabilization mechanisms or the establishment of an escrow account to provide transparency and to secure payments to investors. With its experience and influence, a multilateral development bank's involvement could also increase the project's attractiveness to the private sector.

In the event the Ayidan landfill is the only newly developed final disposal site, there is unlikely to be a need for minimum revenue guarantees as all waste flows are to the Project, but credit support would still be necessary given the Government's track record of missing payments.

6 Recommendations

Several short-term and long-term changes must be made in order to move the sector toward sustainability. In the short term, the sector can make progress by making reforms that enable a successful Ayidan Project to serve as an example for future PPP projects. If the Project is to last a minimum of 10 years and meet its goals, certain essential steps must be taken, which are described first. Afterwards, the section explores additional longer-term reforms that the Government should consider to modernize sector operations and move the entire solid waste management system to a sustainable model.

In the absence of changes set out in Section 6.1, the Ayidan project is highly likely to reach capacity in 3 to 4 years and will not deliver a sustainable solution to GAMA's immediate solid waste management needs. This is broadly what occurred at Kpone and would be perceived as a

failure by markets and potential investors. The success of the Project hinges on reasonable and important changes to sector operations being made in the short-term.

Table 6.1: Suggested reforms

Short-term actions required to deliver a sustainable Ayidan Project	Longer-term steps required to deliver sustainable sector operations
▪ Agree to risk mitigation and credit enhancement measures ▪ Form a dedicated contract management team to monitor clear KPIs and enforce contractual obligations ▪ Control waste flows to the Project	▪ Develop an integrated resource plan ▪ Reform collections' practices ▪ Empower national regulator to enforce standards ▪ Address gaps in existing monitoring and evaluation of the sector ▪ Develop additional funding sources for the sector to ensure its sustainability

6.1 Essential steps for the success of the Ayidan Project

A suitable and implementable business model the Government could target is one in which a private operator finances equipment and operates and maintains the Project over its life, which should be a minimum of 10 years as described under the Lifecycle Scenario. There are several significant obstacles to this outcome, including:

- If too little waste reaches the Project, it could earn insufficient revenue in tipping fees. Alternatively, if too much waste reaches the site, maintaining service standards at increased demand could increase costs, shorten the project life, and make total cost recovery difficult
- If waste quantities flowing to the Project exceed 350,000 tons per annum, the Project's life could be cut short.
- If Government is unable to assess and evaluate performance, the Project is unlikely to deliver value for money or the benefits the sector requires.

Steps to address these challenges are discussed below.

Agree to risk mitigation and credit enhancement measures to be included in the contract

There is significant payment risk around the Project as the Government has a history of payment defaults to private operators. Credit enhancements would reduce this risk for a private operator. This step must be taken even in the Waste Capture Scenario. These enhancements could take the form of:

- Escrow accounts, which can be used to hold funds until payments are due
- Multilateral development bank guarantees, which also helps the Project's creditworthiness through the bank's reputation
- Minimum revenue guarantees/assurance on waste inflows in the event of large competition (three potential landfills); If there are three competing landfills in the GAMA,

the Project is at risk of receiving waste flows in quantities below those necessary for cost recovery. A minimum revenue or minimum waste flow guarantee would reduce this risk for a private operator

Control waste flows to the Project

While the Lifecycle Scenario has been modeled as the Project receiving a proportional reduction in the total waste available, in practice, this could not work. Instead, Government should define a service area that achieves a similar reduction by using clear geographic and technical criteria. It could define this area through a proximity principle, through an optimization of traffic and waste flows to the site, or through a combination of these and other measures.

Government could define the scope by directing certain MMDAs to send waste to the Project site, or by directing specific companies only to tip waste at the Project site. Further, the Project agreement could cap waste flows at a certain tonnage for a period, which would force remaining waste to be diverted to other sites.

Form a dedicated contract management team to monitor clear KPIs and enforce contractual obligations

- Creating clear KPIs and service standard as part of the deal structure would allow clear monitoring of the Project to ensure it is meeting its goals
- To ensure that the Project meets its KPIs, there must be a robust monitoring and enforcement mechanism with a contract management team to oversee the Project. The Government should have the ability to restrict payments to the operator if KPIs are not met.
- This step must be taken in the case of either scenario to ensure a high level of performance from the operator

6.2 Additional steps that would improve the Project and sector

The steps listed above would help to create a financially viable and sustainable Ayidan Project. Beyond these, there are additional long-term changes that could be made to improve overall sector operations, to reduce the risk that future projects reproduce the outcome at Kpone, and to increase coordination and effective planning. These steps are not necessary to create a viable Project in the short-term but are essential to move the entire sector toward sustainability. These include:

Develop an integrated resource plan

An integrated resource plan would help the Government to plan and coordinate sector needs effectively. This plan would provide a clear view of where the sector is heading, what resources are needed to meet demand, and the cost of doing so in a transparent manner. The plan should:

- Describe the policy and strategic objectives of the sector over the short- and long-terms and the infrastructure and reforms required to achieve these objectives. It should identify, clearly, the needs for investment across the entire value chain, highlight projects in

Government's pipeline, and identify which are likely PPP candidates. It should, where possible, link service areas to need and show how specific projects will deliver on those needs

- Assess the cost of providing various services like:
  - Collections
  - Waste transfer
  - Final disposal and materials recovery.

  Understanding the true costs of services will help the Government establish cost-recovery tariffs and move the sector toward sustainability.
- Explain the private sector's role and opportunity to provide additional capacity across the solid waste management service chain. The private sector's plans must be a part of the Government's long-term plans, as these have a significant impact on the entire sector.

Reform collections' practices

Changes in collections' practices could improve the sector significantly. The Government could:

- *Evaluate service areas to create more efficient routes*. By analyzing traffic routes, service areas could be structured to allow more efficient collections and reduce operating costs.
- *Develop standardized contracts that include well-defined KPIs/service agreements*. Creating standardized contracts will create consistency across MMDAs, allowing a greater scale of operations for private operators. Clear KPIs will help to ensure frequent and consistent collection of waste, reducing illegal dumping. Making the tenure of a standard contract reflect the typical lifecycle of a collection fleet would encourage operators to make more capital investments.
- *Increase utilization of transfer stations***.** By using transfer stations to accept waste from small vehicles like borla taxis and tricycles, waste can be transferred to larger vehicles. Using these larger vehicles to deliver waste to final disposal sites will shorten queue times and reduce operators' costs.
- *Require segregation of waste at source to extend landfills useful lives*. By segregating waste at source, capture rates for organic waste could reach 30-40 percent. Treating this organic waste reduces total waste for landfill and provides additional revenue through the sale of the compost-like product and recyclables.
- *Develop a tariff pricing method that considers the cost of service and consumers' willingness to pay*. Drawing on the cost-of-service study, the Government can develop a tariff pricing method that ensures fees cover operation costs. By considering consumers' willingness to pay, the fees can allocate a higher level of service to those willing to pay more, increasing revenue for the sector. Understanding the gaps between revenue and costs can enable the Government to plan funding for the sector, incorporating subsidies where needed.

- *Allocate the role of fee collection to MMDAs/Government*. As discussed above, risks must be allocated to the party best capable of managing them. Customer payment risk is best left with the Government, as it has the means of enforcing collections. The legal aspects of this change must also be considered.
- *Assess/coordinate role for the informal sector*. The informal sector must be managed efficiently to increase coordination in the sector. Informal operators must be subject to some regulation to reduce illegal dumping and prevent them from undercutting formal operators.

Empower national regulator to enforce contracts and standards

The National Sanitation Authority must be operationalized and given the authority to enforce solid waste contracts and standards. A strong central enforcement authority will help to create a sector that performs to standard.

Address gaps in existing monitoring and evaluation of the sector

While MMDAs collect data in the GAMA, this data is not consolidated by any one agency. The Government should allocate this responsibility to one entity, such as the National Sanitation Authority, that will collate sector-wide data on solid waste flows and financial flows in the sector. This consolidated data will help to create a clear view of the sector and assist in planning.

Develop additional funding sources for the sector to ensure its sustainability

The main source of revenue to the sector from customers is through user fees collected by private sector service providers. Across the globe, there are other effective methods in use that could be implemented in Ghana. These alternative methods could yield a greater level of collection than the current method. Some possible funding sources are:

- Property taxes – the fee for waste disposal is included in the property tax
- A sanitation levy – a surcharge is applied to water bills
- A direct tax from MMDAs
- Taxes on waste imported from outside Ghana

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