



**Western Cape  
Government**  
Environmental Affairs and  
Development Planning

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# WASTE CHARACTERISATION GUIDELINE FOR MUNICIPALITIES



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## 1. INTRODUCTION AND BACKGROUND

### 1.1 Purpose and Background

This guideline is intended for municipalities (local, district and metro) who wish to conduct waste characterisation studies to determine the types and quantities of waste generated within their municipal areas. Waste characterisation studies form part of the Integrated Waste Management Planning (Status Quo Analysis). It provides decision-makers with real data of current and expected (future) solid waste generation trends in different demographic and socio-economic categories. It also provides valuable information for the planning of waste management systems and infrastructure to recover waste and minimise its disposal at waste disposal facilities.

In terms of section 11 (4) (a) (i) and (ii) of the National Environmental Management: Waste Act (Act No. 59 of 2008) (Waste Act), municipalities must submit Integrated Waste Management Plans (IWMPs) to the Member of the Executive Council (MEC) for endorsement, which must then be included in the municipal Integrated Development Plan (IDP). Section 12 (1) (a) (ii) of the Waste Act stipulates that IWMPs must contain a situation analysis with an assessment of the quantities and types of waste generated within a municipal area. Most municipalities within the Western Cape do not have waste quantifying systems or infrastructure in place to accurately measure waste disposed or diverted from Waste Disposal Facilities (WDFs). IWMPs are developed without accurate data on waste quantities and types generated within their municipal jurisdiction. The collection and analysis of accurate and reliable waste data is a key requirement to inform the development of IWMPs and assists municipalities:

- to establish baseline information from which short-, medium- and long-term integrated waste management targets can be set;
- with the design and implementation of more efficient and effective integrated waste management systems or technologies;
- ensure that waste is disposed of at the appropriate waste management facility;
- ensure that only leachable substances are accepted at the WDF in terms of their design, operation and overall management; and
- ensure that appropriate treatment options are applied.

The overall vision of the National Waste Management Strategy (2011) is to reduce the generation and environmental impacts of all forms of waste. The Constitution of South Africa (Act No. 108 of 1996) provides for provincial governments to support local municipalities in matters relating to waste management. In support of this provision, the Western Cape Government: Department of Environmental Affairs and Development Planning (DEA&DP) conducted waste characterisation surveys in 2007 at selected WDFs within the Western Cape Province. The aim of the surveys was to:

- stimulate job creation and skills transfer;
- improve the quantity of information on the various waste streams generated within municipalities;
- establish the potential monetary value of different waste streams and their recycling potential;
- determine the calorific value of the waste streams to establish their potential for energy recovery; and
- improve waste management planning at all spheres of government.

Subsequent to the WDF surveys conducted in 2007, the Department conducted waste characterisation studies focused on collecting and analysing data directly from the waste generator, from November 2012 to date (September 2016/ March 2017, Stellenbosch). The waste characterisation studies were initiated after the Department received a request from the National Department of Environmental Affairs' (DEA) Municipal Support section to assist the Central Karoo local municipalities (Beaufort West, Laingsburg and Prince Albert) with the review and development of their 2<sup>nd</sup> generation IWMPs. Waste characterisation studies were conducted in collaboration with the Stellenbosch Municipality. This provided necessary expertise to conduct the studies and provide training to other municipalities (Kannaland, Swellendam, Cederberg, Matzikama, Cape Agulhas (the town of Elim), Witzenberg, Langeberg, Breede Valley and Drakenstein). Furthermore, training was provided on waste characterisation to the Eden District Municipality, which initiated waste characterisation studies for its municipal area. The Department supervised one study for the Bitou Municipality and the District conducted the rest of the studies independently.

Municipalities need to be able to conduct waste characterisation studies without supervision from the Department during all seasons and periods that may affect the quantity, quality and composition of the waste generated within their respective municipal areas. The financial austerity measures implemented nationally and provincially make it impossible for the Department to continue to plan for and conduct waste characterisation studies for municipalities. This financial austerity measures also exist within municipalities. The latter motivated the Department to draft this guideline document to assist municipalities that wish to undertake waste characterisation studies. Waste characterisation studies can be undertaken to:

- obtain up-to-date information on the quantity of each waste stream generated and an estimation of possible waste diversion from waste disposal facilities;
- generate comprehensive information on the quantities and types of recyclables as well as recoverable material for prioritisation of recovery efforts;
- use the information in the development and review of municipal IWMPs;

- enable municipalities to use the information for future planning regarding the design and implementation of efficient and effective collection, waste minimisation (recovery, reuse, recycling) and transportation services and technologies for the various solid waste streams;
- test the effectiveness of public education programs; and
- estimate environmental impacts of diversion and solid waste systems.

Waste characterisation studies of this nature are cost-effective as the main costs include the procurement of the equipment required for the study as well as the labour costs, should a Municipality elect not to use municipal officials or workers. The scope for the waste characterisation studies described in this guideline focuses mainly on municipal solid waste (domestic waste) generated by households and businesses (residential and commercial waste). It includes household hazardous waste (batteries, used paints, some oils, etc.) but excludes hazardous waste from businesses or industry. The residential waste generated by households may contain some building rubble, organic waste (food and garden waste), recyclable (plastics, paper, glass, cans, etc.) and non-recyclable waste.

## 1.2 Overview of the Guideline

The waste characterisation study and design described in this guideline is based on the United Nations Environment Programme (UNEP) guidelines (2009) that aim to assist local governments in developing an Integrated Solid Waste Management (ISWM) System. The UNEP guidelines (2009) include one that is key for the development of ISWM plans as it focuses on the collection and analysis of data to create a baseline on waste characterisation and quantification with future projections. In the South African context, as previously indicated, municipalities are legally required to draft IWMPs, which must have information on the current trends of waste generation. Municipalities in the Western Cape Province have developed second (2<sup>nd</sup>) generation IWMPs with some in the process of finalising third (3<sup>rd</sup>) generation IWMPs. This guideline document covers the waste characterisation approach used by the DEA&DP's Waste Management Planning Sub-directorate as represented in **Figure 1** below.



**Figure 1:** Flow diagram of the waste characterisation approach used for the guideline

The approach involves the kerbside collection of waste samples from residential and commercial waste generators. The next step is the transportation of the samples to a secure venue (for hand-

sorting into various waste types) instead of disposal at a Waste Disposal Facility (WDF). The waste characterisation approach incorporates the following:

**Planning phase (Study Design):** which involves the sourcing of required resources (a suitable venue, workers, etc.) and the procurement of equipment and/or material required for the study. In this phase, a sampling plan is drawn up using municipal zoning maps and an appropriate as well as representative sample size is determined. The sampling programme that follows is also designed around the weekly municipal waste collection program.

**Sampling phase (Sample Collection):** involves the collection of the waste samples (refuse bags from households (waste generators) to a secured venue. Municipalities generally use black refuse bags for non-recyclables and blue or clear refuse bags for recyclables.

**Data Collection phase (Collecting Data):** The waste samples are hand-sorted into various pre-selected waste types, placed in containers for weighing and volume estimation, and recorded on a data-capturing sheet.

**Assessment phase (Data Analysis):** this phase involves the electronic capturing of the recorded data, which may be input into a Microsoft Excel spreadsheet for analysis. Analyse the data per area or town to determine –

- the total mass per waste stream for each area;
- the total mass generated for each area;
- the total mass generated per waste type for the municipal area (total waste sampled for the municipal area); and
- convert the volume estimates (percentages) to litres to determine how much space each waste type occupies of the 20L container, which can then be converted to cubic metres.

**Reporting Phase (Report):** involves the interpretation and presentation of the data in terms of the National Waste Information Regulations, promulgated in August 2012. Use pie charts to show the percentage contribution of waste generated per area as well as the percentage contribution of each waste stream. Also, look at the data for the waste stream generated the most and least; as well as the area that generates the most and the least waste.

## 2. WASTE CHARACTERISATION STUDY DESIGN AND METHOD

### 2.1 Waste Characterisation Study Approach

The waste characterisation approach involves the kerbside collection of samples (refuse bags or waste from wheelie bins transferred into refuse bags) from residential and commercial waste

generators and the transportation of the refuse bags to a secure venue. The sampling must be done randomly using the municipality's standard waste collection programme/ route. The refuse bags are weighed to determine total mass (kg) before separation (hand-sorting) of the waste into the various types pre-selected by the municipality. The various waste types are then placed in different containers, weighed and the percentage volume that each stream occupies within a container is estimated and recorded for analysis.

The mass recorded during the hand-sorting of waste into the various types includes the natural moisture content of the disposed materials. Moisture correction, which is achieved by drying a sample of the wet materials to determine the dry weight and then adding back the weight of the moisture that is expected to be found in waste in an "as-disposed" condition (SENES Consultants Limited, 1999), for cross-contamination of waste with waste liquids or rainwater is not considered in this waste characterisation approach. Liquids or residuals may be left in the containers but these are considered as a limitation in the characterisation process, as it would be impractical to remove liquid content before weighing.

The municipality needs to organise, plan and obtain critical information before conducting a waste characterisation study. Ideally about three (3) to four (4) municipal officials are needed to ensure all logistical arrangements are in place for the study. These officials must collect information regarding residential (number of households) and business areas that will be sampled and collect, transport as well as store the waste samples (refuse bags). The number of municipal officials or the Expanded Public Work Programme (EPWP) / Youth in Waste (YIW) workers required for the study depends on the number of teams needed for hand-sorting of the waste samples, which in-turn depends on the number of samples that will be collected.

## **2.1.1 Planning Phase: Data Sampling and Procurement**

### **2.1.1.1 Data Sampling:**

#### **Selecting a representative sample:**

Sampling is necessary when a study of an entire population would be too expensive or physically impossible to conduct and determines when, where and how data will be collected. Some questions that can be considered in order to determine whether a study design will produce representative data include:

- Are there segments of the waste stream that will not be encountered during the planned data collection activities? If so, what is the likelihood that those segments are significantly different (in either quantity or composition) from the segments for which data is being collected? The study should not "ignore" segments of the waste stream during data collection if it is going to represent those segments in its conclusions.

- Is one segment of the waste stream overrepresented during data collection activities compared to another segment? If so, is it possible to modify the data collection approach to avoid this overrepresentation? (Even if it is not possible to modify the data collection approach, there may be ways to correct for a biased data collection approach later during analysis of the data.)

The number of samples to be collected depends on the level of accuracy desired for the results of the waste characterisation study. An appropriate sample size depends on the total number of households within a municipal area, the larger the sample size the greater the confidence in the results of the waste characterisation study. There is however a point of diminishing returns with respect to the additional accuracy obtained with each additional sample. – Waste Characterisation Guideline – WDC, prepared by Cascadia Consulting Group, Inc. June 2003. Smaller samples would produce less accurate results as they are likely to be less representative of the total population (UNEP Guideline, 2009). The UNEP guideline indicates that the confidence level for solid waste data is typically set at 80 to 90%. Generally, municipalities will have a record of the total number of households within their municipal areas. However, if an updated households survey has not been conducted then municipalities need to determine the total number of households as well as the number of households per income group within the municipal area in order to estimate an appropriate sample size as shown in the examples below:

- The sample size is estimated using **Figures 2, 3 & 4**, which show examples for -
  - areas with less than 4 000 households;
  - areas with greater than 4000 but less than 26000 households; and
  - areas with more than 25000 households, respectively.
- **Figure 2** is an example of an area with a total number of 800 households and an estimated sample size of 80 households. Furthermore, the calculations in **Table 1** below provide a breakdown of the samples that may be collected from the various income groups when the number of households per income group is known (200, 350 and 250 for the low-, middle- and high-income respectively). This is used to determine the number of refuse bags that must be collected from each income group.

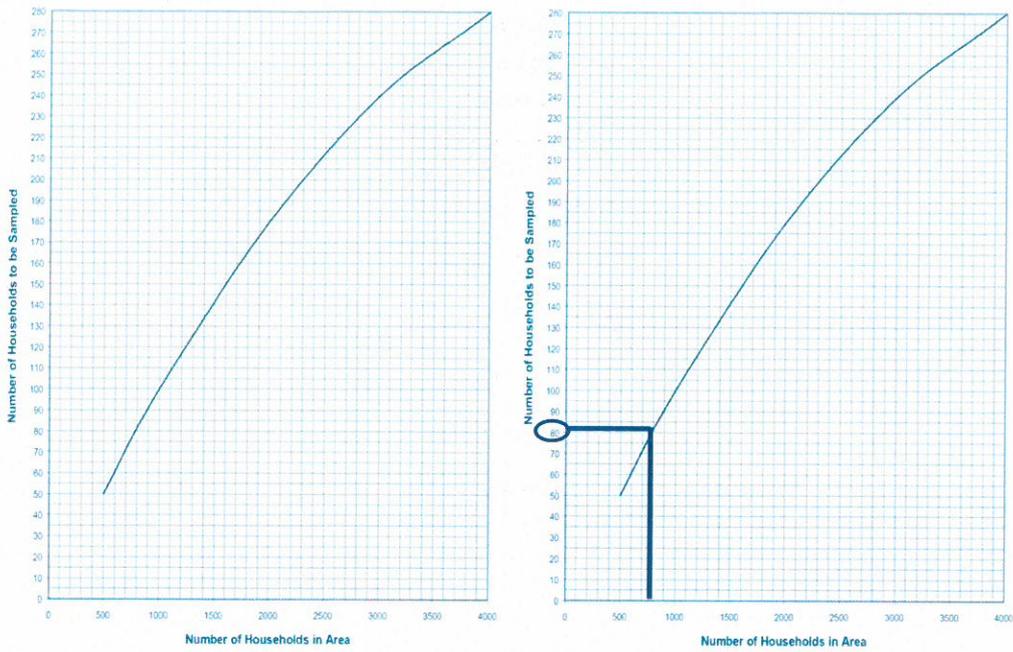
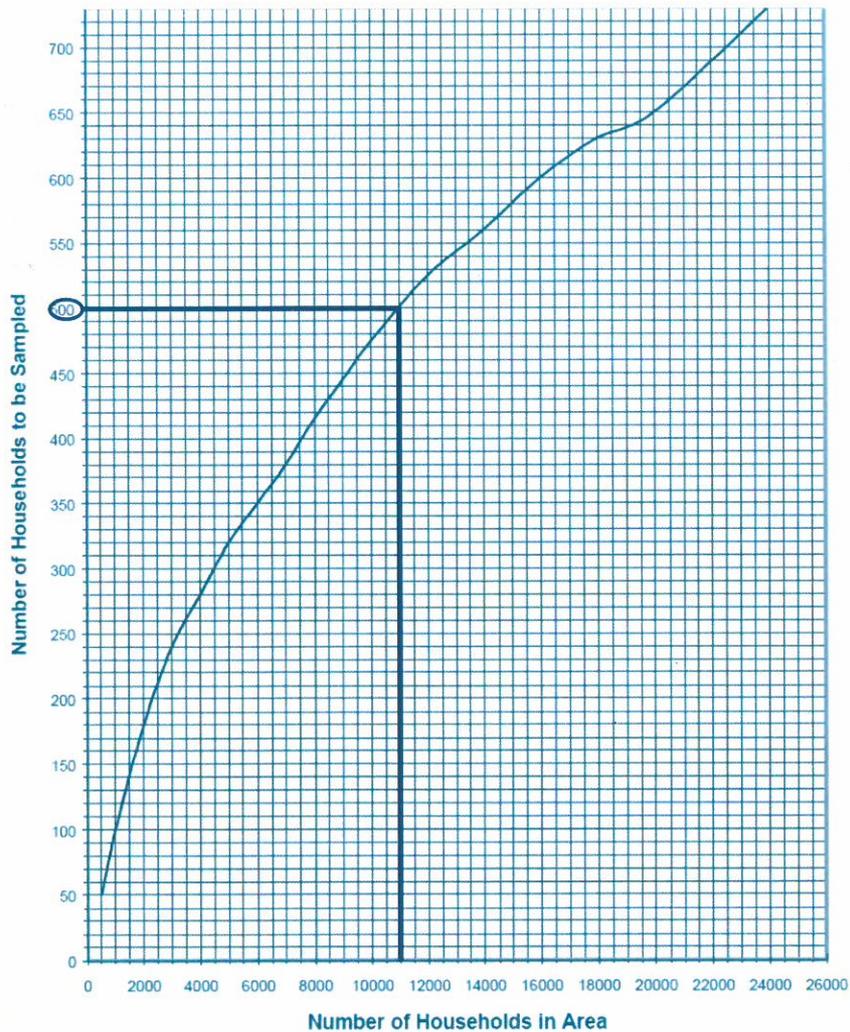


Figure 2: Estimating sample size for areas with households less than 4000 (EPA-Ireland, 1996)

Table 1: Calculations for the samples that may be collected from the various income groups		
Low income	Middle income	High income
200 households	350 households	250 households
Calculation: $200/800 = 25\%$	Calculation: $350/800 = 44\%$	Calculation: $250/800 = 31\%$
Sample: 25% of 80 = <b>20 bags</b>	Sample: 44% of 80 = <b>35 bags</b>	Sample: 31% of 80 = <b>25 bags</b>
<b>800</b> Households in total and 80 households must be sampled (see Figure 1 above)		



**Figure 3:** Estimating sample size for areas with households above 4000 but less than 26000 (EPA-Ireland, 1996)

- Figure 3** above is an example of an area with a total number of 11000 households and an estimated sample size of 500 households. However, in this example unlike the one in **Figure 2**, the number of households per income group is unknown and therefore the number of bags to be collected from each income group must be determined. The Cape Agulhas Municipality has 11 110 households as at 2015, which is similar to the number of households in the example used in **Figure 3** above (IDP Review, 2016/ 2017). Income level percentages obtained from the Provincial Treasury Department (2016) for the Cape Agulhas Municipality can be used to determine the number of refuse bags that must be sampled from each income group (**Table 2**).

**Table 2: Shows the waste to be sampled per income group**

Income group	Percentage households (%)	Households (Total)	Households (Sampled)
Low income (No income – R50 613)	49.1	5 455	246
Middle income (R50 614 - R404 901)	44.5	4 944	222
High income (R404 902 - R3 239 207 or more)	6.4	711	32
<b>Total</b>	<b>100</b>	<b>11 110</b>	<b>500</b>

Income levels obtained from the WCG: Provincial Treasury Department (Pers. Comm. 2016)

- According to the EPA-Ireland (1996), an estimate mass of the total sample that can be collected during a survey can be determined. The minimum number of households that can be sampled for a survey is 50, which translates to an approximate sample of 1 tonne (1 000 kg) in mass, assuming a waste generation rate of 20 kg /household/ week (Table 3, EPA-Ireland, 1996). Using this assumed waste generation rate (20 kg /household/ week) for a sample size of 500 households in an area of 11000 households in total, then the estimated mass of the sample is 10 tonnes (Table 3).

**Table 3: Waste sample mass at an assumed waste generation rate of 20 kg/household/week**

Households (Total)	Households (Sampled)	Estimated mass
500	50	1 tonne/ 1000kg
11000	500	10 tonnes/ 10000kg

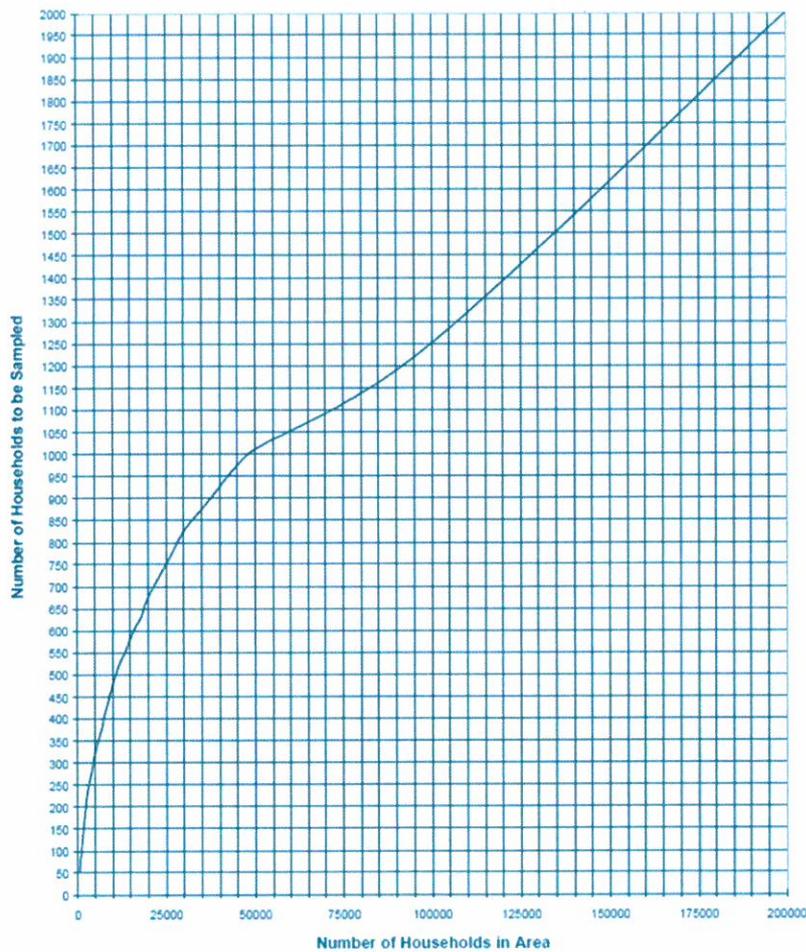
- Table 4 below shows the waste generation rates in kg/person/week (converted from kg/person/day) for the South African context (State of the Environment Report (SOER), 2006). This must be converted into a waste generation rate per household, which is determined using an average household size of four (4) (WCG: Human Settlement Department, Personal Communication, 2016).

**Table 4: Estimated waste sample mass per income group**

	Waste generation rate (kg/person/week)	Waste generation rate (kg/HH/week)	Households (Sampled)	Estimated mass
Low income group	2.87	11.48	246	2.82 tonnes/ 2824kg
Middle income group	5.18	20.72	222	4.61 tonnes/ 4600kg
High income group	9.03	36.12	32	1.16 tonnes/ 1156kg

1) StatsSA (2010/2011) <http://www.statssa.gov.za/publications/P0100/P01002011.pdf> (Average Household Size)

- The estimate mass of the waste sample is then calculated using the sampled households from **Table 2** (Cape Agulhas Municipality example) and the household waste generation rate for each income group (**Table 4**). This estimated mass can be compared to the actual mass, once a characterisation study is conducted for the Cape Agulhas Municipality.
- Examples similar to the above-mentioned one (**Figure 3**) can be done for households greater than 25000 using **Figure 4** below to determine the total sample size.



**Figure 4:** Estimating sample size (for areas with households above 25000, EPA-Ireland, 1996)

**Sample collection:**

The sampling must be spread across the municipality and concentrated in towns and residential areas with the highest number of households. A sampling plan (**Table 5**) must be drawn up using information obtained from municipal zoning maps (**Figure 5**) and waste collection programmes:

- ensure the sample is representative of all waste generators in the low-, middle- and high-income groups (Figure 5);
- select households and businesses at random from the municipal zoning maps so the refuse bags can be spread over the towns and residential areas, which may be mapped on the municipal zoning maps; and



Figure 5: Municipal zoning map for selection of representative samples from the various income groups

Table 5: Depicts the random sampling of refuse bags within a residential area							
No.	Street name	House/ Business No.	Description (House/ Business)	Total number to be collected in street	Number of bags collected from each house	Total number of bags collected	Number of bags remaining and to be collected
1	Douche Street	1	House	20	1	1	19
2	Douche Street	4	House	20	1	2	18
3	Douche Street	7	House	20	1	3	17
4	Douche Street	10	House	20	1	4	16
5	Douche Street	13	House	20	1	5	15
6	Douche Street	16	House	20	1	6	14
7	Douche Street	19	House	20	1	7	13
8	Douche Street	22	House	20	1	8	12
9	Douche Street	25	House	20	1	9	11
10	Douche Street	28	House	20	1	10	10

- in areas with wheelie bins, the waste must be transferred (without compacting i.e. the waste must not be collected by a compaction vehicle) into refuse bags and labelled appropriately (**Figure 6**).



**Figure 6:** Proper labelling for refuse bags

#### **Human Resources:**

The number of municipal officials or EPWP workers required for a waste characterisation study will depend on the number groups or teams the Municipality decides to have for the hand-sorting of waste as well as the number of waste categories or types the waste will be divided into:



**Figure 7: Training of EPWP workers**

- identify the number of municipal officials or the Expanded Public Works Programme (EPWP) workers that will be required for hand-sorting of the waste. They need to be trained to (**Figure 7** above):
  - identify and understand the definitions of the waste material;
  - hand-sort (physically separate) the waste into the different types;





**Figure 8:** Enclosed venue

- the storage area for the sampled bags (collected sample) must be secured or fenced to prevent access to by animals or unauthorised personnel; and
- a separate eating area must be provided.

#### **Waste Categories:**

The waste types have been categorised into groups of items that are relatively easy to recognise (to facilitate accurate sorting) and to the extent possible; the number of categories has been minimised to reduce the level of possible error and cost involved in conducting the study. The stakeholder consultation program undertaken indicated that a flexible methodology, which is capable of addressing the local study objectives, is required. The methodology therefore allows for the combination and splitting of the standard material categories as found necessary.

- Identify the different types the waste will be sorted or categorised into (see **Appendix A and B**). The list and definitions of materials that are examined in a waste characterisation must be guided by the information needs of the study. The list of materials can be based on recycling needs within a municipal area, e.g. soft plastics or plastic film, hard plastics or plastic bottles, paper, cardboard, glass, metals, organics (e.g. food and greens/ garden waste), composite packaging (e.g. tetrapak), household hazardous waste (e.g. pesticides, herbicides, corrosives, flammable liquids, aerosols), e-waste (e.g. old computers, electrical appliances, batteries, bulbs) medical waste (e.g. needles, used and expired medicine, tablets), human hygiene waste (e.g. used nappies, sanitary towels, condoms) and other (e.g. wrappers for candy, chips packaging, foil, cling wrap, animal faeces, sand, stone, ash, fabric/ textiles); and
- Visual aids or posters of the various waste material (**Appendix B**) can be posted on a wall at the venue to assist workers with separating waste into the appropriate categories.

### 2.1.1.2 Procurement of Material

Municipalities must ensure that the correct specifications are used when procuring the necessary equipment.

- Portable and mobile floor, platform as well as table top scales may be used, which must be calibrated and of a suitable range that accommodates weights between zero (0) and a reasonable maximum weight between fifty (50) and one hundred (100) kilograms (kg) for the purposes of this kind of waste characterisation study (for e.g. see **Figure 9** below). Scales with a greater weight range for e.g. 500 - 1000kg, may not accurately read values less than 1kg. The surface area of the scale needs to accommodate the size of the container that will be used to weigh the waste types.
- The venue must have electricity and plug points or extension cords must be used to charge the scales. Cubicles made of plywood can be constructed to minimise wind interferences.



**Figure 9:** Portable platform scale

- Plastic containers for sorting of the waste into the identified types. The DEA&DP uses 20L basins (**Figure 10**), however the municipalities may use different containers as long as the volumes are known to enable easy estimation of waste volume. The number of containers to be procured will depend on the number of identified waste types as well as the number of teams or workers identified for the characterisation study as each sorting team needs to use their own containers.



**Figure 10:** 20L basins/ plastic containers

- Appropriate Personal Protective Equipment (PPE) (gloves, masks, safety aprons and safety or closed "hard" shoes) must be procured and the PPE requirements must be understood.
- Municipalities need to ensure that the EPWP workers receive vaccinations for hepatitis A, hepatitis B and tetanus as they will be exposed to numerous hazards during the study (waste municipal officials will have received vaccinations). A risk assessment can be done to determine vaccination requirements.
- Nitrile gloves (**Figure 11**) offer resistance to many chemicals and are generally safe for people who are allergic to latex. It is best to order the thicker gloves as these may be reused but need to be cleaned after each use. Flexibility of the gloves must also be considered.



**Figure 11:** Nitrile gloves

- Tables/ trestles that are 3 metres in length and 1.5 metres in width and Damp Proof Course (DPC) material to cover and protect the tables/ trestles (**Figure 12**). The number of tables will depend on the number of teams/ groups that can be formed.



**Figure 12: Tables/ trestles**

- Additional refuse bags for disposal of waste after sorting and quantifying.
- A recycler can be brought on board to collect the separated recyclables.
- An effective insecticide to ensure the venue is kept clean of cockroaches, weevils and other pests.
- Antimicrobial hand wash, hand towels and dishwashing liquid to wash the basins, tables and floors after daily use.

### 2.1.2 Sampling Phase: Sample Collection

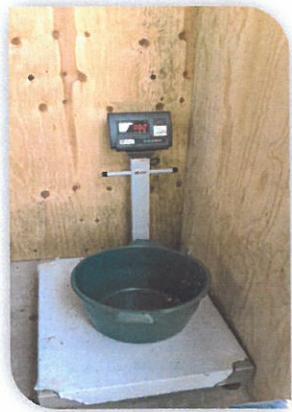
Sampling phase: this phase involves the collection of the waste samples (refuse bags) from households (waste generators) to the secured venue.

#### ● Sample collection -

- Use the Municipality's standard waste collection programme (i.e. the waste must be collected on the day that the municipality would normally collect it).
- Collect waste bags but instead of disposal at a landfill, the waste is transported to a central location or the identified and appropriate venue where the categorisation will take place. It is important to label all bags with the town, address and bag number (if a household has three bags then these should be identified as bag 1 – 3 i.e. bag 1 of 3, bag 2 of 3 and bag 3 of 3). If only one bag needs to be collected from each household

then one of the three bags must be selected randomly, however the total number of bags per household must be recorded for data analysis purposes;

- Municipal towns with a wheelie bin system need to transfer the waste into refuse bags, which must be labelled as indicated above without compacting; and
- The collected waste sample (bags) is then transported to the storage area of the identified venue where the basins, tables and scales (fully charged and tared with an empty container/ basin as shown in **Figure 13** below) are set up.



**Figure 13:** Scale tared/ zeroed using an empty container

## 2.2 Waste Characterisation Study Method

### 2.2.1 Data Collection Phase: Collecting Data

Data collection phase: in this phase the waste samples are hand-sorted into various pre-selected waste types, placed in containers for weighing and volume estimation, and recorded on a data-capturing sheet.

#### ● Data collection -

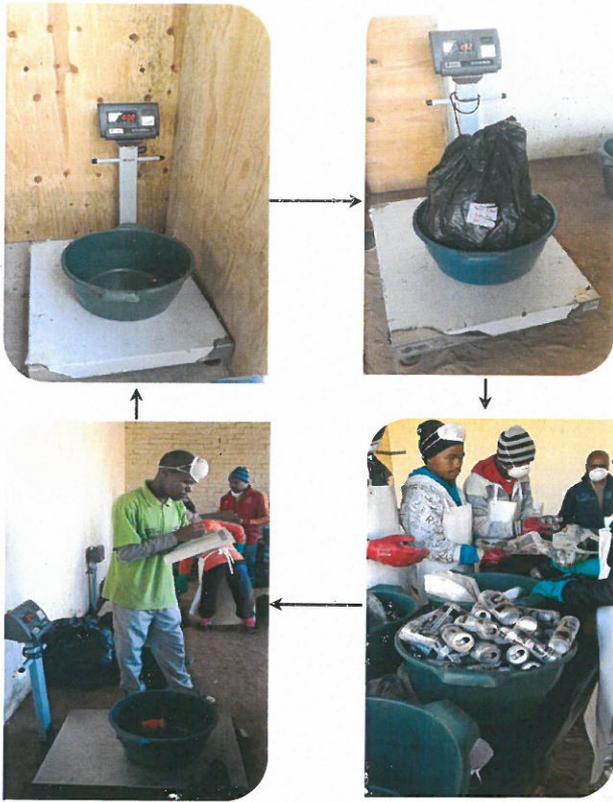
- As indicated before, the number of municipal officials or EPWP workers required for a waste characterisation study will depend on the number groups or teams the Municipality decides to have for the hand-sorting of waste as well as the number of waste categories or types the waste will be divided into;
- Identify the number of municipal officials or the Expanded Public Works Programme (EPWP) workers that will be required for hand-sorting of the waste, which need to be trained to:

- identify and understand the definitions of the waste material
  - hand-sort (physically separate) the waste into the different types;
  - use the scales (how-to tare or zero the scale with the basins and weigh the samples);
  - estimate the volume occupied by the waste in the basin;
  - record the data or sample values/ information on a data capturing sheet; and
  - capture and analyse the data on an Excel spreadsheet.
- If for example 20 EPWP workers or municipal officials are used then they can be separated into four (4) groups each with 4 people and a supervisor per table. Each group must be divided into two (2) sub-groups such that 2 people will make up a team that will work on one (1) refuse bag (**Figure 14**). Each group must be allocated a scale and one person to supervise and record data on a capturing sheet. The size of the venue will determine the table layout. Please see **Appendix C** for the table layout.
  - Each group must collect 2 refuse bags from the storage area so that each team or sub-group (2 people) will sort one.
  - The supervisor must record the label (town, address with street name and house number as well as the bag number) of each bag.
  - Each team must then weigh the bag on the scale (after it has been tared/ zeroed) to record the total mass/ weight before opening and hand-sorting.
  - The bag is weighed before hand-sorting to quantify mass losses during sorting and mass losses can be calculated when the data is verified during capturing on a Microsoft Excel spreadsheet as the difference in net mass of waste before and after the sorting process. Also any errors due to contamination during the sorting process i.e. the migration of moisture from food waste to other components such as paper, cardboard, plastic, etc. was also not calculated).
  - The team can then open the bag, hand-sort and place the waste according to the identified types into the designated basins as shown below in **Figure 15**.

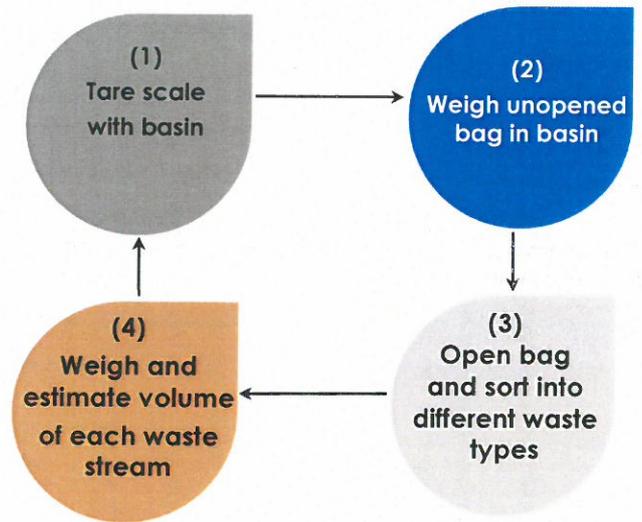


**Figure 15:** Hand-sorting of waste into various types

- Once all the waste in the bag has been placed into the designated (per identified waste stream) basins then:
  - each basin must be weighed and the mass per stream/ category recorded by the group supervisor;
  - the volume of waste in each basin must be estimated and the percentage of space occupied per stream/ category must be recorded by the group supervisor;
  - the full capacity of the basin is 100%, it makes it easier for the workers or officials to estimate the volume waste materials occupy within the basin if a 25%, 50% and 75% mark is drawn on the inside of the basin with a permanent marker. If available, a second basin may be used for each stream/ category should waste be above the basins full capacity level and
  - since volume is estimated, it will be subject to error and it should be noted that the waste is not compacted during this or any other step of the characterisation study.
- the above-mentioned steps must be done for the selected sample size and each team needs to ensure that the basins and the scale are clear of any waste before proceeding to hand-sort the next refuse bag of waste (**Figure 16**).



**Figure 16:** Waste Characterisation Study Methodology



## 2.2.2 Assessment Phase: Data Analysis

For data analysis, the important considerations would be to produce representative results with high confidence levels.

● **Assessment phase:** this phase involves the electronic capturing of the recorded data for analysis. The results for the study are calculated and reported in terms of percent composition for each waste type per area. Percent compositions allow for the determination of the majority or minority waste type generated within a municipal area, information that can be used to plan for recovery measures. Therefore, the data is analysed per area or town to determine the total mass per waste type for each area, the total mass generated for each area and the total mass generated per waste stream for the municipal area (total sampled area) -

- once the field work is completed, then the data needs to be captured electronically on a Microsoft Excel spreadsheet, which must be filed properly for record purposes (to compare with other studies conducted during a different season). **Table 7** below shows a spreadsheet with actual data (for one town/ area) captured during a waste characterisation study that was conducted for the Matzikama Municipality in October 2014.

**Table 7: Microsoft Excel Spreadsheet with actual data for the Matzikama Municipality studies**

Data Capturer: Xoliswa Nazama		Collected: 23 October 2014																																	
Area: 1		Sorted: 23 October 2014												Nappies/ Sanitary/ Condors												Glass		Fabric		Other(batteries, globes etc)		Total			
Bag no.	Address of origin	unopened mass (kg)	Plastic Film		Dense Plastics		Paper		Cardboard		Metal		Organics		Nappies/ Sanitary/ Condors		Fabric		Glass		Other(batteries, globes etc)		Total Mass (Kg)	Total Vol (m³)											
			Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)	Mass (Kg)	Vol (m³)													
1	Black	2	0	75	0.015	0	60	0.012	0	30	0.006	0	45	0.009	0	5	0.001	1	30	0.006	0	0	0.000	0	0	0.000	0	0	0.000	0	25	0.005	2	275	0.06
2	Black	5	1	95	0.019	1	90	0.018	1	95	0.019	0	40	0.008	0	20	0.004	2	70	0.014	0	0	0.000	0	10	0.002	0	0	0.000	1	45	0.009	5	465	0.07
3	Black	4	0	70	0.014	0	70	0.014	1	95	0.019	0	0	0.000	0	10	0.002	2	70	0.014	0	0	0.000	0	0	0.000	1	25	0.005	0	0	0.000	4	340	0.07
4	Black	2	2	250	0.050	0	5	0.001	0	80	0.016	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	2	335	0.07
5	Black	6	0	95	0.019	1	95	0.019	0	30	0.010	0	60	0.012	0	25	0.005	2	40	0.008	2	50	0.010	0	15	0.003	0	5	0.001	0	20	0.004	6	465	0.07
6	Black	5	0	80	0.016	0	85	0.017	0	65	0.013	0	70	0.014	0	30	0.006	3	60	0.012	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	5	390	0.08
7	Black	7	0	65	0.013	0	65	0.013	0	5	0.001	0	10	0.002	0	20	0.004	7	80	0.016	0	0	0.000	0	10	0.002	0	0	0.000	0	0	0.000	7	245	0.05
8	Black	5	0	85	0.017	1	130	0.026	0	30	0.006	0	10	0.002	0	45	0.009	3	70	0.014	0	0	0.000	0	10	0.002	0	0	0.000	0	0	0.000	5	380	0.08
9	Black	4	1	105	0.021	1	105	0.021	0	40	0.008	0	0	0.000	0	10	0.002	3	85	0.017	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	4	345	0.07
10	Black	3	0	110	0.022	0	45	0.009	0	90	0.018	0	35	0.007	0	10	0.002	15	0.003	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	3	350	0.07	
11	Black	3	0	60	0.012	0	40	0.008	0	20	0.004	0	60	0.012	0	0	0.000	1	45	0.009	0	0	0.000	0	0	0.000	1	35	0.007	0	0	0.000	3	240	0.05
12	Black	4	0	110	0.022	1	130	0.026	0	15	0.003	0	85	0.017	0	10	0.002	2	75	0.015	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	4	425	0.09
13	Black	10	1	110	0.022	0	60	0.012	3	105	0.021	0	25	0.005	0	15	0.003	3	70	0.014	0	0	0.000	0	0	0.000	1	25	0.005	0	0	0.000	10	410	0.08
<b>Totals</b>		<b>40</b>	<b>6</b>	<b>1310</b>	<b>0.26</b>	<b>6</b>	<b>980</b>	<b>0.20</b>	<b>7</b>	<b>720</b>	<b>0.14</b>	<b>2</b>	<b>440</b>	<b>0.09</b>	<b>1</b>	<b>200</b>	<b>0.04</b>	<b>28</b>	<b>710</b>	<b>0.14</b>	<b>2</b>	<b>50</b>	<b>0.01</b>	<b>0</b>	<b>35</b>	<b>0.01</b>	<b>5</b>	<b>140</b>	<b>0.03</b>	<b>1</b>	<b>90</b>	<b>0.02</b>	<b>60</b>	<b>4475</b>	<b>0.9</b>

- the data needs to be captured per area as it was recorded in the field and the total mass per waste type must be determined for each area.
- the total mass generated for each area must be determined (Figure 17 & Table 8 below).

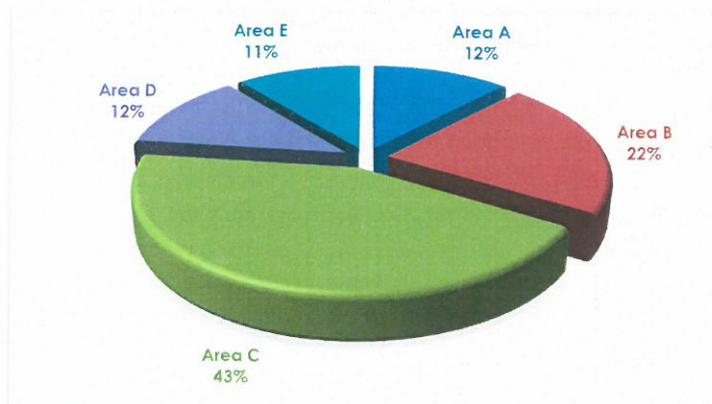


Figure 17: Percentage (%) mass per sampled area (Laingsburg Municipality waste characterisation study data, 2012/13)

Table 8: Total mass generated per sampled area											
Town/ Area	Black/ Recycling bag no.	Plastic Film	Dense Plastics	Paper	Packaging Material	Medical	Organics	Glass	Metal	Other	Total Weight
Area A	84	20.99	26.26	69.15	12.37	12.13	70.06	29.68	14.64	10.34	265.61
Area B	100	32.01	45.22	80.06	17.14	33.21	148.52	54.47	19.00	56.49	486.09
Area C	233	65.66	115.14	282.26	32.62	56.01	247.72	24.62	86.08	58.12	968.23
Area D	59	15.73	52.64	43.90	10.21	33.15	78.93	8.52	13.02	17.01	273.11
Area E	41	13.32	27.98	23.86	7.69	59.33	70.74	6.19	16.93	17.89	243.93
<b>Total</b>	<b>517</b>	<b>147.7</b>	<b>267.2</b>	<b>499.2</b>	<b>80.0</b>	<b>193.8</b>	<b>616.0</b>	<b>123.5</b>	<b>149.7</b>	<b>159.9</b>	<b>2237.0</b>

- then combine the data for all areas to determine the total mass generated per waste type for the municipal area (Figure 18 & Table 8 above);

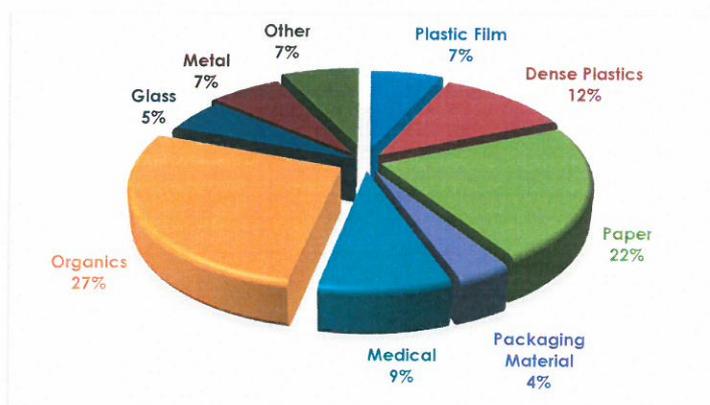


Figure 18: Percentage (%) mass per waste type (Laingsburg Municipality waste characterisation study data, 2012/13)

- the percentage (%) volume that the waste occupies in the basin (20L) can be converted to actual volume in litres and then to cubic metres (m<sup>3</sup>) (Table 9 below). The volume estimates can be used to determine how much space the waste may occupy at the landfill by converting the volume from litres to cubic metres. It is important to note that the estimated volume of waste was not compacted as is the case for waste disposed at landfills and therefore, this needs to be considered when calculating potential landfill airspace savings.

**Table 9: Estimated volume formula**

$$\text{Volume (m}^3\text{)} = \text{Estimated volume (\%)} \times \text{capacity of basin (L)} / 100\% / 1000$$

- Table 10 below shows the extrapolation of the waste generated from the sampled areas, for all the households in the municipal area. The resultant estimate of waste generated in the municipal area for the year is 650 150 kilograms. Table 11 below shows the extrapolation of the waste generated for the various income groups.

Table 10: Extrapolation of the sample mass generated for the municipal area							
Town/ Area	Number of Black/ Recycling bags	Income level	Number of Bags per income level	Number of Households (HH)	Waste generated (kg/week)	Waste generated (kg/day)	Waste generated (kg/annum)
Area A	84	Middle/ High	3	28	265.61		
Area B	100	Low	1	100	486.09		
Area C	233	Low	1	233	968.23		
Area D	59	Middle	2	30	273.11		
Area E	41	Low	1	41	243.93		
<b>Total</b>	<b>517</b>			<b>432</b>	<b>2237.0</b>	<b>320</b>	<b>116643</b>
<b>Waste generated by a single HH</b>				<b>1</b>	<b>5.178</b>	<b>0.740</b>	<b>270</b>
<b>HH as per 2011 Census data</b>				<b>2408</b>	<b>12469</b>	<b>1781</b>	<b>650160</b>
<b>ASSUMPTIONS:</b>							
(1) Low income households generate 1 bag per week							
(2) Middle income households generate 2 bags per week							
(3) High income households generate 3 bags per week							
(4) The 517 refuse bags were collected from 432 households and generate 2237kg per week							
<b>CALCULATIONS: Kg generated by -</b>							
1 HH per week = 1 / 432HH X 2237 = 5.178				2408 HH per week = 5.178 X 2408 = 12469			
1 HH per day = 1 / 7 days X 5.178 = 0.740				2408 HH per day = 0.740 X 2408 = 1781			
1 HH per annum = 0.740 X 365 days = 270				2408 HH per annum = 270 X 2408 = 650160			

<b>Income groups</b>	<b>Percentage per income group</b>	<b>Number of Households (HH)</b>	<b>Mass generated (kg/week)</b>	<b>Waste generated (kg/day)</b>	<b>Waste generated (kg/annum)</b>
Low income (No income - R50 613)	57%	1373	7107	1015	370598
Middle income (R50 614 - R404 901)	38%	915	4738	677	247066
High income (R404 902 - R3 239 207 or more)	5%	120	623	89	32509
Total	100%	2408	12469	1781	650173

### 2.2.3 Reporting Phase: Data Interpretation

The useful aspects for data presentation would be to provide overall current and future waste trends graphically and in tables. The data presentation may be used for future projections of recyclable and non-recyclable waste types. This phase involves the interpretation and presentation of the data, using pie charts, for example, to show the percentage contribution of waste generated per area as well as the percentage contribution of each waste stream. Also, look at the data for the waste type generated the most and least; as well as the area that generates the most and the least waste.

The results of the study may be presented in a format that meets the objective of the study and it is important to report the uncertainty in the estimated values. The reporting should include information of the study area in the introduction, the description of the method, the results with the analysis and interpretation of data as well as the conclusions for the study and any recommendations. Any significant findings on differences when studies are conducted during different seasons. Any changes to the format used for the waste characterisation study and how the calculations were done should be recorded and reported. A database of the raw data should be kept for future reference. Clear descriptions for extrapolation of the data to provide annual figures should be recorded and reported.

## 3. GENERAL

- It is important to give feedback to the municipal officials or EPWP workers on the outcome/ results of the study. EPWP workers are able to be incorporated within the municipality as they acquire some skills and knowledge regarding waste management. The EPWP workers can be utilised to create awareness around waste minimisation initiatives.

#### 4. REFERENCES

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## APPENDIX A

### INTERNATIONAL EXAMPLES OF WASTE TYPES

Waste type list showing three different levels (Level I, Level II, and Level III)			
Level I	Level II	Level III	
1-Food waste	1.1 Vegetable food waste 1.2 Animal-derived food waste	1.1.1 Avoidable-processed food waste 1.1.2 Avoidable-unprocessed food waste 1.1.3 Unavoidable food waste	
2-Gardening waste	2.1 Dead animal and animal excrements (excluding cat litter) 2.2 Garden waste	2.1.1 Dead animals 2.1.2 Animal excrement bags from animal excrement  2.2.1 Humid soil 2.2.2 Plant material 2.2.3 Woody plant material 2.2.4 Animal straw	
3-Paper	3.1 Advertisements 3.2 Books & booklets 3.3 Magazines & Journals 3.4 Newspapers 3.5 Office paper 3.6 Phonebooks 3.7 Miscellaneous paper	3.7.1 Envelopes 3.7.2 Kraft paper 3.7.3 Other paper 3.7.4 Receipts 3.7.5 Self-adhesives 3.7.6 Tissue paper 3.7.7 Wrapping paper	
4-Board	4.1 Corrugated boxes 4.2 Folding boxes 4.3 Cartons/plates/cups 4.4 Miscellaneous board	4.4.1 Beverage cartons 4.4.2 Paper plates & cups 4.4.3 Cards & labels 4.4.4 Egg boxes & alike 4.4.5 Other board 4.4.6 Tubes	
5-Plastic	5.1 Packaging plastic 5.2 Non-packaging plastic 5.3 Plastic film	5.1.1 PET/PETE (Polyethylene terephthalate) 5.1.2 HDPE (Density polyethylene) 5.1.3 PVC/V (Polyvinyl-chloride) 5.1.4 LDPE/LLDPE (Low density polyethylene) 5.1.5 PP (Polypropylene) 5.1.6 PS (Polystyrene) 5.1.7 Other plastic resins labelled with [1-19] and ABS (Acrylonitrile/butadiene/styrene) 5.1.8 Unidentified plastic resin  5.3.1 Pure plastic film 5.3.2 Composite plastic + metal coating	
6-Metal	6.1 Metal packaging containers 6.2 Non-packaging metals 6.3 Aluminium wrapping foil	6.1.1 Ferrous 6.1.2 Non-ferrous	
7-Glass	7.1 Packaging container glass 7.2 Table and kitchen ware glass 7.3 Other/special glass	7.1.1 Clear 7.1.2 Brown 7.1.3 Green	
8-Miscellaneous combustibles	8.1 Composites, human hygiene waste (diapers, tampons, condoms, etc.) 8.1.1 Diapers 8.1.2 Tampons 8.1.3 Condoms 8.2 Textiles, leather and rubber 8.3 Vacuum cleaner bags 8.4 Untreated wood 8.5 Other combustible waste	8.1.1 Diapers 8.1.2 Tampons 8.1.3 Condoms  8.2 8.2.1 Textiles 8.2.2 Leather 8.2.3 Rubber	
9-Inert	9.1 Ashes from households 9.2 Cat litter 9.3 Ceramics, gravel 9.4 Stones and sand 9.5 Household constructions & demolition waste	-	
10-Special waste	10.1 Single Batteries/non-device specific Batteries	10.2	

	<p>10.2 WEEE 10.3 Other household hazardous waste</p>	<p>10.2.1 Large household appliances (Washing machines, dryers, refrigerators, air-conditioners, vacuum cleaners, etc.)</p> <p>10.2.2 Small household appliances (Vacuum cleaners, coffee machines, irons, toasters, etc.)</p> <p>10.2.3 IT and telecommunication equipment (PCs, laptops, mobile phones, telephones, fax machines, copiers, printers etc.)</p> <p>10.2.4 Consumer equipment and photovoltaic panels (Televisions, VCR/DVD/CD players, Hi-Fi sets, radios, etc.)</p> <p>10.2.5 Lighting equipment (Fluorescent tubes, sodium lamps etc. (except: bulbs, halogen bulbs))</p> <p>10.2.6 Electrical and electronic tool (no large-scale stationary tools - Drills, electric saws, sewing machines, lawn mowers etc. (except: large stationary tools/machines))</p> <p>10.2.7 Toys, leisure and sports equipment (Electric train sets, coin slot machines, treadmills etc.)</p> <p>10.2.8 Medical devices (except implanted and infected products – ultrasound &amp; X-ray equipment, glucose &amp; blood pressure monitoring equipment, etc.)</p> <p>10.2.9 Monitoring and control instruments (Microscopes, Thermometers, TDS Meters, Conductivity Meters, Water Analysis Equipment, Paint Testing Equipment, etc.)</p> <p>10.2.10 Automatic dispensers (air freshener, hand sanitiser, vending machines, etc.)</p>
<p>Edjabou, V. M. E., Jensen, M. B., Götze, R., Pivnenko, K., Petersen, C., Scheutz, C., &amp; Astrup, T. F. (2015). Municipal solid waste composition: Sampling methodology, statistical analyses, and case study evaluation. <i>Waste Management</i>, 36, 12-23.</p>		

APPENDIX B

IMAGES OF EXAMPLES OF WASTE TYPES USED BY DEA& DP IN WASTE CHARACTERISATION STUDIES

 <p>Paper</p>	 <p>Cardboard</p>
 <p>Glass</p>	 <p>Dense plastic</p>
 <p>Soft plastic</p>	 <p>Food and Garden waste</p>
 <p>Medical waste</p>	 <p>Composite packaging</p>



Metals



Human Hygiene/ Sanitary waste



Electronic waste (e-waste)



Other (non-classified waste, non-recyclable packaging, etc.)

APPENDIX C



Scale 1



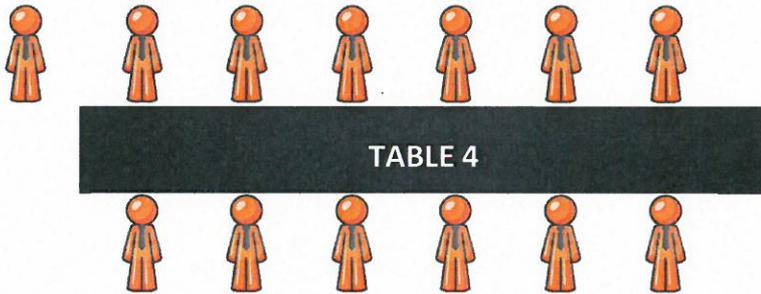
Scale 2



Scale 3



Scale 4



**SIGN-OFF**

I hereby approve the Municipal Waste Characterisation Guideline



Eddie Hanekom

Director: Waste Management

Date: 28-03-2017