

## **West Midlands Regional Assembly – Regional Planning Body**

This report has been prepared on behalf of the West Midlands Regional Assembly, the Regional Planning Body, as technical advice to inform the Regional Spatial Strategy Revision process. It is one of a suite of technical reports commissioned to inform the development of spatial policy as part of Phase Two of the Revision of the West Midlands Regional Spatial Strategy.

Every effort has been made to verify and check the contents of this report including all figures and tables. However the West Midlands Regional Assembly can not accept any responsibility for errors or inaccuracies.

Further information and details of the West Midlands Regional Strategy and the Revision process can be found on our web site [www.wmra.gov.uk](http://www.wmra.gov.uk)

A REPORT BY ENVIROS CONSULTING LIMITED: JUNE 2006

**WEST MIDLANDS REGIONAL  
ASSEMBLY**

**WASTE RESIDUES REPORT**



**Publication title** Waste Residues Report  
**CAN** WE09200016  
**Version** Draft Report  
**Date** June 2006  
**File Reference** Waste Residues Report\_Draft270206.Doc

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## 1. INTRODUCTION

The West Midlands Regional Assembly (WMRA) as the Regional Planning Body (RPB) is currently undertaking a partial revision of the Regional Spatial Strategy (RSS). Phase 2 of the revision was launched on 7 November 2005 and includes in its objectives a requirement "to provide sufficient opportunities to meet identified needs of the West Midlands for waste management for all streams."

The Regional Technical Advisory Board (RTAB) on behalf of the WMRA, has commissioned three pieces of work to assess:

- The existing capacity in the region to manage controlled waste;
- The anticipated controlled waste arisings in the region as a result of known legislative change; and
- Scenarios for managing controlled waste arising in the region.

The Scenarios Study identified a number of physical, biological and thermal treatment facilities which will each generate different quantities of waste residues. These waste residues also require waste management provision.

As a follow on from this work Enviro Consulting Ltd (Enviro) were commissioned to undertake a study to provide information on the potential volume, characteristics and disposal options for waste residues arising from the different waste management technologies.

This report presents the results of this study and sets out the information in tabular format. Section 2 summarises the technologies and the waste outputs and Section 3 summarises the management routes required for the key waste residues, including re-use, recycling, treatment or disposal.

## 2. TREATMENT TECHNOLOGIES

Waste management technologies which might be employed within the region to manage Municipal Solid Waste (MSW) and general Commercial and Industrial (C&I) waste include:

- Materials Recovery Facility;
- In-vessel Composting;
- Anaerobic Digestion;
- Mechanical Biological Treatment;
- Pyrolysis;
- Gasification; and
- Energy from Waste.

A summary definition of each technology is set out in Appendix 1. Each of the above treatment technologies produces different types and quantities of residual outputs, all of which will require further management. Table 1 below identifies the types, characteristics and anticipated proportions of waste outputs arising from each technology.

The proportions of each output to be managed from each technology have been sourced primarily from technology case studies on the Environment Agency's Waste Technology Data Centre, along with figures from the Mechanical Biological Treatment report by Juniper<sup>1</sup>, and figures quoted in the report for the Strategy Unit on 'The Role of New and Emerging Technologies'<sup>2</sup>.

Figures quoted are therefore based primarily on figures for municipal waste so actual figures for the handling of commercial and industrial waste are likely to vary. However these figures will provide an indication of the proportion of waste that will require handling via a particular waste management route.

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1 Mechanical Biological Treatment: A Guide for Decision Makers Processes, Policies and Markets, Juniper Consulting, 2005

2 Delivering the Landfill Directive: The role of new and emerging technologies, Report for the Strategy Unit 2002, Stuart McLanaghan



## WASTE RESIDUES REPORT

Table 1 Characteristics and proportions of outputs from waste management technologies

Type of Technology	Typical Input	Output	Proportion <sup>3</sup>	Characteristics
<b>Materials Recovery Facility (MRF)</b>	Mixed waste or source segregated co-mingled recyclables	Recyclate metal	85-95% dry recyclables from source segregated.	Recyclate from source segregated collection will be quite clean with minimal contamination depending on quality of materials received.
		Recyclate glass		
		Recyclate plastic		
		Recyclate paper/card		
		Reject to landfill	5-15%	Rejected recyclables, and organic fraction above if not processed prior to landfill
<b>In-vessel Composting</b>	Source segregated biodegradable waste (i.e. kitchen and garden waste)	Compost	50-60%	Organic material (biomass, decomposition by-products, humus and woody fragments)
		Reject to Landfill	5-30%	Oversize organic fraction (and pre-sorted material or contaminants in source segregated waste stream e.g. Plastic bags)
	Water and Air	Waste water	0-20%	
		Water vapour and Carbon Dioxide	20-30%	

<sup>3</sup> Proportions may not add up to 100% due to mass loss occurring during the treatment process



Type of Technology	Typical Input	Output	Proportion <sup>3</sup>	Characteristics
<b>Anaerobic Digestion</b>	Source segregated biodegradable waste (i.e. kitchen and garden waste)	Digestate	20-50%	Organic material (biomass, decomposition by-products, humus and woody fragments)
		Reject to Landfill	5-20%	Pre-sorted material or contaminants in source segregated waste stream e.g. Plastic bags
	Water	Liquor	18-23%	High organic content liquid
		Biogas	7-17%	Composition approximately 50% Methane and 50% Carbon Dioxide with some water, dust, trace gases e.g. Hydrogen Sulphide, halogenated compounds, siloxanes
		Water Vapour	approx. 12%	
<b>Mechanical Biological Treatment (Sort First<sup>4</sup>)</b>	Mixed waste (municipal or general commercial and industrial)	Partially stabilised organics	25-30%	Termed Soil Conditioner. Of lower quality organic material than that produced from source segregated waste, due to contaminants present in mixed MSW/C&I. Will contain all biodegradable material not removed as the high calorific fraction, and also contaminants such as heavy metals, plastics and some glass.
		High calorific fraction	25-45%	Paper, card and plastics
		Recyclate metals	4-6%	Ferrous and non-ferrous metals
		Recyclate glass	8%	Usually removed along with stones and heavy inert materials for recycled aggregate
		Recyclate paper, plastics, textiles		Not usually removed as individual waste streams for recycling due to low or zero value as recyclate
		Reject to Landfill	15-65%	Will contain some biodegradable material and inert material, rejected recyclables, rejected partially stabilised organics after screening The reject rate will depend on whether markets can be found for the partially stabilised organic fraction and the high calorific fraction.
		Heat		

<sup>4</sup> MBT Sort First indicates the sequence in which the mechanical sorting element of the process occurs, in this case before the biological treatment element



Type of Technology	Typical Input	Output	Proportion <sup>3</sup>	Characteristics
		Water vapour and Carbon Dioxide	20-25%	
		Biogas (if AD based system)	4-17%	Composition approximately 50% Methane and 50% Carbon Dioxide with some water, dust, trace gases e.g. Hydrogen Sulphide, halogenated compounds, siloxanes
<b>Mechanical Biological Treatment (Bio-drying<sup>5</sup>)</b>	Mixed waste (municipal or general commercial and industrial)	Partially stabilised organics	25-30%	Termed Soil Conditioner. Of lower quality than material produced from source segregated waste. Will contain all biodegradable material not removed as the high calorific fraction, and also contaminants such as plastics and some glass <sup>6</sup> .
		High calorific fraction	50%	Paper, card and plastics.
		Recyclate metals	7%	Ferrous and Non-ferrous metals
		Reject to Landfill	17-66%	Will contain some biodegradable material and inert material, rejected recyclables, rejected partially stabilised organics after screening The reject rate will depend on whether markets can be found for the partially stabilised organic fraction and the high calorific fraction.
		Heat		
		Water vapour and Carbon Dioxide		
<b>Mechanical Heat Treatment</b>	Mixed waste (municipal or general commercial and industrial)  Heat and/or Steam	Fibrous floc	50-70%	All biodegradable material (paper, card, organics)
		Recyclate metals	7-10%	Ferrous and non-ferrous metals
		Recyclate glass	5-20%	Mixed glass
		Recyclate plastics	9-11%	Mixed plastics
		Reject to Landfill	10-90%	Will contain biodegradable material and inert material, rejected recyclables, rejected floc material

5 MBT Bio-drying indicates that the biological element of the process occurs before mechanical sorting has taken place

6 MBT Bio-drying systems usually configured to produce a fuel, therefore all organic material including plastics remaining after removal of metals and some screening would constitute the fuel fraction



Type of Technology	Typical Input	Output	Proportion <sup>3</sup>	Characteristics
				The reject rate will depend on whether markets cannot be found for the recyclate and fibrous floc.
<b>Pyrolysis</b>	Refuse Derived Fuel  Heat	Char	20-30%	Carbonaceous material, usually hazardous.
		Pyrolysis Oil		Oil containing tars and organic liquids
		Recyclate metals	3-8%	Ferrous and non-ferrous metals
		Fly Ash	2-5%	Hazardous ash containing heavy metals and particulates from Air Pollution Control system
		Syngas (combusted to produce heat and power)		Methane, Carbon Monoxide, Carbon Dioxide, Water, Hydrogen, trace gases
<b>Gasification</b>	Refuse Derived Fuel  Possible mineral additives/blended fuels	Char	14-35%	Inert slag material containing a small amount of carbon and ash
		Fly Ash	2-4%	Hazardous ash containing heavy metals and particulates from Air Pollution Control system
		Syngas (combusted to produce heat and power)		Methane, Carbon Monoxide, Carbon Dioxide, Water, Hydrogen, trace gases
<b>Energy from Waste</b>	Mixed waste (municipal or general commercial and industrial)	Bottom Ash	20-30%	Inert ash.
		Recyclate metals	3-5%	Ferrous and non-ferrous metals
		Fly Ash	3-7%	Hazardous ash containing heavy metals and particulates from Air Pollution Control system
		Gas to Air		Carbon Dioxide, Carbon Monoxide, Water vapour, Nitrogen Oxides, Sulphur Oxides, trace gases

### 3. MANAGEMENT OF OUTPUTS

Table 1 shows that each technology produces a number of different outputs, some of which are suitable for recycling or reuse and others that must be disposed to landfill. In some cases the final disposal route is influenced by regulatory issues. These issues are summarised in Table 2 along with details of the key management methods for each output identified in Table 1.

**Table 2 Markets and outlets for outputs from waste treatment technologies**

Type of Technology	Output	Markets and Outlets
Materials Recovery Facility (MRF)	Recyclables	<b>Recycle:</b> Recyclate from source segregated collection will be cleaner than that from mixed MSW collection, and therefore may attract a higher market price.
	Reject to landfill	<b>Disposal in non-hazardous landfill.</b> (For MSW will require testing by the EA to establish biodegradable content of this fraction with respect to LATS).
In-vessel Composting	Compost	<b>Recycle:</b> May qualify for composting standard PAS100, if so, this material will be of higher value than that which does not qualify. There are many viable markets for either standard of output. If markets cannot be found then the material may need to be landfilled.
	Reject to Landfill	May be turned into mulch and used as soil conditioner: spreading to land will require meeting EA criteria to avoid counting as disposal. Alternatively, direct disposal in <b>non-hazardous landfill</b> .
	Waste Water	Releases to water do not generally result: any leachate arising is generally re-circulated or disposed to sewer
	Water vapour and Carbon Dioxide	Released to air in accordance with licence/permit
Anaerobic Digestion	Digestate	<b>Recycle:</b> Requires further composting before use. May qualify for composting standard PAS100, if so, this material will be of higher value than that which does not qualify. There are many viable markets for either standard of output. If markets cannot be found then the material may need to be landfilled
	Reject to Landfill	Disposal in <b>non-hazardous landfill</b>
	Liquor	<b>Recycle:</b> May be re-circulated within system, or used as liquid fertiliser if it meets appropriate criteria, or used in subsequent composting of digestate fibre
	Biogas	<b>Recover:</b> Fuel. Captured and combusted to produce electricity either on-site or off-site. Eligible for

Type of Technology	Output	Markets and Outlets
		Renewable Obligation Certificates.
	Water Vapour	Released to air in accordance with licence/permit
Mechanical Biological Treatment (Sort First)	Partially stabilised organics	<b>Potential to Recycle, alternatively disposal in non-hazardous landfill:</b> Usually composted further to stabilise material. Unlikely to qualify for composting standard PAS100 or BVPI 82b 'Composting'. Can be spread to land if it meets EA criteria i.e. providing ecological benefit or agricultural improvement. This may be for example on contaminated land or as landfill restoration. Unsuitable for agricultural or grazing land. If it meets EA criteria and qualifies for a Waste Management License exemption, will not count as disposal activity.
	High calorific fraction	<b>Recover:</b> Fuel fraction. Can be co-combusted in cement kilns or other industrial kilns. Can be burnt in dedicated facility such as an Advanced Thermal Treatment plant, or dedicated Energy from Waste plant. Unlikely to be accepted by power stations due to requirement for compliance with Waste Incineration Directive. Likely to have to pay a gate fee to end user. If markets cannot be found then the material may need to be landfilled
	Recyclate metals	<b>Recycle:</b> Almost always recovered from MBT processes, and for many systems this is the only recyclate extracted. Easily recycled. Stable market. Currently qualifies for BVPI 82a 'Recycling'
	Recyclate glass	<b>Recycle:</b> Glass may be segregated with other inert materials such as stones for use as low grade aggregate. Glass is likely to be smashed up during waste preparation processes.
	Recyclate paper, plastics, textiles	These materials if extracted are unlikely to receive a significant income as a recyclate, and in some instances may not yield a positive value.
	Reject to Landfill	<b>Disposal in non-hazardous landfill.</b> Will require testing by the EA to establish biodegradable content of this fraction with respect to LATS.
	Biogas (if AD based system)	<b>Recover:</b> Fuel. Captured and combusted to produce electricity either on-site or off-site. Eligible for Renewable Obligation Certificates.
	Heat	<b>Recover:</b> Dissipated to atmosphere. Some systems may try to use this heat in other areas of the process to increase efficiency. Heat may be used if there are suitable local heat users.
	Water vapour and Carbon Dioxide	<b>Released to air</b> after undergoing Air Pollution Control cleaning (usually by passing through a biofilter) in accordance with licence/permit.

Type of Technology	Output	Markets and Outlets
Mechanical Biological Treatment (Biodrying)	Partially stabilised organics	<b>Potential to Recycle/Recover, alternatively disposal in non-hazardous landfill:</b> Biodrying MBT systems are usually configured to produce a fuel, therefore the partially stabilised organics and high calorific fraction are both sent for combustion as a fuel. This system is unlikely to significantly reduce the biodegradability of the organic fraction, and so disposal of this fraction to landfill will count towards LATS. Unlikely that this system would be configured to produce a soil conditioner, but if it were, it would have to comply with EA criteria for spreading to land as with the MBT Sort First system described above.
	High calorific fraction	<b>Recover:</b> Fuel fraction. Can be co-combusted in cement kilns or other industrial kilns. Can be burnt in dedicated facility such as an Advanced Thermal Treatment plant, or dedicated Energy from Waste plant. Unlikely to be accepted by power stations due to requirement for compliance with Waste Incineration Directive. Likely to have to pay a gate fee to end user.  If markets cannot be found then the material may need to be landfilled
	Recyclate metals	<b>Recycle:</b> Almost always recovered from MBT processes, and for many systems this is the only recyclate extracted. Easily recycled. Stable market.
	Reject to Landfill	<b>Disposal in non-hazardous landfill.</b> Will require testing by the EA to establish biodegradable content of this fraction with respect to LATS.
	Heat	<b>Recover:</b> Dissipated to atmosphere. Some systems may try to use this heat in other areas of the process to increase efficiency.
	Water vapour and Carbon Dioxide	<b>Released to air</b> after undergoing Air Pollution Control cleaning (usually by passing through a biofilter) in accordance with licence/permit.
Mechanical Heat Treatment	Fibrous floc	<b>Potential to Recycle/Recover, alternatively disposal in non-hazardous landfill:</b> Variety of potential outputs. Biodegradability unlikely to be significantly reduced. (For MSW disposal to landfill will count against LATS). May be further composted to produce a soil conditioner and spread to land if it meets EA criteria as with MBT soil conditioner - will require a Waste Management License exemption.  May be used as a raw material in construction applications e.g. mixed with concrete, encased in resin and used in floor of roof tiles. Market for these applications is undeveloped.  May be used as a fuel in co-combustion applications. The same barriers to use as a fuel apply as to fuel fraction from MBT systems. This fibre will have different characteristics to the fuel

Type of Technology	Output	Markets and Outlets
		fraction produced from MBT plant and this may affect the operational requirements for this material.
	Recyclate metals	<b>Recycle:</b> Has the potential to be significantly cleaner than those from MBT processes due to the action of steam cleaning, which removes glue and labels. Easily recycled. Stable market. Should qualify for BVPI 82a 'Recycling'
	Recyclate glass	<b>Recycle:</b> Has the potential to be significantly cleaner than those from MBT processes due to the action of steam cleaning, which removes glue and labels. Easily recycled. For MSW Should qualify for BVPI 82a 'Recycling'.
	Recyclate plastics	<b>Recycle:</b> Has the potential to be significantly cleaner than those from MBT processes due to the action of steam cleaning, which removes glue and labels. Can be recycled. Different plastics undergo different transformations under the action of heat, which may make them easier or harder to recycle. For MSW should qualify for BVPI 82a 'Recycling'
	Reject to Landfill	<b>Disposal in non-hazardous landfill.</b> For MSW will require testing by the EA to establish biodegradable content of this fraction with respect to LATS.
Pyrolysis	Char	<b>Possibility to Recycle alternatively disposal in hazardous landfill:</b> Hazardous material. Requires further processing to convert to a recyclable material (e.g. Through a gasification process to gasify the excess carbon present). Once processed can be used as a secondary aggregate. Otherwise disposal to hazardous landfill is required. Char is non-biodegradable, so disposal to landfill will not count towards LATS.
	Pyrolysis Oil	<b>Possibility to Recover:</b> May be refined and used as a feedstock in chemical applications, or used as a fuel in co-combustion activities. Regulatory barriers to this as still classified as waste.
	Recyclate metals	<b>Recycle:</b> Easily recycled. However, will not count towards BVPI 82a 'Recycling'.
	Fly Ash	<b>Requires disposal in hazardous waste landfill.</b>
	Syngas (combusted to produce heat and power)	<b>Recover:</b> Combusted to produce electricity and heat. Eligible for Renewable Obligation Certificates.
Gasification	Char	<b>Recycle:</b> Contains less carbon than char from pyrolysis. Can be recycled and used as aggregate, or disposed to non-hazardous landfill
	Fly Ash	<b>Requires disposal in hazardous waste landfill.</b>
	Syngas (combusted to	<b>Recover:</b> Combusted to produce electricity and heat. Eligible for Renewable Obligation Certificates.

Type of Technology	Output	Markets and Outlets
	produce heat and power)	
Energy from Waste	Bottom Ash	<b>Recycle:</b> Can be recycled and used as aggregate, or disposed of to non-hazardous landfill
	Recyclate metals	<b>Recycle:</b> Easily recyclable. For MSW will not qualify for BVPI 82a 'Recycling'
	Fly Ash	<b>Requires disposal in hazardous waste landfill.</b>
	Gas to Air	<b>Released to atmosphere</b> after Air Pollution Control cleaning
	Heat	<b>Recover:</b> May be used if suitable local heat user.

In conclusion, Table 3 summarises the key waste management methods for the process outputs described in Tables 1 and 2.

**Table 3 Summary of the waste management route required for each output**

Type of Technology	Output	Recycle	Recover	Recycle /Landfill <sup>7</sup>	Landfill
Materials Recovery Facility (MRF)	Recyclables	✓			
	Reject to landfill				✓
In-vessel Composting	Compost			✓	
	Reject to Landfill				✓
	Waste Water	✓			
	Water vapour and Carbon Dioxide	n/a			
Anaerobic Digestion	Digestate			✓	
	Reject to Landfill				✓
	Liquor	✓			
	Biogas		✓		
	Water Vapour	n/a			
Mechanical Biological Treatment (Sort First)	Partially stabilised organics			✓	
	High calorific fraction			✓	
	Recyclate metals	✓			
	Recyclate glass, stones and grit	✓			
	Recyclate paper, plastics, textiles	✓			
	Reject to Landfill				✓

<sup>7</sup> Dependent on quality of product and regulations

Type of Technology	Output	Recycle	Recover	Recycle /Landfill <sup>7</sup>	Landfill
	Biogas (if AD based system)		✓		
	Heat		✓		
	Water vapour and Carbon Dioxide	n/a			
Mechanical Biological Treatment (Bio-drying)	Partially stabilised organics			✓	
	High calorific fraction			✓	
	Recyclate metals	✓			
	Reject to Landfill				✓
	Heat		✓		
	Water vapour and Carbon Dioxide	n/a			
Mechanical Heat Treatment	Fibrous floc			✓	
	Recyclate metals	✓			
	Recyclate glass	✓			
	Recyclate plastics	✓			
	Reject to Landfill				✓
Pyrolysis	Char			✓	
	Pyrolysis Oil		✓		
	Recyclate metals	✓			
	Fly Ash				✓
	Syngas (combusted to produce heat and power)		✓		
Gasification	Char	✓			
	Fly Ash				✓
	Syngas (combusted to produce heat and power)		✓		
Energy from Waste	Bottom Ash	✓			
	Recyclate metals	✓			
	Fly Ash				✓
	Gas to Air	n/a			
	Heat		✓		



**APPENDICES**

## 1. DEFINITION OF TREATMENT TECHNOLOGIES

### **Materials Recovery Facility (MRF)**

A Materials Recovery Facility (MRF) processes clean dry co-mingled source segregated recyclables into separate clean recycle streams.

### **In-vessel Composting**

In-vessel composting (IVC) embraces a variety of techniques whereby organic wastes (either source segregated kitchen and garden waste, or the organic fraction from mechanically separated MSW/C&I) may be composted in an enclosed vessel or tunnel. These processes are controlled and can be designed to achieve and maintain specified temperatures to facilitate bacteria destruction in accordance with the requirements of the Animal By-products Regulations.

### **Anaerobic Digestion**

Anaerobic Digestion (AD) is a biological process where biodegradable wastes, such as garden and kitchen waste or the mechanically separated organic rich fraction of MSW/C&I, are converted into a 'digestate' (containing biosolids and a liquid) and biogas. The wastes are decomposed by bacteria in the absence of air: this is a key differentiation from Composting processes. In AD systems, biodegradable material is placed into an enclosed vessel under controlled conditions and degrades generating elevated temperatures. The decomposition of the biodegradable material leads to the release of a methane rich biogas which can be collected and burnt as a fuel to produce electricity.

### **Mechanical Biological Treatment (MBT) Sort First**

A generic term for mechanical sorting and separation technologies used in conjunction with biological treatment processes, such as in-vessel composting and anaerobic digestion. In this system mechanical separation would take place before the biological treatment process. MBT systems are designed to treat and separate out the waste into useable fractions for materials and/or energy recovery.

### **Mechanical Biological Treatment (MBT) Bio-drying**

Similar to system above except that the biological treatment element would happen before any mechanical sorting takes place. The biological treatment in this instance would be more of a drying process or partial composting, rather than intensive techniques such as in-vessel composting or anaerobic digestion. MBT systems are designed to treat and separate out waste into useable fractions for materials and/or energy recovery.

### **Mechanical Heat Treatment**

Processes which use a combination of mechanical, and heat or steam technologies, to change the nature of mixed waste into a fibrous material which is partially sanitised. Recyclables are cleaned by the action of the heat and steam. An autoclave system is an example of this technology.

### **Pyrolysis**

Pyrolysis is a medium temperature thermal treatment process where waste is heated in the absence of air to produce a mixture of gaseous and liquid fuels and a solid, inert residue (mainly carbon).



### **Gasification**

Gasification is a high temperature thermal treatment process whereby organic wastes are heated in the partial presence of air or steam to produce fuel-rich gases. The technology is based on the reforming process used to produce town gas from coal.

### **Energy from Waste**

The controlled thermal treatment of waste by burning in the presence of air, either to reduce its volume or toxicity. Energy recovery from incineration can be made by utilising the calorific value of the waste to produce heat and / or power.

