Appendix A: Stakeholder list

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Appendix B: Competition Commission Resolution

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30 January 2012

Director General: Ms Nosipho Ngcaba
Department of Environmental Affairs
Private Bag X447
Pretoria
0001

Dear Ms Ngcaba

This letter and the contents thereof are in response to the formal request (letter dated 30 September 2011) by the Department of Environmental Affairs to the Competition Commission to provide formal responses on the matter of confidentiality of information contained in the South African Waste Information System as well as on comments on the Waste Information Regulations of 2010.

This request by the Department of Environmental Affairs (the Department) was followed by a meeting between the Commission and the Department of Environmental Affairs on 23 September 2011, convened at the behest of the Department. It was as this meeting that the Commission raised concerns about the Department's form of publication of information concerning waste facilities in South Africa. Particularly, the following were discussed:

- the manner in which SAWIS will publicise the information on tonnage reporting based on activity types, standards industrial classification, waste options, municipality, province as well as the applicable period.
- the acceptable level of reporting in terms of competition law principles.

The meeting evaluated that the manner in which the Department intended to publish information regarding waste firms could possibly fall foul of competition law principles thus further information was requested by the Commission team to assess the matter.

The Commission's view is that:

1. concerning the Draft Waste Regulations: In the regulations, we noted the purpose of the regulations of regulating the collection of data to fulfil the objectives of the national waste information system set out in section 61 of the Act. We also noted that the regulations provide for the transfer of ownership and the registered person must notify the department thirty (30) days prior to the business being transferred. Section 12 of the Competition Act defines a merger *as occurring when one or more firms directly or indirectly acquire or establish direct or indirect control over the whole or part of the business.* A merger may be achieved in any manner including through purchase or lease of shares, an interest or assets of the other firm in question or amalgamation or other combination with the firm in question. However having noted the provisions of the Regulations, we could not find any of its provisions to be raising competition concerns. The Waste Regulations therefore did not raise competition concerns.

2. concerning the SAWIS: only aggregated information on SAWIS should be made available to the general public.
   Information on the type of waste activity, the source of waste, the tonnage of waste, Standard Industrial Classification can be published per province or municipality. However, where there are fewer participants in the waste facilities market within a municipality, the information described above should be published per province. This is to avoid coordinated anti-competitive effects.

   No waste facility specific information will be divulged to the public unless the Department is forced to do so in terms of Waste Information Regulations or any applicable law of the Republic of South Africa.

   No real time information on tonnages, the source of the waste and the period of the waste will be available to the general public.

   The time period for publication of information contained in the SAWIS (South African Waste Information System) should be published **3 months after the end of the year of the Department not after 12 months.**

   Should there be any further questions or issues concerned with the content of this letter, you may contact Mr. Mziwodumo Rubushe on (012) 394 3194 (mziwodumor@compcom.co.za) or Thapi Matsaneng on (012) 394 3535 (thapim@compcom.co.za) .

Yours sincerely,

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Promoting a competitive business environment for the benefit of all South African consumers, workers and owners.

Appendix C: Literature Review

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1 Background

A literature review was undertaken as a desk top study covering a thorough literature search of available waste related information. The internet was searched covering the official websites of:

- National Department of Environmental Affairs (SAWIS and SAWIC);
- National Department of Water Affairs (WARMS);
- Department of Trade and Industry;
- Water Research Commission;
- Provincial Departments responsible for Environmental Affairs;
- Municipalities (Metropolitan, District and Local Municipalities);
- Municipal Demarcation Board;
- Statistics South Africa;
- Industry Associations; and
- Specific industries.

Where information was not readily available on the internet; specific documents were sourced from government departments (national and provincial), municipalities, consulting firms that are known to do work for municipalities, industry associations, research organisations and direct interactions with key players in the waste sector that act as custodians for waste information. The literature search was also expanded to cover research findings and papers published in peer reviewed scientific journals.

The project team focussed their efforts on obtaining as many as possible of the following reports:

- Integrated Waste Management Plans (Provincial, District, Metropolitan and Local municipality);
- Industry Waste Management Plans;
- Hazardous Waste Management Plans;
- Integrated Development Plans;
- State of the Environment Reports;
- Previous National Baseline Studies;
- Surveys conducted at various levels;
- National Government Databases (WARMS, Inventories, SAWIS etc.);
- Industry and waste stream guidelines;
- Sustainability Reports;
- Audit reports; and
- Annual Reports.

The reports thus sourced were reviewed for relevant information on waste figures as well as information on how these figures were derived and recorded. Information extracted from the reports was entered into one of two spreadsheets: one covering general waste and the other hazardous waste. The spreadsheets were designed to allow for data to be recorded in line with the new waste categories as outlined in Schedule 1 of the waste information regulations (RSA, 2012). The sources of the data points were also recorded for tracking purposes. A list of all literature reviewed is provided in Appendix D.

1.1 Integrated Waste Management Plans

The concept of integrated waste management plans was first introduced in South Africa as part of the National Waste Management Strategy Implementation project in 2000. The purpose of integrated waste management planning (IWMP) is to improve the quality of life of all South Africans, through maximised efficiency of waste management services, provided at least cost with minimum environmental impacts (DEAT, 2000). The Department of Environmental Affairs developed a guideline in support of the compilation of IWMPs stating that "c*ollection of reliable data and other information on the existing waste situation...is a critical first step in compiling an integrated waste management plan"* (DEAT, 2000: 4). The guideline specifies that data to be collected include ***waste quantities and characteristics*** (DEAT, 2000).

Some municipalities voluntarily developed IWMPs before it became a legal requirement with the promulgation of the Waste Act. In terms of section 11 of the Waste Act, 2008 (Act 59 of 2008), all municipalities are compelled to develop IWMPs which must be approved by the MEC. The approved IWMP must be included in the Integrated Development Plan (IDP) of the municipality as contemplated in the Municipal Systems Act, 2000 (Act 32 of 2000). The point of departure of the project team was therefore to collect as many as possible IWMPs or Status Quo reports developed in support of IWMPs.

The percentage of municipalities for which the project team could source at least first generation IWMPs (or Status Quo Reports) are summarised in Table 1. The IWMPs (or Status Quo Reports) reviewed by municipal category is summarised in Table 2.

Generally aggregated data is presented in IWMPs whereas Status Quo reports contain more detailed waste data.

Waste quantity data reported in IWMPs (or Status Quo Reports) is largely based on waste generation estimates calculated from population data. Few municipalities record waste disposal data. It is therefore difficult to determine waste flows from generation through to disposal.

Waste generation rates vary depending on geographic location, activity, settlement type, income level etc. A number of IWMPs (NWDACE, 2008; Francis Baard DM, 2010) quote waste generation rates for the various socio-economic groups, commercial and industrial centres and institutions from unpublished guidelines (National Framework Guideline for Integrated Waste Management Plans, 2006). Although these guidelines were not available to the project team, these waste generation rates are provided in Table 3.

The influence of income level on waste generation is illustrated in Table 4.

Table 1: Percentage of Municipalities for which at least 1st generation IWMPs (or Status Quo Reports) could be sourced as part of the project

Province	Local Municipalities			District Municipalities			Metropolitan Municipalities		
	IWMP	Total	% of municipalities with IWMPs	IWMP	Total	% of municipalities with IWMPs	IWMP	Total	% of municipalities with IWMPs
Eastern Cape	8	38	21.1	2	6	33.3	1	1	100.0
Free State	5	20	25.0	3	5	60.0	-	-	-
Gauteng	2	9	22.2	2	3	66.7	3	3	100.0
KwaZulu-Natal	19	50	38.0	6	10	60.0	1	1	100.0
Limpopo	16	26	61.5	4	6	66.7	-	-	-
Mpumalanga	7	17	41.2	1	3	33.3	-	-	-
North West	4	21	19.0	1	4	25.0	-	-	-
Northern Cape	19	26	73.1	4	5	80.0		-	-
Western Cape	24	24	100.0	5	5	100.0	1	1	100.0
Total	104	231	45.0	28	47	59.6	6	6	100.0

Table 2: Summary of IWMPs (or Status Quo Reports) reviewed by municipal category

Type of IWMP	Total number	1st Generation Plans	% 1st generation plans	2nd Generation Plans	% 2nd generation plans	3rd Generation plans	% 3rd generation plans
Provincial	9	7	77.8	1	11.1	0	0.0
Metropolitan municipalities	6	6	100.0	2	33.3	0	0.0
B1 – Local municipalities	21	13	61.9	2	9.5	0	0.0
B2 – Local municipalities	29	17	58.6	0	0.0	0	0.0
B3 – Local municipalities	111	49	44.1	1	0.9	0	0.0
B4 – Local municipalities	70	25	35.7	1	1.4	0	0.0
District municipalities	47	28	59.6	1	2.1	1	2.1

Table 3: Waste generation rates by income level (source: DEAT, 2006; BPDM, 2009)

Income level	Waste generation kg/capita/day					
	DEAT (2006)	DEAT (unpublished)	GDACEL	BPDM (2004)	NWDACE (2008)	Average
Very Low	-	-	0.2-0.4 (average 0.3)	-	-	0.3
Low	0.41	0.2-0.7 (average: 0.45)	0.4-0.7 (average: 0.55)	0.45	0.45	0.46
Medium	0.74	0.7-1.9 (average: 1.3)	0.7-1.1 (average: 0.9)	1.10	1.10	1.03
High	1.29	1.5-3.0 (average: 2.25)	1.1-1.2 (average:1.15)	1.85	1.85	1.68
Very High	-	-	1.2-2.5 (average: 1.85)	-	-	1.85

Table 4: Typical waste generated per Land Use/Activity (DEAT, 2006 in: NWDACE, 2008; Francis Baard DM, 2010)

Land use type/ activity	Typical waste generated	Typical Generation Rates
Residential houses • Low income • Medium income • High income	Kitchen/food waste Packaging Clothing Furniture Electronic Ash Garden waste	(Rate: kg/person/day) • Low income: 0.2-0.7 • Medium income: 0.7-1.9 • High income: 1.5-3.0
Residential Flats	Kitchen/food waste Packaging Clothing Furniture Electronic	(Rate: kg/person/day) 0.5-2.2
Schools, Hostels, Educational centres and other institutions	Office paper and books Packaging Electronic Furniture Kitchen/food Plants and grass cuttings	(Rate: kg/occupant/day) 0.5-1.3
Suburban business centre/office park	Old office material Packaging Electronic Furniture Food Plants and grass cuttings	(Rate: kg/employee/day) 0.8-1.7
Central business area/office buildings and tower	Old office material Packaging Electronic Furniture Food Street sweepings/litter	(Rate: kg/employee/day) 0.7-2.0
Restaurants, hotels, fast food outlets	Food Packaging Cutlery Electronic Textiles	(Rate: kg/client/day) 0.5-1.5
Industrial • Light • Heavy • Services/garages • Chemicals and Allied	Packaging/crates Used Chemicals Old Lubricants Used spares Old Tyres Old office material	(Rate: kg/employee/day) 0.5-3.0
Building/construction	Demolished buildings Wood Concrete Rood sheeting Bricks Pipes Packaging Old paint Used chemicals	(Rate: kg/company/day) 10-1000
Hospitals, Clinics doctors, dentist and healthcare facilities	Old medicine Food Human tissue/organs Textiles Syringes Needles and sharps Packaging Bloodstained bandages/material	(Rate: kg/patient/day) 1.0-3.0

The North West Provincial Integrated Waste Management Plan (NWDACE, 2008) is the only source quoted in Table 3, defining the income levels as follows: low income (R0-R38 600), medium income (R38 601-R153 600) and high income (R153 601 and above).

The per capita waste generation per province according to Fiehn and Ball (2005) is provided in Table 5. It was not possible to confirm or update this data from the information contained in IWMPs available for review.

Table 5: Annual waste generation per capita per province (Fiehn and Ball, 2005)

Province	kg/capita/annum
Western Cape	675
Eastern Cape	113
Northern Cape	547
Free State	199
KwaZulu Natal	158
North West	68
Gauteng	761
Mpumalanga	518
Limpopo	103

Important observations were made while reviewing IWMPs and status quo reports:

- Many IWMPs focus on a status quo analysis and do not follow the guidelines provided by DEA.
- The level of detail in reports compiled by the same professional service provider for different municipalities was comparable.
- The authenticity of these plans and their applicability to local conditions in each local municipality is questionable, as many of the reports appears to be identical in many respects with only the waste amounts adapted to the local conditions.
- The involvement of local stakeholders in the development of many of these plans is questionable.
- The level of ownership taken for these plans by the local authorities is questionable.
- Implementation of IWMPs was not confirmed as part of this project.

Although an audit of the implementation of the IWMPs was beyond the scope of this project, it may be something that government should consider.

1.2 Waste characterisation studies

Waste characterization studies to inform IWMPs are still largely lacking. The composition of waste collected from households differs depending on income level and geographic location of the municipality. Waste composition figures reported in literature are summarized in Table 6.

The following shortcomings relating to waste characterization studies were identified:

- sampling and sorting methods used are not standard
- waste categories vary between studies and are not comparable
- low numbers of samples renders the study unrepresentative
- sampling periods does not cater for seasonal variation (the majority was done in winter)
- variability in sorting accuracy.

Since waste generation rates are influenced by income group, the composition of the waste also differ as indicated in Table 7. In some cases medium and high income groups are lumped together and reported as one figure (DEADP, 2007a; DEADP, 2007b; DEADP, 2007c). This inconsistency in reporting style between municipalities makes is virtually impossible to compare data and to come to conclusions that will be relevant for South Africa.

Table 6: Domestic waste composition (% by weight) by municipality

Municipality	Organic	Paper	Other	Plastic	Glass	Metals	Reference
Cape Town (1999)	45	19	9	13	9	6	CoCT, 2004
Cape Town (2007)	12	34	14	14	17	8	DEADP, 2007a
Cape Town	39	20	5	18	11	7	DEADP, 2011
Cape Winelands DM (2007)	17	34	17	19	7	6	DEADP, 2007b
Cape Winelands DM	29	26	13	18	8	6	DEADP, 2011
Central Karoo DM (2007)	12	24	22	23	11	9	DEADP, 2007c
Central Karoo DM	14	28	6	28	13	11	DEADP, 2011
West Coast DM	18	19	23	27	6	7	DEADP, 2011
Overberg DM	24	22	33	10	5	6	DEADP, 2011
Eden District	32	13	2	33	10	10	DEADP, 2011
Polokwane LM (2007)	40	19	0	18	12	10	Ogola et al, 2011
Sol Plaatjie LM (2010)	10	21	39	18	10	3	SPLM IWMP, 2010
Lejwelepustwa DM (2011)	31	13	27	15	9	5	DEDTEA, 2011
Mangaung LM (2001)	53	15	10	9	7	6	MLM, n.d.
Johannesburg (2001)	36	17	30	10	5	3	Jarrod Ball and Associates, 2001
Johannesburg (2003)	n/a	9	n/a	5	6	2	Pikitup, 2004.
Mafikeng LM (2011)	10	4	61	7	14	4	Mafikeng, 2011
Southern DM (2004)	58	11	14	9	6	2	NW DACE, 2008
Bophirima DM (2004)	58	11	14	9	6	2	NW DACE, 2008
Ngaka Modirti Molema DM (2004)	58	11	14	9	6	2	NW DACE, 2008
Bonjanala Platinum DM (2004)	58	11	14	9	6	2	NW DACE, 2008
uMgungundlovu DM Urban (July 2010)	36	17	28	10	6	3	UDM, 2010
uMgungundlovu DM Rural (July 2010)	37	11	25	9	12	6	UDM, 2010

Table 7: Municipal waste composition by income group

Municipal waste	Income group				Average
	Very Low	Low	Medium	High	
	Mangaung (2001 data) (MLM, n.d.)				
Paper	n/a	11	14	19	15
Plastic	n/a	9	7	10	9
Greens/organic	n/a	58	61	41	53
Glass	n/a	6	7	9	7
Metals	n/a	2	4	11	6
Other	n/a	14	7	10	10
	Johannesburg (Jarrod Ball & Associates, 2001)				
Paper	n/a	13	16	21	17
Plastic	n/a	11	10	9	10
Greens/organic	n/a	28	45	35	36
Glass	n/a	5	4	5	5
Metals	n/a	3	3	2	3
Other	n/a	40	22	28	30
	Johannesburg (Pikitup, 2004)				
Paper	5	7	9	11	9
Plastic	4	3	5	5	5
Greens/organic	n/a	n/a	n/a	n/a	n/a
Glass	1	6	7	7	6
Metals	1	1	2	2	2
Other	89	83	76	75	78
	Polokwane (Ogola et al., 2011)				
Paper	n/a	14	19	25	19
Plastic	n/a	14	17	24	18
Greens/organic	n/a	40	41	39	40
Glass	n/a	20	10	7	12
Metals	n/a	12	13	5	10
Other	n/a	0	0	0	0
	Cape Town (1999 data)(CoCT, 2004)				
Paper	n/a	16	23	17	19
Plastic	n/a	10	16	14	13
Greens/organic	n/a	57	39	39	45
Glass	n/a	6	7	13	9
Metals	n/a	4	5	9	6
Other	n/a	7	11	8	9
	Sol Plaatjie Local Municipality (SPLM, 2010)(winter)				
Paper	25	19	9	37	21
Plastic	15	16	13	30	18
Greens/organic	5	19	16	0	10
Glass	9	6	15	3	10
Metals	2	7	2	4	3
Other	44	33	44	27	39

	uMgungundlovu DM Urban (July 2010) (UDM, 2010)				
Paper	n/a	17	16	16	17
Plastic	n/a	9	10	13	10
Greens/organic	n/a	34	38	37	36
Glass	n/a	4	5	9	6
Metals	n/a	3	2	2	3
Other	n/a	34	29	23	28
	uMgungundlovu DM Rural (July 2010) (UDM, 2010)				
Paper	n/a	9	13	13	11
Plastic	n/a	8	9	9	9
Greens/organic	n/a	33	44	35	37
Glass	n/a	15	6	14	12
Metals	n/a	12	2	4	6
Other	n/a	24	27	25	25

1.5 Hazardous waste management plans

Provincial integrated waste management plans generally contain some hazardous waste data and a few provinces have hazardous waste management plans in place. Some information is also available from landfill audit reports.

The following reports were reviewed for hazardous waste:

- The need for and location of high hazardous waste sites for KwaZulu-Natal: Final Report (2000)
- Status Quo of Hazardous Waste Management in Limpopo Province (2005)
- First Generation Integrated Hazardous Waste Management Plan for Gauteng: Situation analysis and baseline assessment report (2006)
- Hazardous Waste Management Plan for the North West Province: Status Quo Analysis Report (2007)
- Development of a Hazardous Waste Management Plan for Mpumalanga Province: Status Quo Report (2008)
- Integrated Hazardous Waste Management Plan for the Free State Province (2009)
- Integrated Waste Management Plan for the Western Cape Province: Status Quo Report (2011)
- Holfontein HH landfill site, Gauteng: External Compliance and Environmental Audit (March 2009)
- Compliance and Status Quo audit of Bulbul Drive H:h landfill site operated by WasteMan KwaZulu Natal (April 2009)
- Shongweni H:h Landfill site, KwaZulu Natal: External Compliance and Environmental audit (Apr 2011)
- Vissershok waste management facility: External Audit (February 2011)

The data contained in these reports were not very useful for reporting into the categories as outlined in Schedule 1 of the Waste Information Regulations (RSA, 2012). There is no uniformity in the way that hazardous waste streams are categorized and reported. The data used in determining the baseline amount was therefore largely calculated from disposal data obtained directly from industry, waste management companies and disposal site audit reports.

1.6 Literature findings pertaining to specific waste streams

A number of waste streams are listed under both general and hazardous waste in Schedule 1. Since no primary data was collected it was not possible to split the general and hazardous portions of the reported waste figures. Therefore, all the data on these waste streams are reported as unclassified waste. Examples on the types of waste streams covered by each waste category are provided (DEA, 2010).

GW 01 - Municipal waste

Municipal waste is not defined in the Waste Act, 2008. Therefore, for the purposes of this baseline, municipal waste is assumed to be composed of mainline recyclables (including paper, plastic, glass, metals and tyres), organic waste (including garden and food waste), construction and demolition waste and non-recyclables (GDACE, 2008; Gibb, 2008). The detailed composition is illustrated in Figure 1 in the main report. The sources of municipal waste as reported in this baseline include households, commercial, and industrial sites as well as illegally dumped waste (refer to Figure 2 in the main report) (MLM, n.d.; Pikitup, 2004; CoCT, 2004; City of Tshwane, 2004).

Municipal waste generation data is primarily estimated based on modeling techniques. Modeling is perhaps preferred as it is the quickest and cheapest way of generating data in the absence of primary data collection. Unfortunately this approach is dependent on good quality input data which, in most municipalities, are not available.

Disposal data for municipal waste is limited to landfill records which are mostly unreliable as it is seldom based on accurate measurement techniques. There are a few reports of studies where waste generation and disposal data was collected through direct measurements. A comparison and alignment of modeled data to direct measured data is considered to lead to accurate estimates.

The Western Cape Province is the only province where all local and district municipalities have IWMPs in place (see Table 1). Despite all municipalities having IWMPs, four different methods were used to calculate waste generation figures for the province, "*on account of suspect data*" (DEADP, 2011: 20). The average tonnages for the Western Cape and all district municipalities in the province were derived from results of these four methods. A mean and standard deviation was calculated to provide an indication of the confidence associated with these figures, namely (±12.5%) (DEADP, 2011).

The four quantification methods reported (DEADP, 2011) are:

1. Population figures, growth rates and per capita waste generation rates reported in or derived from IWMPs were used to calculate waste generation figures for the baseline year. The per capita waste generation rates were weighted according to the urban/rural distribution where provided. An urban/rural ratio of 60/40 was applied where no population ratios were available.
2. Waste figures from municipal IWMPs were used and projected to the base year based on reported or calculated growth rates.
3. Differences between census populations for 2001 and 2007 were used to calculate a growth rate to project the population data. These results were then multiplied by a weighted per capita waste generation rate of 1.0 kg/p/d for urban and 0.11kg/p/d for rural.
4. Current population and waste figures as supplied by the districts were used together with calculated per capita waste generation rates.

The figure for municipal waste generation in South Africa was therefore calculated as 20 157 335 tonnes in 2011. In order to avoid double counting, only the non-recyclable portion of this waste is reported in Table 8 of the main report.

GW 10 – Commercial and Industrial waste

Commercial and Industrial waste is also not defined by the Waste Act, 2008. The composition of commercial and industrial waste is related to the type and scale of industries prevalent in a specific region. A large portion of this waste stream is collected as part of the municipal waste stream and contains mainly mainline recyclables from offices as well as organic waste. It should however be noted, that pre-consumer recyclables from industrial sources are not collected as part of the municipal waste stream but typically collected by the recyclers themselves.

The best sources of information on commercial waste are municipal service providers and the relevant industry associations for industrial waste. It should however be noted that not all industries are affiliated to industry associations. Therefore, data obtainable from industry associations are limited to their membership base.

Data on general waste from commercial and industrial sources was obtained from the Chemical and Allied Industries Association (CAIA), some IWMPs and national government reports. The data was however not sufficient to allow accurate estimates. Therefore, this waste stream is reported as a portion of the municipal waste based on the assumptions as explained in section 3.5.3 of the main report.

It may be worth investigating whether commercial and industrial waste data can be related to GDP, in a manner that is consistent with historical data. One example could be to use an elasticity approach in the following manner:

Extrapolated waste = (initial waste)*(expected GDP)^(elasticity)

This type of approach would require historical waste and GDP data, in order to estimate the elasticity (using regression). In addition, it would require a projection of future GDP values (possibly from National Treasury) in order to obtain extrapolated waste data. Naturally, this approach operates under the assumption that the elasticity remains unchanged over the period of extrapolation. Otherwise stated, this method assumes that the overall mechanism which produces the waste remains the same (i.e. there are no structural changes).

The estimated amount for commercial and industrial waste reported in Table 8 of the main report is calculated based on the assumed composition of municipal waste.

GW 20 – Organic waste

Organic waste refers to garden and food waste only (Schedule 1, level 3) (RSA, 2010). The food waste component represents kitchen waste as well as pre-consumer condemned foods. Organic waste is generally reported as garden, green, putrescible and in some instances notifiable waste.

Data on organic waste is found in municipal IWMPs and landfill records. Since food waste is not separated at household level, little, if any, data is available. Similarly, food waste is not generally separated from general kitchen waste generated at restaurants and food outlets. It is possible to estimate household food waste based on waste characterization studies provided that food waste is used as a separate waste category during sorting. Reports on waste characterisation studies in South African municipalities are scarce as pointed out in section 1.2 above. However, Nahman *et al*. (2012) estimated the quantities of household food waste generated in South Africa per income group as indicated in Table 8 while Oelofse and Nahman (2012) estimated the magnitude of food waste generated in South Africa as being in the order of 9.04 million tonnes per annum.

All garden and food waste is recyclable provided that the most suitable treatment options are considered. The different recycling/treatment options available for organic waste are summarized in Table 9.

The amount of organic waste reported in Table 8 of the main report is based on the assumption that organic waste contributes 15% of the municipal waste stream.

Table 8: Quantities of household food waste generated annually in South Africa (per income group) (Nahman *et al*., 2012)

Income level	Domestic waste (tonnes / annum)	Food waste (%)	Food waste (tonnes / annum)
Low	5 600 116	18.08	1 012 688
Middle	2 929 639	10.98	321 577
High	1 093 352	9.58	104 713
Total	**9 623 106**		**1 438 977**

Table 9: Organic waste treatment options available (DEADP, 2011)

Method	Potential Input Waste Type	Output product
Windrow composting	Garden waste, wood waste, manures, fruit waste	Compost, soil conditioner
Vermi-composting	Food and garden waste	Compost, soil conditioner
Enclosed composting	Mixed organics (food and garden waste) and sewage sludge	Compost, soil conditioner, high calorific value
Anaerobic digestion	Mixed organics (food and garden waste) and sewage sludge	Biogas, green energy, soil conditioner
Fermentation	Agricultural waste, mixed organics	Liquid fuel

GW 30 – Construction and demolition waste

The Waste Act, 2008 (RSA, 2009) defines building and demolition waste as "*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*". Structures referred to can include residential and non-residential buildings, and public works such as roads, bridges, piers and dams (Macozoma, 2002). As such, construction and demolition waste includes, but is not limited to, concrete, bricks, masonry, ceramics, metals, plastic, paper, cardboard, gypsum drywall, timber, insulation, asphalt, glass, carpeting, roofing, site clearance, excavation material and site sweepings (Macozoma 2002). It is therefore clear that building and demolition waste as defined by the Act is likely to be contaminated with other wastes.

Some IWMPs report builder's rubble data, but this is the exception rather than the rule. It is difficult to calculate waste generation data because it is such a complex waste stream.

Viljoen, (2010) estimated that construction and demolition waste in the Western Cape comprise of:

- concrete and masonry (33.3 %),
- wood (25.0 %), and
- drywall (12.5%).

Viljoen (2010) also identified the most critical sources of waste during construction as follows:

- Waste of materials (75%)
- Rework (58.3%)
- Over-allocation of materials (45.8%)
- Deterioration of materials (41.7%).

Recycling data is calculated at 630 000 tonne/annum in 2007 (Dti, 2009). It should also be noted that builders' rubble are often used as cover material at landfills while informal recycling and reuse is likely to be unreported.

This baseline estimated a recycling rate of about 16% for construction and demolition waste while it contributes about 20% of municipal waste disposed at landfill.

GW 50 – Paper

This waste stream includes all different grades of paper: office paper to newspapers, magazines, telephone directories and boxes. Waste characterization studies listed in Table 6 above included cardboard, white and coloured office paper, newspaper, glossy paper (magazines) mixed grades and non-recyclable paper.

According to a waste characterization study in the City of Cape Town (Gibb, 2008) paper constitutes 12.8% and cardboard 9% of the municipal waste stream. This percentage varies between 5% and 37% of household waste depending on the income level and geographical location of the municipality (refer to Table 7 above). The aerage for the Western Cape (DEADP, 2011) is between 13% and 28% of the total municipal waste stream.

Paper waste generation is estimated by the Paper and Packaging Council of South Africa based on paper consumption in South Africa. Statistics on paper production and consumption in 2011 is reported in Table 10. It is estimated that 1 804 582 tonnes of paper was recoverable for recycling in 2011 (PRASA, 2011). This resulted in a recycling rate of about 59% in 2011.

Of the 38% paper recycled in 2000, 24% was post consumer paper comprising 20% from the wholesalers and retailers, 2% domestic and 2% offices. At the time it was estimated that the potential for additional recycling from wholesalers and retailers is 19% (362 tpa), for domestic sources 17% (317 tpa) and 10% (194 tpa) from offices (DEAT, 2000).

GW 51 - Plastic

Plastic waste consists mainly of six materials, all polymers mainly from petrochemical origin, including (PACSA, 2011):

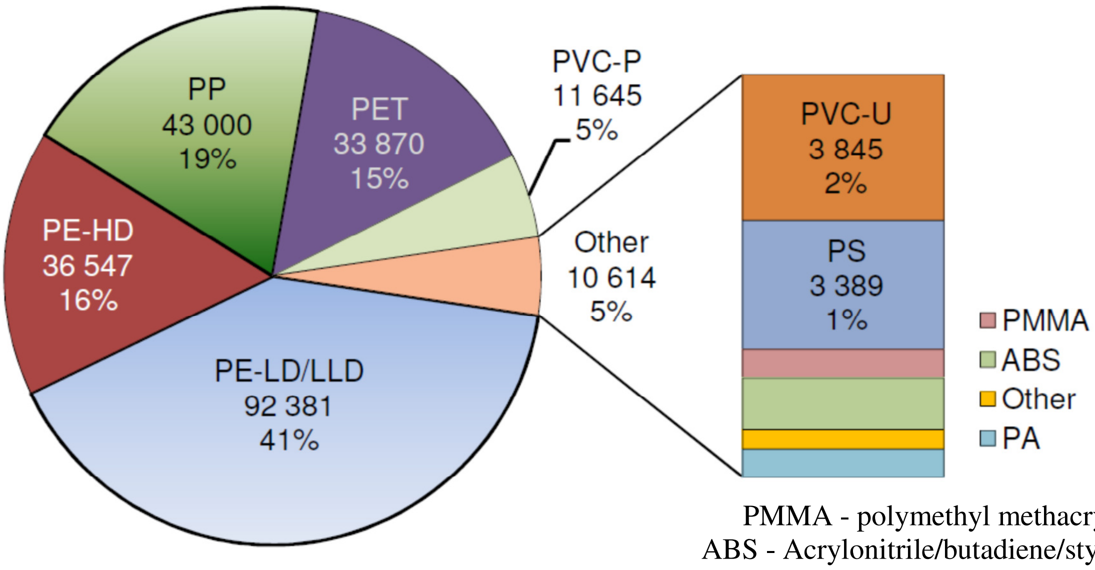
- Polyethylene terephthalate (PET);
- High density polyethylene (HDPE);
- Polyvinyl chloride (PVC) – rigid (PVC-U) and flexible (PVC-P);
- Low and linear density polyethylene (PE-LD and PE-LLD);
- Polypropylene (PP) including expanded polystyrene (PS-E);
- Polystyrene (PS).

Many plastics are packaging materials including bags, bottles and a variety of other containers, but it is also present in the form of pipes, furniture, textiles, etc. in the waste stream. In the Western Cape, plastics contribute between 10% and 33% of the municipal waste stream (DEADP, 2011).

The recycling surveys done by PlasticsSA are considered to be the most comprehensive source of plastics waste data in South Africa. The 2010 survey (covering 2009 data) included personal interviews with 132 recyclers and telephonic interviews with another 49 recyclers. This survey concluded that 1 250 000 tonnes of virgin polymers were converted and 228 057 tonnes of plastics were recycled. This translates into a recycling rate of 18.3 % of all plastics converted. Materials that were not recycled in mentionable quantities include metalized and heavily printed PP films, post-consumer PVC-U and PS-E packaging, biodegradable and oxo-biodegradable films, multi-layer and multi-material packaging films, pesticide and agricultural drums, PET trays and cross linked cable insulation (Plastics Federation, 2010).

Table 10: Paper production and consumption (tonnes) in South Africa, 2011 (PRASA, 2011)

Paper grade	Paper production	Paper Imports	Paper Exports	Paper consumption
Newsprint	316 725	13 900	55 512	275 113
Printing/writing	473 759	562 060	173 265	862 554
Corrugating materials/container board	993 235	87 211	302 025	778 420
Other wrapping papers	89 169		0	89 169
Tissue	203 480	58119	11 247	250 352
Other paper	98 411	65 008	43 984	119 435
Board	27 876			27 876
Total	**2 202 655**	**786 298**	**586 034**	**2 402 919**



PMMA - polymethyl methacrylate
ABS - Acrylonitrile/butadiene/styrene
PA – polyamide (nylon)

Figure 1: Plastics recycled in 2009 (tonnes per material type) (Plastics Federation, 2010)

GW 52 – Glass

This waste streams constitutes many different types of glass including: bottles, jars, flat/sheet glass, laboratory glass, mirrors, windshields and window glass, crystal and opaque drinking glasses, heat-resistant ovenware (e.g. Pyrex and Visionware) and light bulbs. It is estimated that glass comprise 4.5% of the municipal waste stream (www.consol.co.za).Waste characteri-zation studies indicate that glass comprise between 5% and 17% (Table 6) of domestic waste.

Data on glass largely relates to recycling. The data provided in IWMPs for individual cities and municipalities are primarily estimates. However, national data is reported by the Packaging Council of South Africa and the Glass Recycling Company (Table 11). Despite being 100% recyclable, approximately 32% of all non-returnable glass containers produced annually was retrieved for recycling in South Africa in 2010 (www.consol.co.za).

Currently the Glass Packaging Industry, Consol Glass and Nampak Glass, produces glass estimated in the region of one million tons per annum. Of this, less than 25% of the glass containers produced in South Africa, is recovered and recycled. Figure 2 shows the historical glass recycling trend over the past 16 years.

Table 11: Provincial Waste Glass (Cullet) Recoveries (1 July 2010 to 30 June 2011) (The Glass Recycling Company, 2011)

Province	Tonnes
Gauteng	153 304
Kwa Zulu Natal	25 096
North West	23 754
Free State	16 519
Mpumalanga	20 627
Limpopo	17 821
Northern Cape	2 320
Eastern Cape	24 343
Western Cape	54 483
Total: The Glass Recycling Company	**338 267**

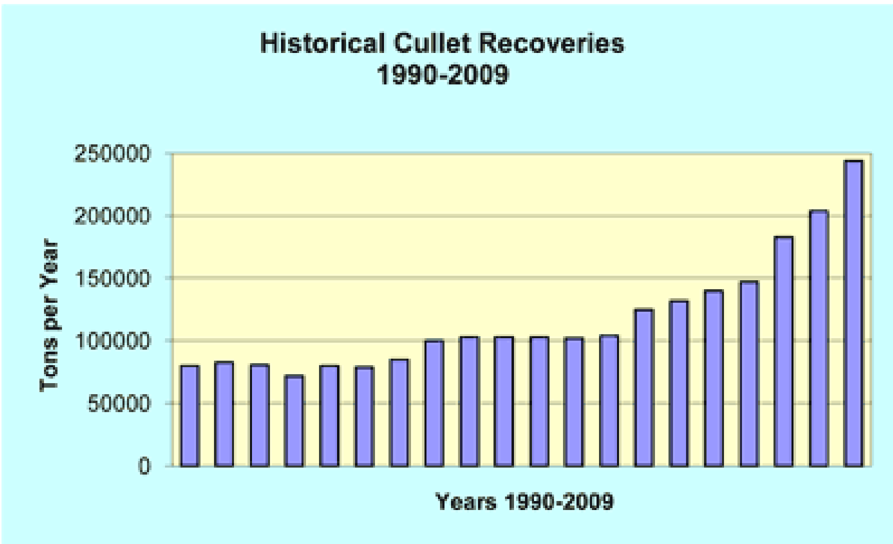


Figure 2: Glass recycling trend 1990-2009 (www.consol.co.za)

GW 53 – Metals

This waste stream consists of old cars, fridges, stoves, beverage cans, steel trimmings, off-cuts etc. The most comprehensive data on metal waste is available from the Metal Recyclers Association of South Africa. According to their records, South Africa produces 2 640 000 tonnes of steel scrap per annum and 420 000 tonnes of non-ferrous scrap per annum. The members of this association are responsible for collection and processing of more than 80% of all scrap metal in South Africa for beneficiation by downstream industries.

Collect-a Can reports on the recovery rate of used beverage cans. The used beverage can recovery rate between 1994 and 2008 is illustrated in

Figure 3.

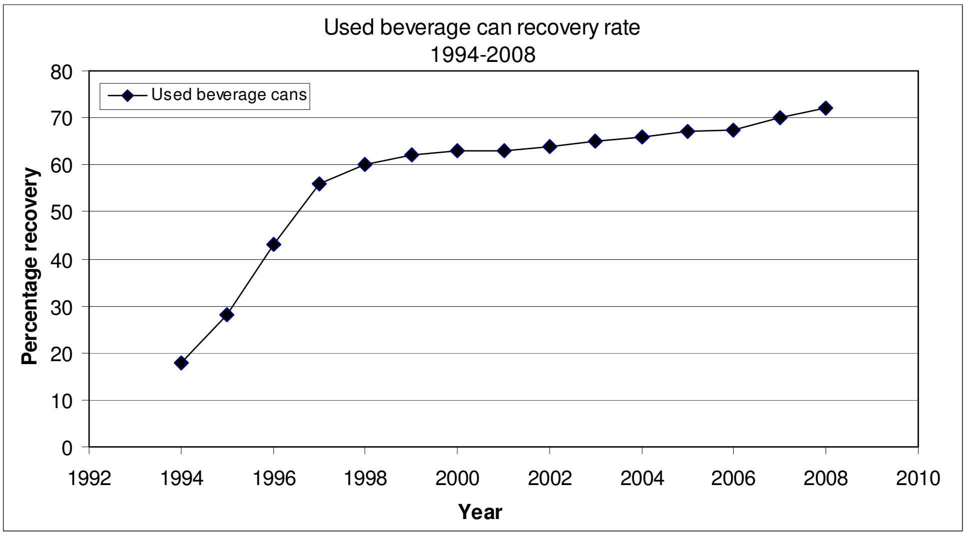


Figure 3: Used beverage can recovery rate 1994-2008 (source: Collect-a-Can)

GW 54 – Tyres

The approved Tyre Industry Waste Management Plan (REDISA, 2012) defines waste tyre as *"a new, used, retreaded or in-roadworthy tyre, not suitable to be retreaded, repaired, or sold as a part worn tyre and not fit for its original intended use"*.

Tyres are categorized into one of the following nine categories (REDISA, 2012):

- Passenger car tyres
- Light commercial tyres
- Heavy commercial tyres
- Agricultural tyres
- Motorcycle tyres
- Industrial tyres
- Aircraft tyres
- Earth moving tyres
- Any other pneumatic tyres

Data on waste tyres are based on tyre sales in South Africa. The REDISA industry waste management plan estimated that 275 000 tonnes of tyres are sold per year. The SATRP industry waste management plan (2010) quotes a figure of 225 000 tonnes of waste tyres generated every year. This figure is calculated based on an 18% reduction in weight between new and waste tyres.

A 4% tyre recycling rate is estimated for 2011.

GW 99 - Other

All general waste not captured under one of the waste streams listed above classifies as "other".

The amount of waste reported in the waste baseline refers to a 2004 study of commercially exploitable biomass resources (DME, 2004). Many IWMPs report "other" waste streams covering packaging materials, forest biomass, sawmill biomass, sugarcane biomass, abattoir waste, hydraulic hoses and pipes, brake pads, printer cartridges, etc. There is however no consistency between these reports and some obvious errors i.e. printer cartridges should be reported as waste electric and electronic equipment.

HW 01 - Gaseous waste

Gaseous waste refers to the gas remaining in gas cylinders and aerosol cans at the end of its use. It includes specialty gases such as those that would be used by the research laboratories as well as for gas stoves, heaters, camping gas etc. Examples include: HCl, NH_3, acetylene, powder extinguisher, N_2, Cl_2, etc. Gas waste cannot be disposed in any other way than being destroyed, e.g. by thermal means or chemical reaction.

The empty cylinders are normally reused, but if they are damaged and cannot be reused, the cylinders become scrap metal. Empty aerosol cans are also recyclable (see GW53 – Metals).

Data on this waste stream is not reported in literature.

The data reported is an estimated by the SA Compressed Gases Association as well as actual data from a thermal waste treatment plant.

HW 02 – Mercury containing waste

All liquid and solid waste containing mercury except compact fluorescent lights (reported as WEEE (HW18)), are reported here. Examples of this waste stream include COD test liquids (Chemical Oxygen Demand) and other mercury containing test liquids; mercury treated seed grain, small packages of chemicals, thermometers, etc.

All data pertaining to mercury waste that is available in the literature relates to the Guernica Chemicals (Pty) Ltd. Industrial site (previously Thor Chemicals). The Thor facility is a historic, nonoperational site with a stockpile of mercury-containing waste. Operations at the site ceased in 1998. The total amount of waste stored at this site is estimated at 2705 tonnes. Of this amount, 972 tonnes are stored in drums in warehouses and the remaining amount (1733 tonnes) is stored in a leach pad.

The data reported is national data for 2010 obtained from waste management companies and excludes the stockpiles mentioned above.

HW 03 – Batteries

Batteries includes all batteries that end up in the waste stream including lead batteries, mercury batteries, Ni/Cd batteries, Manganese dioxide and alkali batteries, lithium and lithium ion batteries, nickel-metal hydride batteries and another type of battery.

Dry-cell battery manufacturers are:

- Uniross (Midrand): Alkaline AAA, AA, C, D and Type 1 9V;
- Eveready (PE); Zinc C (AA, AAA, C and D) batteries and import other types for distribution, most importantly, the alkaline batteries, Lithium Ion (Li-ion) and small numbers of the platinum batteries for special applications plus many types of rechargeable batteries.
- Karbochem (Sasolburg) manufacture Li batteries; and
- A few smaller manufacturers and importers

According to Uniross Batteries, more than 50 million batteries are consumed in South African every year of which 90% is ordinary batteries. The bulk of the ordinary batteries are discarded into the general household waste. This equates to approximately 2500 tonnes of hazardous battery waste being disposed into landfills every year.

Data on lead acid batteries are limited to North West Province and Mpumalanga.

Reported data are calculations of lead batteries based on the assumption that one battery weighs 15 kg plus the 2 500 tonnes of ordinary batteries disposed of annually.

HW 04 – POP waste

POP waste refers to ‘persistent organic pollutants’ or chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. It is normally associated with pesticides. PCB containing waste (>50mg/kg) such as capacitors containing PCB, transformers containing PCB, transformer oil etc. is included.

Data on this waste stream is limited. ESKOM reports PCB data produced at their plants in the ESKOM Integrated Report (ESKOM, 2011) while national data for 2008 is reported in a Disposal Technology study (Dyke, 2008). It is estimated that 70 000 tonnes of this waste stream is stockpiled in South Africa, but no data is available on waste generation figures.

Data reported in the baseline is estimated based on actual data received from the waste management companies dealing with this waste stream.

HW 05 – Inorganic waste

Inorganic waste refers to all solid, liquid and sludge inorganic waste including spent pot linings (inorganic). Examples include: Filter cakes, waste gypsum, hardening salts containing NaCN and $Ba(CN)_2$, inorganic salts, inorganic wood-preserving chemicals, inorganic waste catalysts, borates, etc. Oxidising waste as perborates, bromates, perbromates, chlorates, perchlorates, chromates, dichromates, hypochlorite, iodates, periodates, manganates, permanganates, red-lead, nitrite and nitrates-salts, inorganic peroxides, aluminium chloride (water free), chlorosulphonic acid, ferric chloride (water free), phosphorus oxychloride, etc. Reactive waste such as, phosphorus pentoxide, alkalimetals (e.g. Na) and their alloys, aluminium (powder), metal amides, carbides, chlorosilanes, ferrosilicon hydrides, lithium aluminium hydride, phosphides, silicides etc. Liquid acidic waste (pickling acids, chrome sulphur acids, chrome acids, ferrous and ferric chloride solutions, hydrofluoric acid, galvanic baths, H_3PO_4, HNO_3, HCl, H_2SO_4), liquid basic inorganic waste without cyanide (Hypochlorite solutions, metal hydroxide sludges, NaOH), alkaline inorganic waste with cyanide (pH>10), reactive waste as hydrogen peroxide, thionyl chloride, silicon tetrachloride, sulphur dichloride, titanium tetrachloride etc. are also included.

Data on some inorganic waste streams is reported in the Hazardous waste management plans of Mpumalanga and North West province (MDALA, 2008a; MDALA 2008b; NWDACE 2006; NWDACE, 2007). However, there are no national figures available from reports.

The data reported in the baseline is estimated based on actual disposal figures obtained from waste management companies.

HW 06 – Asbestos containing waste

All waste containing asbestos from insulation, buildings etc. are included in this waste stream.

Due to the asbestos regulation with its requirement to remove all asbestos by 2015, the number contracts to remove asbestos from houses are increasing on a monthly basis. It is therefore expected that asbestos waste from municipal sources will increase up to 2015.

It is assumed that the biggest asbestos waste generators are:

- Department of Public Works
- Transnet
- Eskom
- Municipalities

There is no comprehensive report on asbestos waste in South Africa. ESKOM reports asbestos disposal figures on an annual basis but not waste generation figures. Data contained in the Mpumalanga hazardous waste management plan (MDALA, 2008a; MDALA 200b) is assumed to be largely based on the ESKOM data since most of the ESKOM power stations are situated in Mpumalanga.

The audit report for Bulbul drive H:h landfill (King, 2009) also reports disposal data.

The data reported in the baseline is estimates based on disposal figures obtained from waste management companies.

HW 07 – Waste oils

Waste oils include diesel oil, fuel oil, heating oil, gas oil, hydraulic oil, lubricating oil, oil from oil and petrol traps, heat transmission oils (no PCB) etc. Waste oil typically originates from the crankcase of internal combustion engines (mainly run on petrol or diesel). Used oil or waste oil is also produced and collected from other operating equipment and includes products such as hydraulic oils, gear and transmission oils. It is not recommended that used oils from transformers and switchgear be mixed with other waste oils.

Waste oils is a complex mixture of paraffinic, naphthenic and aromatic petroleum hydrocarbons that may contain one or more of the following: carbon deposits, sludge, aromatic and non-aromatic solvents, water (as a water-in-oil emulsion), glycols, wear metals and metallic salts, silicon-based antifoaming compounds, fuels, polycyclic aromatic hydrocarbons (PCAH's) and miscellaneous lubricating oil additive materials. In the unlikely event that used transformer oils are mixed with other waste oil then polychlorinated biphenyls and terphenyls (PCB's/PCT's) may also be present (www.rosefoundation.org.za).

Based on the US system, about 50% of oil becomes waste oil. In SA it is estimated at between 40-45% - because of losses from old vehicles and oil leaks (Lochan, 2011). This is not an exact science. It is estimated that about 270 million litres of new oil enters the South African market annually and about 120 million litres of used oil becomes collectable (Lochan, 2011).

Waste oil is collected and treated by the ROSE foundation in South Africa.

Several treatment processes are used in South Africa:

- Mechanical separation of contaminants by filtration and centrifuging
- Chemical separation to remove unwanted components
- Thermal refining to improve the quality of the fuel.

Approved Processors of waste oil in South Africa are:

- Oil Separation Solutions Sales & Services (Pty) Ltd, Germiston
- BME, Delmas
- PPC Lime Limited, Limeacres
- The Old Oil Man, Krugersdorp
- FFS Refiners (Pty) Ltd, Durban, Pietermaritzburg, Cape Town, Johannesburg
- Green Mamba Oil Refinery, Centurion
- Kudu Oils, Nelspruit
- Enfields Chemicals CC, Durban
- Gecco Fuels, Cape Town

HW 08 – Organic halogenated and/or sulphur containing solvents

Solvents containing halogens and/or sulphur are included in this waste stream. Examples include: Chloroform, CS_2, chlorethene, Freon, methylene chloride, perchlorethane, tetrachloromethane, trichloromethane, trichloroethylene, cutting oil and drilling oil containing more than 1 % of halogen and sulphur, halogen containing glue waste, waste from dry cleaning companies etc.

No national data on this waste stream is available in literature. The data reported was therefore obtained from the relevant waste management companies.

HW 09 – Organic halogenated and/or sulphur containing waste

This waste stream comprises solids, liquids and sludges containing halogens and/or sulphur.

No national data on this waste stream is available in literature. The data reported was obtained from relevant waste management companies.

HW 10 – Organic solvents without halogens and sulphur

This waste stream refers to solvents without halogens and sulphur. Examples include: Acetone, alcohols, oil from animals, benzene, petrol, butyl acetate, ether, ethyl acetate, thinner, hexane, methyl ethyl ketone, methyl isobutyl ketone, oil emulsions, petroleum ether, styrene, synthetic oils, turpentine, toluene, vegetable oil, xylene, and oxidizing solvents such as acetone-peroxide, acetyl-acetone-peroxide, cyclo-hexanone-peroxide, dibenzoyl-peroxide, methyl-ethyl ketone peroxide etc.

No national data on this waste stream is available in literature. However, the Hazardous Waste Management Plan for North West Province report 50 ton/annum of inks, glue, solvents and water being flushed down drains or dumped at local general waste sites (NWDACE, 2007).

The data reported was obtained from relevant waste management companies.

HW 11 – Other organic waste without halogens or sulphur

This waste stream includes spent pot linings (organic), liquid, solid and sludge organic waste. Examples include: Waste waters, acetic acids, organic acids, amines, degreasing baths, cutting oil and drilling oil, brake wash waters, ethylene glycol, formalin, paint, alkaline bath from acid washing, oil emulsions, phenols, polyols, synthetic oils, soap, tectyl corrosion prevention, printing ink, epoxy compounds, fixing baths, developers etc. Filters, cup grease, lubricants, latex, glue, organic salts, organic wood-preserving chemicals, reactive waste such as fertilizer (NH4NO3), fireworks, methylene diphenyl diisocyanate (MDI), toluene diisocyanate (TDI), laboratory waste, spray cans, empty containers, leaded anti-knock compound sludges, waste leather dust, etc. as well as spent pot liner containing organic fractions, e.g. mixed with organic carbon, are also included.

No national data on this waste stream is available in literature. There is some data available for North West Province (NWDACE, 2007) and the waste generated in the Eastern Cape that is disposed of in the Western Cape (DEADP, 2011).

The data reported was obtained from relevant waste management companies.

HW 12 – Tarry and Bituminous waste

Waste from coal based generated tar and petroleum based manufactured bitumen (including asphalt).

No national data on this waste stream is available in literature. In Gauteng, poisonous and toxic waste reported as consisting predominantly of coal tar and pitch (770.57 t/a) (GDACE, 2006).

The data reported in the baseline waste obtained from relevant waste management companies.

HW 13 and GW 13 - Brines

This waste stream refers to water containing salts, mainly as a result of industrial effluent treatment.

The major industries contributing to the inland volume and salt load are:

- Mining;
- Power generation;
- Paper & pulp;
- Petroleum;
- Steel & metals processing (Van der Merwe *et al.,* 2009).

Discharges of salt to the marine environment were not considered although a considerable amount of brines is discharged to sea .

Brine volumes are generally reported. According to a study that was conducted for the Water Research Commission, a total of just over 530 000 kℓ/d of effluent is discharged to inland systems, containing approximately 1 060 t/d of salt (Van der Merwe *et al*., 2009). The figures quoted by this research are considered to be accurate as it is based on questionnaires completed by the industry.

A summary of industry sectors generating brines, the volumes of effluent and salt load to the environment is provided in Table 12.

For general industry, effluent volumes are likely to be relatively stagnant despite anticipated future growth. This is mainly as a result of cleaner production techniques and recycling opportunities foreseen. In contrast, volumes in the gold and coal mining sectors are expected to increase significantly over the next 20 years and in particular after 2012. This trend is expected to apply in general to all mining basins (Van der Merwe *et al*., 2009).
The current and projected future generation of brines per major industry sector is summarized in Table 13.

Table 12: Industry sectors generating brines (Van der Merwe *et al.*, 2009)

Sector	Total Effluent			Salt load to the environment		
	Total effluent	Total excl marine	Portion excl marine	Total Salt	Total salt excl marine	Portion excl marine
	kl/day	kl/day	%	t/day	t/day	%
Paper & pulp/wood	272001	89001	16.6	1440	80	7.6
General packaging	1950	1950	0.4	2	2	0.2
Steel/metals processing	30500	30500	5.7	72	72	6.8
Petroleum	839000	69100	12.9	354	300	28.4
Chemical	13070	11070	2.1	51	44	4.2
Power generation	132000	132000	24.7	158	158	15.0
Mines	145025	145025	27.1	350	350	33.1
Chemical suppliers	528	528	0.1	0	0	0.0
Dairy	2700	2700	0.5	4	4	0.4
Sugar	8100	3900	0.7	10	2	0.2
Canning	2200	2200	0.4	1	1	0.1
General food	13970	10970	2.1	11	5	0.5
Pharmaceutical & personal care	1430	1430	0.3	1	1	0.1
Animal nutrition	1205	1205	0.2	1	1	0.1
Poultry & meat	12100	12100	2.3	8	9	0.8
Beverage	14670	14670	2.7	11	11	1.0
Textile	6000	6000	1.1	13	13	1.2
Waste management	1909	190	0.0	5	5	0.5
Fish processing	220700	200	0.0	7921	1	0.1
Totals	**962239**	**534739**	**100**	**10413**	**1058**	**100**

Table 13: Current and future projected brine generation by industry sector (van der Merwe *et al.*, 2009).

Industry sector	Brine (tons/day)			
	Current (2009)	5 year	10 year	20 year
Paper and Pulp/wood	50	50	50	50
General packaging	0	0	0	0
Steel/metals processing	240	240	240	240
Petrochemical	100	100	100	100
Power generation	1600	1600	1600	1600
Mining – Platinum	13	13	16	21
Mining – Gold	300	2610	3360	4350
Mining – Coal	840	1740	3240	11010
Other	0	2	2	2

Despite uncertainties inherent to the database (Van der Merwe *et al.*, 2009), the following specific trends was identified in the study:

- Brine volumes generated as a result of coal and gold mining will probably represent the most important challenge over the medium term. Cumulatively, it is possible that brine volumes could be around 4000 t/d within 5 years, and as much as 15 000 t/d of brine within 20 years.
- In terms of the areas in which brine will be generated, in the short term (depending on future strategies to manage the West and East Rand Basins) brine generation could be relatively evenly split between the Johannesburg area, and the Witbank area;
- The greatest increase in brine generation is expected (in the longer term) to be in the area of the Witbank Coal Fields.

The data from this study informed the baseline amounts for 2011. A summary of brine treatment technology options is provided in Appendix E.

HW 14, HW 15 GW 14 and GW 15 - Ash

The categories of waste lumped together here refers to **Fly ash, dusts and residues from dry gas cleaning systems** as well as **Bottom**

ash, residue from power generation, boilers and incinerators.

These waste streams are often reported as one aggregated figure. Ash generation is also not necessarily measured, but rather calculated based on combustion efficiencies. The fly ash to coarse ash ratio is a function of the type of mill used to pulverize the coal. Boilers equipped with tube mills generally produce approximately 10% coarse ash (90% fly ash) whereas boilers equipped with ball mills generally produces 20% coarse ash (80% fly ash) (Heath *et al.,* 2009).

Approximately 90% of power generated in South Africa is generated by means of coal-fired processes (Van Zyl and Premlall, 2005) generating ash as primary waste stream. Coarse ash is damped by water sprays and the slurry is either fed to ash dams where the ash settles down and water are recycled, or it is conveyed to ash bunkers where the surplus moisture is drained off prior to discharge for disposal. Fly ash is small coal particles that did not burn completely and is separated from the flue gasses in scrubbers by means of electrostatic precipitators or bag filter systems (Heath *et al.,* 2009).

Eskom owns 13 coal-fired power stations, the majority situated in Mpumalanga. There are also 5 smaller coal fired stations operated by either regional municipalities or Public Private Partnerships (Van Zyl and Premlall, 2005). The net capacity of ESKOM coal –fired power stations as at 31 March 2011 was 37 745 MW (ESKOM, 2011). The ESKOM coal-fired power stations are fully operated at all times i.e. on a 24 hour basis. Municipal and private power stations add another 900 MW (Van Zyl and Premlall, 2005).

In the order of 25 million tons of combustion fly ash is produced annually, most of which is disposed on land in ash dams or ash dumps (Heath *et al*., 2009). Approximately 1.2 million tons of fly ash per year is sold to amongst others, the cement industry (Heath *et al*., 2009).

The net power generating capacity of the coal-fired power stations is summarized in Table 14.

Table 14: Net power Generating capacity of Coal-fired power stations (Van Zyl and Premlall, 2005; Eskom, 2011)

Power stations	Net Maximum Capacity (MW)
ESKOM	37745
Municipal and Private	900
Total	**38645**

The actual power generation and ash production by the ESKOM coal-fired power stations are summarized in Table 15.

Table 15: Power generation and ash production by ESKOM coal-fired power stations over time (Eskom, 2011)

Year	Total electricity produced by ESKOM coal-fired power stations GWh(net)	Ash produced (Mt)
2007	215211	34.16
2008	222908	36.04
2009	211941	36.66
2010	215940	36.01
2011	220219	36.22

The data reported in the baseline is a combination of ESKOM data and data obtained from relevant waste management companies.

Future projections of ash production by ESKOM should take cognizance of the following expansions (ESKOM, 2012):

- Medupi will add a capacity of 4 764 MW (6 units) with the first unit to be opened in 2012 and the last in 2015.
- Kusile will add a capacity of 4 800 MW (6 units) with the first unit opening in 2014 and the last in 2018. Kusile will also generate Flue Gas Desulphurisation sludge.
- ESKOM plans to double its capacity by 2026 to 80 000 MW, although a proportion of the new capacity will be provided by gas fired or nuclear energy plants.

HW 16 - Slag

Slag includes ferrous metal slag from steel, manganese, chrome, vanadium etc. processing and non-ferrous metal slag from aluminium etc. processing.

The main by-products produced during the iron and crude steel production are slags (90%), dusts and sludges as illustrated in Figure 4.

Waste from the Iron and Steele industry sector in South Africa can be calculated based on the crude steel production figures provided by SAISI (2011) and the by-product estimates and ratio's provided by the Worldsteel Association (2010). With BF/BOF at about 70% and EAF at about 30%, the total by-product production in SA can be estimated (Table 16).

Sintering operations can emit significant dust levels of about 20 kg per metric ton (kg/t) of steel while pelletizing operations can emit dust levels of about 15 kg/t of steel. Process sold waste from the conventional process, including furnace slag and collected dust, is generated at an average rate raging from 300kg/t of steel manufactured to 500kg/t, of which 30kg may be considered hazardous depending on the concentration of heavy metals present (World Bank, 1998)

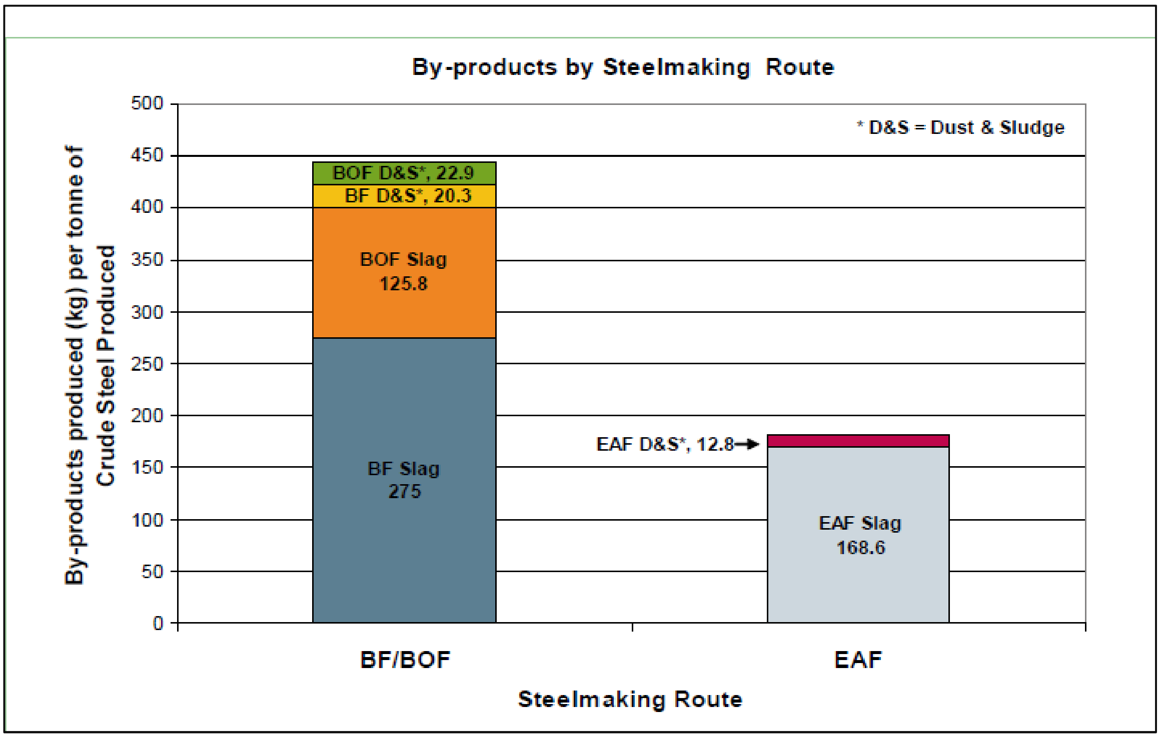


Figure 4: Main by-products of steelmaking (World Bank, 1998)

Table 16: Estimated waste production in the steelmaking industry

By-product/waste	kg/ton crude steel	t/ton crude steel	t/7 million ton crude steel
Blast Furnace dust and sludge	20.3	0.0203	142100
Basic Oxygen Furnace dust and sludge	22.9	0.0229	160300
Blast Furnace slag	275	0.275	1925000
Basic Oxygen furnace slag	125.8	0.1258	880600
	kg/ton crude steel	**t/ton crude steel**	**t/3 million ton**
Electric Arc Furnace dust and sludge	12.8	0.0128	38400
Electric Arc Furnace Slag	168.6	0.1686	505800

Blast furnace slag should be generated at a rate of less than 320kg/t of iron, with a target of 180kg/t. Slag generation rates from the BOF should be between 50 and 120kg/t of steel manufactured. However, both the generation rates depend on the impurities in the feed materials (World Bank, 1998).

The current status (2007) of the ferro alloys plant capacities in South Africa is shown in

Ferrochrome slag is generated at a rate of between 1.1 and 1.6 ton per ton of ferrochrome produced (CSIR, 2006). The production figures were obtained from the latest available SAMI Report (DMR, 2010). The slag generation over a period of 10 years can be calculated as illustrated in Table 18.

The ratio of slag to metal usually varies between 0.8 and 1.2, given typical South African manganese ores (Assmang, 2009). Slag generation can therefore be calculated as indicated in Table 19.

The data reported in the baseline is estimated based on production figures and informed by actual data provided by FAPA and SAISI.

Table 17: Installed capacities of the SA Ferro Alloys Plants (Basson *et al.*, 2007)

Type	Capacity (t/a)
Primary Charge Chrome	3940000
Recovery Charge Chrome	200000
MCFeCr	70000
LCFeCr	40000
SiMn	160000
Recovery SiMn	5000
HCFeMn	480000
Recovery HCFeMn	25000
MCFeMn	160000
FeSi	136000
Si metal	40000
FeV	12500

Table 18: Calculated Ferrochrome slag generation based on production figures

Ferrochrome production		Slag production estimate	
Year	kt	1.1 t/t	1.6 t/t
2000	2574	2831	4118
2001	2141	2355	3426
2002	2351	2586	3762
2003	2813	3094	4501
2004	3032	3335	4851
2005	2802	3082	4483
2006	3030	3333	4848
2007	3561	3917	5698
2008	3269	3596	5230
2009	2346	2581	3754

Table 19: Ferromanganese slag generation as calculated based on production figures.

Ferromanganese Production		Slag production	
Year	Ton	0.8 t/t	1.2 t/t
2000	596873	477498.4	716247.6
2001	523844	419075.2	628612.8
2002	618954	495163.2	742744.8
2003	607362	485889.6	728834.4
2004	611914	489531.2	734296.8
2005	570574	456459.2	684688.8
2006	656235	524988	787482
2007	698654	558923.2	838384.8
2008	502631	402104.8	603157.2
2009	274923	219938.4	329907.6

HW17 and GW 17 – Mineral waste

The mineral waste included is limited to foundry sand and refractory waste.

There is no data on mineral waste at this level available in literature. Data was therefore obtained from the South African Institute of Foundrymen.

There are several waste streams arising from the metal casting process namely:

- SLAG AND DROSS – Estimated to be 15 000 tons of slag and 2 000 tons of non-ferrous dross per annum (Comprising various metal oxides, from which some of original metallics are recovered through recycling)
- DUST FROM FURNACE FUME EXTRACTION – Estimated to be 5 000 tons per annum
- SPENT SAND – Chromite sand estimated to be 20 000 to 24 000 tons per annum; silica sand estimated to be 300 000 to 350 000 tons per annum
- PARTICULATE EMMISSIONS – Very small amounts of dust are also emitted to atmosphere, but we do not have any detailed information on the quantities.

These figures are based on 2011 output information and may vary from time to time.

HW 18 and GW 18 – Waste of Electric and Electronic Equipment (WEEE)

This waste stream refers to discarded electrical and electronic equipment including computers, cell phones, televisions, radios, refrigerators, washing machines etc. Basically anything that operates using electricity or batteries that have reached the end of its useful life. It also includes lighting equipment such as fluorescent tubes and lamps, sodium lamps etc. but excludes incandescent bulbs and halogen bulbs).

Reports indicate that the amount of white goods, consumer electronics and IT in SA homes range between 1 and 2 million tonnes, most of which was likely to enter the waste stream between 2013 and 2018 (Ongondo, *et al.,* 2011).

Typical material fractions (Ongondo, *et al.,* 2011) in WEEE are:

- Printed circuit boards (2%)
- CRT & LCD screens (12%)
- Cables (2%)
- Metal-plastic mixture (5%)
- Plastics (15%)
- Metals (60%)
- Pollutants (3%)
- Others (1%).

Schleup *et al*. (2009) estimate that 59.7 K tonnes of WEEE were generated in South Africa in 2007 as indicated in Table 20. Their estimates are based on the estimated weight and lifespan on electrical and electronic equipment as provided in Table 21.

Table 20: Estimated WEEE generation in South Africa (Schluep *et al.*, 2009)

	Quantities of EEE entering the SA market (Metric ton/annum)	Quantity of e-waste generated (Metric ton/annum)
Assessment date	2007	2007
PCs	32000	19400
Printers	6800	4300
Mobile phones	1900	850
TVs	35800	23700
Refrigerator	22300	11400

Table 21: Estimated Weight and lifespan of electrical and electronic equipment (Schleup *et al.*, 2009).

Appliance	Lifetime in years	Weight (Kg)
PC + Monitor	5-8	25
Laptop	5-8	5
Printer	5	8
Mobile Phone	4	0.1
TV	8	30
Refrigerator	10	45

These estimates are also based on development indicators from the CIA World Factbook (WDI, WFB). It is estimated that e-waste flow will increase by a factor 2 to 4 by 2020 for computers.

For the prediction of e-waste flows from personal computers it is important to take the future development of technology into account. Currently, the present market shows a tendency to move away from desktop computers and towards laptop computers. Additionally, CRT-monitors will be substituted by LCD-monitors. Thus, the weight of future e-waste flows will decrease relative to the number of units discarded and the material composition will also change. These developments will have an effect both on recycling technologies and the secondary market.

The amount reported in the baseline is based on the 2007 estimate of Schleup *et al*. (2009).

HW 19 - Health Care Risk Waste (HCRW)

This waste stream include pathological waste, infectious waste, sharps and chemicals e.g. pharmaceuticals.

The literature reviewed cover health care risk waste generation, treatment and disposal data for all nine provinces as well as national data. Waste generation and disposal/treatment data include public and non-public hospitals and clinics, mine clinics, as well as specialized, district and regional hospitals for the period between 2002 and 2010. Most of these data are given in waste generated per bed per day units. The data reported by the Survey of Generation rates, Treatment Capacities and Minimal Costs of Health Care Waste in the 9 Provinces of RSA (DEAT, 2008) is considered to be the most accurate source available as this is the most comprehensive study that was done in South Africa at national level. The overall HCRW generation in South Africa in 2007 is estimated to amount to approximately 42 200 tons per year.

The data reported in the baseline is based on this 2007 survey.

HW 20 – Sewage Sludge

This waste stream includes the sludge resulting from municipal wastewater treatment processes.

Industrial wastewater in municipal areas is discharged into the municipal sewers. It is therefore impossible to distinguish between sewage sludge and industrial wastewater sludge generation in urban areas in South Africa.

Reports on sewage sludge generation are found in the Green Drop Reports of the Department of Water Affairs and some Water Research Commission reports.

Approximately 309 556 t/a, mainly domestic with some industrial waste sludge is generated in South Africa based on calculations (Herselmann *et al*., 2005). Sewage sludge is generated at wastewater treatment plants, but the Department of Water Affairs does not track the generation or disposal of sewage sludge other than irrigation with wastewater. A total of 821 wastewater treatment facilities receive a total flow of 5 258 Mℓ/day. The collective hydraulic design capacity of these facilities are 6 614 Mℓ/day (DWA, 2009).

Herselmann *et al.* (2005) reports the approximate volumes of sludge produced by industry sector in South Africa (Table 22).

Table 22: Approximate volumes of sludge produced in South Africa by industry sector (Herselmann *et al.*, 2005).

Activity/Industry	Typical volumes produced	Comment
Sewage sludge	312 000 t/a (DEAT, 1997)	
Mining Industry	250 000-400 000t/a (estimate)	Neutralisation of mine water probably the main producer of sludge at present
Paper and pulp industry	234 000 t/a in 2003 @ 50% moisture content (DME, 2004)	Quantity and quality varies according to mill configuration and moisture content
Electricity generation	ESKOM does not report sludge volumes specifically	
Tanneries	7 200 m^3/a (DEAT, 1997) effluent plant sludges	
Petrochemical industries	Data not available	
Textile industry	Effluent plant sludge 240 m^3/a Wool washing sludges20 700 m^3/a (DEAT, 1997)	
Timber processing industry	Treatment sludges: 95 m^3/a (DEAT, 1997) – excludes paper industry	

Table 23: Sewage sludge generation estimates (Tonne/annum) for 2009 (calculated based on General Household Survey (StatsSA, 2009)

Province	Population	Households	Average no of people per household	Households with flush toilet	Sludge generation t/a based on 45g/p/d with access to flush toilet	Sludge generation t/a based on 50g/p/d with access to flush toilet	Sludge generation t/a based on 45g/p/d for entire population	Sludge generation t/a based on 50g/p/d for entire population
Western Cape	5369	1478	3.6	1476	88 469	97 852	88 589	97 984
Eastern Cape	6649	1738	3.8	1730	109 204	120 786	109 709	121 344
Northern Cape	1148	311	3.7	310	18 881	20 884	18 942	20 951
Free State	2905	861	3.4	860	47 877	52 955	47 933	53 016
KZN	10461	2615	4.0	2613	172 474	190 767	172 607	190 913
North West	3454	954	3.6	954	56 991	63 036	56 991	63 036
Gauteng	10556	3531	3.0	3527	173 977	192 429	174 174	192 647
Mpumalanga	3610	978	3.7	970	59 078	65 344	59 565	65 883
Limpopo	5320	1346	4.0	1331	86 802	96 008	87 780	97 090
Total	**49382**	**13812**	**3.6**	**13772**	**812 443**	**898 612**	**814 803**	**901 222**

Smith and Vasiloudis (1989) estimate sewage sludge generation in South Africa at 16.5 kg of dry sludge per person per year (Quoted by other WRC reports). DWA 1997 used 50g dry sludge per person per day in their calculations to get to a total of 309 556 t/annum (Herselman *et al*., 2005). Sewage sludge production in South Africa is therefore estimated at between 45 and 50g of dry sludge per person per day. The production of sludge can be calculated based on population figures as well as on the number of households with access to flush toilets connected to municipal sewer systems. The results of such calculations are presented in Table 23.

The sewage sludge generation for South Africa in 2009 could therefore be estimated at between 812 443 and 901 222 t/a. However, another way of calculating the sewage sludge produced in South Africa is by using the total daily inflow (DWA, 2011a) and geometric mean of 676 mg/l as suggested by Snyman et al. (2004). Data on the total daily inflows at waste water treatment works (WWTW) is reported by the Department of Water Affairs (DWA, 2011a) (Table 24).

Table 24: Actual inflow at WWTW during 2010 (DWA, 2011a)

	No of WWTW	Total design capacity(Ml/d)	Total daily inflow (Ml/d)
Mpumalanga	76	323.1	159.1
North West	35	315.8	143.8
Free State	95	482.2	197.9
Gauteng	56	2595.1	2579
KwaZulu Natal	143	1076.2	715.9
Limpopo	67	150.4	123.2
Western Cape	155	1031.4	901.2
Northern Cape	71	150.3	93.3
Eastern Cape	123	489.5	344.9
Total	**821**	**6614**	**5258.3**

Both methods were used to calculate the sludge generation for comparative purposes. However, the data calculated based on the inflow data for waste water treatment works is reported in the baseline.

Sludge handling at WWTW

The database obtained from the Department of Water Affairs (DWA, 2011b) recorded broad categories of technologies and combinations of technologies used at 1,183 wastewater treatment facilities in South Africa. Sludge drying beds are used at 46.8% of wastewater treatment works and anaerobic digestion of sludge at 31.4% of these works. The available evidence indicates that only 22% of wastewater treatment works with anaerobic digesters utilize the gas produced; the remaining 88% either flare the raw gas or vent the gas to the atmosphere (DWA, 2011b).

Sludge disposal strategies

Herselmann *et al.* (2005) did a survey of disposal options at 234 treatment facilities in South Africa. The results of their survey indicated that sludge is stockpiled at 33% of the surveyed facilities while 3 % is landfilled and only 8% composted (Figure 5).

Current sludge disposal strategies by industry is reported by Van der Merwe *et al.*, (2009) and summarized in Table 25.

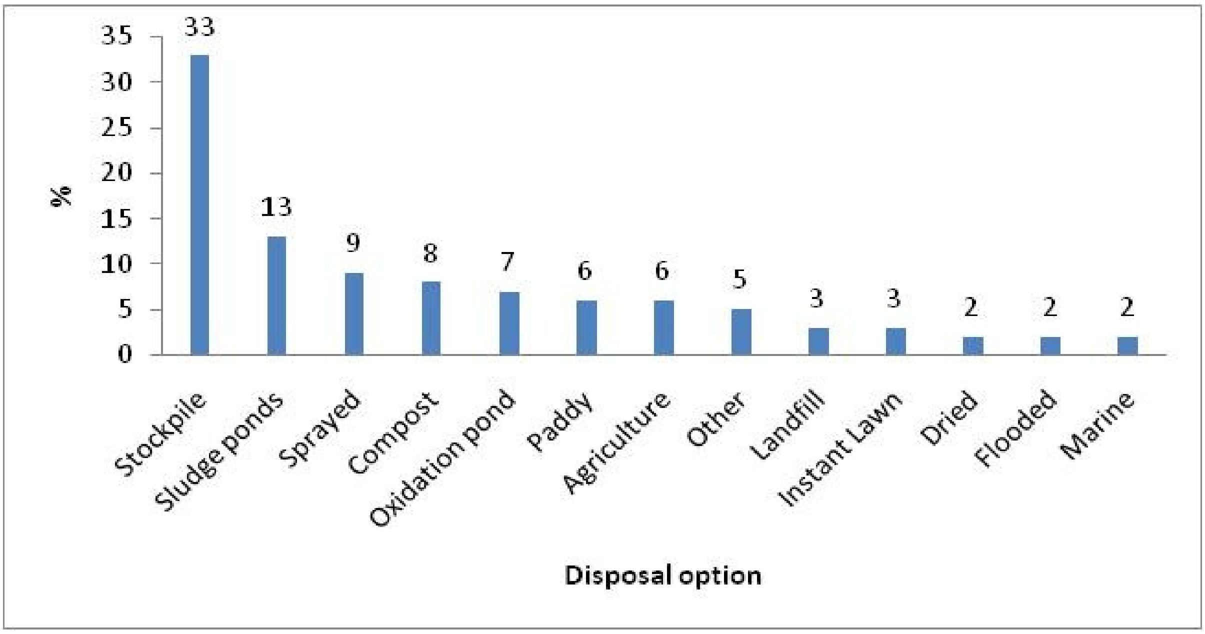


Figure 5: Sewage sludge disposal options at 234 surveyed sites (after Herselmann *et al*., 2005).

Table 25: Sludge disposal strategy by industry sector (Van der Merwe *et al.*, 2009)

Industry	Technology utilized in South Africa	Comments
Sewage sludge	• Agriculture • Land disposal (on or off site) • Beneficial use (mine rehab, soil amelioration , etc) • Thermal treatment • Compost, brick making, pellets	In the EU the split is typically • 32% agriculture • 13% incineration • 5% ocean • 48% landfill
Mining (acid mine drainage)	• Disposal into lined facilities • Sludge deposited inside clay lined water retention dams during neutralization • Co-disposal with other wastes	
Paper and pulp industry	• Landfill	An assessment by the DME of the commercially exploitable biomass resources in the bagasse, wood and sawmill waste and pulp in South Africa showed that 94 GWh of electricity could be generated from this waste stream (DME, 2004)
Electricity generation	Co-disposal with ash	Current study by Eskom is looking at assimilative capacity within the ashing system
Tanneries	Landfill (on or off site) Treatment technologies	
Petrochemical industries	Landfilling of some sludges, but recycling of others	
Textile industry	Landfill (off site)	
Timber processing industry	Landfill (off- site)	

HW 99 - Miscellaneous

The waste reported in this category is waste that is hazardous, but does not fit into any of the above categories. It is typically the result of mixed hazardous waste that cannot be separated into for treatment purposes.

The amount reported in the baseline has been provided by the relevant waste management companies.

References

Assmang Cato Ridge (2009) Waste Licence application for proposed new slag disposal facility. Report prepared by KV3 Engineers. December 2009.

Basson J, Curr TR and Gericke WA (2007) South Africa's Ferro Alloys Industry – Present status and future outlook. Infacon XI, 2007.

BPDM (Bonjanala Platinum District Municipality) (2009) Bonjanala Platinum District Municipality: Integrated Waste Management Plan. Final, 20 November 2009.

City of Tshwane (City of Tshwane Metropolitan Municipality) (2004) Development of an Integtrated Waste Management Plan for the City of Tshwane Metropolitan Municipality. Draft for comment, November 2004.

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

CSIR (Council for Scientific and Industrial Research) (2006) Samancor Chrome slag Classification and Delisting Report, October 2006. CSIR/NRE/PW/ER/2006/0146/C.

DEA (Department of Environmental Affairs) (2010) Development of a Revised Waste Classification System for South Africa: Waste Categorisation System for WIS Reporting. Report No: ESA-HAZR_FG_03V5-Final.

DEADP (Department of Environmental Affairs and Development Planning, Western Cape) (2007a) Waste Characterisation Surveys in the City of Cape Town. Second Draft, 17 April 2007.

DEADP (Department of Environmental Affairs and Development Planning, Western Cape) (2007b) Waste Characterisation Surveys in the Cape Winelands District Municipality. May 2007.

DEADP (Department of Environmental Affairs and Development Planning, Western Cape) (2007c) Waste Characterisation Surveys in the Central Karoo District Municipality, May 2007.

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

DEAT (Department of Environmental Affairs and Tourism) (2000) Programme for the Implementation of the National Waste Management Strategy: Starter Document for Guidelines for the Compilation of Integrated Waste Management Plans Final Draft, May 2000. Department of Environmental Affairs and Tourism, Pretoria.

DEAT (Department of Environmental Affairs and Tourism) (2004) Design, Management and Supervision of Waste Treatment, Waste Disposal and Decontamination at the Guernica Chemicals (Pty) Ltd Industrial Site (Thor Chemicals) in Cato Ridge. Output A – Detailed Waste Inventory. Report No 331652, December 2004.

DEAT (Department of Environmental Affairs and Tourism) (2006) South Africa Environment Outlook: A report on the state of the environment Report. Department of Environmental Affairs and Tourism, Pretoria.

DEAT (Department of Environmental Affairs and Tourism) (2008) Survey of Generation Rates, Treatment Capacities and Minimal Costs of Health Care Waste in the 9 provinces of RSA. January 2008.

DEDTEA (Free State Department of Economic Development, Tourism and Environmental Affairs) (2011) Lejweleputswa District Municipality

Integrated Waste Management Plan. Final IWMP, August 2011.

DME (Department of Minerals and Energy) (2004) Assessment of Commercially exploitable Biomass resources: Bagasse, Wood and Sawmill Waste and Pulp in South Africa. Available online (Accessed on 11/11/2011): www.scribd.com/doc/9521646/Final-Report-Biomass

DMR (Department of Mineral Resources) (2010) South Africa's Mineral Industry 2009/2010. Department of Mineral Resources, Pretoria. p207.

Dti (Department of Trade and Industry) (2009) Proposed Road Map for the Recycling Industry, 2009. Department of Trade and Industry, Pretoria.

DWA (Department of Water Affairs) (2009) Green drop Report 2009. Version 1. South African Waste Water Quality Management Performance. Department of Water Affairs, Pretoria.

DWA (Department of Water Affairs) (2011a) 2011 Green Drop Report. Department of Water Affairs, Pretoria

DWA (Department of Water Affairs) (2011b) DWA Database on Municipalities and Treatment Processes Employed. Excel spreadsheet obtained from the Department of Water Affairs in September 2011.

Dyke PH (2008) Disposal Technology Options Study. Final Report. June 2008.

ESKOM (2011) ESKOM partnering for a sustainable future: Integrated Report 2011.

ESKOM (2012) Status Report on Capacity Expansion Projects. Available online at: http://www.eskom.co.za/c/article/62/status-report-on-capacity-expansion-projects/. (Accessed 22 Aug 2012)

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

Francis Baard DM (2010) Francis Baard District Municipality: Integrated Waste Management Plan (Draft for Public Review), 30 August 2010.

GDACE (Gauteng Department of Agriculture, Conservation and Environment) (2006) First Generation Integrated Hazardous Waste Management Plan for Gauteng: Situation Analysis and Baseline Assessment Report.

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.

Heath RG, van Zyl HD, Schutte CF and Schoeman JJ (2009) First order assessment of the quantity and quality of non-point sources of pollution associated with industrial, mining and power generation. WRC Report No 1627/1/09.

Herselman JE, Wade PW, Steyn CE, and Snyman HG (2005) An evaluation of dedicated land disposal practices for sewage sludge. WRC Report No 1209/1/05. March 2005.

Jarrod Ball and Associates Consortium (2001) A waste stream analysis of the general waste stream. DANCED Environmental Capacity Building Project, Johannesburg. Mini-Project WM4 on Metro-wide waste management planning – Phase 1. Current waste management in the City of Johannesburg. Report No 1A. December 2001.

King V (2009) Compliance and Status Quo Audit of Bulbul Drive H:h Landfill site operated by Wasteman KwaZulu Natal, April 2009.

Lochan R (2011) Personal Communication with Raj Lochan, Rose Foundation.

Macozoma DS (2002) Secondary construction materials: An alternative resource pool for future construction needs. In: *Proceedings Concrete for the 21st Century Conference.* Eskom Conference Centre, Midrand, South Africa, March 2002.

Mafikeng (Mafikeng Local Municipility) (2011) Draft Integrated Waste Management Plan. February 2011.

MDALA (Mpumalanga Department of Agriculture and Land Administration) (2008a) Development of a Hazardous waste management plan for Mpumalanga Province: Draft Final Status Quo Report. February 2008.

MDALA (Mpumalanga Department of Agriculture and Land Administration) (2008b) First Draft Hazardous Waste Management Plan Report Outline. Version 1.1 March 2008.

MLM (Mangaung Local Municipality) (n.d.) Mangaung Local Municipality: Integrated Waste Management Plan. Final Draft.

Nahman A, De Lange W, Oelofse S and Godfrey L (2012) The costs of household food waste in South Africa. Waste Management. (in press)

NWDACE (North West Department of Agriculture, Conservation and Environment) (2006) Development of a Hazardous waste management plan for North West Province: Status Quo Analysis Report. 25 November 2006.

NWDACE (North West Department of Agriculture, Conservation and Environment) (2007) Hazardous Waste Management Plan for North West Province. 28 June 2007.

NWDACE (North West Department of Agriculture, Conservation and Environment) (2008) Provincial Integrated Waste Management Plan: North West, Status Quo Report. 10 June 2008.

Oelofse SHH and Nahman A (2012) Estimating the magnitude of food waste generated in South Africa. Waste Management and Research. (in press).

Ogola JS, Chimuka L and Tshivhase S (2011) Management of municipal solid wastes: A case study in Limpopo Province, South Africa, in: Kumar, S. (Ed.), Integrated Waste Management, Volume 1, InTech, Rijeka, Croatia.

Ongondo FO, Williams ID and Cherrett TJ (2011) How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Management* 31: 714-730

PACSA (Packaging Council of South Africa) (2011) Packaging and Paper Industry waste management plan. August 2011.

Pikitup (2004) Materials Reclamation Study. Pikitup, Johannesburg.

Plastics Federation (Plastics Federation of South Africa) (2010) Plastics Recycling in South Africa – 2009.

PRASA (Paper Recycling Association of South Africa) (2011) Paper Recycling in South Africa – 2011. Available online (accessed on 21 August 2012): http://www.prasa.co.za/sites/default/files/Recycling%20stats%202011-2010_web.pdf).

REDISA (Recycling and Economic Development Initiative of South Africa) (2012) REDISA Integrated Industry Waste Tyre Management Plan. *Government Gazette 35534 Vol. 565 Government Notice, 564 of 23 July 2012.*

RSA (Republic of South Africa) (2008) National Environmental Management: Waste Act, 2008 (Act No 59 of 2008).

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

SAISI (South African Iron and Steel Institute) (2011) Overview of the South African primary Steel Industry. In: Introduction to the South African South African Iron and Steel Institute. Available online at: www.saisi.co.za

SATRP (South Africa Tyre Recycling Process Company) (2010) The Integrated Industry Waste Tyre Management Plan of the South Africa Tyre Recycling Process Company.

Schleup M, Hagelueken C, Kuehr R, Magalini F, Maurer C, Meskers C, Mueller E and Wang F (2009) Sustainable Innovation and Technology Transfer Industrial Sector Studies: Recycling from E-waste to Resources. July 2009. United National Environment Programme and United Nations University.

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

StatsSA (Statistics South Africa) (2009) General Household Survey, 2009. Statistical Release P 0318.

The Glass Recycling Company (2011) Personal Communication.

UDM (uMgungundlovu District Municipality) (2010) Advanced Integrated Waste Management System for uMgungundlovu District Municipality – Waste Characterisation Study.

Van der Merwe IW, Lourens A and Waygood C (2009) An investigation of innovative approaches to brine handling. WRC Report No 1669/1/09.

Van Zyl HD and Premlall K (2005) Water and waste-water management in the power generating industry. Water Research Commission Report: WRC TT 240/05. Natsurv 16.

Viljoen C (2010) Quality factors contributing to the generation of construction waste. Cape Peninsula Univeristy of Technology. Dissertation submitted in fulfillment of the requirements for the degree Master of Technology: Quality. November 2010.

World Bank (1998) Pollution prevention and abatement handbook: Iron and Steel manufacturing. p327-331.

Worldsteel Association (2010) Achieving the goal of zero-waste. Fact sheet: Steel industry by-products. Available online: www.worldsteel.org.

Appendix D: List of Literature Reviewed

Annual Reports

Year	Report title	Author/owner
1998	SASOL Environmental Report 1996-1998	SASOL
2002	SASOL Sustainable Development Report 2000-2002	SASOL
2003	Solid Waste Management Annual Report (Ekurhuleni)	Ekurhuleni Metropolitan Municipality
2004	SASOL Sustainable Development Report 2002-2004	SASOL
2005	SASOL Sustainable Development Report 2005	SASOL
2006	SASOL Sustainable Development Report 2006	SASOL
2007	SASOL Sustainable Development Report 2007	SASOL
2008	Eskom Holdings Limited, Annual Report 2008	Eskom Holdings Limited
2008	Eskom, Together, Rinsing to the Challenge: Annual Report 2008	ESKOM
2008	SASOL Sustainable Development Report 2008	SASOL
2008	Annual Report Solid Waste Landfill Section (Ekurhuleni)	Ekurhuleni Metropolitan Municipality
2009	Safe Sustainable Steel, Arcelor Mittal South Africa Limited Sustainability Report 2009	Arcelor Mittal
2009	Nampak Packaging Excellence, Annual Report 2009	Nampak
2009	SASOL Sustainable Development Report 2009	SASOL
2010	South African Petroleum Industry Association, Annual Report 2010	Sapia
2010	South Africa's Mineral Industry 2009/2010 - SAMI	Department of Mineral Resources
2010	SASOL Sustainable Development Report 2010	SASOL
2010	Arcelor Mittal South Africa, Annual Report	Arcelor Mittal
2011	Eskom Partnering for a Sustainable Future: Integrated Report 2011	ESKOM

Audit reports

Year	Report title	Author/owner
2009	Holfontein HH landfill site, Gauteng: External Compliance and Environmental Audit March 2009	Enviroserv
2009	Compliance and Status Quo audit of Bulbul Drive H:h landfill site operated by WasteMan KwaZulu Natal, April 2009	Wasteman
2011	Shongweni H:h Landfill site, KwaZulu Natal: External Compliance and Environmental audit Apr 2011	Enviroserv
2011	Vissershok waste management facility: External Audit, February 2011	Enviroserv

National Government Reports

Date	Report title	Author/owner
1999	Action plan for integrated waste management planning	DEAT
2000	Programme for the implementation of the national waste management strategy, Starter document: Guidelines for the compilation of integrated waste management plans, Final draft, May 2000	DEAT
2001	Number W.7.0: First Edition. Situation Analysis based on baseline studies regarding waste management in South Africa (in preparation for the National Waste Management Strategy for South Africa)	DWAF
2001	Profiling South African middle-class households, 1998 2006	StatsSA
2004	Assessment of the status quo of cleaner production in South Africa , Final report, August 2004	DEAT
2004	Design, management and supervision of waste treatment, waste disposal and decontamination at the Guernica Chemicals (Pty) Ltd Industrial Site (Thor Chemicals) in Cato Ridge. Output A - Detailed Waste Inventory. Report No 331652	DEAT
2004	Capacity Building in Energy Efficiency and Renewable Energy. Assessment of Commercially exploitable Biomass Resources: Bagasse, Wood and Sawmill waste and pulp in South Africa	DME
2004	SAMI Report 2003/4	DME
2005	Draft national framework guidelines for integrated waste management plans for municipalities, Development of national framework guidelines for integrated waste management plans, Draft document for discussion at work sessions, June 2005	DEAT
2005	Implementation Plan for Transfer of the Waste Permitting Function (Census 2005) Draft 2, December 2005	DEAT
2005	National State of the Environment Project - Integrated Waste management. Background research paper produced for the South Africa Environment Outlook Report	DEAT
2005	National waste management strategy implementation for South Africa: Recycling, Waste stream analysis and prioritisation for recycling, Annexure H, April 2005	DEAT
2005	Status quo of waste management and waste disposal site permitting in South Africa, Final version	DEAT
2005	South Africa's Mineral Industry (SAMI) 2004-5	DME
2006	Environmental Outlook report 2006	DEA
2006	National Waste Management Strategy Implementation for South Africa: Projections for Health Care Risk Waste Treatment	DEAT
2006	National waste management strategy implementation South Africa, Waste Information System Guideline on Technical Implementation, October 2006	DEAT
2007	Assessment of the status of waste service delivery and capacity at the local government level. August 2007 Draft 3. (Data sheet of this project as also consulted)	DEAT
2007	Community Survey 2007: Municipal data on household services, Key Municipal data	StatsSA
2007	General Household Survey, 2007	StatsSA

2008	Survey of Generation Rates, Treatment Capacities and Minimal Costs of Health Care Waste in the 9 Provinces of RSA	DEAT
2008	Local Government Budgets and Expenditure Review: 2003/04 - 2009/10	National Treasury
2008	General Household Survey, 2008	StatsSA
2008	Income and Expenditure of Households 2005/2006: Statistical release P0100	StatsSA
2009	National Waste Quantification and Waste Information System	DEA
2009	Department of Trade and Industry, Proposed Road Map for the Recycling Industry: A Recycling Industry Body (RIB) with Relevant Working Groups, January 2009	Dti
2009	Green Drop Report 2009 Version 1. South African Waste water Quality management Performance	DWA
2009	General Household Survey, 2008	StatsSA
2009	Selected Development Indicators. A discussion document sourced from the General Household Survey, 2009	StatsSA
2010	South Africa's Mineral Industry 2009/2010 - SAMI-, Department mineral resources Republic of South Africa, December 2010	DMR
2010	Blue drop report 2010, South African Drinking Water Quality Management Performance	DWA
2010	Statistical Release: Gross Domestic Product, Annual Estimates 2000-2009, Regional Estimates 2000-2009, Third quarter:2010, November 2010	StatsSA
2011	South Africa's Plan for the Implementation of the Stockholm Convention on Persistent Organic Pollutants	DEAT
2011	2011 Green Drop Report	DWA
n.d.	Technical Background Document for Mercury Waste Disposal	DEAT

State of the Environment Reports

Date	Report title	Author/owner
1999	Midrand State of Environment Report	Fakir S and Broomhall L.
2002	State of the Environment Report for City of Cape Town Year 5 (2002)	City of Cape Town
2002	North West Province State of the Environment Report, Overview 2002	North West Department of Agriculture, Conservation and Environment
2003	Limpopo Overview State of the Environment, October 2003	Department of Finance and Economic Development, Limpopo
2003	Ekurhuleni Metropolitan Municipality First year State of the Environment Report, 2003	Ekurhuleni Metropolitan Municipality
2003	Mangaung State of the Environment Report 2003	Mangaung
2003	Mbombela State of the Environment 2003. Final Report	Mbombela Local Municipality
2003	State of the Environment Report for the Mogale City Local Municipality 2003	Mogale City
2003	Mpumalanga State of the Environment Report	Mpumalanga Department of Agriculture, Conservation and Environment
2003	State of the Environment Report 2003, City of Johannesburg	City of Johannesburg
2004	Gauteng State of the Environment Report	GDACE
2004	Eastern Cape State of the Environment Report	Eastern Cape Department of Economic Affairs, Environment and Tourism
2005	State of the Environment Report 2005 Year one. Provincial Government of the Western Cape	DEDP WC
2005	Drakenstein State of Environment Report Popular version, December 2005	Drakenstein Local Municipality
2005	Knysna Municipality State of the Environment Report Year One	Knysna Municipality
2006	Nkangala District Municipality State of the Environment Report, 2006	Nkangala District Municipality
2009	Free State Environmental Outlook	Free State Government
2002	uMhlathuze Municipality State of the Environment report, Strategic Environmental Assessment for the uMhlathuze Municipality, June 2002	uMhlatuze Municipality

Integrated Development Plans

Year	Report title	Author/owner
2002	Ehlanzeni Integrated development plan: Waste management in-depth study June 2002	Ehlanzeni District Municipality
2004	Central Karoo District Municipality Integrated Development Plan Review 2004/05 for implementation 2005/06	Central Karoo District Municipality
2004	Dipaleseng Municipality Integrated Development Plan - Revision 2004	Dipaleseng municipality
2005	Lephalale Municipality Reviewed integrated development plan 2005	Lephalale Municipality
2006	Greater Sekhukhune District Municipality Integrated Development Plan 2006/07-2008/11	Greater Sekhukhune District Municipality
2006	Mbombela Local Municipality Integrated Development plan 2006-2011 Review 2007/8	Mbombela Local Municipality
2006	Nkomazi Local Municipality Integrated Development Plan 2006/7	Nkomazi Local Municipality
2006	Zululand District Municipality Environmental Management Plan. Municipal wide analysis as a component of the Municipality Integrated Development Plan incorporating the Brief Strategic Environmental Assessment. Final Report	Zululand District Municipality
2007	Albert Luthuli local municipality IDP 2007-2011 Reviewed for 2008/9	Albert Luthuli local municipality
2007	Bushbuckridge Local Municipality Five year Integrated Development Plan 2007-2011	Bushbuckridge Local Municipality
2007	Emalahleni Local Municipality Integrated Development Plan	Emalahleni Local Municipality
2007	Mopani District Municipality Reviewed Integrated Development Plan for 2007/8	Mopani District Municipality
2007	Msukaligwa Municipality IDP 2007-2012	Msukaligwa Municipality
2008	Eden District Municipality Revised Integrated Development Plan 2008/2009	Eden District Municipality
2008	Ehlanzeni District Municipality Integrated Development Plan	Ehlanzeni District Municipality
2008	Gert Sibande District Municipality Integrated Development Plan	Gert Sibande District Municipality
2008	Lekwa Local Municipality Reviewed IDP 2008-2011	Lekwa Local Municipality
2008	Metsweding District Municipality IDP review 2008-2009	Metsweding District Municipality
2008	Thaba Chweu Local Municipality Integrated Development Plan 2008/2009	Thaba Chweu Local Municipality
2008	Umjindi Municipality IDP 2008/09	Umjindi Local Municipality
2009	Amajuba District Municipality Integrated Development Plan review for 2009/10 Final report May 2009	Amajuba District Municipality
2009	Mbombela Local Municipality Integrated Development plan review2009-2010	Mbombela Local Municipality

Integrated Waste Management Plans – Metro's and Local Municipalities

Code	Year	Title/ Municipality
A	2003	The Waste management plan for the City of Johannesburg Final report: A Framework for sustainable waste management in the City of Johannesburg, June 2003
A	2004	City of Cape Town Integrated solid waste management plan Final status quo report, March 2004
A	2004	City of Tshwane Draft IWMP for comment
A	2004	Integrated waste management plan for eThekwini Municipality, August 2004
A	2005	Integrated waste management plan 2005-2010. Nelson Mandela Metropolitan Municipality, July 2005
A	2006	Waste optimisation study: Ekurhuleni
A	2007	Solid waste management department sector plan for integrated waste management and service delivery in Cape Town
A	2011	City of Johannesburg Integrated waste management plan
B1	2004	Drakenstein Municipality integrated waste management plan, December 2004
B1	2004	Integrated Waste management plan Polokwane municipality: Environmental and waste management (Draft)
B1	2005	Mangaung: Final draft IWMP
B1	2005	George IWMP
B1	2005	uMhlathuze local municipality: Integrated waste management plan for the uMhlathuze Municipality Kwazulu-Natal April 2005
B1	2006	Local Municipality of Madibeng: Status Quo and needs analysis study, June 2006
B1	2006	Mbombela local municipality draft integrated waste management plan.
B1	2006	Rustenburg Local municipality Integrated waste management plan, April 2006
B1	2006	Stellenbosch
B1	2007	Nkangala District Municipality: Emalahleni Local Municipality Integrated Waste Management Plan. Status Quo Report, Draft report No 20149-REP-002. April 2007
B1	2008	Emfuleni municipality Status quo and needs analysis study for the Emfuleni municipality October 2008
B1	2009	Drakenstein Municipality Integrated waste management plan 2nd version December 2009
B1	2009	Emalahleni Municipality Status Quo and needs analysis study for the Emalahleni municipality, May 2009
B1	2009	Msunduzi Local Municipality (KZN) Review IWMP
B2	2005	Breede Valley Local Municipality
B2	2005	Gert Sibande District Municipality, Msukaligwa Local Municipality: Integrated waste management plan: Phase 1 Information gathering and Gap analysis, September 2005
B2	2006	//Khara Hais Municipality status quo and needs analysis study for the //khara Hais Municipality
B2	2006	Knysna Municipality
B2	2006	Mossel Bay local municipality, Integrated waste management plan for the Mossel Bay local municipality, Western Cape, June 2006
B2	2006	Oudtshoorn
B2	2006	Saldanha Bay
B2	2008	Kungwini Local Municipality: Metsweding District. Integrated Waste Management Plan, November 2008
B2	2008	Makana municipality Status Quo and needs analysis study for the Makana municipality July 2008
B2	2008	Metsimaholo municipality Status quo and needs analysis study for the Metsimaholo municipality May 2008
B2	2008	Moqhaka municipality Status quo and needs analysis study for the Moqhaka municipality April 2008
B2	2009	Emakhazeni Municipality, Status quo and needs analysis study for the Emakhazeni municipality June 2009
B2	2009	Integrated waste management plan (Second edition) Overstrand Municipality, February 2009
B2	2009	Umdoni Local Municipality (KZN) Final IWMP
B2	2009	uMngeni Local Municipality (KZN) Review of IWMP
B2	2010	Hibiscus coast municipality integrated waste management plan for the Hibiscus coast municipality, Draft Final, February 2010
B2	2010	Integrated waste management plan for Emnambithi/Ladysmith Municipality
B3	2004	Ga - Segonyana
B3	2004	Gamagara IWMP
B3	2004	Greater Ba-Phalaborwa Local Municipality: Mopani District Municipality. Integrated waste management plan Feasibility study, August 2005
B3	2004	Vhembe District; Musina Local Municipality Integrated waste management strategy plan, February 2005

B3	2005	Beaufort West
B3	2005	Kareeberg Municipality Status Quo and needs analysis study for the Kareeberg Municipality. December 2005
B3	2005	Laingsburg local Municipality; Integrated waste management plan for the Laingsburg local municipality Western Cape, September 2005
B3	2005	Prince Albert IWMP
B3	2005	Swartland IWMP
B3	2005	Umvoti Municipality: Status Quo and needs Analysis study for the Umvoti municipality KwaZulu-Natal. May 2005
B3	2006	Bergrivier (Draft Report)
B3	2006	Bitou
B3	2006	Breede River Winelands Municipality
B3	2006	Cape Agulhas (Draft Report)
B3	2006	Hantam draft IWMP
B3	2006	Hessequa
B3	2006	Kamiesberg
B3	2006	Kannaland
B3	2006	Karoo Hoogland
B3	2006	Khai Ma
B3	2006	Matzikama Local Municipality (Draft Report)
B3	2006	Nama Khoi
B3	2006	Richtersveld
B3	2006	Swellendam Local Municipality (Draft Report)
B3	2007	Cederberg Municipality
B3	2007	Emthanjeni municipality: Status Quo and needs analysis study for the Emthanjeni municipality final July 2007
B3	2007	Kareeberg municipality Status quo and needs analysis study for the Kareeberg municipality September 2007
B3	2007	Ndlambe municipality Status quo and needs analysis study for the Ndlambe municipality June 2007
B3	2007	Renosterberg municipality Status quo and needs analysis study for the Renosterberg municipality
B3	2007	Siyancuma municipality Status quo and needs analysis study for the Siyancuma municipality
B3	2007	Siyathemba municipality Status quo and needs analysis study for the Siyathemba municipality September 2007
B3	2007	Theewaterskloof Municipality Draft Report
B3	2007	Thembelihle muncipality Status quo and needs analysis study for the Thembelihle municipality September 2007
B3	2007	Ubuntu municipality Status quo and needs analysis study for the Ubuntu municipality September 2007
B3	2007	Umsobomvu municipality Status quo and needs analysis study for the Umsobomvu municipality September 2007
B3	2007	Witzenberg Municipality (Draft Report)
B3	2008	Baviaans municipality Status quo and needs analysis study for the Baviaans municipality , August 2008
B3	2008	Camdeboo municipality Status quo and needs analysis study for the Camdeboo municipality , July 2008
B3	2008	Ikwezi municipality Status Quo and needs analysis study for the Ikwezi municipality August 2008
B3	2008	Kouga municipality Status Quo and needs analysis study for the Kouga municipality August 2008
B3	2008	Kou-Kamma municipality Status Quo and needs analysis study for the Kou-Kamma municipality August 2008
B3	2008	Mafube municipality Status quo and needs analysis study for the Mafube municipality April 2008
B3	2008	Ramotshere Moila municipality Status quo and needs analysis study for the Ramotshere Moila municipality July 2008
B3	2008	Sunday's River Valley municipality Status Quo and needs analysis study for the Sunday's River Valley municipality August 2008
B3	2009	Delmas municipality Status Quo and needs analysis study for the Delmas municipality June 2009
B3	2009	Mkhambathini Local Municipality (KZN) Review IWMP
B3	2009	Mpofana Local Municipality (KZN) Review of IWMP
B3	2009	Status Report Setsoto Local Municipality integrated waste management plan May 2009 Final version 2

B3	2010	uMuziwabantu Local municipality, integrated waste management plan for the Umuziwabantu local municipality, Draft Final, February 2010
B4	2004	Capricorn District Municipality. Integrated waste management plan Aganang local municipality Status Quo report Volume 1, November 2004
B4	2004	Fetakgomo Local Municipality Integrated waste management plan
B4	2004	Greater Giyani Local Municipality: Mopani District Integrated waste management plan: Status Quo report; May 2005
B4	2004	Greater Letaba Local Municipality: Mopani District Integrated waste management plan: Status Quo Report, May 2005
B4	2004	Greater Tzaneen Local Municipality: Mopani District Integrated waste management plan, Status Quo report, May 2005
B4	2004	Maruleng Local Municipality Mopani District Integrated waste management plan Status Quo report, March 2006
B4	2004	Moshaweng Local Municipality
B4	2004	Mutale Municipality Status Quo and needs analysis study(for the development of an integrated waste management plan) for the Mutale local municipality, May 2010
B4	2004	Sekhukhune District Greater Tubatse Local Municipality Integrated Waste Management Strategy Plan February 2005
B4	2004	Sekhukhune District, Greater Groblersdal Local Municipality Integrated waste management plan: Draft Status Quo report September 2004
B4	2004	Sekhukhune District, Greater Makhuduthamaga Local Municipality Integrated waste management plan: Draft status quo report, September 2004
B4	2004	Sekhukhune District, Greater Marble Hall Municipality Integrated waste management plan: Draft status quo report, September 2004
B4	2004	Vhembe District; Makhado Local Municipality Integrated waste management strategy plan, February 2005
B4	2004	Vhembe District; Mutale Local Municipality Integrated waste management strategy plan, February 2005
B4	2004	Vhembe District; Thulamela Local Municipality Integrated waste management strategy plan, February 2005
B4	2006	Bushbuckridge Local Municipality Draft copy Status quo study for the integrated waste management plan of the Bushbuckridge local municipality Mpumalanga
B4	2006	Integrated Waste Management Plan for Nkandla Local Municipality
B4	2009	Dr JS Moroka Municipality, Status quo and needs analysis study for the Dr JS Moroka municipality May 2009
B4	2009	Richmond Local Municipality (KZN) Review of IWMP
B4	2009	uMshwathi Local Municipality (KZN) Review of IWMP
B4	2010	Ezinqolweni Local municipality, Integrated waste management plan for the Ezinqolweni local municipality, Draft Final, February 2010
B4	2010	Jozini municipal integrated waste management plan (IWMP), Draft Status quo reprot for discussion - Jozini, October 2010
B4	2010	Review of the Integrated Waste Management plan of the uMgungundlovu District Municipality (IWMP - 2009 Update) Impendle Local Municipality IWMP
B4	2010	Umzumbe local municipality, integrated waste management plan for the Umzubme local municipality, Final draft, February 2010
B4	2010	Vulamehlo local municipality, integrated waste management plan for the Vulamehlo local municipality, Final draft, February 2010
B4	2011	Okhahlamba Draft IWMP

District Municipality and Provincial Waste Management Plans

Code	Year	Title
C	2002	uMgungundlovu District Municipality Integrated Waste management plan Report 261575/3 - Volume 1 of 2. August 2002
C	2002	Zululand DM (KZN) Solid Waste Management Master Plan
C	2003	Amajuba DM (KZN) Integrated Waste Management Master Plan
C	2003	Nkangala District Municipality General Waste management plan: Status Quo Report. Final report November 2003
C	2004	Integrated Solid Waste Management Plan for the uMkhanyakude District Municipality
C	2004	Kgalagadi IWMP
C	2004	uMgungundlovu District Municipality Integrated Waste management plan (IWMP -2004 update) Volume 1 of 3, November 2004
C	2005	Chris Hani District Municipality: Status Quo study for the Integrated Waste management plan, June 2005
C	2005	Central Karoo District Management Area
C	2005	Greater Sekhukhune District Municipality Integrated waste management Strategy Plan. February 2005
C	2005	Metsweding District Municipality Integrated waste management plan. Final report April 2005
C	2005	Umzinyathi District Municipality Status Quo and needs analysis study: Umzinyathi District Municipality
C	2005	uThungulu District Municipality Integrated waste management plan, August 2005
C	2005	Vhembe District Municipality Integrated waste management strategy plan status quo report, January 2005
C	2006	Eden District Municipality Integrated waste management plan for the Eden District Municipality. Western Cape, November 2006
C	2006	Greater Mopani District Municipality Integrated waste management plan. Status Quo report April 2006
C	2006	Namakwa: IWMP
C	2006	Waterberg District: IWMP
C	2007	Cape Winelands District Municipality (Draft Report)
C	2007	Pixley ka Seme District management area
C	2007	Overberg District Municipality Plan (Draft Report)
C	2007	Pixley ka Seme: Summary of Local Municipality IWMPs
C	2007	West Coast District Municipality (Draft Report)
C	2008	Cacadu District management area Status quo and needs analysis study for the Cacadu district management area August 2008
C	2009	Advanced integrated solid waste management system: uMgungundlovu
C	2010	Integrated waste management plan 2010-2020 Compiled on behalf of West Rand District Municipality
C	2010	Siyanda District Municipality (NC) Condensed IWMP
P	2005	Limpopo: Hazardous waste management plan (Status Quo)
P	2006	North West: Hazardous waste management plan (Status Quo)
P	2007	Gauteng: 1st generation Hazardous waste management plan

P	2008	Mpumalanga: Draft Final status Quo - Hazardous waste management plan
P	2008	Northern Cape Province Integrated Waste Management plan: Final draft IWMP April 2008
P	2008	Provincial Integrated waste management plan: North West, Status Quo report
P	2009	Draft Integrated General Waste Management Plan: Eastern Cape
P	2010	Provincial Integrated waste management plan for the Western Cape Draft 1. November 2010

Datasets

Year	Report title	Author/owner
2000	Waste Stream Analysis - Appendix	City of Johannesburg
2007	PDG data sheet on capacities	DEA
2007	PDG full municipal listing	DEA
2007	PDG municipality responses	DEA
2007	Sewage works inventory	DWA
2007	Landfill yearly mass stats 1999 - 2007	eThekwini
2009	CAIA waste table 2004-2009	CAIA
2009	Disposal site permit database	DEA
2009	List of plastic recyclers	DEA
2009	DWA inventory of WWTW	DWA
2009	Treatment processes at water care works	DWA
2009	Forestry and Forest Products industry facts 1980 to 2009	SA Forestry Industry
2009	Categories and quantities of tyres - SATRP Company	SATRP
2010	City of Tshwane, Landfill yearly waste volumes received: 2001/2 - 2009/10	City of Tshwane
2010	Waste sum landfill	City of Tshwane
2010	Pikitup Landfill per category July 2007 to March 2010	Pikitup
2010	Pikitup Landfill Tonnage Report 2001 -2010 Rev 2	Pikitup
2011	Minimisations stats July 2011, 2006 to 2011 data Cape Town	City of Cape Town
2011	SAWIS, February 2011	DEA
2011	Inventory of Waste Water Treatment Works Authorisations	DWA
2011	WARMS database	DWA
2011	LEDET Summary	Limpopo Department
2011	Waste volumes received at Arlington Landfill	Nelson Mandela Metro
2011	The glass recycling company, Provincial Cullet (Waste Glass) Recoveries, F10/11, 1 July 2010 to 30 June 2011	The glass recycling company
n.d.	Food waste estimates	Earth Probiotic
n.d.	Pikitup - Composition of waste streams	Pikitup

Industry reports and plans (not annual reports)

Date	Report title	Author/owner
2005	e-Waste assessment in south Africa, a case study on the Gauteng province, Final version	Swiss global e-waste programme
2008	e-Waste Assessment South Africa.	Finlay A and Liechti D.
2008	Report on commercial timber resources and primary roundwood processing in RSA	Forestry Technical and information services
2009	Forestry and Forest Products industry facts 1980 to 2009	Forestry Technical and information services
2009	Plastics Recycling survey 2009	Plastics SA
2009	Recycling and Economic Development Initiative of South Africa Integrated Waste Tyre management plan	REDISA
2009	The Integrated industry waste tyre management plan of the South African tyre recycling process company	SATRP
2009	Scaw Metals Sustainable development report 2009	SCAW metals group
2010	2009 Recycle assessment, prepared for RAG Members Revised Targets	RAG
2011	ITA industry waste management plan, Draft V0.8, October 2011 (e-Waste)	IT association of South Africa
2011	Packaging and paper industry waste management plan, Augustus 2011	PACSA

Water Research Commission Reports

Date	Report title	Author/owner
1987	Water and waste water management in the Malt Brewing Industry. WRC report TT 29/87	Binnie and Partners Consulting Engineers
1987	Water and waste water management in the Metal Finishing Industry. WRC report TT 34/7	Binnie and Partners Consulting Engineers
1987	Water and waste water management in the soft drink industry. WRC report TT 35/87	Binnie and Partners Consulting Engineers
1989	Water and waste water management in the dairy industry. WRC report TT 38/89	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1989	Water and waste water management in the sorghum malt and beer industries. WRC report TT 39/89.	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1989	Water and waste water management in the edible oil industry. WRC report TT40/89	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1989	Water and waste water management in the red meat industry. WRC report TT 41/89	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1989	Water and waste water management in the laundry industry. WRC report TT42/89	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1989	Water and waste water management in the poultry industry. WRC report TT43/89	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1989	Water and waste water management in the tanning and leather finishing industry. WRC report TT44/90	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1990	Water and waste water management in the sugar industry. WRC report TT47/90	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1990	Water and waste water management in the paper and pulp industry WRC report TT49/90	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1993	Water and waste water management in the textile industry. WRC report TT 50/90	Steffen, Robertson and Kirsten Inc. Consulting Engineers
1993	Water and waste water management in the wine industry. WRC report TT51/90	Steffen, Robertson and Kirsten Inc. Consulting Engineers
2004	A Metal Content Survey of South African Sewage Sludge and an evaluation of analytical methods for their determination in sludge. WRC Report 1283/1/04	Snyman HG, Herselman, JE. And Kasselman, G.
2004	Laboratory and field scale evaluation of agricultural use of sewage sludge. WRC report 1210/1/04	Snyman, HG and Van der Waals, J.
2005	An evaluation of dedicated land disposal practices for sewage sludge. WRC report 1209/1/05	Herselman JE, Wade PW, Steyn CE and Snyman HG
2005	Water and waste water management in the oil refining and re-refining industry. WRC Report TT 180/05	Pearce, K and Whyte, D.
2005	Water and waste water management in the power generating industry. WRC report TT 240/05	van Zyl, HD and Premlall, K.
2006	Premise for the development of Volume 1 and 2 of the South African Sludge Guidelines. WRC report 1453/1/06	Snyman HG and Herselman, JE.

2006	Guidelines for the utilisation and Disposal of Wastewater Sludge. Volume 1: Selection of Management options. WRC report TT 261/06	Snyman HG and Herselman, JE.
2006	Guidelines for the utilisation and Disposal of Wastewater Sludge. Volume 2 of 5: Requirements for the Agricultural use of Wastewater Sludge. WRC Report TT 262/06	Snyman HG and Herselman, JE.
2007	Methodology and survey of organic pollutants in South African Sewage Sludges. Volume 1. WRC Report 1339/1/07	Jaganyi, D
2007	Methodology and survey of organic pollutants in South African Sewage Sludges. Volume 2. WRC Report 1339/2/07	Jaganyi, D
2009	First Order Assessment of the Quantity and Quality of non-point sources of pollution associated with Industrial, mining and power generation. WRC report 1627/1/09	Heath RG, Van Zyl HD, Schutte CF and Schoeman JJ.
2009	Guidelines for the Utilisation and Disposal of Wastewater sludge. Volume 4: Requirements for the beneficial use of sludge at high loading rates. WRC report TT350/09	Herselman JE and Moodley, P.
2009	Guidelines for the Utilisation and Disposal of wastewater Sludge. Volume 5: Requirements for thermal sludge management practices and for commercial products containing sludge. WRC report TT 351/09	Herselman JE, Burger LW and Moodley P.
2009	Guidelines for the Utilisation and Disposal of Wastewater sludge. Volume 3: Requirements for the on-site and off-site disposal of sludge. WRC report TT 349/09	Herselman, JE and Snyman, HG.
2010	a first order inventory of water use and effluent production by SA industrial mining and electricity generation sectors, April 2010	TE Cloete, A Gerber & LV Maritz

Scientific papers

Year	Report title	Author/owner
1988	Asbestos in South Africa	HP Hart
2000	Guidelines for the compilation of integrated waste management plans, Wastecon 2000, Somerset West, September 2000	Wiechers HNS, Borland J, Hanks J and Scott W
2003	Cape Plc: South African Mineworkers Quest for Justice	Richard Meeran, JD
2003	Asbestos mining in southern Africa, 1893-2002	Jock Mcculloch
2003	Appropriate approach in measuring waste generation, composition and density in developing areas. Journal of the South African Institution of Civil Engineering, 45(3) pages 2-10, Paper 477.	Mbande, C
2005	Consumer choice in an energy efficient lighting context, May 2005	Jabavu Clifford Nkomo
2006	Projection of Hospital and Clinic Health Care Risk Waste Generation Quantities and Treatment Capacities for South African National Waste Management Strategy Implementation Project	Rogers DEC, Molefe S, Gcwensa Q, Van den Bergh C, Kristiannsen,T and Otto, JB
2007	Still Nothing happening at Thor. *Groundwork* Volume 9(3) Sept 2007	Euripidou, R and Peek, B
2010	Solar drying and composition of sewage sludge without a bulking agent.	Boyd, RJA, Deacon, SL and Van Niekerk, AM
2011	How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Management* 31: 714-730	Ongondo FO, Williams ID and Cherrett, TJ.

Other reports

Date	Report title	Author/owner
1997	Energy Efficient Lighting in the Republic of South Africa	Robert Henderson, Electrotek, Technology Research and Investigations, Eskom, SA
2000	Nkomazi Local Municipality Waste management best practice	Nkomazi Local Municipality
2000	The need for and location of high hazardous waste sites for KwaZulu Natal.	Town and regional planning commission
2001	Danced environmental capacity building project, Johannesburg. Mini-project WM4 on metro-wide waste management planning-Phase 1, Current waste management in the city of Johannesburg, A waste stream analysis of the general waste stream, December 2001	Johannesburg Municipality
2001	Profiling South African middle-class households, 1998 2006	StatsSA
2002	statistical infrastructure review of the Demarcated Municipalities	Development Bank
2002	Waste management in-depth study - Ehlanzeni integrated development plan	Ehlanzeni municipality
2002	study on solid waste management options for Africa, Project report final draft version, July 2002	Richard J Palczynski
2003	City of Tshwane metropolitan municipality waste management section in association with USAID, draft, educational strategy to produce increased awareness at the community level in Tshwane regarding solid waste management, Version V2.0, October 2003	BE Ngeleza, LP Mohajane, SJ bellinger and HNS Wiechers
2003	General management assistance contract (GMAC): City of Tshwane metropolitan municipality waste management section in association with USAID, Draft, Educational strategy to produce increased awareness at the community level in Tshwane regarding solid waste management, Version V2.0, October 2003	BE Ngeleza, LP Mohajane, SJ bellinger and HNS Wiechers
2003	KwaZulu Natal Provincial Government, Department of Agriculture and Environmental Affairs, Guidelines for the development of integrated waste management plans for local governments, 2nd draft document, January 2003	DAEA, KZN
2003	Assessment of existing waste management conditions and recommendations concerning service delivery improvement in the Govan Mbeki Municipality, May 2003	Govan Mbeki Municipality
2003	composition and generation of Health Care Risk Waste in South Africa	Torben Kristiansen et al
2004	Pikitup Johannesburg Material reclamation study	Johannesburg Municipality
2004	A Report for the Assessment of Waste Disposal Sites in the Province of Kwazulu-Natal	KZN Provincial Planning and Development Commission
2004	Integrated Environmental management plan Mangaung local Municipality September 2004	Mangaung
2005	Greater Ba Phalaborwa Local Municipality: Mopani District Municipality. Integrated waste management plan Feasibility study, August 2005	Ba Phalaborwa Local Municipality
2005	eThekwini Municipality, Association of clean communities, 2004/2005 Projects	Ethekwini municipality
2005	Learning with Mogale City Part 2. Lessons learnt from conducting a participation process for civil society in developing Mogale City's Integrated Waste Management Policy	Victor Munnik and Joey Mokone
2005	Association of clean communities 2004/2005 Projects	
2005	National waste management strategy implementation South Africa - Recycling. Waste stream analysis and prioritisation for recycling	

2006	Assessment for the best practicable Environmental Option for managing priority hazardous waste streams for the Western Cape.	DEDP WC
2006	Ekurhuleni Metropolitan Municipality waste management optimization feasibility study Volume 2 March 2006	Ekurhuleni Metropolitan Municipality
2006	Waste Origin: Summary report July 2005 - June 2006	Ekurhuleni municipality
2006	Hazardous Waste management in Limpopo province, Draft final report, Augustus 2006	Limpopo municipality
2006	Mittal Steel South Africa Sustainability report 2006	Mittal Steel
2006	Projection for health care risk waste treatment, September 2006	National waste management strategy implementation south Africa
2006	From waste to resource, An abstract of 2006 world waste survey	
2007	Penge Asbestos hazard: Site visit and assessment	Donohue, S
2007	Integrated Analysis Solid waste baseline Report	Engledow, S-A
2007	South Africa's Ferro alloys industry - present status and future outlook	Mintek
2007	Report to Pikitup Johannesburg on development of Strategic road map Phase 2. Volume 1 of 3 Report	Pikitup Johannesburg
2007	Report to Pikitup Johannesburg on development of Strategic road map Phase 2. Volume 2 of 3 Annexure A to G	Pikitup Johannesburg
2007	Report to Pikitup Johannesburg on development of Strategic road map Phase 2. Volume 3 of 3 Annexure H to I	Pikitup Johannesburg
2007	Community Survey 2007 Municipal data on household services, Key Municipal data	StatsSA
2007	General household survey	StatsSA
2007	Theme: Waste management	
2008	Disposal Technology Options Study (POPs waste)	Africa Stockpiles Programme
2008	Municipal demarcation board assessment of capacity for the 2007/08 period district municipality report, Capricorn district municipality (DC35), Limpopo	Capricorn district municipality
2008	Waste Origin: Summary report July 2007 - June 2008	Ekurhuleni municipality
2008	Gauteng Department of Agriculture, Conservation and Environment. General Waste Minimisation Plan for Gauteng (Version 4.1) October 2008	Gauteng Department of Agriculture, Conservation and Environment.
2008	Development of a general waste minimisation plan for Gauteng - Status gap and waste minimisation options report (Draft Final Report, Version3.1)	Gauteng Department of Agriculture, Conservation Environment and Land Affairs
2008	General waste minimisation plan for Gauteng Version V4.1, December 2008	Gauteng municipality
2008	Private Hospital Review 2008, Examination of factors impacting on private hospitals	Hospital Association of South Africa
2008	Municipal capacity assessment 2007/2008 - 48 reports - (One report per District Municipality).	Municipal demarcation board
2008	Local Government Budgets and Expenditure Review: 2003/04 - 2009/10	National Treasury
2008	North West Province Environment outlook, Draft environment outlook report, Revision 3, September 2008	North West Department of Agriculture, Conservation and Environment
2008	General household survey	StatsSA
2008	Income and expenditure of households 2005/2006: Analysis of results	StatsSA
2008	Income and expenditure of households 2005/2006: Statistical release P0100	StatsSA

2008	Seprotech expands water treatment services to include plant operations; Black & Veatch leads desalination research effort; Partnership are key to water markets in south Africa; Nitto denko RO membrane helps win environmental award, membrane technology news, November 2008	
2008	Waste oil management for the Rose Foundation , South Africa	Rose Foundation
2009	Province of KwaZulu-Natal, Department of Agriculture Environmental Affairs and Rural Development, Development of a provincial integrated waste management plan for KwaZulu-Natal	Department of Agriculture Environmental Affairs and Rural Development
2009	General and Hazardous Waste Management Plans, draft integrated general waste management plan, November 2009	Department of Economic Development and Environmental Affairs
2009	Waste Origin: Summary report July 2008 - June 2009	Ekurhuleni municipality
2009	GDARD EIA review system: Feasibility study for the development of an EIA review system, September 2009	Gauteng department of agricultural & rural development
2009	Hospital Association of South Africa, Private Hospital Review 2009	Hospital Association of South Africa
2009	From waste to resource, An abstract of world waste survey, 2009	Philippe Chalmin & Cathenine Gaillochet
2009	Costing the integrated waste management bylaw with specific reference to airspace savings, Draft report Phase II, June 2009	Solid waste management department, city of cape town & School of public management and planning, University of Stellenbosch
2009	General Household Survey, 2009	StatsSA
2009	Selected development indicators. A discussion document sourced from the General Household Survey, 2009	StatsSA
2009	uMgungundlovu DM - Solid waste management, Consulting services Elaboration of a Feasibility Study for an Advanced integrated solid waste management system for uMgungundlovu district municipality*, Terms of reference, December 2009	uMgungundlovu DM
2009	Stockholm Convention on Persistent Organic Pollutants (POPs) as amended in 2009	UNEP
2009	Sustainable Innovation and Technology Transfer Industrial Sector Studies. Recycling - From E-Waste to Resources	UNEP
2009	An investigation of Innovative Approaches to Brine Handling. WRC report 1669/1/09	Van der Merwe IW, Lourens A and Waygood, C
2010	Solid Waste Management Sector Plan (Incorporating Integrated Waste Management Plan) 2010 Review	City of Cape Town
2010	Gaps and needs analysis - Final report, Integrated waste management plan for the Western cape, Augustus 2010	DEDP WC
2010	Synthesis report, Integrated waste management plan for the western cape province, October 2010	Department of Environmental affairs and development planning
2010	Waste Origin: Summary report July 2009 - June 2010	Ekurhuleni municipality
2010	P9115 Unit data 2009 and 2010	StatsSA
2010	Statistical release: Gross domestic product, Annual estimates 2000-2009, Regional estimates 2000-2009, Third quarter:2010, November 2010	StatsSA
2010	Fact sheet steel industry by-products, Achieving the goal of zero waste, February 2010	Worldsteel association
2010	Technical guidelines for the Environmentally sound management of waste consisting of, containing or contaminated with Mercury - 5th draft	
2011	A socio economic profile of south African households in 2010	Andre Roux
2011	Local Government Budgets and Expenditure Review: 2006/07 - 2012/13	Department: National Treasury

2011	Waste Origin: Summary report July 2010 - June 2011	Ekurhuleni municipality
2011	Eskom reporting on Disposal data of ash, brines and compact fluorescent lamps. An overview of the disposal for the period Apr 2010 to March 2011	ESKOM
2011	Foundry industry waste	John Davies
2011	New Technology furthers the Recycling of Waster Oil in SA. Nora-SA News Issue 1:2011	National Oil Recycling Association of SA
2011	Packaging and paper industry waste management plan, Draft version 5.7.2011	Packaging council of South Africa
2011	Blue drop Green Drop assessment Report	
nd	Cape Agulus Draft integrated waste management plan, industrial survey	Cape Agulus municipality
nd	Using indicators to track environmental change, Chapter 9 Waste management	Gauteng provincial department
nd	Hotazel landfill site Checklist	Hotazel landfill site
nd	Environmental measures: Kgalagadi district municipality	Kgalagadi district municipality
nd	health care waste in Southern Africa: a civil society perspective	Lewellyn Leanord
nd	Environmental management framework for the Msunduzi municipality, Stakeholder survey questionnaire	Msundi Local Municipality
nd	South African Iron and steel institute, Introduction to the south African iron and steel institute (SAISI)	South African Iron and Steel Institute
nd	Extract from instructions to members on waste information to be submitted	
nd	review of the integrated waste management plan and solid waste recycling project, Section 2, Clients requirements and terms of reference	

Annexure E: Summary of Brine Treatment Technology options

BRINE TREATMENT TECHNOLOGIES

Different brine management strategies are used in industry, these are grouped as brine minimization processes, product recovery processes and final disposal processes. In this section 16 brine treatment methods are summarised (Van der Merwe *et al*, 2009).

EVAPORATION PONDS

Evaporation ponds are the most popular treatment option for brine wastes. It works well for small brine volumes and is easy to construct and operate. The evaporation process depends on the size of the pond due to the role it plays in the evaporation rate. The salinity of the waste is also important because it has a negative impact on the evaporation rate (Dama-Fakir, n.d.).

The evaporation from the ponds is driven by solar energy (Kepke, n.d.). The salt concentration in the brine is increased when the water is evaporated from it. This method was used for centuries to recover salt from the ocean (Van der Merwe *et al*, 2009).

When the evaporation occurs under natural conditions, large evaporation ponds are required. This can be overcome when wet surfaces (capillaries or clothes) are exposed to the wind. The surface density will be high enough to generate an evaporation flow with minimum energy consumption (Arnal, 2005).

The evaporation ponds can either be lined or unlined ponds, depending on the geographic detail of the area (Van der Merwe *et al*, 2009). The only mechanical equipment, and therefore additional energy, that is required for the evaporation ponds is feed pumps (Van der Merwe *et al*, 2009). The rest of the process relies on heat generated from the sun. This process is not recommended when the weather conditions are generally cold and/or wet, i.e. where the evaporation rates are low, or when the disposal rate is much higher that the evaporation rates (Van der Merwe *et al*, 2009).

MECHANICAL EVAPORATION

Mechanical evaporation is driven by heat transfer. Steam is condensed on a metallic heat transfer surface. The absorbed heat causes the water to vaporise and thus it increases in the salt concentration. The water vapour is then condensed for reuse (Kepke, n.d.). This process is mainly implemented for larger processes (Van der Merwe *et al*, 2009).

The advantage is that the process produces a solid salt product (individual salt product or a mixed waste) (Van der Merwe *et al*, 2009). The disadvantages include the energy intensity of the process, the greenhouse gas production, high maintenance and capital cost due to the use of exotic materials as well as high operating costs (Van der Merwe *et al*, 2009). Skilled operators are also needed on the plant (Van der Merwe *et al*, 2009).

WIND AIDED INTENSIFIED EVAPORATION (WAIV)

This technology uses wind, a natural renewable energy source, to enhance evaporation form brine ponds (Van der Merwe *et al*, 2009).

This was tested on a small evaporation pond. The evaporation of the water increased up to 30 times relative to natural evaporation processes from open ponds. This WAIV process has not been implemented on full scale, yet (Van der Merwe *et al*, 2009).

DEWVAPORATION

This process is base on the natural cycle of humidification and de-humidification. It uses waste heat (a low-energy energy source) to evaporate water from the brine (Van der Merwe et al, 2009). The Dewvaporation system evaporates the water from the liquid surface and therefore, scaling problems are reduced. It also offers the recovery of high quality water as product (Van der Merwe et al, 2009). Another advantage is that the non corrodible material that can be used for construction since the process operates below 100°C. This will significantly reduce the capital and maintenance requirements (Van der Merwe et al, 2009).

The technology was tested in the laboratory. The produced water was comparable to the water produced by a mechanical evaporator (Van der Merwe *et al*, 2009).

DEEP WELL INJECTION (DWI)

Deep well injection ultimately stores liquid wastes in the subsurface geologic formations of the earth (Kepke, n.d.). The selection of suitable well sites involves a complex and detailed process (Van der Merwe *et al*, 2009). To obtain permission for deep well injection in South Africa is unlikely due to the risk of groundwater contamination (Dama-fakir, n.d.).

Other disadvantages of include high costs regarding the conditioning of the brine to prevent well clogging. The possibility of corrosive brines is also a concern because it could cause seismic activity that could damage the well and cause groundwater contamination (Van der Merwe *et al*, 2009).

NATURAL TREATMENT SYSTEMS

Wetlands are natural brine treatment systems. These wetlands rely on naturally occurring processes to improve the water quality. It was found that wetland systems often provided cost-effective, low energy, natural alternatives to energy intensive processes (Kepke, n.d.).

BIOLOGICAL DEGRADATION

Biological treatment processes can be used to remove organics from brines. Unfortunately the high salinity of the brines makes it difficult to treat it with conventional bacteria cultures (Woolard, 1994).

BIOLOGICAL ACTIVATED CARBON (BAC)

The BAC process consists of both activated carbon adsorption and biodegradation of organics by microorganisms. By combining adsorption and biodegradation, it results in partial regeneration of the activated carbon through biochemical activities, while the carbon bed is in operation. The less biodegradable organics are adsorbed on the carbon and then it is slowly degraded by microorganisms (Ng, 2008).

REVERSE OSMOSIS

The major obstacle to operating reverse osmosis units at higher recoveries is the precipitation of sparingly soluble salts. Salt precipitation can be controlled by using an anti-scalant and by controlling the feed water pH. This will result in lower recoveries, which is undesirable (Kepke, n.d.).

HIGH EFFICIENCY REVERSE OSMOSIS (HERO™)

The HERO™ process consists of several proven pre-treatment steps in combination with reverse osmosis units that operate at high pH levels.

In order to operate the reverse osmosis unit at a high pH, all the hardness and other cationic species in the brine that causes scaling should be removed first. The suspended solids should also be reduced to near zero in order to minimise plugging (Kepke, n.d).

VIBRATING SHEAR ENHANCED PROCESSING (VSEP) MEMBRANES

The VSEP membrane process would decrease the amount of concentrate needed to be disposed off, like the previous two processes. However an ultimate disposal mechanism would still be required to completely dispose of the brine, like all the other membrane processes (Kepke, n.d.).

ELECTRODIALYSIS (ED)

An ED process can increase the salt content of the brine. Though, it still needs to be treated/disposed of after wards (Turek, 2003). This process is subject to high capital and operating costs (Kepke, n.d.).

CAPACITIVE DEIONISATION (CDI)

The CDI process can remove inorganic compounds. The process cycle consist of three phases namely the purification phase, the rejection phase and the purge phase. During the purification phase, the electrical potential (about 1.5 volts) between the two electrodes removes the dissolved ions form the water as its passes through the cell. The permeate conductivity will decrease and therefore generate a water product. Regeneration takes place by reversing the potential across the two electrodes. The ions are expelled from the electrodes into the rinse water that is purged out of the cell. In general, the CDI process has lower energy requirements as compared with other membrane process since high pressure pumps are not needed (Ng, 2008).

FREEZE DESALINATION

Freeze desalination is based on the solubility difference of salt, liquid water and ice. It enables the recovery of ice crystals form brine, without the addition of chemicals or fresh water to wash the ice with (Mtombeni, n.d.).

The concerns with freeze desalination are the salt content in the ice and the efficiency of vacuum pumps. These pumps are used to lower the temperature of the brine (Van der Merwe *et al*, 2009). The advantages include the reduction in energy demand in comparison with evaporation processes since the heat of fusion of ice (6.01 kJ/mol) is six times less than the heat of evaporation of water (40.65 kJ/mol) and the reduction in corrosion and scaling problems due to the low temperature (Nathoo, 2009; Van der Merwe *et al*, 2009).

HybridICE® is a freeze desalination method. This process of desalination is economically feasible in most brine treatment processes. Particularly when the secondary fluid is utilised for cooling purposed and when contaminated fluid can be used as a secondary refrigerant without the need to purchase ethylene glycol.

A significant benefit of this technology is that the cold energy that is generated can be stored, taking advantage of off-peak energy rates and incorporating the recovery of water as part of the cooling process (Mtombeni, n.d.).

EUTECTIC FREEZE CRYSTALLIZATION (EFC)

By treating brines with the EFC method, potable water and pure salts can be recovered (Randall, 2010). The operation principle of the process can be described is as follows. When the salt solution is slowly frozen, water ice crystals form on the surface and can be separated from the solution. The salt is concentrated in the remaining solution. The salt will crystallizes at its eutectic temperature and therefore it can be separated from the solution as a salt product (Nathoo, 2009).

A mixed salt product can be avoided by producing many pure salts, each at their unique crystallization temperatures. The advantages of this process are that it is not complicated by chemical addition, it is a less energy intensive process in comparison to evaporation, and the ice crystals are pure water. The ice crystals that are produced can also be used for cold heat storage and gravitational separation of the ice and salt crystals are an added advantage during EFC since both products are separated by density difference. The salt sinks to the bottom while ice floats on top.

The sequential removal of individual salts form brine is theoretically possible since each salt crystallizes at its own unique eutectic temperature (Randall, 2010). Though, this is not yet proven.

REFERENCE

Van der Merwe, IW; Lourens, A and Waygood, C, 2009 "An investigation of innovative approaches to brine handling" Report to the Water Research Commission 1669/1/09

Dama-Fakir, P and Toerien, A, n.d. "the effect of salinity on evaporation rates of brines form the treatment of mine water" Golder Associates Africa

Turek, M, 2003 "Electrodialytic desalination and concentration of coal mine brine" Desalination 162 (2004) 355-359

Kepke, J, Foster, L, Cesca, J, McCann, D, n.d. "Hold the salt: innovative treatment of RO concentrate"

Nathoo, J, Jivanji, R and Lewis, WE, 2009 "Freezing your brines off: eutectic freeze crystallization for brine treatment" International mine water conference October 2009

Arnal, JM, Sancho, M, Iborra, I, Gozalvez, JM, Santafe, A and Lora, J, 2005 "Concentration of brines from RO desalination plants by natural evaporation" Desalination 182 (2005) 435-439

Woolard, CR, Irvine, RL, 1994 "Biological treatment of hyper saline wastewater by a biofilm of halophilic bacteria", Water environment research 66(3) pp 230-235

Randall, DG, Nathoo, J and Lewis, AE, 2010 "A case study for treating a reverse osmosis brine using eutectic freeze crystallization – approaching a zero waste process" Desalination (2010) doi:10.1016/j.desal.2010.08.034

Mtombeni, T, Zvinowanda, CM, Maree, JP, Oosthuizen, FS and Louw, WJ, n.d. "Brine treatment using freeze desalination"

Ng. HY. Lee. LY, Ong, SL, Tao, G Viawanath, B, Kekre, K, Lay, W and Seah, H, 2008 "Treatment of RO brine – towards sustainable water reclamation practice" Water Science and Technology 54(4) IWA Publishing