



Performance Audit  
Report No. 2 of  
2018

# Management of Gamodubu Landfill



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REPUBLIC OF BOTSWANA

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27<sup>th</sup> April, 2018

The Chief Executive Officer  
Kweneng District Council  
Private Bag 005  
Molepolole

Dear Sir,

**PERFORMANCE AUDIT REPORT ON MANAGEMENT OF GAMODUBU LANDFILL**

The Local Government Act No. 18 of 2012, Section 68 (11) incorporates Performance Audit as one of my functions. The Act also provides that Performance Audit Reports be tabled before the Full Council by the City, Town Clerk or Council Secretary.

Accordingly, I submit the following report to be tabled before the Full Council in accordance with Section 68 (12) of the Local Government Act;

Performance Audit Report No. 2 of 2018 on Management of Gamodubu landfill.

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P.D. LETEBELE (Ms)  
**AUDITOR GENERAL**

## **AUDITING FOR BOTSWANA GOVERNMENT**

The Auditor General is the head of the Office of the Auditor General, appointed under the Constitution. The Auditor General carries out her duties under the Public Audit Act 2012. She therefore, undertakes Performance Audits on the public sector bodies and submits reports to the National Assembly. The aim of the audit is to improve the public sector administration and accountability.

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## ACRONYMS

<b>AFROSAI-E</b>	African Organisation of English –Speaking Supreme Audit Institutions
<b>DWMPC</b>	Department of Waste Management and Pollution Control
<b>EHD</b>	Environmental Health Division
<b>ISSAIs</b>	International Standards for Supreme Audit Institutions
<b>KDC</b>	Kweneng District Council
<b>MARD</b>	Maximum Annual Rate of Deposition
<b>NDP</b>	National Development Plan
<b>OAG</b>	Office of the Auditor General
<b>SEHO</b>	Senior Environmental and Health Officer
<b>PEHO</b>	Principal Environmental Health Officer

## GLOSSARY

**Ambient air**- the highest concentration of a specific air pollutant at a particular outdoor location, in a specified unit of time that is not considered hazardous to humans

**Berms** - Walls built around cells which also separates the cells

**Cells** - Demarcated areas of different wastes

**Compactor**- Power driven mechanical equipment designed to compact waste in large volumes

**Garden waste cell**- where waste from gardens, trees, grass is disposed of

**General waste**- where domestic waste is disposed of

**Incinerator** – A furnace or apparatus for burning or treating clinical waste

**Landfill Area** - The landfill area is essentially the waste disposal area, which consists of 5 cells

**Landfill gases** – Gases formed due to disposal and treatment of waste

**Landfill manual**- Provides guidance on how operations of landfill can be carried out

**Leachate** - A solution resulting from leaching, as of soluble constituents from soil, landfill

**Rubble cell**- building material cell

**Scavengers** - Search for and collect (anything usable) from discarded waste

**Scrap-metals** from cars, windows disposed off

**Storm water drains** - These have been provided at the toe of the berms around the cells. The drain at the toe of the berms collects storm water and discharges it into a leachate pond

**Tyre cell**-tyres disposed of here

**Weighbridge**- Building intended for keeping records of waste disposed and for issuing receipts of waste disposal charges

**Working face**- division on different waste cell

## **EXECUTIVE SUMMARY**

The way waste is managed is one of the many key factors which can have an impact on the environment. Waste if incorrectly deposited in the landfill, may not cause an immediate problem but, with time, may create adverse environmental effects such as water contamination and environmental pollution, which may be extremely difficult and expensive to rectify.<sup>1</sup> As such, Botswana Government has developed strategies and guidelines to manage operations of the landfills countrywide including the Gamodubu landfill. This is to prevent environmental degradation and promote wellbeing of the public as well as animal health.

However, there had been growing concern over the years (2009-2013) by the Gamodubu residents that the operations of the Gamodubu landfill had brought with it adverse environmental problems to their livelihood. This was corroborated by the reports discussed in the Media- Articles 206 and 128 of Botswana Daily News dated 3 November 2009 and 9 July 2010 respectively. The reports highlighted that the landfill posed environmental challenges to residents in villages and farming areas around Gamodubu. It is within this background that the Office of the Auditor General carried out a performance audit to determine whether Kweneng District Council efficiently managed the Gamodubu landfill in order to prevent it from being a threat to the environment and the public at large.

The audit covered the financial years 2009/2010, 2010/2011, 2011/2012, 2012/2013, 2013/2014 and 2014/2015. The significant observations made during the audit are outlined overleaf;

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<sup>1</sup> Botswana's Strategy for Waste Management, 1998



## **1. COMPLIANCE TO THE LANDFILL POLICY FRAMEWORK**

### **a) Licensing of the Gamodubu Landfill**

The Gamodubu landfill had been operating without a licence since it was commissioned more than five (5) years ago, contrary to the requirements of the Waste Management Act which stipulated that the license should be acquired prior to the landfill construction. The landfill had several violations with respect to the Waste Management Act. These violations included inter-alia; failure to install incinerator testing component, landfill gas monitoring system not in place, no ground water monitoring system, no proper covering and compaction and unavailability of fully functional equipment.

#### **Recommendation:**

- **The Kweneng District Council should liaise with the Department of Waste Management and Pollution Control to ensure that the Gamodubu Landfill meets all the design and operational standards for it to be licensed.**
- **Environmental Health Division should ensure the Gamodubu landfill holistically adheres to the requirements of the Management Waste Act, the Guidelines for the Disposal of Waste by Landfill and the Operational Manual.**

## **2. LANDFILL OPERATIONS**

### **a) Inspection at the Weighbridge**

The visual examination of incoming waste was intermittent in that the landfill Enumerators had not always thoroughly inspected vehicles entering the landfill for waste disposal. As a result, some waste ended up being deposited at the wrong cells.

**Recommendation:**

**Environmental Health Division should ensure that;**

- **Appropriate guidelines on how best waste can be inspected upon entering the landfill are developed for consistency and accountability thus preventing adverse environmental effects.**

**b) Daily compaction and covering**

Daily compaction and covering of waste at the Gamodubu landfill was inadequate in that waste disposed of could be left for days without being compacted and covered. This led to the landfill being aesthetically not pleasing.

**Recommendation:**

- **Ensure that the Landfill guidelines are adhered to, to the letter during compaction and covering of waste to prevent potential human health risk and negative adverse impact to the environment.**

**c) Frequent breakdown of equipment**

The landfill experienced continuous breakdown of different equipment and machinery which affected the Environmental Health Division service delivery leading to adverse impact on the environment.

**Recommendation:**

**The OAG recommends that EHD should;**

- **Ensure that equipment is instantly repaired and maintained to enhance its capacity and availability for improvement of service delivery and to curb adverse environmental effects.**

### **3. MONITORING OF GASEOUS EMISSIONS**

#### **a) Ambient Air**

There was no documentary evidence to indicate that the Landfill Management had ever sampled ambient air to detect gaseous movements from the boundaries of the landfill. Such anomaly could lead to these landfill gases migrating off-site and causing odour and potentially dangerous conditions.

#### **Recommendation:**

**The OAG recommends that Environmental Health Division should;**

- **Develop a plan on how these tests will be conducted to assess the toxicity of air released at the waste cells.**
- **Appropriately make an effort to manage and monitor landfill gases to avoid any negative impacts on the environment.**

#### **b) Leachate Monitoring**

Leachate sampling and analysis had not been carried out bi-annually contrary to the requirements of the Landfill Operational Guidelines despite the fact that small amounts of leachate may pollute large amounts of ground water, rendering it unusable for domestic and other uses.

#### **Recommendation:**

**The OAG recommends that Environmental Health Division should;**

- **Ensure that regular sampling and testing of leachate is carried out to ensure that both underground and surface water as well as soil in the vicinity of the landfill are not contaminated.**

#### **4. MONITORING BY THE COUNCIL**

The supervision and monitoring of landfill operations by SEHO are not adequate thus leading to landfill operatives not always adhering to the set environmental standards.

#### **Recommendation:**

**The OAG recommends that the EHD should;**

- **Put measures in place to ensure that the landfill management adequately supervises and monitors the landfill operations in order to adhere to the set environmental standards.**

# CHAPTER 1

## 1.0 BACKGROUND

### 1.1 INTRODUCTION

Human activities continue to have adverse impact on the environment, natural resources and public health. However, a society striving for sustainable development needs sustainable methods of waste disposal such as landfilling. A landfill site (also known as tip or dump area), is a site for the disposal of waste materials by burial and is the oldest form of waste treatment.<sup>2</sup> The landfill plays a crucial role in waste management system in preventing environmental degradation and health hazards.<sup>3</sup>

Waste if incorrectly deposited in the landfill, may not cause an immediate problem but, with time, may create more serious effects such as water contamination and environmental pollution, which may be extremely difficult and expensive to rectify.<sup>4</sup> The important objective is therefore to ensure that landfilling is carried out in such a manner that it does not cause harm to the environment. This is done by ensuring that landfills are located, designed, constructed, operated and restored to ensure that ground and surface water is not contaminated. Furthermore, landfilling if carried out properly, is an environmentally acceptable and low cost solution for the disposal of a wide range of wastes, including household waste which makes up the largest part of the waste produced in Botswana.<sup>5</sup>

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<sup>2</sup> [en.wikipedia.org/wiki/Landfill](https://en.wikipedia.org/wiki/Landfill)

<sup>3</sup> Botswana's Strategy for Waste Management, 1998

<sup>4</sup> Botswana's Strategy for Waste Management, 1998

<sup>5</sup> Guidelines for the Disposal of Waste by the Landfill, 1997

In cognizance of the need to prevent environmental degradation and promote wellbeing of the public and animal health through landfilling, the Botswana Government built landfills countrywide, including the Gamodubu Landfill.<sup>6</sup>

## 1.2 MOTIVATION OF THE AUDIT

There had been a growing concern over the years (2009-2013) by the Gamodubu residents that the operations of the Gamodubu Landfill had brought with it adverse environmental problems to their livelihood. This was reiterated by the reports carried in the Media- Articles 206 and 128 of Botswana Daily News dated 3 November 2009 and 9 July 2010, respectively. The reports highlighted that the landfill was posing environmental challenges such as stench emanating from there, indiscriminate dumping and littering along the Gaborone Molepolole Road. In addition, Parliamentarian debates during the Parliamentary Sessions of July 2010, expressed concern that “there were environmental challenges posed by the Gamodubu Landfill to the surrounding villages and farming areas of Gakuto, Metsimothabe, Makante and Gamononyane”.

Furthermore, at the village kgotla meeting held on 2 November 2012, the Gamodubu residents expressed their concerns over “swarms of flies that had been terrorising their village for the past two (2) months. Moreover, on 11 February 2013, the Kweneng District Council Chairperson expressed fear that the Gamodubu Landfill was experiencing a challenge in having to deal with more refuse than was planned for. He indicated that the landfill had been receiving excess waste with the maximum annual rate of deposition (MARD) at 79000 tonnes, compared to the expected 65000 tonnes MARD (**Refer to Table 1.1 for details**).<sup>7</sup>

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<sup>6</sup> en.wikipedia.org/wiki/Landfill

<sup>7</sup> The Daily Newspaper dated 11 February 2013

Therefore, on account of these concerns, the Office of the Auditor General carried out a preliminary study to understand how the Gamodubu Landfill in the Kweneng District Council was managed. The preliminary study revealed that there were some challenges in the management of the Gamodubu Landfill including, inter-alia that; the Gamodubu Landfill was not licensed to operate as a waste disposal and treatment facility, there was no monitoring of gaseous emissions from the landfill, there were challenges with compaction and covering of waste, landfill equipment had frequent breakdowns, leachate was not adequately sampled and tested as per the Guidelines on Disposal of Waste by the landfill and there were gaps in the monitoring of the landfill operations by the Landfill Management. Furthermore, considering the materiality and extension of repercussions and social impact of the problem, the OAG conducted an in-depth audit in order to get comprehensive information on the operations of the landfill as well as its management.

### 1.3 AUDIT OBJECTIVE

The objective of audit was to assess whether the Environmental Health Division appropriately managed the Gamodubu Landfill in the Kweneng District Council.

#### **Specific Objectives**

The specific objectives were to;

- Determine how the facility's operations complied with the provisions of the Waste Management Policies and Operational Guidelines as well as environmental requirements to reduce the impact of inappropriate waste disposal on the environment and its effects on human health through proper compaction and covering of waste.
- Assess whether there was adequate inspection of waste at the weighbridge.
- Assess whether there was adequate maintenance of the landfill equipment

- Ascertain the extent to which Landfill management monitored Landfill operations to ensure appropriate waste management for sustainability.

## 1.5 AUDIT SCOPE

The audit focused on the operations and procedures that the Environmental Health Division employed in ensuring that the Gamodubu landfill was appropriately managed as a way of protecting the environment, providing quality environmental services which may prevent pollution and degradation of the environment. The audit was conducted at the Gamodubu landfill in the Kweneng District and covered the financial years; 2009/2010, 2010/2011, 2011/2012, 2012/2013, 2013/2014 and 2014/2015. This was to have an informed view of how the landfill had been managed over the years.

## 1.6 AUDIT METHODOLOGY

### 1.6.1 AUDITING STANDARDS

The audit was conducted in accordance with International Standards for Supreme Audit Institutions (ISSAIs).

### 1.6.2 DATA COLLECTION METHODS

The following methods were employed in collecting data to understand how the Gamodubu Landfill was managed in order to prevent pollution that may affect public health and cause environmental effects:

- **Document Review**

Documents concerning the management of the Gamodubu Landfill were reviewed to get comprehensive information on the operations of the landfill and have an understanding of the processes followed in disposing of waste and management of the landfill. Details of documents are depicted at **Annexure 1**.

- **Interviews**

The audit team conducted eight (8) interviews at the Kweneng District Council and Gamodubu landfill. The interviews were conducted to solicit more



information on the operations and processes involved in disposing of and treatment of waste as well as gathering information on the management of the landfill. The interviews were also carried out to substantiate information obtained from the documents reviewed. Open ended interviews were used by the audit team. The audit team also conducted five (5) focus group discussions with Gamodubu village leadership and residents. The discussions were conducted to gather information on how the operations of the landfill had impacted on the livelihoods of people living within its proximity. Details of the interviewees are depicted at **Annexure 2**.

- **Site Visits**

Visits were made from the 13 January 2015 up to the 26 January 2015 at the Gamodubu landfill to observe the operations of the landfill and check the status of the waste cells and machinery. Observations were made within the following areas;

- Incinerator room
- Weighbridge
- Different waste cells
- Boreholes
- Leachate pond

# CHAPTER 2

## 2.0 DESCRIPTION OF THE AUDIT AREA

### 2.1 GAMODUBU LANDFILL MANAGEMENT

The Environmental Health Unit within the Public Health Department manages the Gamodubu Landfill. The Unit monitors the landfill operations including landfill gas generation and migration, groundwater quality and storm water runoff. This is to control landfill gas emissions, mitigate inputs to groundwater to protect public health and minimise impacts to the environment.<sup>8</sup> The Unit ensures that equipment and facilities within the landfill are appropriately maintained in order to maintain their level of serviceability and prolong their life span.<sup>9</sup> The Gamodubu Landfill management therefore ensures that the landfill is in compliance with the overriding policy frameworks and related guidelines.

### 2.2 REGULATORY FRAMEWORK

Landfills in Botswana are operated under the Waste Management Act of 1998, the Guidelines for the Disposal of Waste by Landfills First Edition, 1997 and Atmospheric Pollution Prevention Act, Cap 65:03 of 1971. Other guiding instruments are Botswana's Strategy for Waste Management and the Landfill Operational Manual and Environmental Management Plan of June 2009.<sup>10</sup>

### 2.3 GAMODUBU LANDFILL

The Gamodubu Regional Landfill is located at the Gamodubu village approximately 30 kilometres west of Gaborone along the Gaborone-Molepolole Road. The landfill, operated by the Kweneng District Council receives waste from Gaborone, the greater Gaborone areas that is; South East District Council (Tlokweng) as well as Kweneng District Council (Molepolole and Mogoditshane

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<sup>8</sup> Landfill Operational Manual and Environmental Management Plan, 2009

<sup>9</sup> Landfill Operational Manual and Environmental Management Plan, 2009

<sup>10</sup> Landfill Operational Manual and Environmental Management Plan, 2009

Region). It was commissioned on the 1<sup>st</sup> October 2009 and it covers a total of 80 hectares, of which approximately 30 hectares have been developed. The whole area has been fenced with 2.4 meters high security welded mesh fence. It is divided into services area and the waste disposal area. The service area consists of buildings and facilities used for landfill operations which include the incinerator, wash bay, administration block and the weighbridge. The waste disposal area consists of different cells where waste is disposed of and treated. This landfill is classified as G: L (general waste, Large Landfill) and has a maximum annual rate of deposition (MARD) of more than 65 thousand and its lifespan is estimated to be 20 years.<sup>11</sup>

The amount of waste deposited at the Gamodubu Landfill over the last six (6) years is shown in Table 1.1 below;

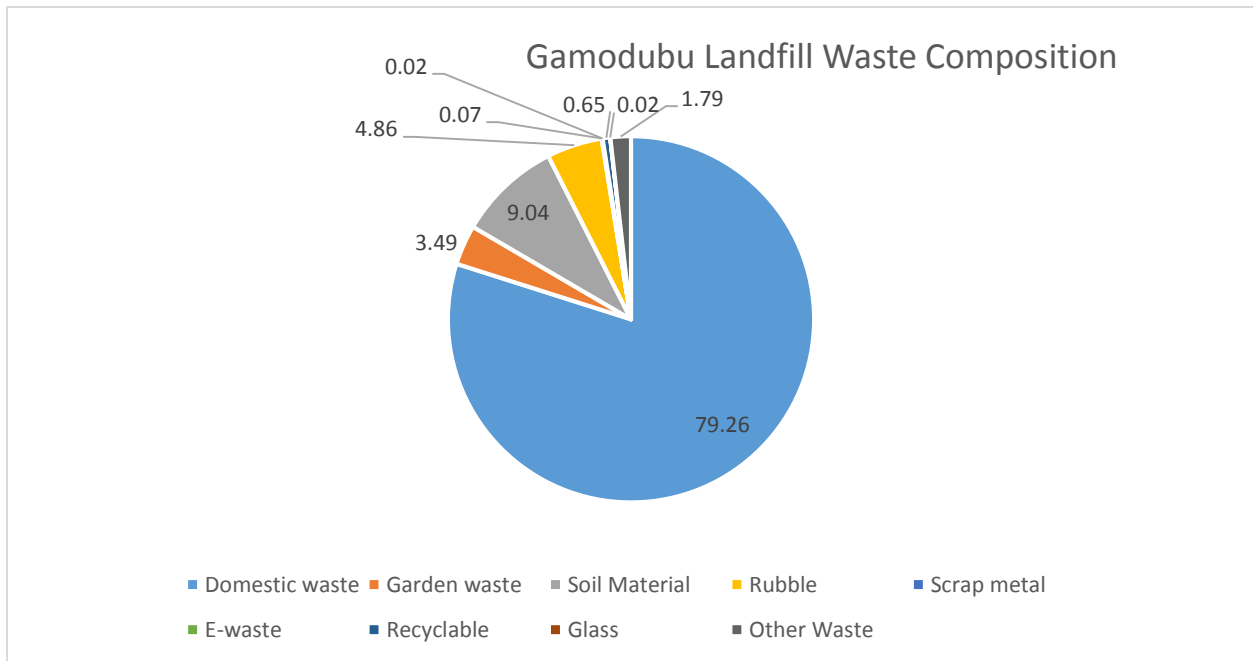
**Table 1.1: Amount of waste disposed of since October 2009 – December 2014 (tons)**

Year	Waste disposed of (tons)	Expected Annual Waste Deposition (tons)	Variance (tons)
2009	15 307.2	65 000	(49 692.80)
2010	68 395.64	65 000	3 395.64
2011	87 339.35	65 000	22 339.35
2012	90 937.10	65 000	25 937.10
2013	106 723.8	65 000	41 723.80
2014	92 499.51	65 000	27 499.51
Totals	465 344.68	390 000	75 344.68

**Source: Gamodubu Landfill Waste Tonnage Report (2010-2014)**

<sup>11</sup> Gamodubu Landfill Progress Report

The Gamodubu Landfill receives controlled waste which includes among others; general waste, clinical, scrap metal, tyres, garden waste and building rubble. The waste composition at the Gamodubu Landfill, during the period 2009 – 2014, is shown in **Figure 1** below;



**Figure 1: Composition of waste disposed of at Gamodubu landfill (2009-2014)**

**Source: Gamodubu Landfill Waste Tonnage Report (2010-2014)**

The domestic waste accounts for 79.26% of all the waste deposited followed by soil material at 9.04% and rubble at 4.86%. Garden waste stood at 3.49% while recyclables from the Landfill were 0.65% of the waste disposed of for the years under review. In addition, around 0.02% of the waste disposed of was glass and e- waste respectively. Other waste (which includes clinical waste, confidential items, condemned food stuffs, carcasses, ash, abattoir sludge, food animal waste and industrial waste) accounted for 1.79% of the total waste for the years 2009 – 2014.

### 2.3.1 FUNDING ARRANGEMENTS AND BUDGET

The finances shown in the Table 1.2 illustrates the amounts warranted and expended for the Gamodubu Landfill operations for financial years under audit from 2009-2010 until 2014/2015.

**Table 1.2: Gamodubu Landfill Recurrent Budget**

YEAR	ACTUAL BUDGET BWP	ACTUAL EXPENDITURE BWP	VARIANCE BWP
2009/10	5 798 060.00	8 060 673.90	(2 262 613.90)
2010/11	9 404 890.00	10 153 115.77	(748 225.77)
2011/12	15 015 060.00	13 866 805.96	1 148 254.04
2012/13	14 032 800.00	13 951 042.81	81 757.19
2013/2014	3 675 950.00	2 676 325.26	999 624.74
2014/2015			
TOTAL	47 926 760.00	48 707 963.70	(781 203.70)

**Source: Kweneng District Council Financial Statements**

### 2.3.2 STAFFING

The Establishment Register for the financial year 2013/2014 shows that the Gamodubu Landfill has a staff complement of 36 employees. The organogram is depicted at **Annexure 5**.

### 2.3.3 KEY STAKEHOLDERS AND THEIR ROLES AND RESPONSIBILITIES

The Gamodubu Landfill stakeholders and their roles and responsibilities are depicted at **Annexure 6**.

## 2.4 SYSTEMS AND PROCESS DESCRIPTIONS – GAMODUBU LANDFILL

### 2.4.1 ACQUIRING A WASTE FACILITY LICENCE

The Waste Management Act of 1998, Chapter 65:06 mandates the DWMPC to license the landfill facility to ensure compliance with environmental regulations and prevent pollution to both animal and human life. Before a landfill may be constructed or operated, a license is acquired from the DWMPC. The license application has to include all the necessary information for the DWMPC to make an informed decision. During the consultation process, the DWMPC assesses the results of the investigations together with the design information. The DWMPC also ensures that appropriate consultation has taken place through the Planning Permission or Tribal Lands Act Procedures. The license is to contain conditions relating to all aspects of the landfill. Notable among these are specification of the types and quantities of waste which are accepted at the landfill.<sup>12</sup>

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<sup>12</sup> Botswana Landfill Guidelines, 1997

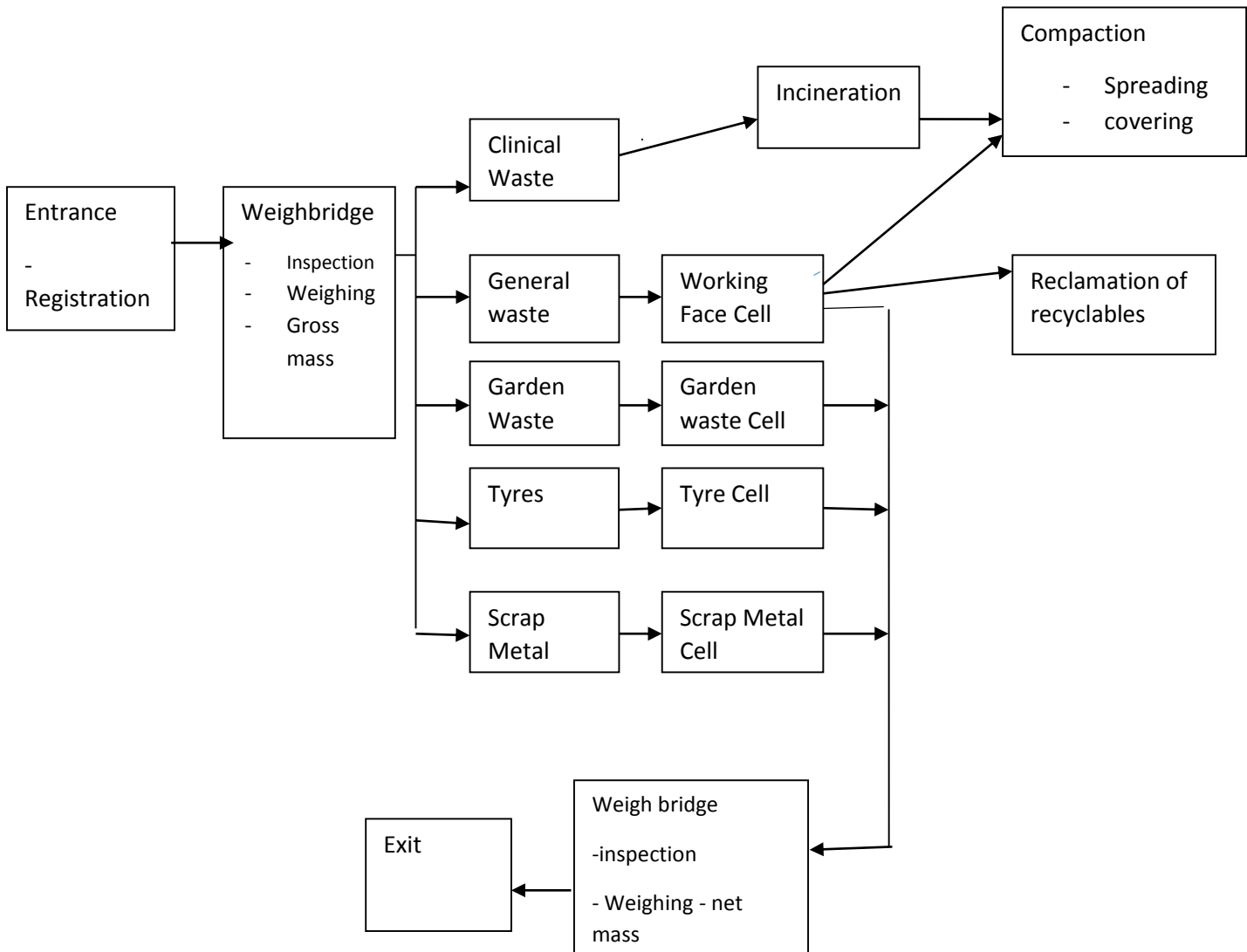
## 2.4.2 DISPOSAL OF WASTE BY THE LANDFILL PROCESS

The disposal of waste by the Gamodubu Landfill process is depicted by the flow chart below:

**Figure: 2 DISPOSAL AND WASTE TREATMENT**

**Process flow- refer to Annexure 3**

Source: Kweneng District Council; Public Health Waste Treatment and Disposal Uncontrolled Document



## **2.4.3 MONITORING OF THE LANDFILL AND ENVIRONMENTAL EFFECTS**

### **a) Gas Monitoring and Handling of Gas Produced**

According to the Guidelines for the Disposal of Waste by Landfill of 1997, where potential gas problems are identified, appropriate monitoring systems are to be installed. These must be monitored at three monthly intervals during the operation and at the discretion of the DSWM (currently DWMPC) after site closure. If the soil gas concentrations exceed 1% by volume at Standard Temperature and Pressure (STP), the DWMPC must be informed. Air quality monitoring at landfill sites mainly addresses odour, which could be related to gaseous emissions indicated above, and usually undertaken in response to complaints<sup>13</sup>.

### **b) Monitoring of leachate and handling of leachate produced**

Leachate production is expected to be minimal as no wet wastes are envisaged. In any case any leachate produced is expected to be intercepted by the ground perforated pipes, which terminate into the leachate/storm water pond and can be checked at manholes through vertical pipes for monitoring purposes. Once a year the underground perforated pipes are to be flushed with water to remove any blockage or any situation that might have occurred<sup>14</sup>. Moreover, once leachate is produced and accumulated in the leachate pond, it is sampled and tested to determine its toxic substances. Leachate analysis provides a detailed characterisation of the leachate by constituents and concentration. A diluting agent is determined, and applied in appropriate proportions. The leachate pond is monitored for any odour. The leachate analysis enables a trend analysis that may generally indicate the effectiveness of operational procedures and integrated waste management in the service area.

Furthermore, leachate is analysed to provide characterisation data to waste water treatment facilities that accept leachate. Leachate if allowed to stand

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<sup>13</sup> Botswana Landfill Guidelines , 1997

<sup>14</sup> Landfill Operational Manual and Environmental Management Plan, 2009



in the pond for a prolonged period such that it becomes a nuisance to the public and landfill users. Three boreholes have been drilled within and outside the landfill area and equipped for sampling underground water. One is located near the leachate pond while two are located just outside the perimeter fence. A regular sampling of underground water from these boreholes is carried out after every six months and tested to determine any impact caused by landfilling on the quality of water regime in the vicinity of the site. Any contamination observed is referred to DWMPC for agreement on remedial measures to be done.<sup>15</sup>

#### **2.4.4 MONITORING OF LANDFILL AT DIFFERENT LEVELS**

##### **a) Department of Waste Management Pollution and Control**

The Department of Waste Management Pollution and Control conducts audit inspections once every year. The purpose of the audit inspection is to monitor the waste disposal operation. The landfill site audit includes; considerations for site security, site access, conditions of roads and traffic control. The actual waste deposition is to be addressed in terms of cell construction, waste deposition, spreading, efficiency of burning, compaction and covering. The DWMPC also assesses license conditions and design requirements. Waste reclamation is also audited for health and safety risks as well as its aesthetic impact.<sup>16</sup>

##### **b) Council Level**

The Senior Environmental and Health Officer (SEHO) visits the landfill site at the least once a week to inspect the operations and the performance of the staff on site and later compiles monthly briefs to the Council Secretary via the Principal Environment Health Officer (PEHO) on landfill operations and

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<sup>15</sup>Landfill Operational Manual and Environmental Management Plan, June 2009

<sup>16</sup> Botswana Landfill Guidelines, 2007

prepares reports to be submitted at DWMPC on landfill operations and arranges for sampling and testing of underground water.<sup>17</sup>

### **c) At the Landfill Management Level**

The Landfill Manager compiles and consolidates on a weekly basis all individual reports prepared by the operators and other staff on a daily basis. Moreover, the Landfill Manager on a monthly basis submit reports to the Council as a monitoring procedure regarding the operations of the landfill for the preceding month including among others; the challenges encountered and proposed mitigation measures, the type, volume and tonnage of waste disposed of during the month and staff issues and any training that has been carried out or required. The Landfill Manager is also expected to provide update on the equipment utilisation, status of the cover material and also give recommendations for improvement.<sup>18</sup>

### **2.4.5 MAINTENANCE OF INFRASTRUCTURE AND FACILITIES**

Regular maintenance of facilities and infrastructure provided for the landfill is a mandatory requirement in order to maintain their level of serviceability and prolong their life span. Therefore, it is the Landfill Manager's responsibility to prepare a maintenance schedule of all facilities and infrastructure at the landfill and ensure that it is strictly adhered to. The equipment includes; incinerators, landfill compactors, tractor-loader-backhoes, tyre cutter, tipper trucks, water bowsers, clinical waste van, borehole sampling kit and bulldozer. Servicing and maintaining equipment and trucks working at the landfill site is undertaken at the workshop building within the landfill.<sup>19</sup>

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<sup>17</sup>Landfill Operational Manual and Environmental Management Plan, June 2009

<sup>18</sup> Landfill Operational Manual and Environmental Management Plan, June 2009

<sup>19</sup>Landfill Operational Manual and Environmental Management Plan, June 2009

# CHAPTER 3

## 3.0 FINDINGS

### 3.1 COMPLIANCE TO THE LANDFILL POLICY FRAMEWORK

Compliance to policies relevant for the controlling and management of the landfill is of paramount importance in ensuring that the environment is protected from potential environmental damage and the public from adverse health hazards.

However, the review of documents for the years under audit highlighted that the Kweneng District Council through Environmental Health Division (particularly the Landfill Management) had not been complying to the Waste Management Act Chapter 65:06 and Guidelines for Disposal of Waste by the Landfill which require that “no person shall operate a waste disposal site unless the waste disposal site is registered” and also the Atmospheric Pollution and Prevention Act Chapter 65:03 which states that “ no person shall within a controlled area carry out in or on any premises an industrial process capable of causing or involving the emission into the atmosphere of objectionable manner unless he is the holder of a current registration certificate authorising him to carry on that industrial process in or those premises”. The following sub – paragraphs give details of evidence of non – compliance:

#### 3.1.1 LICENSING OF THE GAMODUBU LANDFILL

The Department of Waste Management and Pollution Control is mandated by the Waste Management Act to license all waste management facilities. Thus, according to Section 15 (2) of the Waste Management Act, Cap 65:06, “no person shall manage controlled waste, on or upon any land or other premises, without a waste management facility licence“. Daily operations at the landfill are carried out under stringent regulations and standards designed to protect

the environment and the public health hence the importance of acquiring a licence. However, interviews conducted at the Kweneng District Council and Department of Waste Management and Pollution Control revealed that the Gamodubu landfill had been operating without a licence since it was commissioned more than five (5) years ago, contrary to the requirements of the Act. The licence needed to have been acquired prior to the landfill construction. As a result, the landfill had several violations with respect to the Waste Management Act. These violations included inter-alia; lack of incinerator testing component, landfill gas monitoring system in place, ground water monitoring system, proper covering and compaction and the non-availability of fully functional equipment. This was further corroborated in almost all Department of Waste Management and Pollution Control Annual Audit Reports, for the years under review.

On enquiry as to why the facility was not licensed, the Landfill Management and the DWMPC Management attributed the anomaly to the fact that the Gamodubu landfill had not met all the design and landfill operational standards. However, the DWMPC as the coordinating agency had not managed to take any remedial actions against the Gamodubu Landfill Management for violation of the licensing requirements. This is despite the fact that the DWMPC yearly audits at the landfill had made similar observations.

### **Recommendation:**

#### **The OAG recommends that;**

- **The Kweneng District Council should liaise with the Department of Waste Management and Pollution Control to ensure that the Gamodubu Landfill meets all the design and operational standards for it to be licensed.**
- **Environmental Health Division should ensure that the Gamodubu landfill holistically adheres to the requirements of the Management Waste Act, the Guidelines for the Disposal of Waste by Landfill and the Operational Manual.**

### **Management Comment**

*“The Auditors recommendation is noted. Efforts were made to apply for a licence in 2014 but could not go through due to some observations among others relating to registration of incinerator, functionality of all equipment and desludging of storm water/leachate pond. The Council had some problem of limited funds to fulfil some of the requirements during the previous years, therefore it is done at a piecemeal basis. The Council is currently processing the tender for sampling at the chimney stack, to monitor ambient air while service and maintenance contracts for landfill equipment were signed on the 10 March 2015 and maintenance is done accordingly. Quotations for desludging were sourced in 2014/15 financial year but the bidders quoted more than the threshold that warranted a tender and the Council did not have enough funds to cater for that as it was in the range of millions. This is because in order to desludge the storm water/leachate pond the wastewater has to be all drained, dry and sample the sludge and subsequently dispose of the sludge. However, provision has been made in the District Development Plan 8. It is hoped that after that all the requirements will be met and a licence will be issued”.*

### **3.1.2 INCINERATOR REGISTRATION CERTIFICATE**

The incinerator Registration Certificate gives the Landfill Management authority to test the toxic substances emitted into the environment during the incineration process.<sup>20</sup>The Certificate needed to have been applied for immediately after the commissioning of the landfill to enable the Air Pollution Control Officers to ensure that “the best practicable means have been installed and will be employed for preventing or reducing the escape into the atmosphere of the objectionable matter for potential production of toxic emissions”.<sup>21</sup> Despite these requirements, the audit revealed that the

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<sup>20</sup> Atmospheric Pollution and Prevention Act

<sup>21</sup>Atmospheric Pollution and Prevention Act

incinerator did not have a certificate attached with a testing component which would enable testing of gases emitted. This was reiterated by several DWMPC reports which stated that the incinerator had to be registered to operate. According to documents, absence of the registration certificate was due to failure by the landfill Management to have installed the sampling port in the incinerator as per the requirement. This made it difficult for the Landfill Management to test the toxicity of the gases emitted by the incinerator. Therefore, this meant that the Management had not assessed the extent to which the gases impacted on the environment and the public.

Clinical waste incinerators not operated in accordance with their design specifications emit black smoke, offensive odour and high dioxin level which present risks to human health as well as wildlife and biodiversity.<sup>22</sup>

#### **Recommendation:**

- **The Environmental Health Division should liaise with the DWMPC to ensure that the incinerator design requirements are adhered to, to the letter, to enable the incinerator to be registered, in order to enable Landfill Management to test gases emitted in accordance with the Atmospheric Pollution and Prevention Act.**

#### **Management Comment**

1. *"The management noted the recommendation. The Kweneng District Council had during the 2014/15 financial year floated TENDER-KDC/TR/PH/HQ/001/2014. Unfortunately the tender did not attract any bidder. A further tender number KWDC/TR/PH-HQ/001/2017 was rejected by the Adjudication Committee on 11/10/17 for insufficiency of funds. However, efforts will be made to source funds for the project during this financial year (2017/18)*
2. *Annual Calibration and verification of the Incinerators has not been done as required because Botswana Bureau of Standards (BOBS) did not*

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<sup>22</sup> Code of Practice for Clinical Waste Management

*have the appropriate equipment to do the exercise. Moreover, the Landfill Incinerators developed mechanical faults hence could not be calibrated and verified by BOBS. However, a Service Agreement has been signed with MCTB Technologies (PTY) LTD on the 30<sup>th</sup> November 2017, thus a request for calibration will follow after maintenance of the incinerator.*

## 3.2 LANDFILL OPERATIONS

### 3.2.1 INCOMING WASTE

#### **Inspection at the Weighbridge**

It is a requirement that waste is inspected as it enters the waste management facility to ensure that it is acceptable waste. Thus every vehicle entering the landfill to dispose of waste has to stop at the weighbridge to enable the enumerators to inspect its load and guide it to the relevant cell for disposal.<sup>23</sup>

However, visual examination of the incoming waste was intermittent. This was corroborated by the audit team's observations made on the 13 January 2015 and 15 January 2015. For instance, it was observed that the Enumerators had not uncovered the whole vehicle to check the contents therein. They however, depended more on the information provided by the drivers. Out of the 64 vehicles that entered the landfill on the stated dates, 42 representing 65.6% of the observed vehicles, had not been thoroughly inspected to check waste they carried. When interviewed, the Landfill Management expressed the same sentiment, and alluded that there had been inadvertency on the part of their operatives to thoroughly check the incoming waste. This was further corroborated by the Weekly Inspection Reports which revealed that inspection of vehicles carrying waste was not done accordingly. On further enquiry, the Enumerators mentioned that the anomaly occurred because they were without proper protective clothing for protection against any hazardous

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<sup>23</sup> Landfill Operational Manual and Environmental Management Plan, June 2009

waste including among others; chemical and or electronic waste which at times find their way into the landfill (**Refer to Figure1**). To the contrary, documents review and interviews with Management further disclosed that there were no laid out procedures stipulating how best to inspect incoming waste.

As a result of the inadequate inspection of incoming waste, the waste ended up being deposited at the wrong waste cells. This was corroborated by an interview with the Landfill Operatives who highlighted that the inadequate waste inspection by the Enumerators led to waste not earmarked to general waste cells being there, such as tyres, florescent bulbs and metals. This therefore, made it difficult for them to adequately compact waste. During an inspection of the general waste cells by the Audit Team, it was found that there were tyres, garden waste as well as some metals in the general waste cell as evidenced by **Figure(s) 3** and **4** below. However, it is worth noting that the disposal of whole tyres in the landfill can contribute to “surface instability and present a fire risk with the potential for excessive black smoke”<sup>24</sup>



**Figure 3: Garden waste at the general waste cell**



**Figure 4: Tyres disposed at the general waste cell**

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<sup>24</sup> Guidelines for the Disposal of Waste by the Landfill, 1997



## **Recommendation:**

**The Environmental Health Division should ensure that;**

- **Appropriate Guidelines on how best waste can be inspected upon entering the landfill are developed for consistency and accountability thus preventing environmental pollution.**
- **Weighbridge operators are provided with proper protective clothing for protection against the spread of diseases and serious injuries that come with improper waste handling.**

### **Management Comment**

*“Employees are given full and appropriate protective clothing on annual basis. It has however been noted that some employees may not put on full protective clothing and the Department will monitor that. However, the concern on inspection of incoming waste is noted. Inspection of waste is done in accordance with the Public Health Manual under Procedure for Waste Treatment Disposal Step 2. It is worth noting that the situation is exacerbated by the fact that the Council receives mixed waste as there is no segregation of waste at source, hence the reason why some waste may find its way into other cells. Refuse collectors do remove the unacceptable waste and re-direct the waste to the appropriate cells. Waste collectors are always reminded to segregate waste as per the required categories. Garden waste however is used as cover material. Furthermore, the Department will continue to engage with stakeholders on proper handling of waste in order to improve the situation”.*

### **3.2.2 COMPACTION AND COVERING OF WASTE**

#### **a) Compliance to Guidelines Specifications on Compacting and Covering of Waste**

According to the Landfill Operational Manual, waste has to be allowed to accumulate before it is spread, compacted and covered with soil. It further

states that, “waste can be better compacted if the layer thickness of un-compacted waste does not exceed 500mm and the compactors number of passes is at least 5. It is also advisable that the depth of compacted waste should not exceed 1metre before it is covered and the minimum thickness of cover shall be 150mm of compacted soil.”<sup>25</sup>

Interviews conducted at the Gamodubu landfill revealed that the Landfill Guidelines were not accordingly adhered to, during compaction and covering of waste. It transpired from the interviews that the Landfill Operatives used visual judgement to determine the thickness of compacted waste as well as cover material. This was corroborated by observations made on the 22 January 2015 where the audit team observed that there were no measurements made during the process of compaction and covering of waste. On enquiry, Management highlighted that since the landfill started operating, they had never measured the thickness of compacted waste, due to absence of measuring equipment and covering level of waste in the cells. Management also indicated that at the time, the landfill was receiving more waste than was planned for which was a challenge for operatives to handle and compact. (Refer to **Table 1.1**, for details on waste tonnage).

### **b) Daily compaction and covering**

According to Landfill Operational Manual, waste has to be covered at the end of each day's operations. This entails first compacting the waste and covering it thereafter. Furthermore, under no circumstances shall waste be left uncovered for over one day.<sup>26</sup>

Interviews conducted with the landfill personnel and Management highlighted that they were unable to meet daily compaction and covering of waste. This was corroborated by the Weekly Inspection Reports which indicated that daily

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<sup>25</sup> Landfill Operational Manual and Environmental Management Plan, June 2009

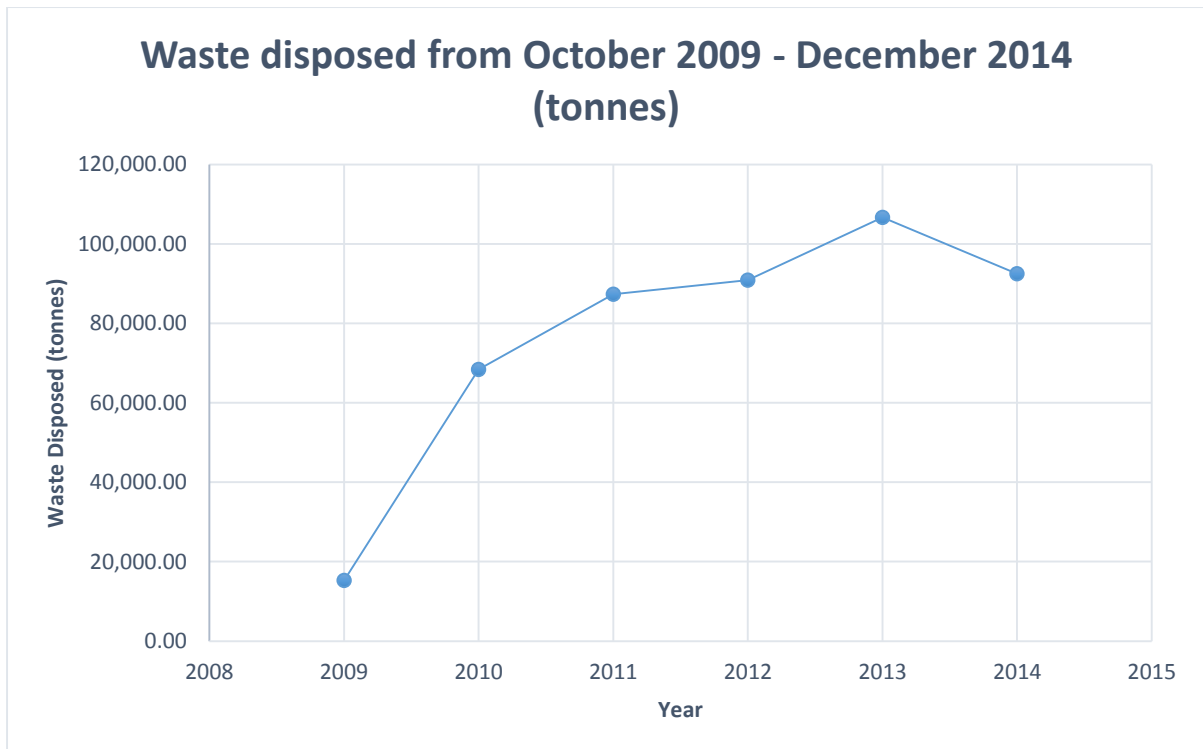
<sup>26</sup> Landfill Operational Manual and Environmental Management Plan, June 2009

compaction was not done accordingly. In some instances waste disposed of by the cells would be 40% or 50% compacted and covered (refer to **Figure 6** page 34 of this report)<sup>27</sup>. This was substantiated by documents reviewed which indicated that there had been backlogs of waste compaction and covering. According to the available documents, waste compaction backlog ranged between two (2) weeks and nine (9) months.

The reason for the anomaly was said to be frequent breakdown of landfill equipment and machinery (Refer to succeeding sub - paragraph **3.2.3** for details). Additionally, Management highlighted that they had challenges of compacting all the waste the landfill received because the quantum of waste deposited over the years, far exceeded the maximum annual rate of deposition expected (MARD) of 65 000 tonnes. For instance, waste deposited therein increased progressively over the years as indicated by **Figure 5** over leaf:

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<sup>27</sup> Technical Staff Meeting Reports



**Figure 5: Amount of waste disposed of since October 2009 – December 2014(tonnes)**

**Source: Gamodubu Landfill Waste Tonnage Report (2010-2014)**

The effect when waste is not appropriately compacted and covered is that it results in the landfill being aesthetically not pleasing (papers, plastic bags lying around). This is evidenced by information from the Internal Reports which indicated that there had been a lot of littering in the landfill. Consequently, there was additional effort made to pick up such litter as the review of documents indicated that for the period ranging from August 2013 to December 2014, the Landfill Operatives on average used 1306 plastic bags per month for litter picking within the landfill.<sup>28</sup> Additionally, this led to waste being deposited outside cells.<sup>29</sup>

Moreover, interviews with the Gamodubu residents on the 23 January 2015 and 24 January 2015 revealed that there were times when they experienced odour and flies in the village due to inadequate compaction and covering of waste

<sup>28</sup> Technical Staff Meeting Reports

<sup>29</sup> Technical Staff Meeting Reports

at the landfill. The residents contended that the landfill Management was not doing enough to reduce the instances of odour and flies which affected their livelihood as it led to their homes being inhabitable. The odour from the waste may also lead to occupational hazard to the landfill workers working at the landfill and also attract the scavengers to enter and obtain contaminated foodstuff which might be hazardous to their lives.



**Figure 6: Waste said to have been compacted**

**Recommendation:**

**The OAG recommends that the EHD should;**

- **Ensure strict adherence to the Landfill Operational Manual and Disposal of Waste by the Landfill Guidelines especially the compaction and covering, so as to prevent potential human health risk and adverse impact to the environment.**

- **Ensure that the Landfill Guidelines are adhered to, to the letter during compaction and covering of waste to enhance capacity of the landfill to enable it to reach its estimated lifespan of 20 years.**

### **Management Comment**

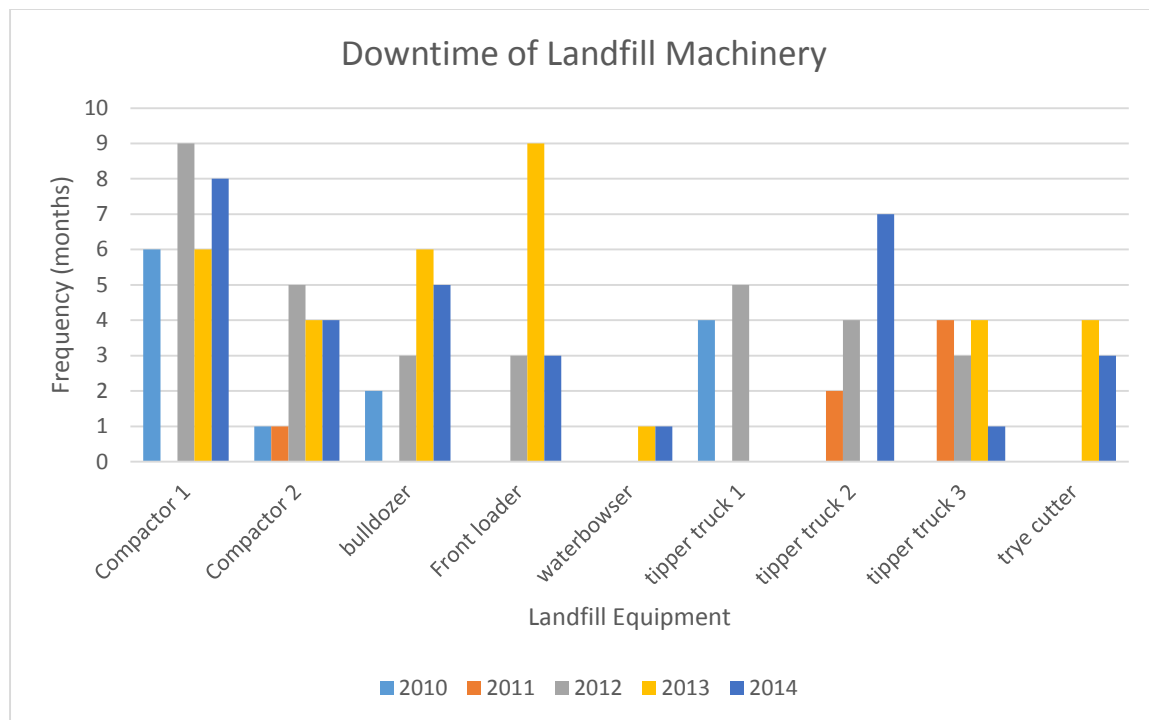
*"The landfill guidelines are followed. However, the nature of waste especially plastic and plastic coated boxes are difficult to handle as they are not easily compactable and are not biodegradable as compared to waste. Additionally the cover material is prone to being blown away and expose the waste as vehicles go over waste. The Council has procured the wooden profiles that will be painted and marked to direct the Plant Operator during compaction" as measurement tools. Moreover, the Department had awarded a Plant Hire tender to Red & White (PTY) LTD which is currently on site (2017/18). In addition, the Council has extended the working hours for Truck Drivers and Plant operators during weekends and public holidays from 1330hrs to 1630hrs to rescue the situation".*

### **3.2.3 FREQUENT BREAKDOWN OF EQUIPMENT**

According to the Operational Manual and Environmental Management Plan 2009, "regular maintenance of facilities and infrastructure provided for the landfill is a mandatory requirement in order to maintain their level of serviceability and prolong their life span".

Documents reviewed and interviews conducted revealed that the Kweneng District Council through the Environmental Health Division (EHD) had been maintaining various landfill equipment (compactors, bulldozer, front loader, waterbowser, tipper trucks and tyre cutter) during the years under review. Nonetheless, despite the landfill equipment being regularly maintained or serviced, documents reviewed revealed that there had been continuous breakdown of different equipment and machinery. On the contrary, there had been some delays by the EHD to repair the landfill equipment to enable the

facility to operate accordingly. The downtime for the landfill equipment and machinery over the years is presented in the graph overleaf;



**Figure 7: Downtime of Landfill Machinery, 2010 – 2014**

**Source: Gamodubu Landfill Technical Staff Reports**

The analysis of data shows that most of the landfill equipment was down at some point during the years under review. For instance, the downtime ranged between zero (0) and nine (9) months. Therefore, the detailed downtime for each equipment is substantiated as follows; Compactor 1 (0 – 9 months); Compactor 2 (1 – 5 months); Front loader (0 – 9 months); Waterbowser (2 – 7 months); Tipper truck 1 (0 – 5 months) and Tipper truck 3 (1 – 4 months). The analysis of the chart shows an annual alternating rise and fall of downtime of different landfill equipment machinery. It is worth noting that each and every equipment was critical for ensuring that waste was appropriately and immediately compacted to prevent any adverse effects on the environment and human health. For instance, appropriate measures such as putrescible material must be taken to eliminate disease vectors.<sup>30</sup> Details of equipment

<sup>30</sup> Guidelines for the Disposal of Waste by Landfill, 1997

and machinery performance over the years under audit is depicted at **Appendix 7.**

Documents reviewed and interviews highlighted that the following were contributory factors for the delay to repair the equipment;

- There was inadequate capacity to maintain machinery, in terms of number and expertise. For instance, there was only one (1) mechanic responsible for Kweneng District Council machinery, despite the vastness of the District.
- Moreover, landfill management stated that some of the parts required to service the landfill equipment, especially compactors had to be sourced outside the country which exacerbated long procurement process.

Equipment and machinery that remain stationary for extended periods of time without being maintained often suffer further damages as they tend to deteriorate. Such deterioration will end up costing the Council and the Government exorbitant maintenance costs in the long run and lead to problems that may otherwise expedite their complete breakdown. Furthermore, continuous breakdown of equipment and machinery inhibited the Environmental Health Unit's service delivery that led to uncontrolled nuisances in the landfill. This negatively affected the ability of the landfill management to manage the landfill sustainably.

The OAG is of the view that the situation contravenes the requirements of the Waste Management guiding framework and it also compromises the Vision 2016 Pillar of "Ensuring a clean and safe environment".<sup>31</sup>

**Recommendation:**

**The OAG recommends that the EHD Management should;**

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<sup>31</sup> National Development Plan 10 (NDP10), p 273



- **Ensure that equipment is constantly repaired and maintained to enhance their capacity and availability.**
- **Device a plan which will ensure timely purchase of spare parts instrumental in timely maintenance of machinery.**
- **Develop timelines (lead times) for procurement of equipment spare parts and ensure that they are strictly adhered to.**
- **Review the appropriateness of the existing spare parts policies and streamline it to suit the present spare parts scenario.**

### **Management Comment**

*“The Council has signed a service and maintenance contract for the landfill compactors and front end loader as well as the incinerators, so as to speed up maintenance of equipment and reduce the waiting time for ordering spares. Furthermore, the Council received P 9 937 005 from Ministry of Local Government and Rural Development in 2015/2016 financial years and has procured 2 additional landfill compactors (Shantui 1 and Shantui 2) after realising that regular break down and maintenance of already existing compactors was costly. In addition, the Council intends to create a post of Heavy Duty Mechanic to take care of the Landfill machinery”.*

### **3.2.4 LANDFILL INCINERATORS**

According to the Atmospheric Pollution (Prevention) Act, Chapter 65:03, “appliances for preventing or reducing of objectionable matter into the atmosphere, shall at all times be properly maintained and operated. The holder of the certificate shall ensure that all other necessary measures are taken to prevent the escape into the atmosphere of objectionable matter”.

Notwithstanding, documents reviewed highlighted that the incinerators which were “to sterilise the clinical waste and destroying it”<sup>32</sup>, continuously emitted

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<sup>32</sup> Botswana Clinical Waste Management Code of Practice

black smoke as evidenced by **Figure 8** hereunder and might have also emitted dioxins, thus having impact on the environment. <sup>33</sup>



**Figure 8: Incinerator Emission**

Interviews conducted showed that the landfill incinerators had not been appropriately maintained. This was further substantiated by documents reviewed which revealed that the incinerators were “long overdue for replacement of fly ash arrestors and lining of internal walls, as they were worn out” (Refer to **Figure 9** for details).<sup>34</sup> Consequently, these “contributed to factors to the emission of respirable particulars from the chimneys which in the long run will affect the health of the employees.”<sup>35</sup> Additionally, the incinerator gas emissions had not been tested, to assess the extent of toxicity of the gases emitted into the atmosphere contrary to the requirements of the Atmospheric Pollution Prevention Act. The contributory factor for the anomaly was said to be that “the sampling ports had not been installed in the incinerators, from the onset (design problem)”.<sup>36</sup>

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<sup>33</sup> Botswana Clinical Waste Management Code of Practice

<sup>34</sup> Environmental Health Division Report, April 2014– December 2014

<sup>35</sup> Environmental Health Division Report, April 2014– December 2014

<sup>36</sup> Interviews with Gamodubu Landfill Management, 29 July 2014

**Figure 9: Gamodubu Landfill Incinerator**



### **Recommendation**

**The OAG recommends that the Environmental Health Division should;**

- **Ensure that the landfill incinerators are adequately maintained to enable them to operate accordingly and minimise the emission of respirable particulars from the chimneys which may affect the health of employees.**

### **Management Comment**

*“The Council has now signed a service and maintenance agreement on the 30 November 2017 for servicing of the incinerators. As for sampling from the chimney stack, the tender for provision of sampling port was rejected due to*

*insufficient funds. As a long term plan, the Council has submitted a proposal for an industrial incinerator machinery to the Ministry as the existing ones are overwhelmed due to demand in incinerator service”.*

### **3.2.5 SHREDDING AND DISPOSAL OF USED TYRES**

The Landfill Manual requires that tyres be stored at the designated used tyre cell. Moreover, the Landfill Manager has to designate the days in a week when the tyres would be shredded, and all shredded tyres have to be landfilled at the general waste cell. Furthermore, the Manual also asserts that before shredding and disposal of waste at the general waste cell, the traders in used tyres be allowed to pick them to retread or re-use them.<sup>37</sup>

Notwithstanding, observations made at the tyre cell, revealed that there was a large accumulation of tyres (Refer to **Figure 10** overleaf for details). However, interviews with the landfill management indicated that even though they had been shredding the tyres, they had not been able to significantly reduce the quantity of tyres disposed of at the landfill. On further enquiry, the landfill Management highlighted that the accumulation of tyres was due to the fact that the landfill had only one (1) tyre cutter which was overwhelmed by the amount of tyres disposed of at the landfill. They also mentioned that the challenge was further aggravated by the fact that there was no reclamation of tyres at the Gamodubu Landfill. These were said to be exacerbated by the delay in awarding of the reclamation tender. Even at the time of audit the reclamation project had not commenced. If the reclamation project becomes successful, it would contribute significantly to the lifespan of the landfill as all the recyclable waste would be salvaged for re-use or recycling. The project would also contribute to local economic empowerment.<sup>38</sup>

Documents reviewed indicated that tyres if deposited whole in a landfill can rise and cause void spaces which break the surface and encourage vermin.

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<sup>37</sup> Landfill Operational Manual and Environmental Management Plan

<sup>38</sup> Briefing notes to Chairman remarks 2013,2014

Moreover, they could also contribute to surface instability and present a fire risk with the potential for excessive black smoke.<sup>39</sup>



**Figure 10: Tyres at the Gamodubu Landfill**

**Recommendation:**

**The OAG recommends that the EHD should;**

- **Expedite the reclamation project to enable management of the accumulation of tyres within the landfill, in order to reduce instances of surface instability that may represent fire risks.**

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<sup>39</sup> Guidelines for the Disposal of Waste by the Landfill, 1997

### **Management Comment**

*“The recommendation is noted. The tender for reclamation of waste at Gamodubu landfill was cancelled because the Council has given Kweneng District Ventures (KDV) a provisional approval to privatize the landfill operations. However, the Council allows small scale recyclers to reclaim while still waiting for the results of the feasibility study being carried out by KDV”.*

## **3.3 MONITORING OF GASEOUS EMISSIONS**

### **3.3.1 Ambient Air**

Air quality monitoring at landfill sites mainly addresses odour related to gaseous emissions and should be done at three monthly intervals.<sup>40</sup> According to the Guidelines for the Disposal of Waste by Landfill of 1997 “where potential gas problems are identified, appropriate monitoring systems are to be installed. These must be monitored at three monthly intervals during the operation and at the discretion of the DSWM (currently DWMPC) after site closure.”

Nonetheless, interviews with Gamodubu Landfill Management revealed that the landfill gaseous emissions had not been accordingly monitored. Moreover, there was no documentary evidence to indicate that ambient air had ever been sampled to detect possible gaseous movements from the boundaries of the landfill. Management highlighted that they had been unable to monitor the gases because type of waste disposed of at the landfill was not wet waste, therefore chances of it producing gases were minimal. In addition, they stated that the landfill had no appropriate monitoring equipment to ensure monitoring of such gases.

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<sup>40</sup> Guidelines for the Disposal of Waste by Landfill, 1997

However, documents reviewed indicated that non-monitoring of these landfill gases could lead them migrating off-site and cause odour and potentially dangerous conditions.<sup>41</sup>

**Recommendation:**

**The OAG recommends that the Environmental Health Division should;**

- **Appropriately make an effort to manage and monitor landfill gases to avoid any negative impacts on the environment.**
- **Develop a plan on how these tests will be conducted to assess the toxicity of air released at the waste cells.**

**Management Comment**

*The KDC concurred with both the observation and recommendation and indicated that "tests for ambient air will be done twice annually starting financial 2015/16 whilst Landfill gases will be monitored appropriately".*

**A further tender number KWDC/TR/PH-HQ/001/2017 was rejected by the Adjudication Committee on 11/10/17 for insufficiency of funds. However, efforts will be made to source funds for the project during this financial year (2017/18)**

### **3.3.2 LEACHATE MONITORING**

Monitoring of landfill operations is critical to assess the impact of the landfill on water quality and water regime in the vicinity of the landfill. This is to ensure that water in the vicinity of the landfill is not contaminated. Additionally, ground water sampling from the boreholes and pond is to be carried out every six (6) months to sample and analyse leachate and determine the leachate substances.<sup>42</sup>

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<sup>41</sup> Guidelines for the Disposal of Waste by Landfill, 1997

<sup>42</sup> Botswana Landfill Guidelines

Notwithstanding, documents reviewed highlighted that the EHD intermittently sampled leachate to determine leachate substances. For instance, leachate sampling and analysis had not been carried out bi-annually contrary to the requirements of the Guidelines. According to the documents, the sampling was only carried out in October 2011 (by the Consultant) and in October 2013 by Environmental Health Division personnel, out of the 5 year period of the landfill operation. The sampling that was carried out by Landfill staff revealed that the leachate retention pond had accumulated a greenish substance, which they referred to the DWMPD for intervention.<sup>43</sup> There was also an accumulation of sludge and debris. Management attributed the inconsistent analysis of leachate to inadequate capacity in terms of human resources and equipment for leachate sampling.

If leachate is inadequately monitored it may contaminate soil as well as groundwater and surface water. Additionally, there are benefits that could have been realised had leachate been continuously monitored (Refer to preceding paragraph 2.4.3 (b)). Moreover, according to experts "small amounts of leachate can pollute large amounts of ground water, rendering it unusable for domestic and many other uses".<sup>44</sup>

The OAG is of the view that rainwater seeping through waste may contain some waste components and carry them into surface water and ground water, thus resulting in negative effects.

**Recommendation:**

**The OAG recommends that the Environmental Health Division should;**

- **Monitor the leachate pond so that any overflow of leachate or plugging of the leachate collection pipe is avoided.**

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<sup>43</sup> Gamodubu Landfill Technical Staff Report, October 2013

<sup>44</sup> Sampling and Analysis of Landfill Borehole and Storm Water Leachate, Wellfield Consulting Services, October 2011



- **Ensure that regular sampling and testing of leachate is carried out to ensure that both underground and surface water as well as soil in the vicinity of the landfill are not contaminated; and that appropriate remedial action is taken in the event of any adverse environmental impacts.**

### **Management Comment**

*“Sampling of leachate and underground water are monitored twice annually. Sampling was however, affected during the previous years but in 2014, sampling for underground water and leachate were done on the 29 May 2014 and 15 August 2014. For the financial year 2015/16 sampling was done on the 2 July 2015 while the second one will be done in January 2016. For the financial year 2017/18 sampling was done in March and August 2017”.*

### **3.4 MONITORING BY COUNCIL**

According to the Landfill Operational Manual, the Senior Environmental and Health Officer (SEHO) is supposed to visit the landfill site at least once a week to inspect the operations of the landfill and the performance of staff on site and later compile monthly briefs to update the Council Secretary on the operations of the landfill for coordination of the activities<sup>45</sup>.

On the contrary, documents reviewed and interviews, highlighted that weekly inspections were inadequate as they were sporadic. Interviews substantiated that physical observations were made once in a while. There was no documentary evidence to confirm the extent at which the Landfill senior Management visited the landfill. Moreover, there were no inspection schedules developed to enable systematic visits. On enquiry, Landfill Management highlighted that the landfill staff submitted reports to enable compilation of Department's report to inform the Council Management on the operations and challenges of the landfill.

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<sup>45</sup>Landfill Operational Manual and Environmental Management Plan, June 2009

Inconsistency in supervision and close monitoring of operations of the landfill contributed to continued landfill challenges. Critical issues reported in the preceding paragraphs by Landfill Operatives were not always promptly attended to. Thus inadequate monitoring of activities at the landfill led to the landfill operatives not complying with the environmental standards, wherein landfill operations were inadequate, to a large extent. Moreover, inadequate monitoring on the daily operations by the Landfill management may lead to problems on the ground not being noticed and appropriately improved thus ultimately having a negative impact on the environment and workers health.

**Recommendation:**

**The OAG recommends that the EHD should;**

- **Put measures in place to ensure that the landfill management consistently supervise and monitor the landfill operations in order to ensure that the set environmental standards, are complied with.**
- **Ensure regular inspections of the landfill in order to detect defects that need prompt action to avoid adverse environmental impacts.**

**Management Comment**

*Monitoring and inspections are done by Officers of different levels of the Council including among others, Deputy Council Secretary (Technical Services, Chief Public Officer and the Senior Environmental Health Officer who ensures daily supervision of the Landfill activities. "However, it should be noted that other work commitment may hinder regular visit to site". As regards inspection schedules, Officers are now expected to develop operational schedules as per the Kweneng District Council Quality Procedure Manuals".*

**3.5 MONITORING BY DWMPC**

The landfill was monitored by the Department of Waste Management Pollution and Control through inspections (Regulatory body). These inspections are

carried out as a way of ensuring compliance to environmental regulations and reports are submitted to the Kweneng District Council Management.

The DWMPC Inspection Reports reviewed highlighted issues of non-compliance with the Environmental Legislations, Procedures and Practices)<sup>46</sup>. (Refer paragraph 3.1). Notwithstanding the adverse comments made by the DWMPC Reports, the OAG observed that Kweneng District Council had still not implemented the inspection recommendations even at the time of audit. For instance, the OAG observed the same issues which were noted in DWMPC Inspection Reports. Despite the recommendations made, and lack of any remedial action taken, the DWMPC had not taken any stringent measures as a result of breach of the landfill principles and environmental standards. The inadvertency on the part of the Landfill Management to implement the recommendations made by the DWMPC, may contribute to adverse environmental effects and health hazard.

The OAG is of the view that monitoring quantifies any effect of the operations on the environment, particularly of the water regime and serves as an early warning system, to ensure that problems that arise can be identified and rectified promptly.

### **Management Response**

*“The management noted the finding. However, the DWMPC did not hand over most of the critical reference documents such as: Landfill License, Environmental Impact Assessment Report, Geological/Hydrogeological Report, Borehole Report Certificate, Landfill Design or Environmental Management Plan (EMP), and the Project Document for the Development of Gamodubu Regional Landfill facility. Therefore, Management was unable to implement the inspection recommendations because there were no adequate environmental documents to guide or address the issue raised:*

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<sup>46</sup> Environmental Audit Report, August 2013 by DWMPC

*Hence a continued communication with the DWMPC to provide these relevant documents in order for us to comply”.*

### **3.6 OTHER OBSERVATIONS**

#### **3.6.1 COST RECOVERY**

The Government of Botswana introduced cost recovery measures for departments to recover the cost of services provided from beneficiaries. The Government of Botswana also encouraged Local Authorities to develop a cost recovery system over time which would enable them to collect 50% of the actual costs during the period of NDP9.<sup>47</sup> This was subsequently followed by the introduction of Cost Recovery Policy of 2003 which encouraged Local Authorities to recover the cost of services provided to beneficiaries by the Government. The essence of the policy in this regard was that the consumer pays for the services that the Councils would have provided.

However, interviews and documents reviewed highlighted that the landfill management had not done well in the cost recovery particularly, regarding disposal of waste by the landfill. The Landfill Management managed to recover P8 768 980.90 out of P26 277 935.85 that was expected to have been recovered during the years under audit. This represented 33.4% of the total expected revenue from the users of the landfill. This then meant that

P 17 508 954.95 representing 66.6% of the total revenue expected during the years under audit, remained outstanding from the Landfill users as at 31<sup>st</sup> March 2014. On enquiry, Management indicated that there had been inadvertency on their part to follow-up clients, but they were randomly written letters as reminders to pay what they owed the Council. On further enquiry, Management cited the lack of a Revenue Officer to bill their clients as a contributory factor for non-collection of the amounts due to the Council for the services rendered during the years under audit.

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<sup>47</sup> Botswana's Strategy for Waste Management, First Edition, 1998

The effect of non-recovery of expected revenue for the landfill services may defeat Government's intent of cost recovery principle, particularly, the budget sustainability for providing the fiscal basis for further improvements and expansion. The amount owed would have assisted the Council to maintain the landfill equipment for sustainability of service provision in both short and long term.

### **Recommendation**

- **The EHD should ensure that cost recovery measures particularly that of landfill services are strengthened to enable sustainable fiscal basis for further improvement and expansion of the landfill.**
- **Should hasten to improve its follow-up initiative of its defaulters for the sustainability of landfill services provision in the long run**

### **Management Comment**

*"The Concern is noted. Companies that were written reminder letters and failed to honor payment were handed to a debt collector in June 2015 being Tholoana Phooko Attorneys. However, challenges encountered during the process led to termination of the service. Council is considering the following initiatives for the financial year 2018/19 to enhance cost recovery and collection of revenue arrears;*

- *KDC to arrange workshop meetings to all landfill debtors to communicate their debts*
- *In addition to the invoices which are being sent to customers on monthly basis, Public Health Department will write letters to the clients about their responsibilities towards landfill debts*
- *Add the council's banking details in the invoices to facilitate easy payment to the banks without necessarily having to come to the Council Revenue offices to make payment*
- *The council will ensure that all companies sign a waste disposal contract before disposing waste*
- *KDC is considering to introduce future use of Prepaid Services. The clients will be able to deposit money into the Council's bank account and the client will be issued a card to swipe at the land fill whenever the client comes to dispose waste".*

## Overall Conclusion

The Gamodubu and other landfills were constructed among others, to fulfill Government's Vision 2016 Pillar of "ensuring a clean and safe environment" and contribute towards enhanced waste management operations.<sup>48</sup> Notwithstanding, the Gamodubu landfill was not appropriately managed as it had the following environmental and human health challenges; non-compliance to the landfill frameworks exacerbating non compaction of waste; littering problems; poor aesthetics; extensive uncontrolled vectors; inadequate monitoring of leachate and landfill gases; non sampling and testing of incinerator emissions which may lead to occupational hazards to the landfill workers. Landfill equipment and machinery waited for periods ranging from 1-9 months without being maintained.

Improper waste management may cause adverse health problems by spreading diseases as well as causing severe environmental impacts by polluting air and soil, surface water and underground water. It is therefore imperative for the Environmental Health Division to strive to follow proper waste management practices to "ensure high level environmental sustainability "and Vision 2016 pillar of ensuring a clean and safe environment.<sup>49</sup>

Nevertheless, the OAG appreciated the Environmental Health Division's efforts notwithstanding the limited resources at its disposal.

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<sup>48</sup> National Development Plan 10 page 273

<sup>49</sup> National Development Plan 10 page 266

## ANNEXURE 1

### DOCUMENTS REVIEW

Document reviewed	Reasons for review
<ul style="list-style-type: none"> <li>Waste Management Act Cap 65:06</li> </ul>	Was read to understand the laws governing the disposal of waste
<ul style="list-style-type: none"> <li>Atmospheric Pollution Prevention Act Cap 65:03</li> </ul>	The Act was read to understand the laws governing the control or monitoring of air pollution by gases emitted at the Gamodubu Landfill
<ul style="list-style-type: none"> <li>Botswana's Strategy for Waste Management</li> </ul>	Instrument guiding the role of Botswana in terms of mitigating waste illegally disposed
<ul style="list-style-type: none"> <li>Botswana Clinical Waste Management Code of Practice</li> </ul>	How clinical Waste should be handled and disposed off
<ul style="list-style-type: none"> <li>Landfill Operational Manual and Environmental Plan , June 2009</li> </ul>	Guiding tool on the operation of management of landfill in general. document
<ul style="list-style-type: none"> <li>Guidelines for the Disposal of Waste by Landfill , 1997</li> </ul>	How waste should be disposed of in a landfill
<ul style="list-style-type: none"> <li>Sanitary Landfill Recycling Policy, 2010</li> </ul>	Recycling policy of different kinds of waste and how it was going to be instrumental in the operations of managing waste in the Gamodubu Landfill
<ul style="list-style-type: none"> <li>Kweneng District Strategic Plan</li> </ul>	To understand the Councils vision and what they aspire to achieve with respect to the management of the landfill
<ul style="list-style-type: none"> <li>Incinerator File</li> </ul>	All documents concerning incinerator such as letters indicating that they is need

	for service and guidelines of operating incinerator
• Weighbridge File	To understand the operations of the weighbridge and assess the extent to which waste is weighed and inspected before disposed in the landfill
• Gamodubu Landfill Correspondence File	To understand the citizens' complaints and feedback on the environmental impacts of the landfill
DWMPC Audit File	To understand how the DWMPC have been monitoring compliance to environmental standards by the landfill
Landfill Public Health Uncontrolled Document	Clearly outline the process of waste disposal from entering the gate until disposal at the landfill
Maintenance job cards and register	To review the time it takes to report a faulty machine and time it took to repair machines
Gamodubu Landfill Quarterly Reports	To appreciate issues discussed under all quarters which were prepared to inform the Council about the issues affecting the Gamodubu Landfill
Gamodubu Landfill Weekly Reports	To understand the weekly inspections on issues and challenges experienced at the landfill, on which the head of department was updated.
Gamodubu Landfill Technical Staff Reports	To review and understand the operations of the Landfill on a monthly basis.



## ANNEXURE 2

### INTERVIEWS

Chief Public Health Officer	To understand the overall view of the management of the landfill from a senior officers perspective.
Landfill Manager	The Landfill Manager is involved with the day to day operation of the landfill and reports to the Chief Public Health Officer. To get a full overview of the landfill operations and understand waste disposal and management.
Chief Environmental Health Technician	To understand the day to day operations of the landfill and any challenges encountered
Incinerator Operator	To understand the operations of the incineration of clinical waste, and the challenges they encounter in their day to day operation
Enumerator-weighbridge	To understand how they check and inspect waste to be disposed of by the landfill and also how they weigh the waste
Plant Operator	He was interviewed because he is the one responsible to check conditions of the machines, observe meter gauges, and maintain log books and reports faulty machines. To get an understanding of the conditions of the machines and their responsibilities and the challenges they encounter
Head of Transport, Mechanical Services	He was interviewed to understand the operations of the department and issues pertaining to the landfill machinery
Chief Technical Assistant-Civil and Mechanical Services	Interviewed to get an insight on the landfill machinery and the contributory factor to the frequent machinery breakdowns
Gamodubu Kgosi(chief),deputy chief and administration staff	They were interviewed to get an appreciation of the issues and challenges they are faced with as a village with regard to the landfill.

Village Development Committee Members	Members of the VDC were also interviewed on challenges they are faced with regarding the landfill
School Head and 2 Teachers	Interviewed on challenges they are faced with regarding the landfill
Village Nurse	Interviewed on challenges they are faced with regarding the landfill
Villagers	Interviewed on challenges they are faced with regarding the landfill
Litter pickers	They were interviewed to appreciate their roles and responsibilities in the landfill

## ANNEXURE 3

### DISPOSAL AND WASTE TREATMENT

#### DISPOSAL PROCESS

##### **a) Register vehicle**

The security guard registers the vehicle entering by the main gate on the Landfill security register (WM-WTD-FM-01) and proceeds to the weighbridge.

##### **b) Inspect the vehicle**

The Enumerator inspects the vehicle carrying waste, to check if it is an acceptable or unacceptable waste. If it is unacceptable waste it is rejected then registered in the Landfill waste rejection register (WM-WTD-FM-02). Moreover, if it is an open vehicle, the guard checks if the vehicle is covered with the quality of the cover material as per standards on Transportation of goods and waste material

##### **c) Weigh the vehicle carrying waste**

Vehicles carrying waste for disposal are required to pass through the weighbridge to be weighed before proceeding to dispose the waste. Therefore, the Enumerator weighs the vehicle and enters the following information into the computer: company name, vehicle number plate, type of waste and mass of vehicle with waste.

##### **d) Direct vehicle**

The Enumerator directs the vehicle to the appropriate offloading point. Therefore, if it is general waste the refuse collector (spotter) directs the vehicle to the working phase and if it is clinical waste the incinerator Operator directs the vehicle to the incinerator house.

### e) Offload waste

Refuse vehicle offload refuse as follows:

<b>IF</b>	<b>THEN OFFLOAD</b>
Domestic Waste	In the domestic waste cell
Tyres	At the tyre cell
Clinical Waste	The incinerator
Garden waste	The garden waste cell
Scrap Metal	The scrap metal cell
Condemned food stuffs	Core- dispose in the presence of officer and client if need be

### f) Inspect and weigh the vehicle

The Enumerator inspects the vehicle for any salvage material, if found carrying salvageable materials then return to the cell to the working face. Otherwise weighs the vehicle to determine the net mass. After the inspection for any salvage material the vehicle then exits the landfill.

## TREATMENT

### a) Treatment of waste

The following waste requires treatment before disposal as per the table below

<b>IF</b>	<b>THEN</b>
Clinical waste	Incinerate Operator Incinerate as per the work instruction on incineration of Clinical Waste (WM-WTD-WI-01)
Tyres	Public health Attendant I (machines) shred the garden waste as per work instruction on shredding of garden waste (WM-WTD-WI-02)
Garden waste	Public Health Attendant I (machines) shred the garden waste as per work instruction on shredding of garden waste (WM-WTD-WI-03)

**b) Salvage recyclable**

The EHO allows the salvages to collect recyclables as per the landfill salvaging guideline (WM-WTD-GL-01)

**c) Compaction and covering of waste**

At the end of each disposal operation, spreading and compaction of waste and application of cover material is carried out. Waste is covered on a daily basis at the end of each day's operation. Waste disposed is allowed to accumulate before it is spread, compacted and covered with soil. As a guide, when the waste disposed amounts to 50 truckloads, it shall be spread, compacted and covered with soil. The depth of compacted waste should not exceed 1 meter before it is covered and the minimum thickness of cover shall be 150mm of compacted soil

## ANNEXURE 4

### DIFFERENT TYPES OF WASTE

Controlled waste is defined as all waste which falls under the control of the Waste Management Act. It therefore consists of solid household, commercial and industrial wastes. Controlled wastes are subdivided into four categories according to the potential risk posed to the environment, on account of their potential to generate significant leachate and/or their inherent hazardous properties.<sup>50</sup>

#### **a. Inert waste (I)**

Although no waste is totally inert, Inert is the term used for wastes which contain negligible amounts (generally less than five percent) of bio-degradable organic components and which are neither Wet nor Hazardous. Inert waste include builders' rubble, excavation spoil, and material from desiling of drains.

#### **b. General waste (G)**

General waste is a generic term applied to all controlled waste that is not Inert, Wet or Hazardous. It may comprise garden, domestic, commercial and general dry industrial waste. This waste stream contain greater than five percent of readily bio-degradable wastes as well as small quantities of Hazardous substances dispersed within it, for example, batteries, insecticides, weed-killers and medical waste discarded on domestic and commercial premises. If excess water is permitted to enter the waste body, General wastes may generate leachate with an unacceptably high pollution potential. Dry General wastes may sometimes be disposed of on wet/hazardous waste sites in order to soak up moisture (practice of co-disposal).

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<sup>50</sup> Guidelines for the Disposal of the Waste By the Landfill,1997

### **c. Special waste (Sp)**

Special waste is defined as waste that requires special treatment and/or disposal because of its properties and/or quantities. Special waste is divided into Hazardous and Wet wastes.

### **Special Wet wastes (Sp: W)**

High moisture content General wastes have a particularly high leachate generation potential. For this reason, these wastes have been placed in a separate category and are termed wet wastes. Wet wastes must be disposed of on Special waste landfills, where special consideration has been given to a leachate management system. Such wastes would include:

**d.** Liquid wastes

**e.** Sludges such as heavy metal sludge and solutions (for example Cr<sup>6+</sup> from tanneries)

**f.** Certain high moisture content wastes such as some abattoir wastes  
It is often preferable not to mix these wastes, but to create specific mono disposal cells if there is sufficient need.

### **g. Special: Hazardous waste (Sp:H)**

Hazardous waste is waste (solid or liquid) which has the potential, even in low concentrations, to have a significant adverse effect on public health and/or the environment. This would be on account of its inherent chemical and physical characteristics, such as toxic, ignitable, corrosive, and carcinogenic or other properties. The following types of waste should be regarded as potentially hazardous:

Inorganic waste

- Acids and alkalis
- Cyanide waste

- Heavy metal sludges and solutions, such as Cr6+ from tanneries
- Waste containing appreciable proportions of fibrous asbestos

### **Oily waste**

- Halogenated and Non-halogenated solvents residues
- Phenolic and PCB waste
- Paint and resin waste
- Biocide and other organic chemical residues

### **Miscellaneous waste**

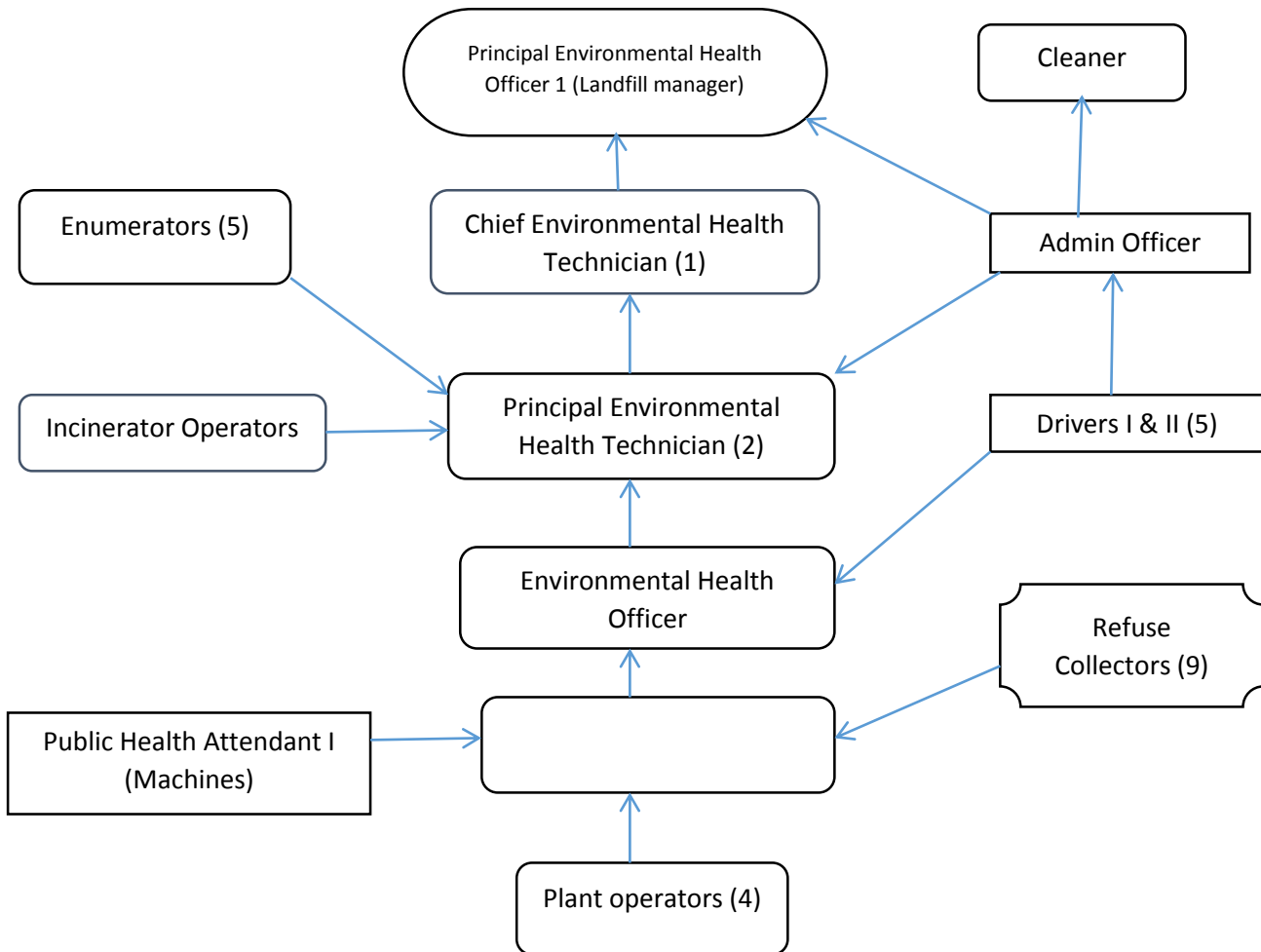
- Waste from the production of edible oils, slaughter houses, tanneries and other animal and vegetable based products
- Infectious waste such as diseased human/animal tissues, soiled bandages and syringes
- Redundant chemicals or medicines
- Explosive waste from manufacturing operations or redundant munitions



## ANNEXURE 5

### ORGANOGRAM - GAMODUBU REGIONAL LANDFILL

#### REPORTING STRUCTURE AT THE LANDFILL



## ANNEXURE 6

### KEY STAKEHOLDERS AND THEIR ROLES AND RESPONSIBILITIES

- **Department of Waste Management Pollution and Control**

The Department of Waste and Pollution Control (DWMPC) is mandated to construct and license all waste management facilities in the country to ensure compliance with Environmental Regulations, to prevent pollution and environmental effects.<sup>51</sup> The DWMPC conducts audit inspections once every year. The purpose of the audit inspections is to monitor the waste disposal and treatment operations.<sup>52</sup>

#### **Kweneng District Council**

The Kweneng District Council is an overall coordinator of the Gamodubu Landfill operations. The Council finances the landfill operations and is accountable for any challenges experienced at the landfill. It also receives reports from the Landfill Management for monitoring purposes and informed decisions.

- **Clients**

The landfill clients involve Government Departments, private companies, other Councils (Gaborone City Council and South East District Council) and the public at large who dispose of waste at the landfill.

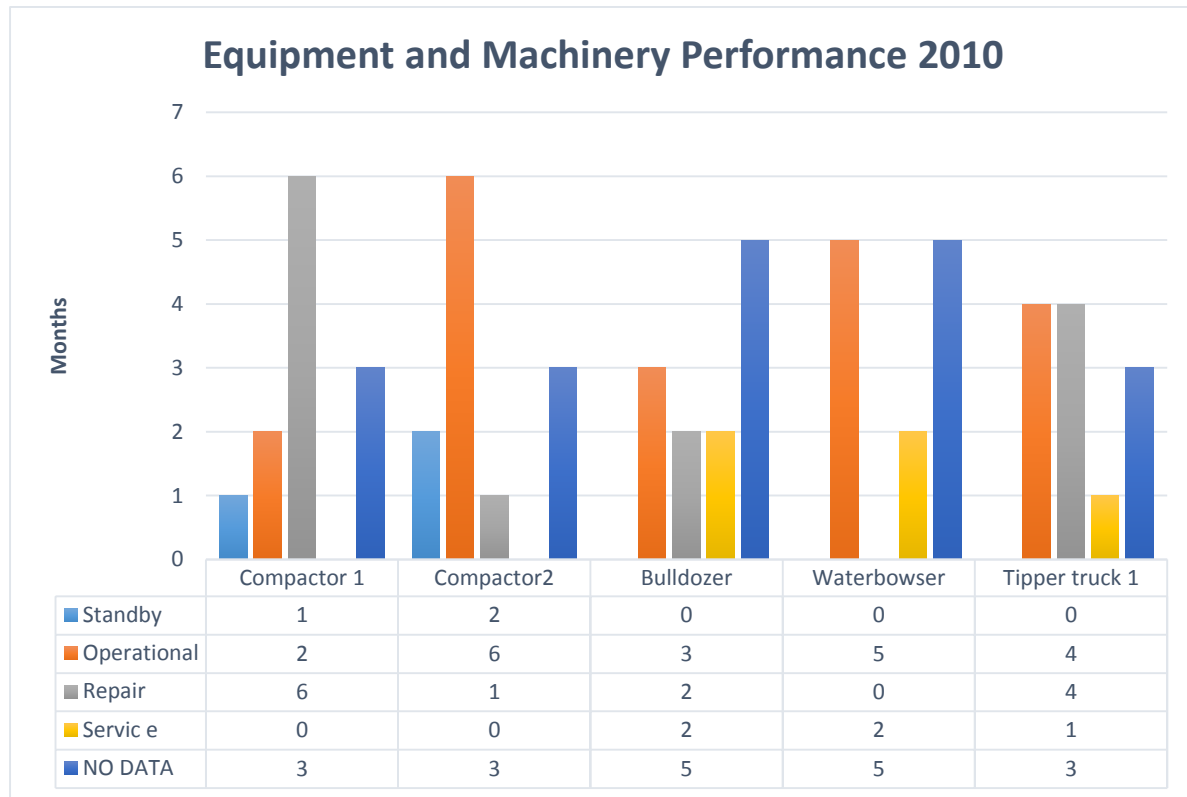
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<sup>51</sup> Waste Management Act, Cap 65:06, 2002

<sup>52</sup> Botswana Landfill Guidelines, 1997

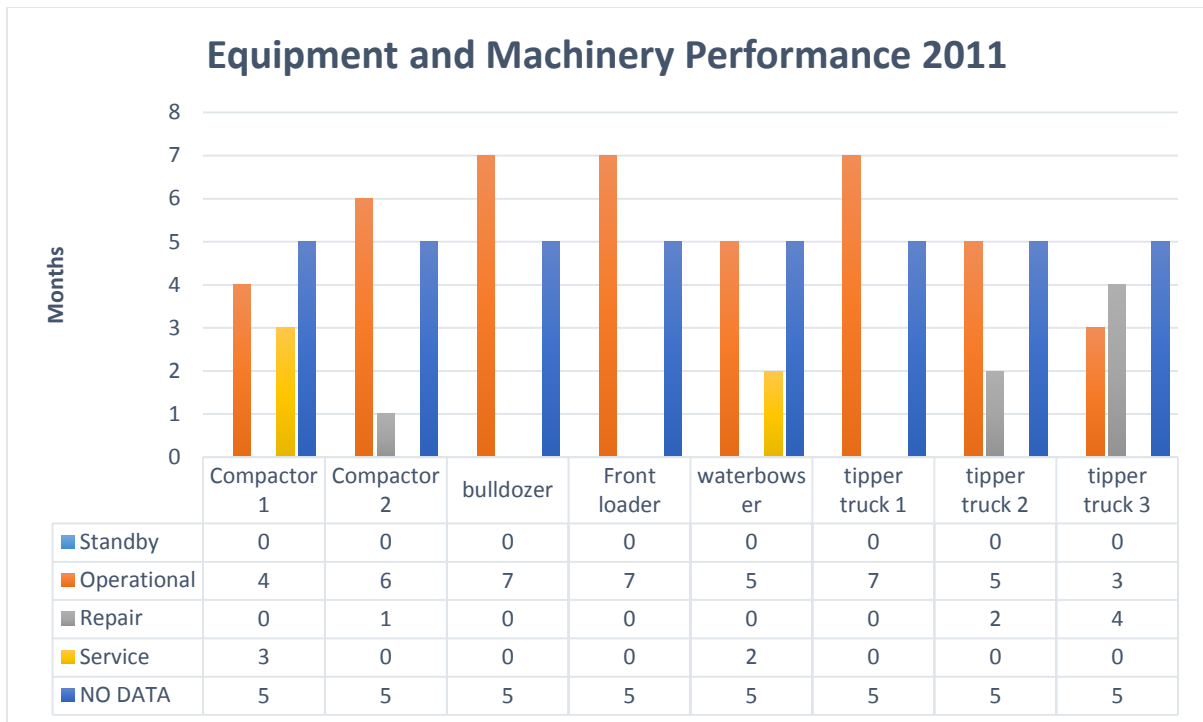
## ANNEXURE 7

### GAMODUBU LANDFILL EQUIPMENT AND MACHINERY PERFORMANCE



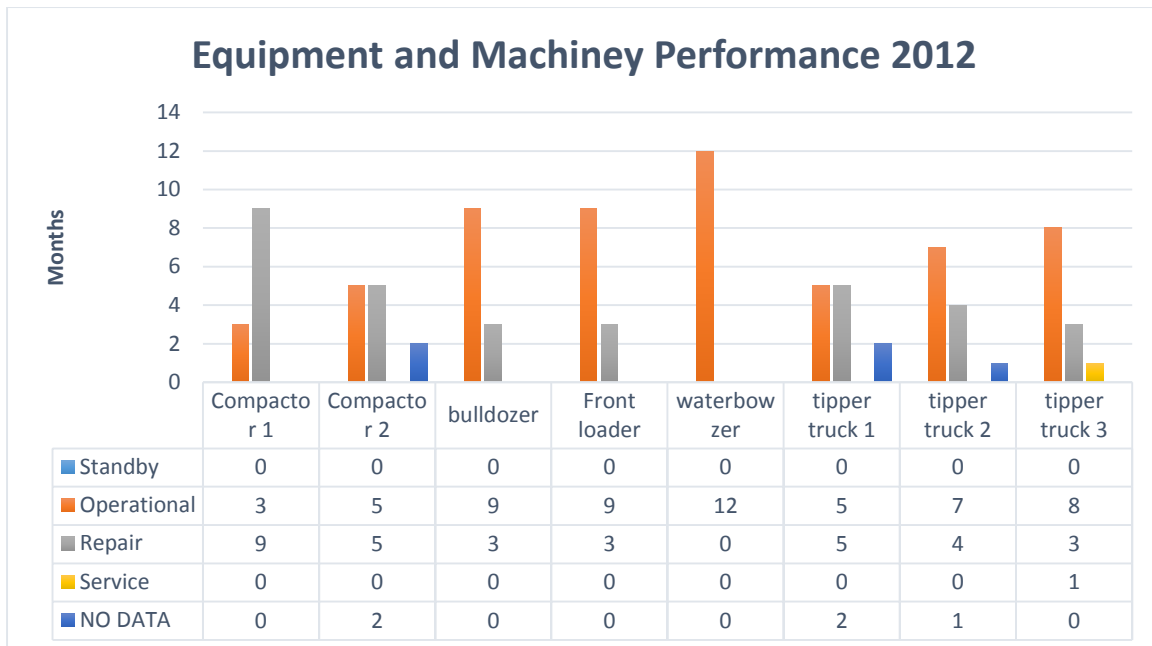
**Figure 1: Landfill Equipment and Machinery Performance, 2010**

The chart shows that for the year 2010, Compactor 2 operated for 6 months, while other equipment was operational for 5 months or less. The analysis also shows that Compactor 1 was under repair for six (6) months in the year under review, while other equipment were under repair for four (4) months or less. There was no data provided to the auditors on the status of the landfill equipment (Bulldozer and Waterbrowser) for five months and three months (Compactor 1, Compactor 2 and Tipper Truck 1) respectively.



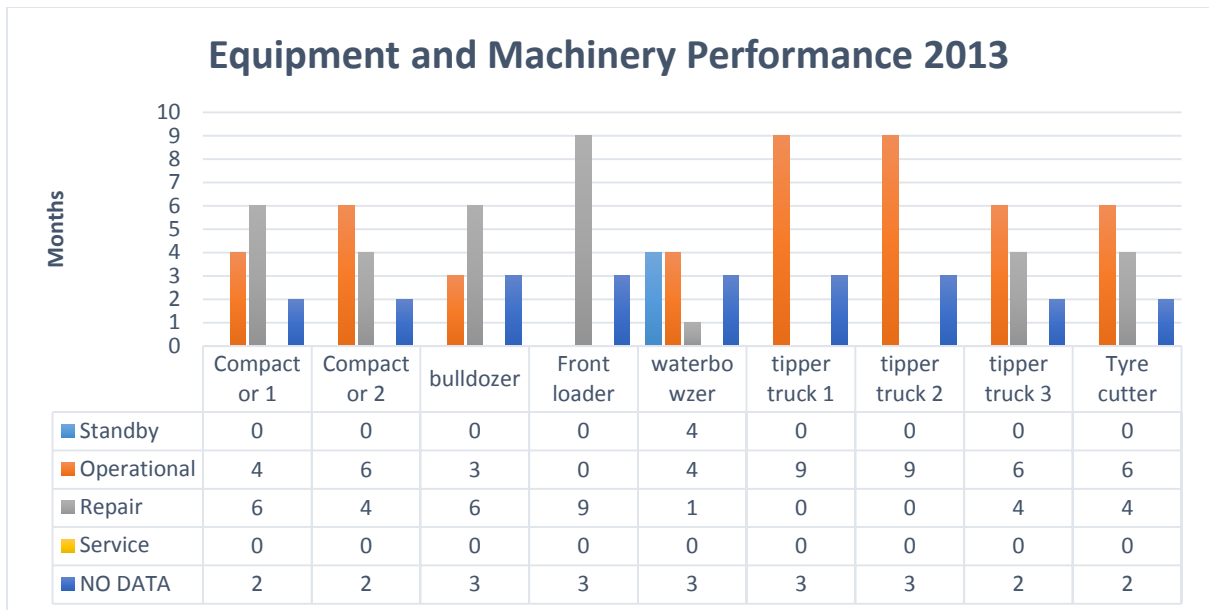
**Figure 2: Landfill Equipment and Machinery Performance 2011**

The chart shows that the landfill equipment was operational most of the time in the year 2011. However, this was with the exception of Tipper truck 3 and Compactor 1 which were operational for less than 40% of the time in a year. In addition, there was no data provided to the auditors on the status of the equipment for months starting from January to May 2011.



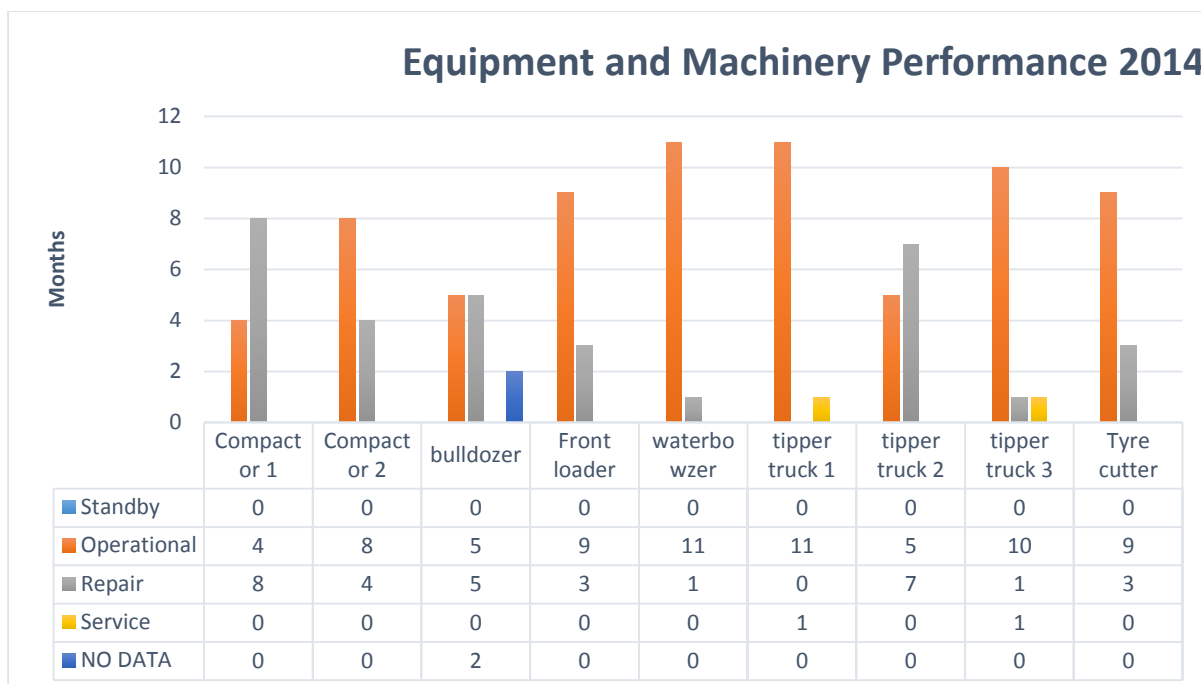
**Figure 3: Landfill Equipment and Machinery Performance 2012**

The analysis of the data shows that both compactors and tipper truck 1 were operational for less than six (6) months in the year under review. However, other landfill equipment such as bulldozer, front loader, waterbowser, tipper truck 2 and tipper truck 3 were operating for seven or more months. The chart also shows that compactor 1 spent most of the time (nine months) under repair while compactor 2 and tipper truck 1 were under repair for five months respectively.



**Figure 4: Landfill Equipment and Machinery Performance 2013**

The analysis of the chart depicts that compactor 2, tipper truck 1, tipper truck 2, tipper truck 3 and tyre cutter were operational for more than six (6) months in a year. However, compactor 1, bulldozer and water bowser were operating for less than 50% of the time. Moreover, compactor 1, bulldozer and front loader spent 50% or more of the time under repairs.



**Figure 5: Landfill Equipment and Machinery Performance 2014**

The chart shows that most of the landfill equipment were operational for eight months or more in the year 2014. However, this is with the exception of compactor 1 (four months), bulldozer (five months) and tipper truck 2 (five months). The chart also shows that compactor 1 and tipper truck 2 spent a considerable amount of time under repairs with compactor 1 having spent eight months and tipper truck 2 spending seven months. Other equipment which spent some time under repairs included ; compactor 2 (four months), bulldozer (5 months), front loader (three months), tyre cutter (three months) water bowser and tipper truck (one month) respectively.