NATIONAL WASTE INFORMATION BASELINE REPORT

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DEA Project Team
Mr Obed Baloyi (Project Leader)
Mr Donald Sehaswana
Mr Musa Maringa
Mr Jeremia Sibande

CSIR Project Team:
Dr Suzan Oelofse
Ms Manja Schubert
Ms Hulde Swanepoel
Dr Linda Godfrey
Dr Lulama Wakaba
Mr Aubrey Muswema

COWI Project Team
Simon Graasbøll
Erik Nørby

En-Chem Consultants cc
Dr Dave Baldwin

DISCLAMER:

The statements made and conclusions drawn in this report are based on the available documented data and research findings. No primary data collection was done. While every effort has been taken to verify the data, the Department of Environmental Affairs, CSIR and COWI cannot be held accountable for the accuracy of the data on which the conclusions are based.

EXECUTIVE SUMMARY

The third national waste baseline shows that South Africa generated approximately 108 million tonnes of waste in 2011, of which 98 million tonnes was disposed of at landfill. In the order of 59 million tonnes is general waste, 48 million tonnes is currently unclassified waste and the remaining 1 million tonnes hazardous waste. In the order of 10% of all waste generated in South Africa was recycled in 2011.

Determining a waste information baseline for South Africa is essential in order to track the implementation of the National Environmental Management: Waste Act (Act 59 of 2008) (RSA, 2009) and the National Waste Management Strategy (DEA, 2012). This report therefore attempts to provide a national baseline for South Africa of the tonnages of waste recycled, treated, landfilled and exported. In the absence of a fully operating South African Waste Information System (SAWIS), a general lack of accurate waste data remains a huge challenge in South Africa. However, it is expected that the promulgation of the Waste Information Regulations (RSA, 2012a) will provide the necessary incentives for accurate waste data to be reported onto SAWIS.

The data presented in this baseline report is not directly comparable to the 1991 (DEAT, 1991) and 1997 (DWAF, 2001) baselines due to the fact that the definition (and categorization) of waste has changed significantly with the promulgation of the Waste Act (RSA, 2009). Previous baseline reports include by-products and mining waste while the by-products are now specifically excluded from the definition of waste. The Waste Act also states that "*this Act does not apply to residue deposits and residue stockpiles that are regulated under the Mineral and Petroleum Resources Development Act, 2002"*. The scope of this report was therefore limited to the current legal definition of waste, as per the Waste Act (RSA, 2009).

No primary data was collected for the 2011 baseline study. Since the categorization of hazardous waste has recently changed from SANS 10228 to the new system (RSA, 2011; RSA, 2012b) many organizations are still collecting data as per the old categories. Waste data sourced for this baseline was therefore not necessarily available according to the waste categories required for reporting. For instance, it was not possible to distinguish between the general and hazardous portions of waste streams in the absence of re-classification according to the new regulations. In such instances the waste streams are listed as 'unclassified waste' and reported separately.

ABBREVIATIONS

AVCASA	Association of Veterinary and crop Associations of South Africa
BUSA	Business Unity South Africa
CAIA	Chemical and Allied Industries Association
CBA	Clay Brick Association
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism (now DEA)
DEADP	Department of Environmental Affairs and Development Planning, Western Cape
EC	Eastern Cape
FAPA	Ferro-Alloy Producers Association
FS	Free State
GDACE	Gauteng Department of Agriculture, Conservation and Environment
GDP	Gross Domestic Product
GT	Gauteng
GW	General Waste
HW	Hazardous waste
IDP	Integrated Development Plan
IWMP	Integrated Waste Management Plan
IWMSA	Institute of Waste Management of Southern Africa
IZWA	Institute for Zero Waste in Africa
KZN	KwaZulu Natal
LDEDET	Department of Economic Development, Environment and Tourism, Limpopo Province
LP	Limpopo
MDALA	Mpumalanga Department of Agriculture and Land Administration
MP	Mpumalanga
NFMI	Non-Ferrous Metal Industry Association of South Africa
NW	North West
NWDACE	North West Department of Agriculture, Conservation and Environment
NWMSI	National Waste Management Strategy Implementation
PAMSA	Paper Manufacturers Association of South Africa
RCMSA	Responsible Container Management Association of South Africa
RPMASA	Responsible Packaging Management Association of South Africa
RSA	Republic of South Africa
SAICI	South African Institute of Civil Engineers
SAISI	South African Iron and Steel Institute
SAIMM	South African Institute of Mining and Metallurgy
SALGA	South African Local Government Association
SAWIS	South African Waste Information System
SAWIC	South African Waste Information Centre (www.sawic.org.za)
SAWPA	South African Wood Preservers Association
StatsSA	Statistics South Africa
SPLM	Sol Plaatjie Local Municipality
TPSSA	Technical Association of Pulp and Paper Industry of South Africa
WC	Western Cape
WEEE	Waste electric and electronic equipment
WRC	Water Research Commission

TABLE OF CONTENTS

LIST OF APPENDICES

1 INTRODUCTION

1.1 How to read the baseline

In order to facilitate easy access to the South African Waste Information Baseline, the report is structured to be short, focusing on the current waste information baseline as estimated for 2011. Background and supporting information is provided in the Appendices.

The waste information baseline reported here is a **best estimate** aimed at answering the question: *"How much waste is generated, stored, treated, re-used, recycled, recovered and disposed of in South Africa?"* The estimates reported here are based on modeled results which were informed by background research and interpretations of available data from various sources, as indicated in Appendix D. Although the available data does not support an answer at a very high level of accuracy, the overall accuracy of the data that was used in the predictions are deemed to be sufficiently high for the purposes of decision making at national level.

In this report, ***Section 1*** provides a short introduction to the background of the project including the objectives of establishing a National Waste Information Baseline for South Africa. ***Section 2*** summarizes the definitions of waste streams from the Waste Act, 2008 and outlines the classification of waste that informed this baseline. The information provided in this section is of particular relevance when comparing the results of this baseline to previous baselines.

The method used to determine the 2011 National Waste Information Baseline, including calculations and data verification, is provided in ***Section 3.*** The study faced a number of limitations which impacted on the findings; these limitations are also discussed in ***Section 3***. Since no primary data was collected to establish this baseline, some comments are made on the accuracy of the available data on which these estimates are based. Stakeholders consulted during this project are listed in Appendix A.

The results of the modeled data are presented in ***Section 4***. The data is divided into relevant groups for ease of interpretation. Only aggregated data is provided to protect the identity of the sources in line with the Competition Commission ruling (Appendix B). The results presented here are representative of the waste tonnage estimated for one year, namely 2011**.** Conclusions are drawn in ***Section 5.*** A summary of relevant literature pertaining to each waste type is provided in Appendix C.

The references listed in ***Section 6*** refer to literature referenced in Sections 1 to 5. A complete list of all data sources consulted for this baseline is included in Appendix D.

1.2 Background

Implementation of the National Environmental Management: Waste Act (Act 59 of 2008) (RSA, 2009) (hereinafter referred to as the Act) requires a baseline of waste information as evidence on which to base policy decisions and measure implementation. The Act states that the Minister must establish a national waste management strategy and may amongst others:

- Declare priority waste streams;
- Prescribe measures for the management of identified waste streams;
- Set targets for recycling of certain waste streams;
- Set targets for the minimization of certain waste streams; and
- Ban certain waste streams from landfill.

The National Waste Management Strategy (DEA, 2011) was approved by Cabinet in 2011 and sets targets to promote waste minimization, reuse, recycling and recovery of waste. The implementation of the strategy must be monitored and the strategy must be reviewed at least every five years. It is therefore imperative

that the status quo of waste information in the country be recorded as accurately as possible and be made available to decision-makers in government and industry.

It is the intention of the Department of Environmental Affairs (DEA) to provide such a national baseline of the tonnages of waste recycled, treated, landfilled and exported, through the future implementation of the South African Waste Information System (SAWIS). However, until the SAWIS moves from voluntary reporting to enforced reporting under the new regulations (RSA, 2012a), the system is as yet unable to provide annual reports on the state of waste. Given the constraints outlined above, this project aims to model the baseline of waste generation, recycling, treatment and landfilling in South Africa, while making use of existing waste data stored in provincial and national waste information systems, and in public and private reports. The results from the model represent the best estimate of waste generation, recycling, treatment and landfilling in South Africa in 2011 (as the baseline year).

The accuracy of general waste generation data in South Africa is often very low (Godfrey, 2008) and typically based on estimates. Domestic waste quantities are often estimated based on population statistics and economic activity within the municipality, while industrial waste quantities are largely estimated based on production figures. Waste data compared to production figures does however provide a good indication of process efficiencies within an industry. Where accurate information is available from industrial waste generators, the data is often considered to be sensitive or confidential. Similarly, in the case of commercial waste facilities, detailed waste treatment and disposal data, particularly on hazardous waste, is often considered as sensitive data since it can provide an indication of the company's market share. For these reasons, accessing hazardous waste data (generation, treatment and disposal) was problematic, and was ultimately subject to a resolution by the Competition Commission. The DEA obtained a resolution on the confidentiality of information contained in SAWIS as well as on comments on the Waste Information Regulations (RSA, 2010). The Competition Commission resolution is attached as Appendix B.

Every effort has been made to collect waste data at the highest possible level of accuracy. However, it has not always been possible to do so for all waste streams, due to the issues discussed above, and due to the fact that some waste data is not yet collected and reported at the level of detail required for this study. It is anticipated that with the implementation of the waste information regulations and waste classification system, more accurate information will become available at the desired levels of detail in the foreseeable future.

1.3 Objectives of the National Waste Information Baseline study

The objectives of this third national waste information baseline are to:

- Assist with the identification of problem waste streams or waste streams that occur in large quantities, and may require specific management strategies to manage their impacts;
- Support research towards determining the most appropriate storage, collection, treatment and disposal options for each waste stream;
- Measure the diversion of waste from landfill thereby promoting waste reduction, re-use, recycling and waste exchange opportunities;
- Capacitate stakeholders and communities through public access to waste related information;
- Support government in meeting their national and international reporting obligations;
- In time, trace waste from point of generation through to point of treatment or disposal within South Africa.

2 DEFINITIONS AND CLASSIFICATION OF WASTE

2.1 Definitions

This third national waste information baseline is based on definitions as defined in the National Environmental Management: Waste Act (RSA, 2009).

"waste" *means any substance, whether or not that substance can be reduced, re-used, recycled and recovered –*

(a) That is surplus, unwanted, rejected, discarded, abandoned or disposed of;
(b) Which the generator has no further use of for the purposes of production;
(c) That must be treated or disposed of; or
(d) That is identified as a waste by the Minister by notice in the Gazette, and includes waste generated by the mining, medical or other sector; but –
  (i) A by-product is not considered waste; and
  (ii) Any portion of waste, once re-used, recycled and recovered, ceases to be waste.

*"**general waste**" means waste that does not pose an immediate hazard or threat to health or the environment, and includes:*

(a) Domestic waste;
(b) Building and demolition waste;
(c) Business waste; and
(d) Inert waste.

"hazardous waste" *means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment.*

"building and demolition waste" *means waste, excluding hazardous waste, produced during the construction, alteration, repair or demolition of any structure, and includes rubble, earth, rock and wood displaced during that construction, alteration, repair or demolition.*

2.2 Waste classification

The DEA has recently gazetted draft Waste Classification Regulations for public comment (RSA, 2012b). One of the aims of a national waste classification system is to standardize the reporting of waste data. Until recently, waste data has been captured differently, by different role players, which makes compiling data for a national waste baseline challenging. While hazardous waste has typically been reported on against SANS 10228 or a modified 10228, a standard classification for general waste has not, until recently, existed in South Africa. For example, 'construction & demolition waste' adopted in the draft waste classification system has also been referred to in other systems, and reported on, as 'builders' rubble' and 'builders' waste', while the Act defines 'building and demolition' waste (Section1) (RSA, 2009).

Draft waste information regulations were gazetted for public comment in 2010 (RSA, 2010) and finalized in 2012 (RSA, 2012a). The purpose of the waste information regulations is to regulate the reporting on waste information for the protection of the environment and the management of waste. These regulations (RSA, 2012a) include general and hazardous waste categories at levels 1, 2 and 3 of increasing detail. According to the Terms of Reference, the 2011 National Waste Information Baseline is to be reported on against these categories at level 2 (**Table 1 and 2**).

Previous baselines used different categories for reporting. Therefore, a direct comparison between the 1991, 1997 and 2011 baseline studies may not (in all cases) be possible (DEAT, 1991; DWAF, 2001). It should also be noted that the definition of waste as defined in the Act, excludes by-products, while earlier definitions of waste included by-products and

as such would have been included in the 1991 and 1997 baselines.

Further detail on the waste streams included in each waste category is provided in Appendix C.

Table 1: General waste categories

Level 1	Level 2	
General Waste	GW01	Municipal waste
	GW10	Commercial and industrial waste
	GW13	Brine
	GW14	Fly ash and dust from miscellaneous filter sources
	GW15	Bottom ash
	GW16	Slag
	GW17	Mineral waste
	GW18	Waste of Electric and Electronic Equipment (WEEE)
	GW20	Organic waste
	GW21	Sewage sludge
	GW30	Construction and demolition waste
	GW50	Paper
	GW51	Plastic
	GW52	Glass
	GW53	Metals
	GW54	Tyres
	GW99	Other

Table 2: Hazardous waste categories

Level 1	Level 2	
Hazardous Waste	HW01	Gaseous waste
	HW02	Mercury containing waste
	HW03	Batteries
	HW04	POP Waste
	HW05	Inorganic waste
	HW06	Asbestos containing waste
	HW07	Waste Oils
	HW08	Organic halogenated and /or sulphur containing solvents
	HW09	Organic halogenated and/or sulphur containing waste
	HW10	Organic solvents without halogens and sulphur
	HW11	Other organic waste without halogen or sulphur
	HW12	Tarry and Bituminous waste
	HW13	Brine
	HW14	Fly ash and dust from miscellaneous filter sources
	HW15	Bottom ash
	HW16	Slag
	HW17	Mineral waste
	HW18	Waste of Electric and Electronic Equipment (WEEE)
	HW19	Health Care Risk Waste
	HW20	Sewage sludge
	HW99	Miscellaneous

3 DETERMINING THE NATIONAL WASTE INFORMATION BASELINE

3.1 Limitations

No primary data collection was done due to time and cost limitations. Therefore, only available data that could be sourced was included in the baseline calculations. For instance, waste streams that are managed on-site by industries and the agricultural sector, never enter the official waste stream and therefore are not accounted for. The findings of this baseline reports only on waste in official waste streams and are therefore likely to be an under estimate of the total waste generated and disposed of in South Africa.

Another limitation of this baseline is the lack of analytical data pertaining to waste streams listed both in **Tables 1 and 2**. The Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF, 1998) refers to wastes which "*based on their intrinsic properties, present relatively low hazards, but may pose problems because of their high volumes*". The waste streams duplicated in the tables fall into this category e.g. fly-ash from power plants, slag and drilling mud (DWAF, 1998). It is therefore clear that classification of these waste streams is required before reporting to SAWIS. In order not to skew the results of this baseline, these waste streams are reported in a separate table as 'unclassified waste'.

A clear definition of brine is required in order to provide context to the numbers reported. For the purposes of the numbers quoted in this report, brine refers to a concentrated watery solution, typically containing 1-6% of dissolved low value salts, emanating from the reverse osmosis desalination process (Van der Merwe *et al*, 2009). Since salt load is the main concern to the environment, brine is reported as salt load to the environment in tonnes per annum.

Lastly, due to variations in data accuracy of different waste streams it is not possible to assign an overall level of accuracy to the baseline. The project team is however confident that the results reported are in the correct order of magnitude to inform high level policy decisions.

3.2 Method

In the absence of a single waste dataset for South Africa, establishing a national waste baseline has been based on a strong scientific approach. In addition, ongoing consultation and engagement with identified stakeholders has been crucial to ensuring that all potential sources of waste data are identified and verified by peers in the waste sector.

A two-pronged approach was followed in developing the 2011 National Waste Information Baseline for South Africa:

1. Collection, collation and interpretation of existing waste data
2. Numerical modeling of the national waste baseline

The existing data was collected from all relevant stakeholders in the South African waste sector, including both public and private waste organisations, by means of interviews and extracting data from available reports and databases. A list of identified stakeholders is included as Appendix A.

In addition to basic data collection, numerical modelling was undertaken in the following instances:

- data simulation in the absence of accurate data;
- assessing the effectiveness of current reduce, reuse and recycling initiatives;
- determining the extent of energy recovery from waste;
- estimating trends in waste management over time;
- verifying the accuracy of available data.

Modeling of waste generation via a well calibrated model that contains all readily available waste data, as well as forecasted type and number of waste generators is considered to be a reliable and cost-effective method to achieve the project objectives.

3.3 Data verification

Since no primary data collection was undertaken in the preparation of this report, it was important to verify the accuracy of the data as collected from available sources. The degree of accuracy of the data depends on the quality of data. In this regard, the data obtained from industry and waste management companies were considered to be of high accuracy. Calculated numbers were considered to be of medium accuracy and estimated data of low accuracy.

3.3.1 SAWIS

The Department of Environmental Affairs (DEA) developed and piloted the South African Waste Information System (SAWIS) between 2004 and 2006 as part of the National Waste Management Strategy Implementation (NWMSI) project. The aim of SAWIS is to create a single national repository of accurate and reliable tonnages of general and hazardous waste recycled, treated and landfilled, as well as tonnages of waste exported out of South Africa (DEAT, 2005). SAWIS has continued to be implemented by DEA on a voluntary basis since the end of the project in 2006, pending the drafting and gazetting of national waste information regulations (RSA, 2012a).

However, research suggests that the number of waste activities reporting to SAWIS as at 2011 represents only a small fraction of operating waste facilities in the country. For example, the number of landfills reporting data to SAWIS in 2011 represents an estimated 12-13% of currently operating landfills that would be required to submit data as per the SAWIS framework (Godfrey *et al*, 2012; DEAT, 2005). Organisations reporting data to SAWIS include municipalities, industries and private waste companies (DEAT, 2005). Only 38 organisations reported data to the SAWIS in 2010 while 32 organisations reported data into the system for both 2009 and 2010 (Godfrey et al. in press). There are over 2000 waste handling facilities in South Africa (DEAT, 2007) but only 46 waste activities reported data to the SAWIS in 2010 (29 landfills; 9 treatment facilities and 8 re-processors) (Godfrey *et al*. 2012). The small fraction of operating waste facilities reporting into the system renders the SAWIS data incomplete for the purposes of establishing a national waste baseline. In addition, given the voluntary status of SAWIS, data within the system has not yet been validated for accuracy. Reviewing the SAWIS data suggests that there are inaccuracies within the system which will need to be corrected, such as order of magnitude changes in waste tonnages from one month to the next, suggesting a data capturing error in the placing of the decimal figure, or order of magnitude differences in data for landfills of similar size, suggesting lack of consistency in units, i.e. tonnages versus kilograms. It is acknowledged that reporting into the SAWIS is still voluntary and that increased reporting is to be expected following the promulgation of Waste Information Regulations.

So, while the data in SAWIS is useful to benchmark calculations made during this baseline project, SAWIS cannot as yet provide a complete overview of waste data for South Africa. In addition to SAWIS, the Western Cape and Gauteng provincial departments of environment embarked on developing their own waste information systems. The Gauteng provincial department of environment promulgated regulations in 2004 to enforce waste data reporting in the province (GPG, 2004). Although the two provincial systems are functional, reporting onto these systems are, as with SAWIS, incomplete. The data from provincial systems has been used to verify calculations made in this project.

3.3.2 General Waste

Most municipal integrated waste management plans (IWMP) highlighted concerns around the accuracy of waste data (DEADP, 2011) e.g. "not accurate", "theoretical" or "assumed to be typical". Few waste characterization studies have been undertaken in South Africa (Sibernagl, 2011), which further complicates the issue of reporting waste streams at the required level of detail. Where waste characterization studies have been undertaken, these studies have used different methods and waste categories, which make direct comparison difficult (Wise *et al*., 2011). Other limiting factors of available characterization studies include the low number of samples, limited sampling periods (often only done in one season) and sorting accuracy (SPLM, 2010).

A study on the collection of waste information by municipalities (Godfrey, 2008) revealed that in 2005 only 68.9% of municipalities were collecting some form of waste data. Sixty two percent of those municipalities collecting data believed that they were collecting unreliable data. It was further reported that 74.6% of municipalities collecting waste data were collecting data on landfills and 46.5% data on waste generators (not waste generation). Only 33.8% collected data on waste transportation, 14.1% on recyclers and 4.2% on waste treatment (Godfrey, 2008). Since the municipalities collecting waste data often do so at landfills, only waste disposed of at municipal landfills are accounted for. In addition, when comparing service delivery data from the Community Survey, 2007 (StatsSA, 2007) with the annual service delivery survey for the same year, the service backlog figures differs significantly (National Treasury, 2011). It could therefore be expected that estimates of waste that are not accounted for, is also a challenge. While fairly extensive waste data is now collected by metropolitan municipalities, it is clear that accurate municipal waste data, for the majority of municipalities in South Africa, is not available.

3.3.3 Hazardous waste

Provincial hazardous waste plans (HWMP) also indicated some reservations about the accuracy of the waste data reported. Data surveys undertaken by service providers during the development of provincial HWMPs are characterised by poor response rates. It is reported that "*the majority of those interviewed do not fully comprehend what constitutes hazardous waste and do not (as a rule) record volumes generated*" (LDEDET, 2006). The small sample (5.3%) of industrial operations included in the survey for the Gauteng HWMP does not provide enough data for accurate waste generation estimations (GDACE, 2007). The data collected through surveys are generally statistically insignificant and therefore not suitable for use in waste generation extrapolations.

In instances where hazardous waste quantities are not measured, estimates are generally made by extrapolation or by using industry averages for hazardous waste generation rates for similar manufacturing facilities (MDALA, 2008; NWDACE, 2006; LDEDET, 2006). However this approach is complicated by the fact that most local authorities do not have readily available information on the industries operating in their areas (LDEDET, 2005). It is therefore difficult to ascertain the exact size of each industrial sector and hence virtually impossible to determine the exact volume of hazardous waste generated by a specific sector in a specific province.

Hazardous waste generators located at distances greater than 100 km from hazardous waste treatment facilities or landfills are faced with huge financial implications for waste haulage. A general reluctance to release information relating to waste by these companies is therefore reported (DEADP, 2011). Many large industries in South Africa dispose of industrial waste on-site. Waste

generation at these facilities is seldom measured but it is often calculated based on production figures or resource input versus operational efficiency. Since this hazardous waste does not enter the 'formal' waste stream, there is also often little reported data available.

The status of hazardous waste in South Africa is therefore largely based on treatment and disposal figures. The most reliable data are obtained from commercial waste treatment and disposal facilities where the generators are charged for the treatment or disposal of the hazardous waste based on weight or volume.

There are instances where in-depth research projects were undertaken on certain waste types, e.g brines. The data contained in research reports on these waste streams are considered to be accurate.

3.4 Baseline year

Since data on different waste streams are not always available for consecutive years, deciding on the baseline year, based on available information, was challenging. For this reason, all data was captured and normalized to one baseline year (2011), from which future projections were made.

3.5 Calculations

The waste quantities have been calculated from various sources and typically from different years to the agreed baseline year of 2011. Furthermore, waste quantities often only cover one municipality or one province. Calculations from province level to national level, or from one year to the baseline year, have been based on either population or economic data.

The latest available official population statistics including 2011 census data (**Table 3**) and economic data (**Table 4**) published by Statistics South Africa, were used in the calculations of general and hazardous waste generation figures for South Africa.

$$\frac{Waste\ amount}{Population\ in\ waste\ generation\ year}\ x\ Population\ in\ 2011 \quad (1)$$

Table 3: Population distribution per province (StatsSA, 2010; *StatsSA, 2012).

Province	Total population (thousand)									
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Western Cape (WC)	4646	4755	4859	4964	5071	5162	5258	5369	5468	5823
Eastern Cape (EC)	6521	6541	6558	6574	6587	6612	6633	6649	6656	6562
Northern Cape (NC)	1088	1098	1106	1115	1123	1131	1140	1148	1154	1146
Free State (FS)	2777	2795	2811	2826	2842	2863	2884	2905	2919	2746
KwaZulu Natal (KZN)	9683	9802	9915	10024	10134	10242	10348	10461	10551	10267
North West (NW)	3227	3261	3294	3325	3357	3389	3421	3454	3479	3510
Gauteng (GT)	9189	9387	9577	9766	9961	10142	10333	10556	10754	12272
Mpumalanga (MP)	3391	3430	3464	3493	3519	3546	3576	3610	3639	4040
Limpopo (LP)	5011	5048	5081	5111	5138	5171	5201	5230	5250	5405
Total	45533	46117	46665	47198	47732	48258	48794	49382	49870	51771

Table 4: GDP contribution per province (StatsSA, 2011b).

Economic data 2000-2009 - Current prices - Rand million									Calculated data	
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WC	165 265	183 462	209 602	229 150	256 935	293 243	324 381	336 234	342 958	349 818
EC	91 123	101 806	112 592	123 551	135 503	151 785	172 375	182 146	185 789	189 505
NC	25 793	28 167	30 776	34 049	39 454	45 497	52 526	54 916	56 014	57 135
FS	65 847	69 424	76 219	81 361	95 333	108 552	122 369	130 973	133 592	136 264
KZN	191 433	209 133	232 571	254 938	285 663	324 961	363 511	384 936	392 635	400 488
NW	77 109	80 082	87 932	100 628	114 068	130 071	149 947	156 373	159 501	162 691
GT	392 705	428 624	477 927	539 120	598 114	685 942	765 323	811 906	828 144	844 707
MP	83 162	87 432	94 980	104 168	122 069	138 841	161 609	169 973	173 372	176 840
LP	78 644	84 403	92 669	104 112	120 279	137 269	162 093	168 505	171 876	175 313
Total	1 171 081	1 272 533	1 415 268	1 571 077	1 767 418	2 016 161	2 274 134	2 395 962	2 443 881	2 492 761

3.5.1 Waste generation per province

In the absence of more recent data, and comprehensive waste characterization studies, it is assumed that the per capita waste generation per province as quoted by Fiehn and Ball (2005) is still relevant in 2011. The percentage municipal waste contribution by province was therefore calculated based on population and is estimated as indicated in **Table 5**.

Table 5: Percentage municipal waste contribution by province in South Africa, 2011

Province	kg/capita/annum	Waste generated as % of Total waste
Western Cape	675	20
Eastern Cape	113	4
Northern Cape	547	3
Free State	199	3
KwaZulu Natal	158	9
North West	68	1
Gauteng	761	45
Mpumalanga	518	10
Limpopo	103	3

However, the calculations used to normalise data to the baseline year, assumed equal per capita waste generation across provinces.

3.5.2 Municipal waste composition

Only a few waste characterization studies on municipal waste have been undertaken to date, in South Africa. Organic waste is sometimes split into putrescibles, greens and garden waste. However, if these waste streams are added together and reported as organic waste, it is possible to find comparable data for Gauteng (GDACE, 2008) and Cape Town (Gibb, 2008), as illustrated in **Figure 1**.

There are no statistically significant differences in the findings between Gauteng and Cape Town. Therefore, it was assumed that the municipal waste composition for Gauteng could be extrapolated to fairly represent the composition of municipal waste in South Africa.

The municipal waste composition for Gauteng was therefore applied to calculate GW20 (organic waste, 15%) and GW30 (construction and demolition waste, 20%) (**Table 5**).

The waste reported as mainline recyclables include paper, plastics, glass, tins and tyres (GDACE, 2008; Gibb, 2008). These waste streams are already reported under GW20, GW30, GW50, GW51, GW52, GW53 and GW54 since these waste streams includes the recyclables from municipal waste as well as recyclables collected directly from industrial sources.

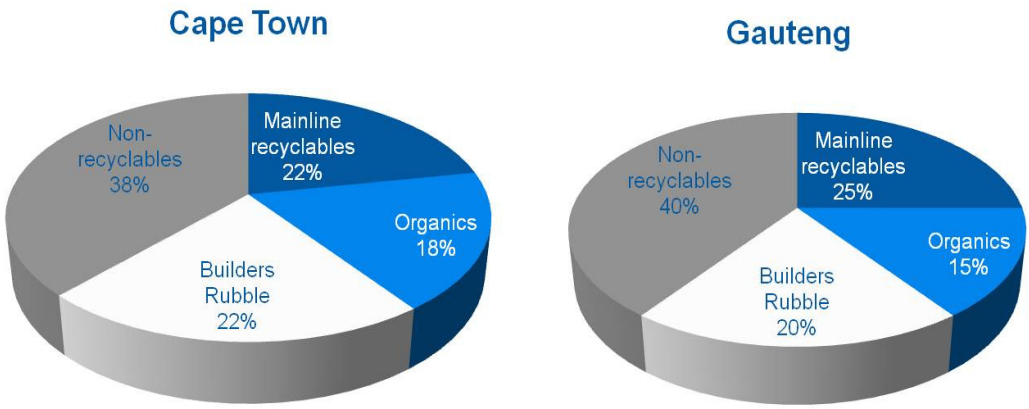

Figure 1: Municipal waste composition (Percentage by Mass)

In order to avoid double-counting only the non-recyclable portion (40%) is reported under GW01 (**Table 6**).

3.5.3 Commercial and industrial waste

Commercial and industrial waste is reported as part of the municipal waste stream in Cape Town (2004), Johannesburg, (2004), Tshwane (2004) and Mangaung (no date) as illustrated in **Figure 2**.

It was assumed that the waste streams "illegal dumping" and "other", recorded in Johannesburg, would be coming from household sources and was therefore added to household waste in Johannesburg. In addition all waste, excluding household waste, organics and construction and demolition waste would be coming from commercial and industrial sources.

Data reported by municipalities includes both household, commercial and industrial waste (referred to as municipal waste). For the purposes of this study and to be able to separate out the commercial and industrial waste, this waste type (GW 10) was assumed to contribute about 21% of the municipal waste stream in South Africa. Household waste is about 44% (average for Tshwane, Mangaung, Johannesburg and Cape Town as illustrated in figure 2), organics 15% and contruction and demolition waste 20% as determined in section 3.5.2. (**Table 6**).

3.5.4 Avoiding double counting

Double counting is a real concern especially in determining the amounts of general waste reported in the baseline. Many of the waste categories listed as general waste are also reported under municipal waste (GW01) and commercial and industrial waste (GW10). This is especially true for the recyclable waste types. Commercial and industrial waste (GW10), as determined in Section 3.5.3, represents 21% of the municipal waste stream (GW01) and the recyclable content is reported under GW20, GW30, GW50, GW51, GW52, GW53 and GW54. Adding GW10 to the equation when counting total general waste will result in double counting. For this reason GW10 is left out of the equation.

It was also necessary to determine which portion of the municipal waste is non-recyclable. Based on the assumptions made in sections 3.5.1 to 3.5.3, it is possible to conclude that 60% of the municipal waste stream is reported as GW30 (20%), GW20 (15%) and mainline recyclables (i.e. paper, plastics, glass, metals and tyres) (25%). The remaining 40% of municipal waste is therefore assumed to be non-recyclable and not recorded elsewhere.

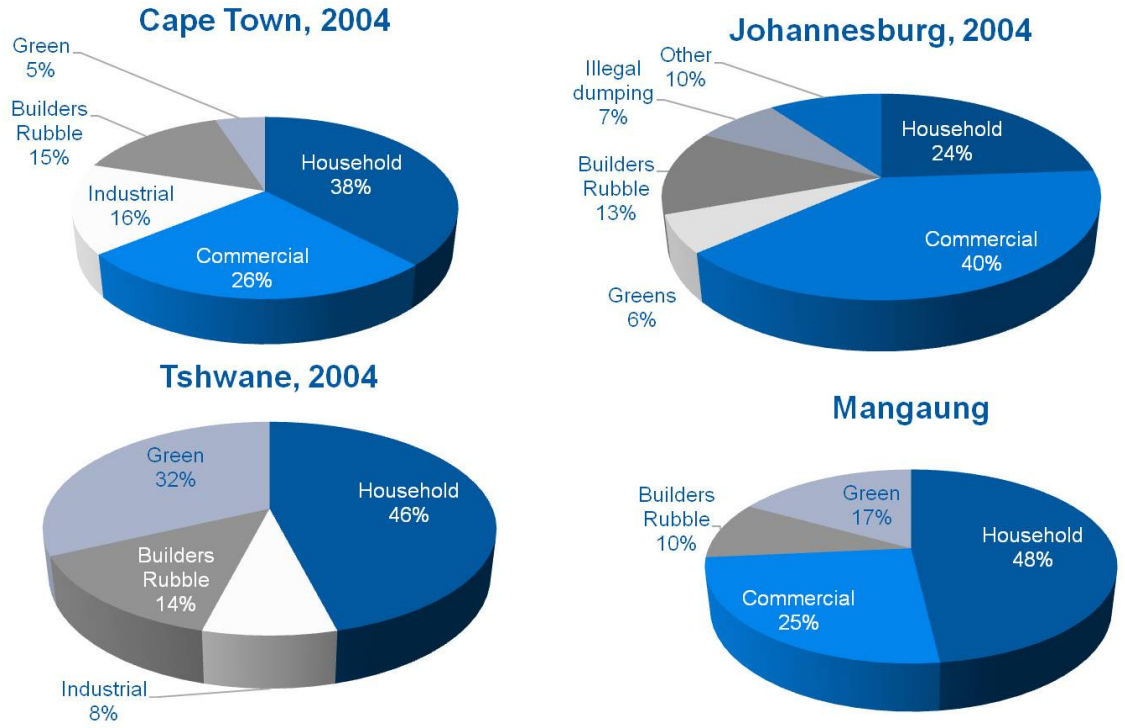

Figure 2: Municipal waste composition by source

It can therefore be concluded that the total general waste generated in South Africa is the sum of 40% of GW01 and all the GW- waste streams excluding GW10.

3.5.5 Waste quantity calculation by category

In most cases the waste quantities are given for 'waste generated'. However, in some cases it has only been possible to find data on waste collection, treatment or disposal. This division in methodology has been impossible to avoid because of the lack of comprehensive data and differences in data collection approaches. However, the differences are highlighted in **Table 6** and **Table 7** and the reader will thus know which methodology has been used to derive the given amounts.

Table 6: Calculation methods applied to general waste categories

General Waste 2011		Calculation Comment
GW01	Municipal waste	(Western Cape amount 2010/ Western Cape population 2010* SA population 2011 (refer to Table 3) = **20 157 335**. To avoid double counting only 40% of total adjusted to 2011 is reported here (refer to section 3.4.2). The remaining 60% is reported against specific waste streams i.e. GW20, GW30, GW50 etc.
GW10	Commercial and industrial waste	21% of total GW01 based on Municipal waste compositions (2004) for Cape Town, Johannesburg, Tshwane and Mangaung (refer to section 3.4.3)
GW13	Brine	See Table 7
GW14	Fly ash and dust from miscellaneous filter sources	See Table 7
GW15	Bottom ash	See Table 7
GW16	Slag	See Table 7
GW17	Mineral waste	See Table 7
GW18	Waste of Electric and Electronic Equipment (WEEE)	See Table 7
GW20	Organic waste	Organic component of Municipal solid waste (15%) based on the estimate for Gauteng in 2008 waste minimisation status quo report
GW21	Sewage sludge	See Table 7
GW30	Construction and demolition waste	Recycling data South Africa amount 2007/South Africa GDP 2007 * South Africa GDP 2011 (refer to Table 4) plus disposal data estimated at 20% of municipal waste (GDACE, 2008)
GW50	Paper	South Africa amount 2009/South Africa population 2009*South Africa population 2011 (refer to table 3)
GW51	Plastic	South Africa amount 2009/South Africa population 2009*South Africa population 2011 (refer to table 3)
GW52	Glass	South Africa amount 2010/South Africa population 2010*South Africa population 2011 (refer to table 3)
GW53	Metals	South Africa amount 2010/South Africa GDP 2010*South Africa GDP 2011 (refer to table 4)
GW54	Tyres	South Africa amount 2008/South Africa GDP 2008* South Africa GDP 2011 (refer to table 4)
GW99	Other	Biomass waste from industry. South Africa amount 2004/South Africa GDP 2004*South Africa GDP 2011 (refer to table 4).
	Total General Waste	GW01+GW13+GW20+GW30+GW50+GW51+GW52+GW53+GW54+GW99

Table 7: Calculation methods applied to hazardous waste categories (including unclassified waste)

Hazardous and unclassified waste		Calculation comments
HW01	Gaseous waste	South Africa amount 2010*2% increase
HW02	Mercury containing waste	South Africa amount 2010*2% increase
HW03	Batteries	Mpumalanga amount 2008/Mpumalanga population 2008*South Africa population 2011 (refer to Table 3)
HW04	POP Waste	South Africa amount 2010*2% increase
HW05	Inorganic waste	South Africa amount 2010/south Africa population 2010*South Africa population 2011 (refer to Table 3)
HW06	Asbestos containing waste	South Africa amount 2010/South Africa population 2010*South Africa population 2011 (refer to Table 3)
HW07	Waste Oils	South Africa amount 2011
HW08	Organic halogenated and /or sulphur containing solvents	Western Cape amount 2002/Western Cape population 2002*South Africa population 2011 (refer to Table 3)
HW09	Organic halogenated and/or sulphur containing waste	North West amount 2006/North West population 2006*South Africa population 2011 (refer to Table 3)
HW10	Organic solvents without halogens and sulphur	North West amount 2006/North West population 2006*South Africa population 2011 (Refer to Table 3)
HW11	Other organic waste without halogen or sulphur	South Africa amount 2010/South Africa population 2010*South Africa population 2011 (Refer to Table 3)
HW12	Tarry and Bituminous waste	South Africa amount 2010*2% increase
*HW13 & GW13	Brine	Tonnes of salt to the environment. South African amount 2008/South Africa GDP 2008*South Africa GDP 2011 (refer to Table 4).
*HW14 & GW14	Fly ash and dust from miscellaneous filter sources	South Africa 2010*2% increase
*HW15 & GW15	Bottom ash	South Africa 2010*2% increase
*HW16 & GW16	Slag	South Africa 2011 Estimated based on production figures (refer to Appendix C)
*HW17 & GW17	Mineral waste	South Africa amount 2011
*HW18 & GW18	Waste of Electric and Electronic Equipment (WEEE)	South Africa amount 2007/South Africa population 2007*South Africa population 2011 (refer to Table 3)
HW19	Health Care Risk Waste	South Africa amount 2007/South Africa population 2007* South Africa population 2011 (refer to Table 3)
*HW20 & GW21	Sewage sludge	South Africa amount 2010/South Africa population 2010*South Africa population 2011 (refer to Table 3)
HW99	Miscellaneous	South Africa amount 2010*2% increase
	Total Hazardous	The sum of all HW waste categories
	Total unclassified waste	The sum of all * waste categories

* The prefix must be decided based on the analytical results from waste classification

4 RESULTS: WASTE GENERATION IN SOUTH AFRICA, 2011

The data presented in **Table 8, 9 and10** is the calculation of national data for the whole of South Africa per waste management option i.e. recycled, treated or disposed. Data has been collected from various sources and verified by the project team, stakeholders and also by outside experts.

A number of waste types are duplicated in Schedule 1 for reporting to the South African Waste Information System, thus appearing under general and hazardous waste. In the absence of analytical data to inform the distinction between hazardous and non-hazardous portions of these waste types, and in order not to skew the results, these wastes are reported separately in **Table 10** as unclassified waste. The split between general, hazardous and unclassified waste is illustrated in **Figure 3**.

Figure 3: Waste Composition as percentage of Total waste generated in SA, 2011

4.1 General waste

According to the modeled waste data, South Africa generated 59 million tonnes of general waste in 2011 (**Table 8**). An estimated 5.9 million tonnes of general waste was recycled (~10%) with the remaining 53.5 million tonnes of general waste being landfilled (**Table 8**). Municipal (GW01) and commercial and industrial waste (GW10), generated within municipalities represents a total of **20,157,335 tonnes** when the recyclables (reported under GW 30, GW 50, GW51, GW52, GW53 and GW54) are included. The percentage contribution of each waste stream to the composition of general waste is illustrated in **Figure 4**. Non-recyclable municipal waste contributes 35% (by weight) of the overall general waste, construction and demolition waste, 20%, followed by metals (13%), organic waste 13% and mainline recyclables (including paper, plastics, glass and tyres (19%).

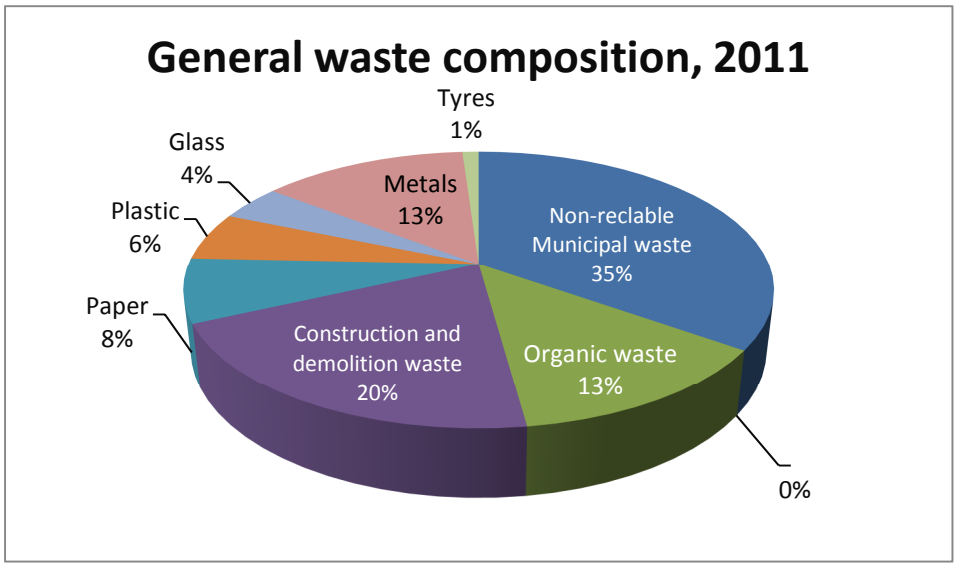

Figure 4: The waste composition for general waste, 2011 (percentage by mass), (excluding GW99-Other, which is mainly biomass waste from industrial sources).

Table 8: General waste by management option - 2011

General Waste 2011		Generated	Recycled	Landfilled	Recycled
		Tonnes			%
GW01	Municipal waste (non-recyclable portion)	8 062 934	-	8 062 934	0
GW10	Commercial and industrial waste	4 233 040	3 259 441	973 599	77
GW13	Brine	See Table 10			
GW14	Fly ash and dust from miscellaneous filter sources	See Table 10			
GW15	Bottom ash	See Table 10			
GW16	Slag	See Table 10			
GW17	Mineral waste	See Table 10			
GW18	Waste of Electric and Electronic Equipment (WEEE)	See Table 10			
GW20	Organic waste	3 023 600	1 058 260	1 965 340	35
GW21	Sewage sludge	See Table 10			
GW30	Construction and demolition waste	4 725 542	756 087	3 969 455	16
GW50	Paper	1 734 411	988 614	745 797	57
GW51	Plastic	1 308 637	235 555	1 073 082	18
GW52	Glass	959 816	307 141	652 675	32
GW53	Metals	3 121 203	2 496 962	624 241	80
GW54	Tyres	246 631	9 865	236 766	4
GW99	Other	36 171 127	-	36 171 127	0
Total general waste [T]		**59 353 901**	**5 852 484**	**53 501 417**	**~10**

(-) means no data on recycling was available. GW01 – only the non-recyclable portion is reported here.

4.1.1 Trends

While it has been mentioned that the 2011 baseline data is not directly comparable to previous studies, it is useful to place the data in the context of other studies as a means of benchmarking the results and to reflect on trends and growth rates in general waste generation in South Africa over the past decade.

Based on the data presented in **Figure 4**, growth rates for general waste were calculated.

- Using the DWAF (2001) 1997 and 2010 modeled data results in a growth rate in general waste of 3.26% per annum
- Using the DEAT (2001) 2006 and the DEA (2009b) data results in a growth rate in general waste of 3.95% per annum
- Using the DEA (2012) 2002 to 2010 modeled data results in a growth rate in general waste of 1.57% per annum

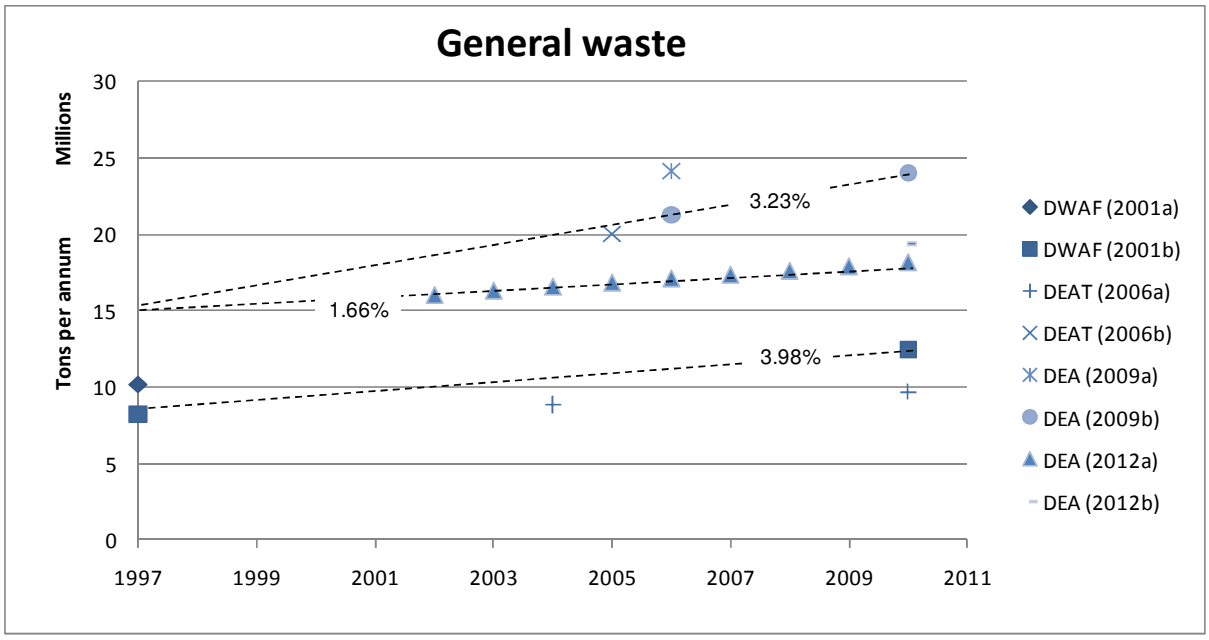

Figure 5: Analysis of available general waste data (from municipalities) for South Africa

Notes on Figure 5:

DWAF (2001a) – Baseline 1997 general waste disposal (questionnaires at landfill)
DWAF (2001b) – Baseline 1997 domestic & commercial (general waste) generation (calculated from population)
DEAT (2006a) – Environmental Outlook 2006 domestic waste generated (calculated from population)
DEAT (2006b) – Strategic Framework for Sustainable Development in SA, municipal solid waste (no info on method)
DEA (2009a) – NWMS Research Paper, total general waste disposed (2006/7) (Purnell adapted from DEA, 2007)
DEA (2009b) – NWMS Research Paper, total general waste collected (2006/7) (Purnell adapted from DEA, 2007)
DEA (2012a) – National waste information baseline, municipal waste generation (calculated from population)
DEA (2012b) – National waste information baseline, municipal waste generation (refer to Table 6)

According to DEA (2006b) "*MSW quantities are growing faster than the economy in many cities – for example, at 5% per annum in Cape Town*". Fiehn & Ball (2005) suggested a current growth rate envelope of between 2-3% per annum from a starting tonnage of ±15mT/a. Calculating general waste tonnages based only on annual increases in population may be under-estimating the quantities of general waste produced, as suggested by the low generation rate of 1.57% (DEA, 2012a) (**Figure 5**). It is therefore suggested that the modeled municipal waste generation rate referred to in **Table 6** is likely to be a fair estimate of the municipal waste generation in South Africa in 2011.

4.2 Hazardous waste

According to the modeled waste data, South Africa generated 1,319,096 tonnes of hazardous waste in 2011 (**Table 9**). The composition of the hazardous by mass is illustrated in **Figure 6**.

Table 9: Hazardous waste by management option - 2011

Hazardous Waste		Generated	Recycled	Treated	Landfilled	Recycled
		Tonnes				%
HW01	Gaseous waste	55	-	55	-	-
HW02	Mercury containing waste	868	-	-	868	-
HW03	Batteries	32 912	32 254	-	658	98
HW04	POP Waste	486	-	80	406	-
HW05	Inorganic waste	290 154	-	-	290 154	-
HW06	Asbestos containing waste	33 269	-	-	33 269	-
HW07	Waste Oils	120 000	52 800	-	67 200	44
HW08	Organic halogenated and /or sulphur containing solvents	111	-	-	111	-
HW09	Organic halogenated and/or sulphur containing waste	8 389	-	64	8 325	-
HW10	Organic solvents without halogens and sulphur	771	-	-	771	-
HW11	Other organic waste without halogen or sulphur	202 708	-	-	202 708	-
HW12	Tarry and Bituminous waste	255 832	-	-	255 832	-
HW19	Health Care Risk Waste	46 291	-	46 291	-	-
HW99	Miscellaneous	327 250	-	-	327 250	-
Total Hazardous [T]		**1 319 096**	**85 054**	**46 490**	**1 187 552**	**~ 6**

(-) Blank cell means that we have no data on this waste stream being recycled or treated.

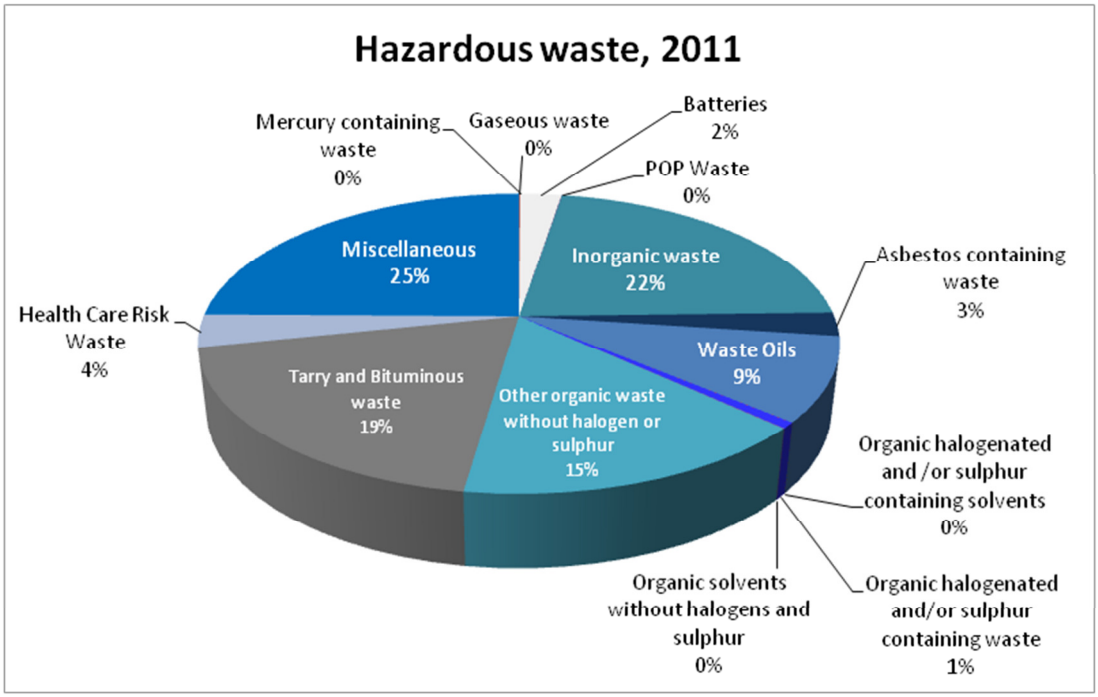

Figure 6: Percentage (by mass) composition of hazardous waste, 2011.

4.3 Unclassified waste

The Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF, 1998) refers to relatively low hazard wastes which are generated in high volumes. The waste streams that are listed under both general and hazardous waste fall into this category of waste and will require classification before reporting into SAWIS. In order not to skew the results of this baseline, these waste streams are reported here as 'unclassified waste' (**Table 10**). The prefix GW or HW will depend on the analytical results of classification.

Table 10: Unclassified waste by management option - 2011

Unclassified Waste		Generated	Recycled	Treated	Landfilled	Recycled
		Tonnes				%
HW13 & GW13	Brine	4 166 129	-	-	4 166 129	-
HW14 & GW14	Fly ash and dust from miscellaneous filter sources	31 420 488	1 885 229	-	29 535 259	6
HW15 & GW15	Bottom ash	5 717 324	-	-	5 717 324	-
HW16 & GW16	Slag	5 370 968	2 685 484	-	2 685 484	50
HW17 & GW 17	Mineral waste	369 000	-	-	369 000	-
HW18 & GW18	Waste of Electric and Electronic Equipment (WEEE)	64 045	6 884	-	57 161	11
HW20 & GW 21	Sewage sludge	673 360	130 160	42 624	500 508	19
Unclassified [T]		**47 781 314**	**4 707 757**	**42 624**	**43 030 865**	**~ 10**

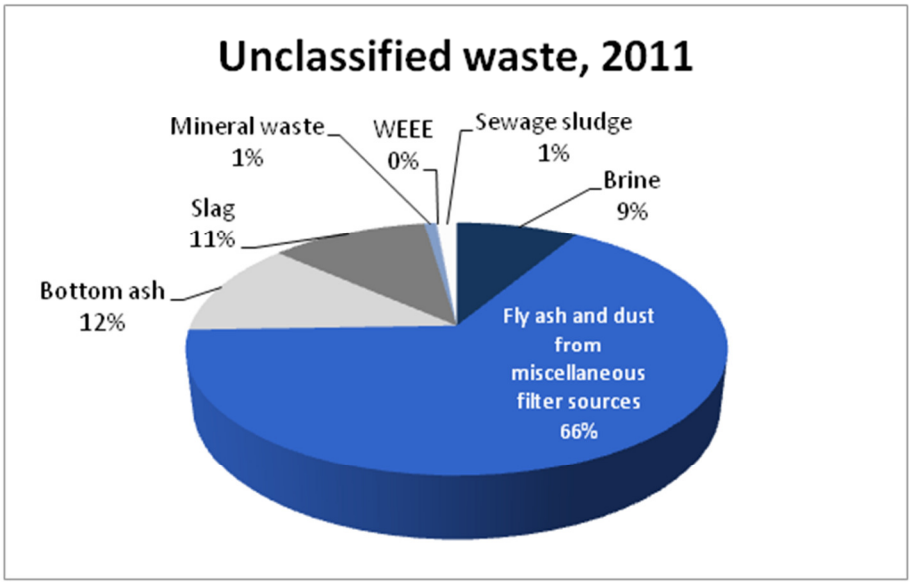

Figure 7: Percentage (by mass) composition of unclassified waste

The bulk of the unclassified waste is fly ash, bottom ash and slag (**Figure 7**). Both fly ash and slag has significant recycling potential in the cement and construction industry as aggregates and cement extenders. It is therefore possible to significantly reduce the amount of unclassified waste disposed of at landfill by optimizing and extending the recycling potential of these waste streams. Fly ash is a case in point where "*ash utilization is a sustainable business providing cost–effective solutions to pertinent problems*" (Kruger and Krueger, 2005).

Similarly, sewage sludge has reuse potential as soil conditioner (agricultural use). In addition, utilising the calorific energy value of the sludge (generating heat) or extracting useful constituents from the sludge (example: extraction of phosphorus) should be considered. In this regard, the reader is referred to the "*Guidelines for the utilization and disposal of wastewater sludge*" series of documents developed by the Water Research Commission.

5 CONCLUSIONS

From the modeling of available data, it can be concluded that South Africa generated approximately 108 million tonnes of waste in 2011, of which 98 million was disposed of at landfill. In the order of 59 million tonnes is general waste, 1 million tonnes is hazardous waste and the remaining 48 million tonnes is unclassified waste, which still needs to be classified based on analytical data. In the order of 10% of all waste generated in South Africa was recycled in 2011. Waste management in South Africa is thus still heavily reliant on landfilling as a waste management option, with 90.1% of waste generated being disposed of to landfill in 2011.

Determining a national waste information baseline for South Africa for 2011 has proven extremely challenging due to a general lack of accurate waste data reporting. The fact that all waste streams are not currently classified and/or reported according to the new waste types as specified in Schedule 1 (RSA, 2012a), added to the challenge. Waste streams, listed under both general and hazardous waste of Schedule 1 (RSA, 2012a), have been reported as 'unclassified waste' since it is not possible to split the hazardous and non-hazardous components in the absence of analytical data. According to the 1998 classification of waste (DWAF, 1998), ash and slag present relatively low hazards, but may pose problems because of their high volumes. It is therefore imperative that where utilisation potential of these waste streams exist that it should be encouraged in order to reduce the amounts being disposed of at landfill.

Despite being unable to accurately split the waste between general and hazardous waste, the reported amounts are deemed as fair estimates to inform policy decisions.

6 REFERENCES

City of Cape Town (2004) City of Cape Town Integrated Waste Management Plan: Final Status Quo Report, March 2004.

City of Tshwane (2004) Development of an integrated waste management plan for the City of Tshwane Metropolitan Municipality. November 2004.

DEA (Department of Environmental Affairs) (2011) National Waste Management Strategy. *Government Gazette 35306 Government Notice 344 of 4 May 2012.*

DEADP (Department of Environmental Affairs and Development Planning, Western Cape) (2011) Status Quo Report: Integrated Waste Management Plan for the Western Cape Province. DEADP, Cape Town.

DEAT (Department of Environmental Affairs and Tourism) (1991) First report on the situation of waste management and pollution control in South Africa. CSIR Report No. CPE 1-91. CSIR: Pretoria.

DEAT (Department of Environmental Affairs and Tourism) (2005) National Waste Management Strategy Implementation, South Africa. Waste Information System Framework Document, Final Report. DEAT: Pretoria.

DEAT (Department of Environmental Affairs and Tourism) (2007) Assessment of the status of waste serviced delivery and capacity at the local government level. Department of Environmental Affairs and Tourism. Pretoria, South Africa.

DWAF (Department of Water Affairs and Forestry) (1998) Waste management Series: Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste. Second Edition. DWAF: Pretoria.

DWAF (Department of Water Affairs and Forestry) (2001) Water Quality Management Series: Waste Generation in South Africa. DWAF: Pretoria.

Fiehn H and Ball J (2005) Background research paper: Waste. South Africa Environment Outlook. National State of the Environment Project. Department of Environmental Affairs and Tourism: Pretoria

GDACE (Gauteng Department of Agriculture, Conservation and Environment) (2007) First Generation Waste Management Plan for Gauteng (GHWMP) – G/DACE 07/2006. Situation Analysis and Baseline Assessment Report. 3 December 2007.

GDACE (Gauteng Department of Agriculture, Conservation and Environment) (2008) Gauteng Waste Minimisation Plan: Status Quo Report V3.

Gibb (2008) A study on waste categorisation for solid waste services in the City of Cape Town.

Godfrey L (2008) Facilitating the improved management of waste in South Africa through a national waste information system. *Waste Management* 28: 1660-1671.

Godfrey L, Scott D, Difford M and Trois C (2012) Part 1: The role of waste data in building knowledge: The South African waste information system. *Waste Management*, 32(11): 2154-2162.

GPG (Gauteng Provincial Government) (2004). Gauteng Waste Information Regulations. Gazette No. 372, Notice No: 3035b.

Kruger RA and Krueger JE (2005) Historical Development of Coal Ash Utilisation in South Africa. *Proceedings 2005 World of*

Coal Ash (WOCA), April 11-15, 2005, Lexington, Kentucky, USA.

LDEDET (Department of Economic Development, Environment and Tourism, Limpopo (2005) Development of a hazardous waste management plan for Limpopo Province: Status Quo Analysis of Hazardous waste management in Limpopo Province (Draft Final Report V1.1.) DEDET, Polokwane.

LDEDET (Department of Economic Development, Environment and Tourism, Limpopo Province) (2006) Hazardous waste management in Limpopo Province. Draft Final Report. LDEDET, Polokwane.

Mangaung Local Municipality (no date) Mangaung Local Municipality: IWMP – Final Draft.

National Treasury (2011) Local Government Budgets and Expenditure Review: 2006/07 – 2012/13.

NWDACE (Department of Agriculture, Conservation and Environment, North West Province) (2006) Development of a hazardous waste management plan for North West Province: Status Quo Analysis Report. NWDACE, Mmabatho.

Pikitup (2004) Pikitup Johannesburg Material Reclamation Study. Report by DSM and KV3.

RSA (Republic of South Africa) (2009) National Environmental Management: Waste Act, 2008: No. 59 of 2008. Government Gazette No. 32000, Vol. 525. Government Printers: Pretoria.

RSA (Republic of South Africa) (2010) National Waste Information Regulations in terms of the National Environmental Management: Waste Act, 2008 (Act No 59 of 2008). Government Gazette No 33384 Government Notice 718 of 23 July 2010. Government Printers: Pretoria.

RSA (Republic of South Africa) (2011) National Environmental Management: Waste Act (59/2008): Draft waste classification and management regulations. Government Gazette No. 34417, Vol. 553. Government Printers: Pretoria.

RSA (Republic of South Africa) (2012a) National Environmental Management: Waste Act (59/2008): Waste information regulations. Government Gazette No. 35583, Vol. 625. Government Printers: Pretoria.

RSA (Republic of South Africa) (2012b) National Environmental Management: Waste Act (59/2008): Waste classification and management regulations. Government Gazette No. 35572 of 10 August 2012. Government Printers: Pretoria.

Sibernagl P (2011) What's the composition of your domestic waste stream? Is there value in recycling? The Waste Revolution Handbook 1, 136-141.

SPLM (Sol Plaatjie Local Municipality). (2010) Sol Plaatjie Local Municipality Integrated Waste Management Plan.

Statistics South Africa (StatsSA) (2007) Community Survey 2007: Municipal data on household services. Report No 03-01-22(2007). Statistics South Africa. Pretoria, South Africa.

Statistics South Africa (StatsSA) (2010) General Household Survey, 2010. Statistical Release P0318. Statistics South Africa, Pretoria, South Africa.

Statistics South Africa (StatsSA) (2011a) Mid-year Population Estimates 2011. Statistical Release P0302. Statistics South Africa, Pretoria, South Africa.

Statistics South Africa (StatsSA) (2011b) Statistical release: Gross domestic product, Annual estimates 2002-2010, Regional estimates 2002-2010, Third quarter: 2011, November 2011b. Statistics South Africa, Pretoria, South Africa

Statistics South Africa (StatsSA) (2012) Census 2011. Census in Brief. Statistics South Africa, Pretoria, South Africa

Wise CC, Emery RC and Coetzee JA (2011) Composition of waste landfilled at metropolitan landfills and the impact of the new draft waste regulations. In: Proceedings of the LANDFILL 2011 Seminar, "Waste Management Facilities – The New Order", 18-20 October 2011, Durban, South Africa.