Review of England's Waste Strategy

Environmental Report under the "SEA" Directive

APPENDICES PART 1

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APPENDIX A - ENVIRONMENTAL BASELINE

CONTENTS

1 Introduction

1.1 Overview

This document forms part of the strategic environmental assessment (SEA) of the waste strategy review. The SEA Directive and its associated UK regulations require the Environmental Report to include information on, amongst other things, "the relevant aspects of the current state of the environment", the "environmental characteristics of areas likely to be significantly affected" and "any existing environmental problems which are relevant to the plan or programme"[1]. This document provides this environmental 'baseline'. A summary of this baseline is included in Section 4 of the Environmental Report.

The SEA Directive requires the SEA to assess the likely significant effects on the environment on issues such as "*biodiversity, population, human health, fauna; flora; soil; water; air; climatic factors; material assets; cultural heritage (including architectural and archaeological heritage); landscape and the inter-relationship between the above factors*"[2]. This baseline document therefore focuses on these issues where they are considered relevant to and affected by waste management policy at a national level.

Section 2 provides a summary of the extent of waste management infrastructure in England today, and a high-level indication of pollution incidents recorded by the Environment Agency. These focus on impacts on water, air and land at a very broad level; and subsequent sections of this baseline deal with contamination of these media by waste activities in greater detail.

The rest of the baseline contains a section on each of the impact areas in italics above, identifying current conditions and, where possible, recent trends.

The document concludes with a short section which summarises the principal environmental problems and issues which are caused or contributed to by waste management activities.

Reference sources are quoted as fully as possible. Wherever possible data refer to England only, however in some instances they are only available for England and Wales, and in others for the UK as a whole.

1.2 Relationship between the baseline and indicators

The SEA Directive requires that the assessment defines the current condition of the environment likely to be significantly affected by the plan or strategy, and that it includes proposals to monitor its effects once it is implemented. Chapter 5 of the environmental report identifies the indicators defined for this SEA and these are used in the assessment and form the structure of the monitoring proposals (see Chapter 8 of the environmental report).

[1] See Annex 1 of the SEA Directive.
[2] For the purposes of this SEA, biodiversity, flora and fauna are combined into a single topic.

It is therefore correct that the baseline should be assembled to closely reflect the indicators in order to define current conditions under the existing waste strategy and prior to any changes in policy, targets or direction. This baseline is therefore structured around the principal topics defined by the Directive (see italicised text in the section above) and a range of indicators is calibrated in each.

In several instances the data supporting the indicator is not available at present. The rationale for proposing the indicator is summarised here and the monitoring proposals in Chapter 8 of the Environmental Report indicate how it might be developed.

Given the strategic scope of the SEA this baseline focuses on environmental impacts observable at national level, whether these are drawn from aggregated data or concluded from case studies. Some potential impacts which must be included in the baseline will have current impacts that vary from site to site. Examination of individual site conditions lies outside the scope of this strategic SEA, however the baseline indicates how impacts on these assets is controlled under the current legislative and spatial planning regime.

Table 1.1: Locating baseline information about indicators proposed in the Environmental Report

No.	*Indicator*	*Location in baseline*
1	Waste management sites with a Local Biodiversity Action Plan.	3.4
2	Waste management sites with a registered Environmental Management System.	3.5
3	Land taken per site and for all new infrastructure	7.1
4	No. of fly-tipping incidents	12.1
5	No. of complaints associated with operation of waste sites	2.3
6	Sites exceeding EA discharge authorisations in previous year	6.6
7	Serious waste-related incidents affecting water	6.3, and see 2.3 for a summary
8	Serious waste-related incidents affecting land and soil	7.2 to 7.4, and see 2.3 for a summary
9	Eutrophication of water resources	6.6
10	Serious waste-related incidents affecting air	8.4, and see 2.3 for a summary
11	Annual concentrations of dioxins	8.2
12	Annual concentrations of mercury	8.2
13	CO_2 emissions from waste management	9.1
14	Methane emissions from waste mgmt	9.1
15	Proportion of waste sites in principal landscape designations	4.2

No.	*Indicator*	*Location in baseline*
16	Resource use – domestic material consumption	10.1 to 10.4
17	Electricity generated from waste	9.2
18	Arisings of municipal and household wastes	2.2[3]
19	Household waste arisings per person	
20	Proportion of municipal and household waste arisings recycled or composted	
21	Arisings of commercial and industrial wastes	
22	Proportion of commercial and industrial wastes recycled	2.2
23	Arisings of construction and demolition wastes	2.2
24	Proportion of construction and demolition waste recycled	2.2
25	Arisings of hazardous waste	2.2
26	Proportion of hazardous waste treated and diverted permanently from landfill	2.2
27	Hazardousness of waste	2.2

[3] The baseline presents a summary of waste arisings and recent trends. The appendices to the Consultation Document contain further detail.

2 Overview of waste management infrastructure

2.1 Waste management infrastructure in England

Prior to Waste Strategy 2000, England's waste management infrastructure was dominated by various types of landfill sites, with much smaller numbers of other treatment facilities, including municipal and hazardous waste incinerators, metal recycling facilities, etc. Transposition of the EU Waste Framework Directive, publication of Waste Strategy 2000, and the adoption of exacting targets for recycling (and the corresponding diversion of waste away from landfill) has resulted in greater numbers of facilities for handling and treating waste over the last few years, and this will increase as a result of Waste Strategy Review 2005.

Figure 2.1 shows the current number of facilities based on data from the Environmental Agency's REGIS database, which identifies most types of waste management sites which have a Pollution Prevention & Control (PPC) licence.

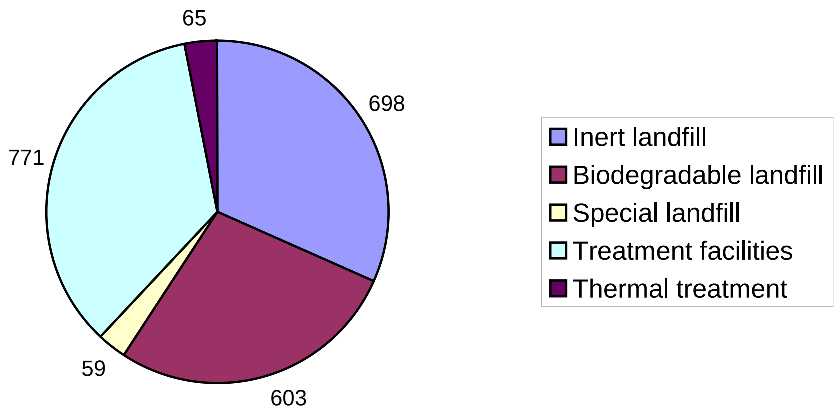

Figure 2.1: Estimated numbers of waste management facilities in England in 2004/5 [Environment Agency, Enviros / Scott Wilson[4]]

Figures 2.2 to 2.4 show the distribution of waste management facilities across the UK. These diagrams are based on REGIS datasets, and sites which appear to be no longer operational (PPC licence withdrawn or surrendered, or other reasons) have been excluded.

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[4] 2004/5 data estimated from REGIS dataset supplied by the Environment Agency for this assessment. Note that landfill sites can be categorised in many different ways according to type. Environment Agency figures for numbers of operating landfills in England range between approximately 500 and 2000, depending on the categorisation used. The Environmental Report uses an estimated 1170 landfills in operation in 2002/03 for the purposes of this assessment. . Also, note that the number of incinerators includes a large number of small privately operated sites and not just commercial/ community facilities.

2.2 Waste arisings[5]

Data on waste arisings are separated into four principal streams:

- Municipal solid waste (MSW), which includes waste from households, street collection from bins and litter, etc.
- Commercial & industrial waste (C&I), which includes a range of recyclable materials (paper, glass, etc.), biodegradable wastes from food processing and catering, and inert materials
- Construction & demolition waste (CDW), which includes rubble, hardcore, topsoil and earth, and aggregates,
- Hazardous waste, which is an element of all three streams above – including batteries (domestic), oils and acids (industrial), and contaminated materials from construction sites. It also includes other special materials such as clinical wastes. Most hazardous waste is produced by the C&I sector.

Other streams of waste include: radioactive material; sludge from waste water treatment, agricultural waste; mining / quarrying residue; and wastes from dredging. However some of these wastes required treatment separately from the main streams identified above. Mining and agricultural waste streams are excluded from the SEA for the following reasons:

- mining waste – specific proposals await the anticipated EU Directive on Management of waste from extractive industries;
- agricultural waste – the Government is bringing into force regulations to bring agricultural waste within the controls of the Waste Framework and Landfill Directives and a full regulatory impact assessment is being prepared.

Therefore the SEA concentrates on the four main waste streams identified above which are the result of the main areas of economic activity in the UK.

Total arisings

Comparison of the relative sizes of the waste streams is affected by differences in the frequency with which data are collected. The MSW stream is monitored regularly by local authorities which are responsible for collecting these materials. C&I waste arisings are currently estimated by periodic surveys as these materials are collected, treated and disposed of by waste collection authorities and private contractors. CDW arisings are also surveyed intermittently.

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[5] This sub-section presents a summary of trends in waste arising and treatment of the principal waste streams addressed by Waste Strategy 2000. A comprehensive review of these data are provided in Annex D of the Consultation Report on the WS Review.

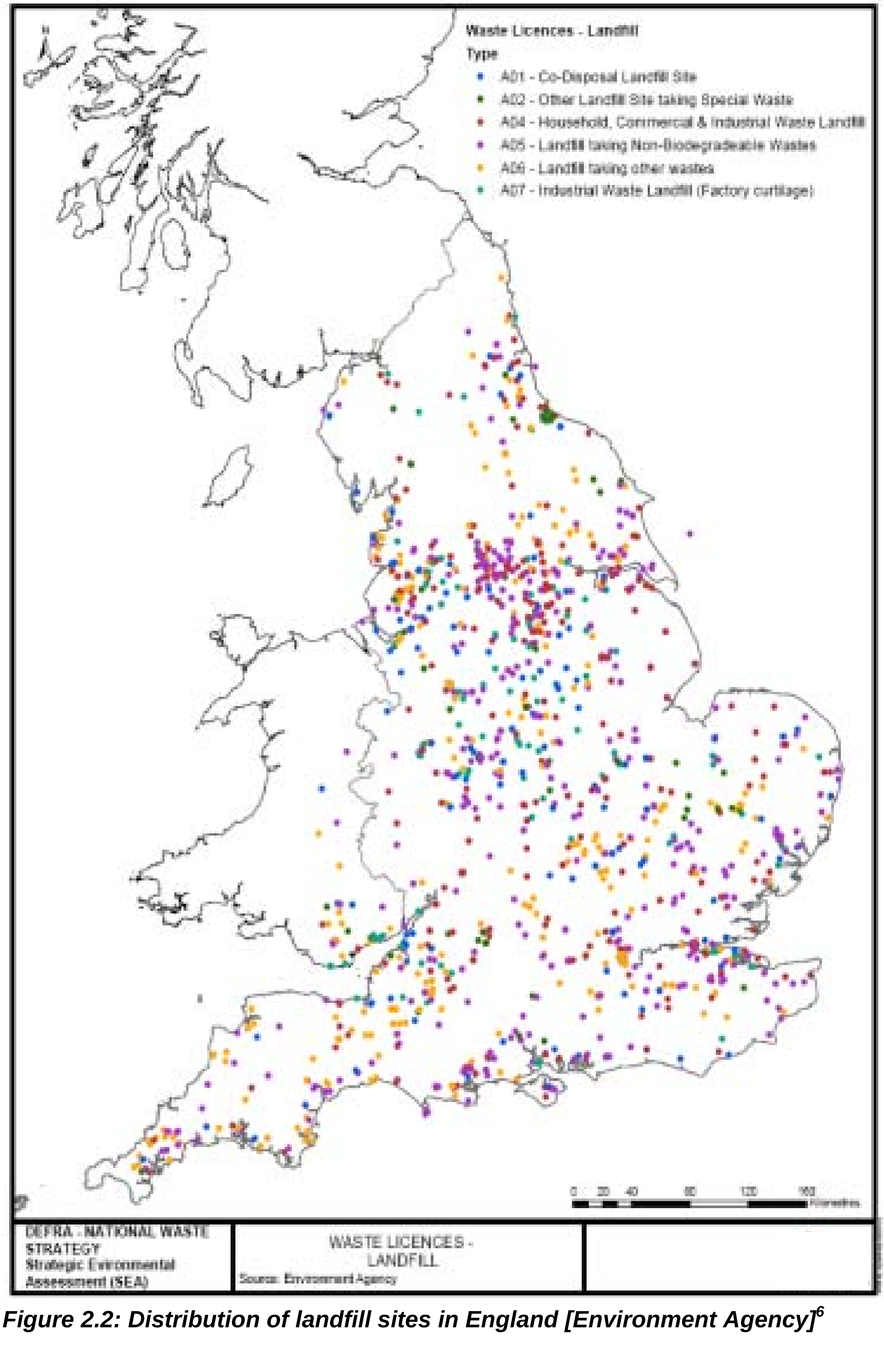

Figure 2.2: Distribution of landfill sites in England [Environment Agency][6]

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[6] Source: REGIS data download provided by Environment Agency specifically for this assessment.

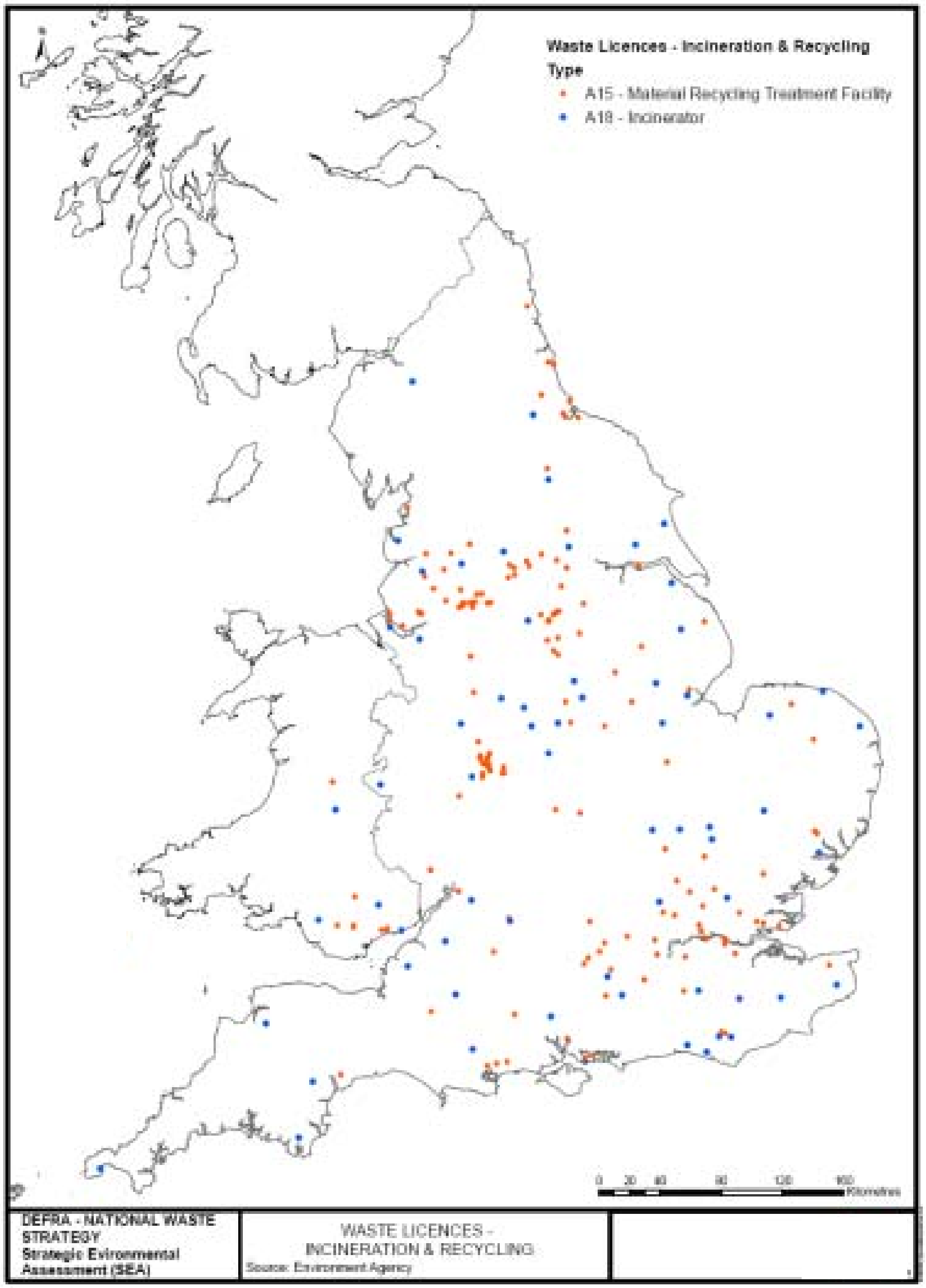

Figure 2.3: Distribution of energy from waste and recycling facilities in England & Wales [Environment Agency][7]

[7] Ibid.

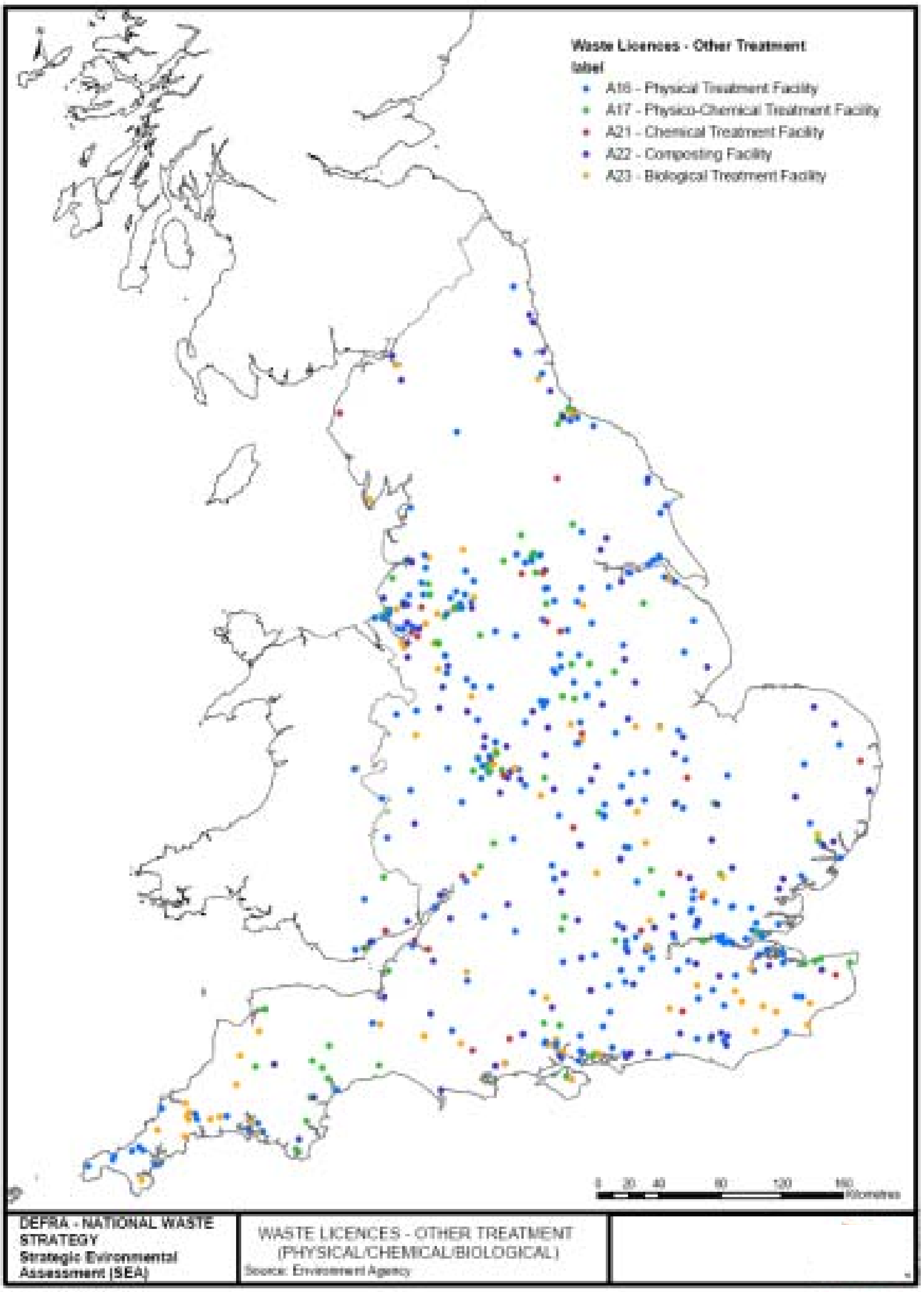

Figure 2.4: Distribution of other treatment facilities in England & Wales [Environment Agency][8]

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[8] Ibid.

As a result, 2002/3 is the latest year for which there are comprehensive and reliable data for all the main waste streams in England. Their relative size is shown in Figure 2.4, representing a total of 280m tonnes almost two-thirds of which derive from mining, quarrying and construction / demolition activities[9].

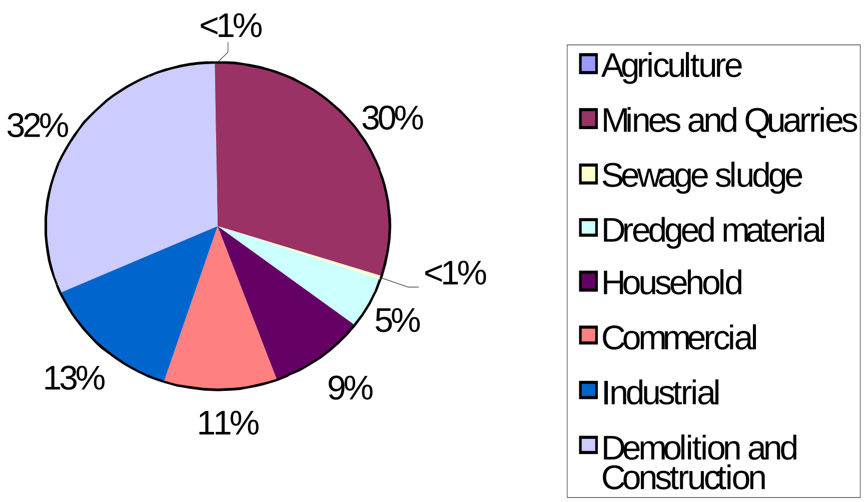

Figure 2.4: Estimated waste arisings by sector in 2002/3 [Defra, EA, ODPM, Water UK[10]]

Whereas Figure 2.4 presents a snapshot of the recent situation, Figure 2.5 indicates the recent changes in volumes over the initial period of Waste Strategy 2000. This indicates growth in CDW of 28% over the period 1999-2003, while municipal waste grew by 12% over a similar period, although the total fell by 0.5m tonnes in 2003/4.

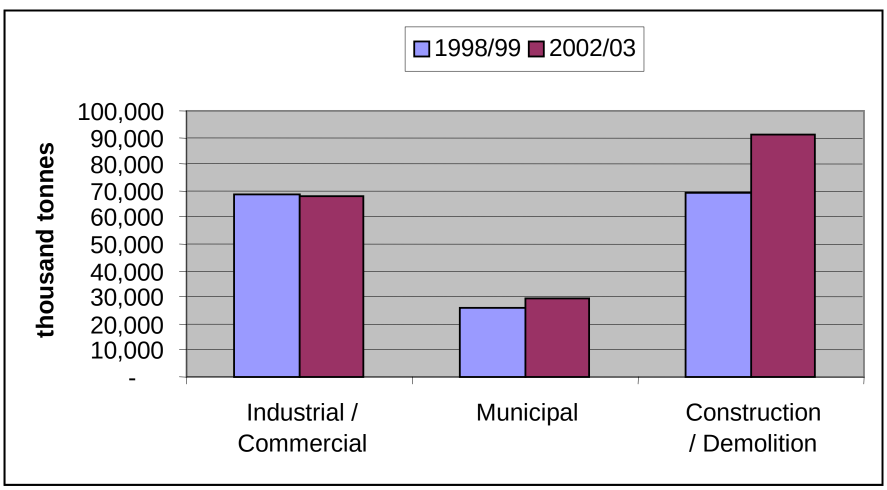

Figure 2.5: Recent trends in arisings in the three principal waste streams addressed by Waste Strategy 2000 [Defra[11]]

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[9] The UK total for the corresponding period was 330m tonnes, indicating that around 85% of all wastes arise in England.
[10] See: http://www.defra.gov.uk/environment/statistics/eiyp/pdf/eiyp2005.pdf (p.43).
[11] See: http://www.defra.gov.uk/environment/statistics/waste/wrmunicipal.htm#wrtb2.

Dealing with waste streams

MSW In response to the requirements of the EU Landfill Directive, *WS2000* set a short-term target of recycling 25% of all household wastes by 2005/6. The two largest components of this waste stream are paper / card and compostable materials[12]. In 2003/4 this stream comprised 25.4m tonnes of waste in England. Figure 2.6 summarises the trend since 1990, illustrating the response to WS2000 with acceleration in recycling rates becoming noticeable in 2002/3. By 2002/3 almost 18% of this waste was recycled, reaching 23% in 2003/04. This evidence suggests that the 2005/6 target should be met providing the trend is maintained.

C&I In 2002/3 almost 70m tonnes of this waste were generated in England, representing a drop of only 1% over the period since 1998/9. However this statistic masks a change in the balance between the components, with a 6% drop in the industrial component over the period, and a corresponding increase in commercial wastes which reflect the increased contribution of the service sector to GDP, and increased levels of imports. Figure 2.7 shows the change in treatment of these wastes.

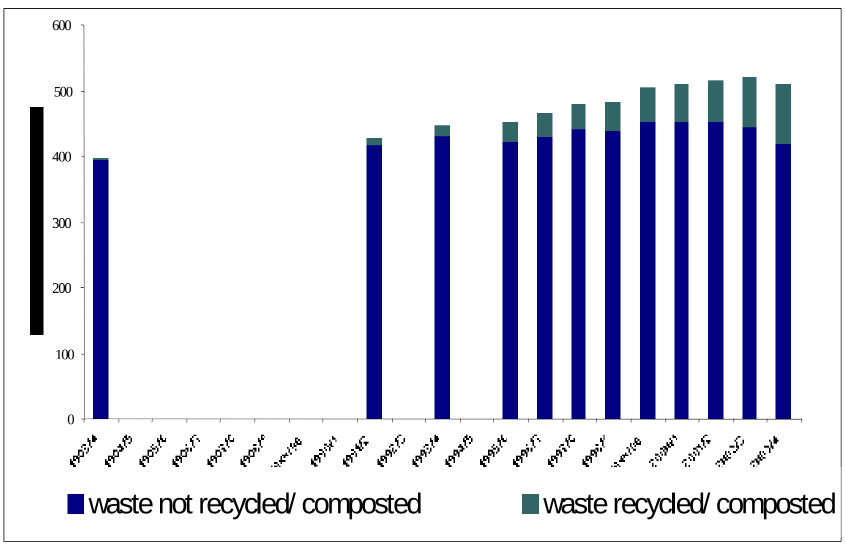

Figure 2.6: Recent achievement in household recycling rates in England [Defra[13]]

[12] See: http://www.defra.gov.uk/environment/statistics/eiyp/pdf/eiyp2005.pdf (p.46).
[13] See: http://www.defra.gov.uk/environment/statistics/eiyp/pdf/eiyp2005.pdf (p.45).

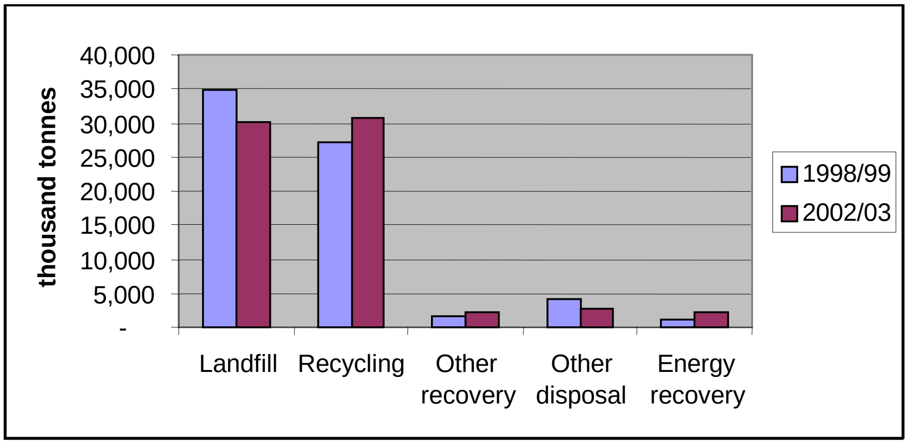

Figure 2.7: Recent changes in treatment and disposal of commercial & industrial wastes in England [Defra[14]]

C&I Figure 2.7 illustrates the initial impact of *WS2000*, with recycling overtaking landfill as the principal technique for managing these wastes. In 2002/3 41% of this waste stream was sent to landfill, whereas 45% was recycled or recovered.

CDW In 2003 around 91m tonnes of construction and demolition wastes were generated in England, with bricks and rubble making up almost half this total. Figure 2.8 shows that this total represents a 31% increase on arisings in 1999, although it also shows growth has tailed off in the current decade.

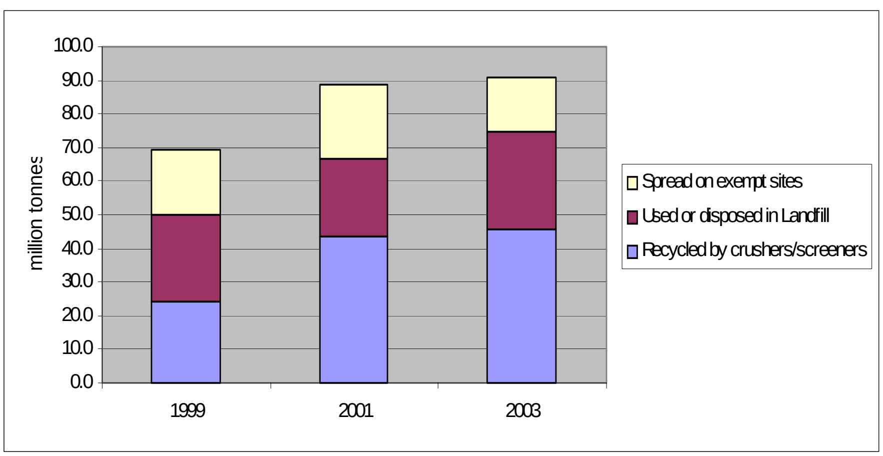

Figure 2.8: Recent trends in the volume and treatment of construction and demolition wastes in England [ODPM, Defra[15]]

[14] See: http://www.defra.gov.uk/environment/statistics/eiyp/pdf/eiyp2005.pdf (p.47).
[15] See: http://www.defra.gov.uk/environment/statistics/waste/kf/wrkf09.htm; this has been supplemented by Defra using 2003 data.

In 2002/3 around half this stream was recycled, either by reusing topsoil and excavated earth for ground-raising and landscaping, or by re-use of crushed rubble as sub-base and for other purposes. There are concerns about the reliability of data about CDW due to the way they are collected, and the data summarised in Figure 2.8 include an unknown volume of material which arose in Northern Ireland, Scotland and Wales but which was sent to England for re-use.

Hazardous wastes

Almost 4.2m tonnes of hazardous waste was managed in 2002/3, and Figure 2.9 shows the trend in arising since 1998/9. Note that these figures include arisings generated locally, as well as material arising elsewhere which was treated and / or disposed of in England.

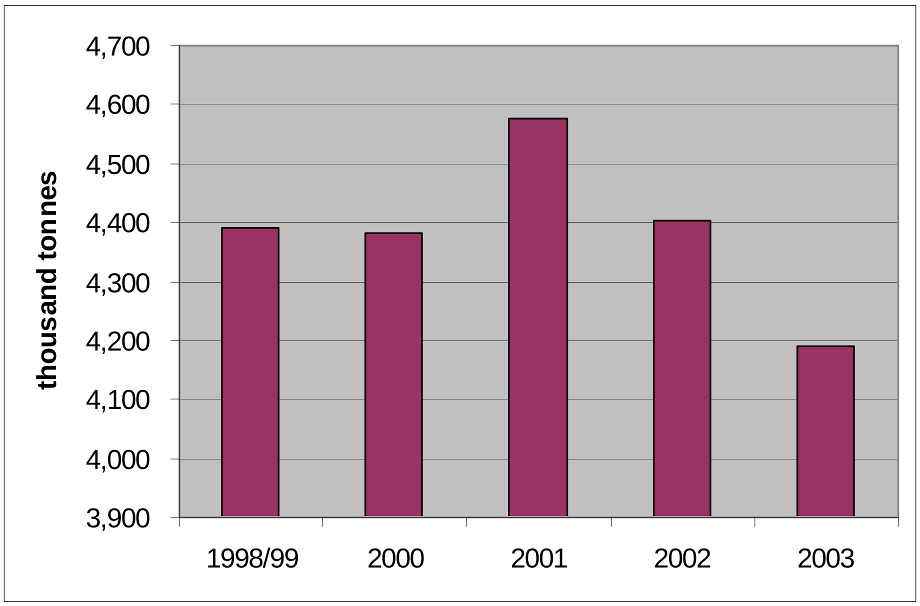

Figure 2.9: Recent trends in the volume of hazardous waste managed in England [EA[16]]

Around two-thirds of hazardous wastes are contaminated construction or demolition wastes (including asbestos), industrial process residues and oils. Most of the 8% drop in arisings since *WS2000* was published is attributed to reductions in all three of the streams mentioned above.

Transposition of the EU Landfill Directive into UK law in July 2004 ended the co-disposal of hazardous wastes and other materials, and the effect of this change on treatment / disposal methods has yet to be reflected in sector data, however in 2002/3:

- 41% of these waste were sent to landfill sites
- 13% were recycled or re-used in some way
- 5% were sent for incineration (energy was recovered from 3%)
- 29% were subject to treatment processes before disposal

[16] Source: Environment Agency.

- the rest were disposed of by other methods, or stored.

Waste reduction and recycling targets

Reflecting the UK's obligations under the EU Waste Framework Directive, WS2000- introduced a range of targets to tackle the problem of continued growth in arisings, particularly in MSW and to increase recycling or re-use of its biodegradable fraction. The key targets are:

- Recycling or composting of household wastes: 25% of weight by 2005; 30% by 2010; 33% by 2015.
- Landfill of biodegradable municipal waste: reduce level to 75% of 1995 levels by 2010; to 50% of 1995 levels by 2013; to 35% of 1995 levels by 2020.
- Value recovery from municipal waste: from 40% of this waste stream by 2005; from 45% by 2010; from 67% by 2015.
- Reduce landfilling of industrial & commercial wastes to 85% of 1998 levels by 2005.

These target rates are subject to change as a result of the current review of waste strategy.

2.3 Waste impacts

Pollution incidents

The environmental impacts of waste management range can be considered in two ways:

- *Their type* – nuisance (noise, light, vibration) or contamination (pollution of media affecting quality of resources temporarily or permanently).
- *Their severity* – ranging from non-serious (discharge of materials within authorised levels or in situations that pose no immediate or long-term threat to human health or to the natural environment) to serious (one-off or repetitive incidents)

Data about the nature of these impacts is incomplete, but improving. (See Section 8 of the Environmental Report for a description of the Waste Data Strategy.) The Environment Agency is the competent authority for regulating pollution in England and it is normal practice for permits granted by such authorities to include a condition requiring licensees to report pollution incidents to the EA. In practice however, many cases are reported by members of the public using the EA hotline service.

Some nuisance complaints are also handled by local authorities and procedures exist to ensure that events reported through different channels are not double-counted. As a result this is the most comprehensive dataset to indicate the scale and nature of the problem. Note however that the current data focus on the severity of the incident and the nature of the incident (dust, odours, nuisance from lights, noise or traffic) cannot be determined readily.

Pollution incident categories

The Environment Agency responds to complaints and reported incidents of pollution. Each incident is logged and categorised according to its severity. The category describes the impact of each incident on water, land and air (and the criteria applied to each category are shown in a table situated at the end of this chapter). The impact on each medium is considered and and the list of impacts shown in this table is used to determine the severity of the incident[17]. If no impact has occurred for a particular medium, the incident is reported as a Category 4.

The most common types of pollutants that were found at substantiated (category 1-4) incidents during 2004 were:

- **Specific waste** (20.9% of incidents) – household and commercial waste, other biodegradable materials, types and vehicle parts.
- **Sewage** (17.5%)
- **Fuels and oils** (15.9%)
- **Chemicals** (3.9%).

Other common pollutants include inert materials and wastes (10.5%), and organic materials (3.3%). The remaining pollutants (28.0%) do not fit any one category and range from fire fighting run off to silt and urban run off. However these data refer to all incidents irrespective of sector and therefore include, for example, contamination from industrial processes, food processing and catering, as well as fly-tipping and illegal dumping of vehicles.

Waste-related incidents

The recent historical trend in the most serious incidents (categories 1 and 2 above) is shown in Figure 2.10.

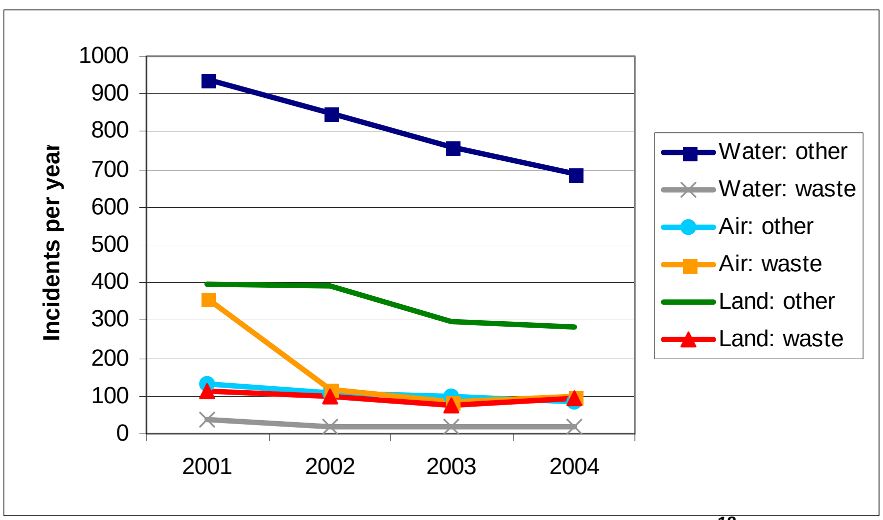

Figure 2.10: Serious pollution incidents since 2000 [EA[18]]

[17] http://www.environment-agency.gov.uk/yourenv/eff/1190084/pollution/296030/296054/297197/?lang=_e
[18] Ibid.

The trends shown in Figure 2.10 can be summarised:

- *water*: in 2004 waste activities represented a very small share (<3%) of incidents to this medium, and the overall number has dropped since *WS2000* was published. Section 6 of this report provides further detail on the nature of these incidents;
- *air*: waste activities accounted for around half of incidents to this medium in 2004 making this the medium that is most affected by the sector; the level incidents has remained roughly the same since 2002. Section 8 of this report provides further detail on the nature of these incidents;
- *land*: in 2004 waste activities have accounted for around 25% of incidents to this medium over the period, and the number of incidents per year has remained roughly the same over the past four years. Section 7 of this report provides further detail on the nature of these incidents.

There were 25,196 substantiated pollution incidents of all media reported in 2004 of which 9.5% (2,394) were associated with waste management sites. However it is important to note that the categorisation of incidents treats an impact on each medium as a separate incident. The total number of 'incidents' therefore overstates the number of actual events.

Table 2.2 summarises the distribution of incidents attributed to waste management by category in 2004 and medium, showing that 8.4% of incidents were in the two most serious categories.

	Water	Air	Land
Category 1 & 2	19	100	94
Category 3	225	1354	848
Category 4		255 [19]	

Table 2.2: Distribution of incidents by medium and severity [Environment Agency[20]]

Table 2.3 summarises data for all Category 1, 2 and 3 incidents in 2004 by the type of facility. This summary shows that four types of facility are responsible for around 75% to 85% of problems[21]:

- waste transfer stations
- metal recycling facilities
- non-inert landfill sites
- other waste management sites.

[19] The currently available statistics do not distinguish between media affected by events which have not evident adverse impact.
[20] Ibid.
[21] Note that some incidents are recorded more than once if they result in contamination of more than one medium.

Facility type	*Water*	*Air*	*Land*
Composting Facility	5	162	14
Exempt Spreading/Recovery Facility	18	40	57
Household Waste Site	15	164	56
Metal Recycling	74	152	160
Inert Landfill	7	19	38
Non-Inert Landfill	40	425	126
Other Waste Management	35	155	180
Transfer Station	50	325	308
Waste Incinerator		12	3
TOTAL:	**244**	**1454**	**942**

Table 2.3: Distribution of category 1, 2 and 3 pollution incidents in 2004 by waste management site [Environment Agency[22]]

Finally Figure 2.11 below summarises the distribution of incidents attributed to waste management by EA region.

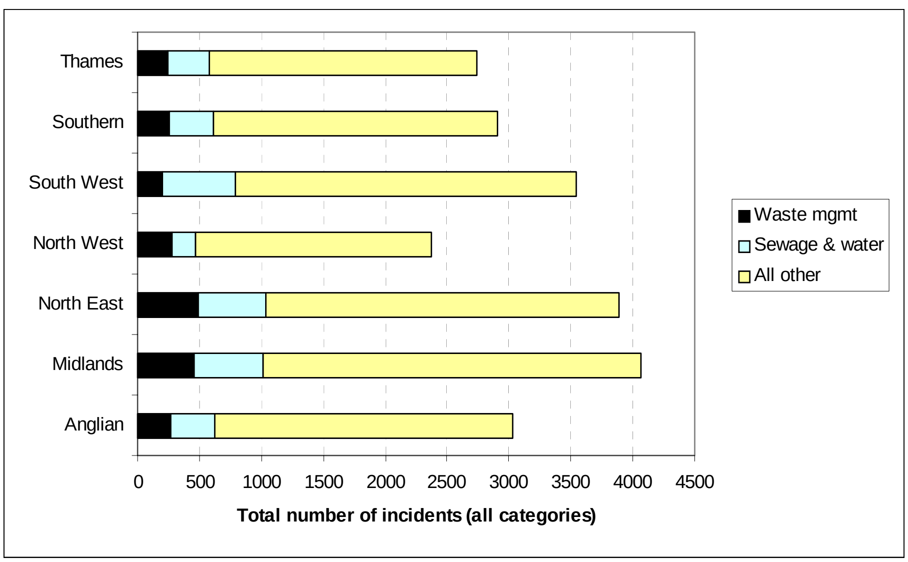

Figure 2.11: Distribution of waste incidents by region [Environment Agency[23]]

Further detail on the nature of waste-related impacts on the water, soil and air environment are provided in later sections of this document.

[22] http://www.environment-agency.gov.uk/yourenv/eff/1190084/pollution/296030/296054/
[23] Ibid.

Categorisation of the significance of pollution incidents [Environment Agency[24]]

	Water	Land	Air
Category 1 - the most serious			
▪ persistent and extensive effects on quality	*	*	*
▪ major damage to ecosystem	*	*	*
▪ closure of potable abstraction	*		
▪ major impact on property		*	
▪ major impact upon amenity	*	*	*
▪ major damage to agriculture / commerce	*	*	*
▪ serious impact upon man	*	*	*
Category 2 - significant but less severe			
▪ significant effect on quality	*	*	*
▪ significant damage to ecosystem	*	*	*
▪ non-routine notification of abstractors	*		
▪ significant impact on property		*	
▪ reduction in amenity value	*	*	*
▪ significant damage to agriculture / commerce	*	*	*
▪ impact on man	*	*	*
Category 3 - relatively minor			
▪ minimal effect on quality	*	*	*
▪ significant damage to local ecosystems	*	*	*
▪ marginal effect on amenity	*	*	*
▪ minimal impact to agriculture / commerce	*	*	*

[24] http://www.environment-agency.gov.uk/yourenv/eff/1190084/pollution/296030/296054/297197/?lang=_e

3 Biodiversity, flora and fauna

This section identifies the principal wildlife conservation designations in the UK and their potential sensitivity to impacts; it then summarises the principal legislative and planning controls on these effects and the apparent impact of waste management activities.

3.1 Principal designations

Sites of special scientific interest

There are more than 4,000 Sites of Special Scientific Interest (SSSI) in England which cover approximately 7% of England's land area[25] (English Nature 2005). They are distributed throughout England, and comprise a wide range of sites designated for the importance and in certain cases for the rarity of their wildlife, nature conservation value, geomorphological or geological importance.

Just over two-thirds of the sites are currently classified as being in favourable or unfavourable recovering condition (the basis of the current sustainable development indicator) in October 2005. This situation has improved moderately since 2002 but indicates the need for further improvements and protection.

The condition of each site is a function of several factors, including agricultural practices over long periods and other forms of land management or human activity. Certain habitats may be particularly vulnerable to increases in dust and contaminants which may harm the species for which the site is designated; others may be susceptible to changes in the level and quality of the surface and groundwater environment. In all cases the physical setting of the site may also contribute to its value, particularly where this is an intrinsic aspect of an important habitat.

SSSI is primarily a blanket designation, and includes certain sites which are covered by more stringent designations based on national or international legislation.

Special areas of conservation and similar sites

The UK's SSSI designation covers a wide range of natural conservation assets, some of which are afforded greater importance because of their rarity in the UK and Europe, and internationally in some instances. These sites are designated as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) which contain important, rare or potentially endangered habitats, species and other ecological assets, and both coastal and landlocked wetland areas which are important to resident and migrating bird populations in particular. The network of these sites in the UK is based on designations defined by international legislation – the EU Habitats and Birds Directives for SACs/SPAs and the RAMSAR convention for wetlands.

At the end of 2004, the UK had 236 SACs/SPAs and a further 76 RAMSAR sites, all distributed across the country.

The key issue for all these sites is their scarcity as a habitat and the species they support and therefore any activity which may affect them whether through

[25] English Nature (2005). *Sites of Special Scientific Interest.* Retrieved on 11th November 2005 from the World Wide Web: http://www.english-nature.org.uk/special/sssi/report.cfm.

disturbance, prevent flight or movement, or which present a pollution threat must be avoided.

National Nature Reserves

There were 217 National Nature Reserves (NNR) in England in 2004, covering 87,650 ha. NNRs are a subset of SSSIs designated by English Nature to protect and manage the uniqueness and quality of their wildlife[26]

In addition, local authorities are obliged to prepare Local Biodiversity Action Plans (LBAPs) which specify priorities for conserving locally important or rare habitats and species.

3.2 Legislation and waste impacts

All the designations summarized above are protected by extensive legislation. Protection of SACs and SPAs derives from the EU Birds Directive of 1979 and the Habitats Directive of 1992, the latter resulting in the designation of the Natura 2000 network of sites designated to protect characteristic, internationally important and rare species and habitats. In UK law protection is afforded through the Wildlife and Countryside Act of 1991 and by amendments introduced by the Countryside and Rights of Way Act of 2000 (section 75). This legislation also protects RAMSAR sites and all SSSIs.

Section 28 of the Countryside and Wildlife Act requires a range of bodies including planning authorities to conserve and enhance SSSIs and this will be achieved primarily through the planning application process for new development. Under their obligations under the Town and Country Planning Regulations (1991 and subsequently 2004), planning authorities must make clear the protective measures that will apply to implement the requirements of the Directives locally. Guidance on appropriate procedures and considerations is given in PPS9 and the supporting circular[27]. The requirement to have regard to protection of nationally and internationally designated sites is also stated in Planning Policy Statement 10 (PPS 10)[28], and larger sites would require assessment of their ecological impacts under the Town and Country Planning (EIA) Regulations.

Legislation seeks to prevent any development which might have an adverse impact on any aspect of the site and is based on application of the precautionary principle, namely that it should be prevented if there is a possibility of an adverse effect. Provision is made to allow for development where there are over-riding issues or national or regional importance (particularly related to public health and safety) though effective mitigation would still be necessary.

Protection is afforded from development within the site (for the largest designations) and within its vicinity. PPG9 made reference to a "consultation zone" of up to 2kms from the boundary of a SSSI[29], and English Nature may be required to advise on whether a greater distance is appropriate under the provisions of the Wildlife and Countryside Act as modified by the Countryside and Rights of Way Act of 2000.

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26 http://www.english-nature.org.uk/special/nnr/nnr_what.htm

27 ODPM, Planning Policy Statement 9: Biodiversity and Geological Conservation and Circular 6/05 (both August 2005).

28 The Government published its planning policy statement on Planning for Sustainable Waste Management (PPS 10) in July 2005, see http://www.odpm.gov.uk/index.asp?id=1143989

29 ODPM, Planning Policy Guidance 9: Nature Conservation (1994), paras. 31 and 32.

The extent of restrictions would be determined on a case-by-case basis taking account of the nature of the development, the particular sensitivity of the site to its likely effects, the relative positions (ie. whether the site is downstream or downwind of the facility). Sensitivity to airborne pollutants and substantial changes in the hydrological regime may require consideration of impacts over longer distances.

Under the planning structure summarised above, local authorities are also obliged to incorporate in their Local Plans policies which support the conservation and enhancement objectives of local natural designations and the objectives of the LBAP, and these would also be material considerations in assessing planning applications.

With the data sources available currently it is not possible to establish a picture of the extent to which waste infrastructure impacts these assets on a national scale. The number and extent of the designations means that they potentially lie close to settlements where there may be waste infrastructure at present or a requirement for it in the future. However the legislative and planning controls above provide the mechanism to prevent impacts, and it is not readily apparent from material prepared by the principal environmental agencies that waste currently presents a widespread problem, though clearly the management activities and the materials involved have clear potential adverse impacts on biodiversity assets. These considerations apply also to the other environmental assets discussed in sections 4 and 5.

Most waste management facilities generate impacts from dust and other emissions, noise and traffic which are likely to be considered adverse impacts on sites with this level of designation and are therefore likely to be considered inappropriate development within the vicinity. However the extent of impacts of existing waste management facilities on these assets at present cannot be determined from the data available. SACs, SPAs and RAMSAR sites are almost entirely situated in rural areas and therefore more likely to affect planning decisions on landfill and composting sites, whereas the wider network of SSSIs could affect a broader range of infrastructure.

It is expected that the legislative and planning controls summarised above will control the potential impacts of any new waste infrastructure.

The indicators developed for this SEA include two parameters for which data is not currently available but which could be used in this context; these are summarised below.

3.3 Waste management sites and Biodiversity Action Plans

The % of sites with a Local Biodiversity Action Plan (LBAP) in place is an indicator which could potentially be used to monitor the environmental performance of the waste sector, and which is designed to help companies produce their own targets and improve their environmental management. This indicator is one of several proposed by the Green Alliance, published in 2001, and which bodies including private sector waste management operators are encouraged to monitor and publish. The indicators were separated by Green Alliance into two categories. Stage 1 indicators are those indicators based on data likely to be more readily available and therefore less of a challenge for the operators. The proportion of sites with a Local Biodiversity Action Plan is, however, a Stage 2 indicator meaning it may be re-defined following further consultation.

Most companies have not yet started reporting data for this indicator. Consequently there is no clear picture of the national situation, and the performance of those companies which are publishing details is not necessarily representative of the wider picture. Biffa has however, provided some data: for 2003–2004 34% of its sites had an LBAP in place which was a significant increase from 2002-2003 when 15% had an LBAP[30].

Although a reliable national picture of current deployment is not currently available, this parameter is included as an indicator which could potentially be monitored over the period to the next review of waste strategy once national data begin to be reported. See Section 8 of the Environmental Report.

3.4 Waste sites with registered Environmental Management Systems

The proportion of sites with registered Environmental Management Systems (EMS) is a stage 1 indicator of those proposed by the Green Alliance. Data for 2004 for ESA members show that 45% had an EMS in place[31]. A number of operators have reported this indicator e.g. Biffa (70% of sites had an EMS in 2003 reduced to 43% in 2004) and Shanks (16 sites in 2004 reduced to 9 in 2005)[32], have seen a decline in numbers of sites with EMS but this has largely been a result of disposal of sites. Other companies such as Cleanaway and Cory have increased the proportion of sites with EMS (Cleanaway for 2002/2003 had 15 sites which increased to 31 by 2004 and Cory had 32% in 2002, which increased to 64.5% in 2003 and again to 71 % in 2004)[33,34].

There is currently insufficient information for this indicator to produce an overall figure for England or to understand the trends in activity. See Section 8 of the Environmental Report for more information.

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[30] Biffa (2005) Corporate Responsibility: Biodiversity accessible via: http://www.biffa.co.uk/publications/CorporateResponsibility/biodiversity.php
[31] ESA (2005) *Annual Statement 2005* accessible via http://www.esauk.org/publications/reports/ESA_annual_statement_05.pdf
[32] Shanks (2005) Environmental Report 2004-2005 accessible via http://www.shanks.co.uk/shanks/uploads/environment/Environment2004_05.pdf
[33] Cleanaway (2005) Environmental Report 2004 accessible via. http://www.cleanaway.co.uk/
[34] Cory Environmental (2005) Environmental Report 2004 accessible via http://www.coryenvironmental.co.uk/media/publications/docs/Corporate%20Publications/Cory-Enviromental-Report%202004.pdf

4 Landscape character and environmental quality

Substantial areas of the UK are protected for the quality, diversity, tranquillity and characteristics of their landscape (including carefully controlled elements of the built environment). The main designations are summarised below and the nature of potential impacts from waste management and controls on these effects are summarised.

4.1 Principal designations

National parks

These are the largest assets in terms of area and 10 are currently designated in England both for the quality of their wildlife habitats as well as for the quality of their landscape, with the purpose of conserving large areas of open space of natural beauty for recreation. They contain SACs and SPAs and approximately 27% of England's SSSIs are found within their boundaries (English Nature 2004). The ratio of proportion of SSSIs in favourable or recovering condition in the Parks is lower than the national average indicating the need for continued controls on all forms of impact.

Threats to the National Parks include overgrazing and moorland burning. However a broader range of intrusions includes inappropriate development which would affect visual character and setting, the impact of pollutants and increases and other disturbances such as traffic levels which conflict with the aims of preserving tranquil areas for recreation.

Areas of Outstanding Natural Beauty

Since initial legislation made provisions for Areas of Outstanding National Beauty (AONBs) in 1949, 36 have been established in England and further one which straddles the border with Wales. These designations are extensive, comprising represent 18% of the Finest Countryside in England and Wales (a figure for England only is not available), the largest being the Cotswolds which covers 2,038 sq km.[35] Introduction of AONB management plans assists in the protection and management of the AONBs.

The visual quality of an AONB is matched by its tranquillity and unspoilt aspect, although the extent means each that will contain settlements. All contain SSSIs and many also contain SACs and SPAs, which are protected by the controls summarised in the previous section.

Heritage coastline

These designations are equivalent to AONBs and currently comprise 33% (1,057km) of scenic English coastline. Again the designation primarily reflects their unspoilt visual quality although they may contain some settlements or urban areas. Potential adverse impacts are as for AONBs.

[35] Source: http://www.aonb.org.uk.

4.2 Regulatory and planning controls

Protection of these principal designations is afforded by the National Parks and Access to the Countryside Act of 1949, as modified by the Countryside and Rights of Way Act of 2000. Responsibility for conserving and enhancing their natural beauty, wildlife and cultural heritage lies with the National Park Authority[36]. Its responsibilities also include identifying policies and priorities for achieving this through a Management Plan which has the same status as the Local Plans produced by other authorities.

Responsibility for AONBs currently lies with local authorities which have responsibility under the preceding Acts to preserve and enhance the beauty of the locations. Controls are therefore exercised through policies in the Local Plan reflecting the authorities' obligations under the Town and Country Planning Regulations. These policies should specify the criteria to be met to limit adverse effects of new development. Planning Policy Statement 7 (PPS 7) makes clear the need to respect national designations in assessing impacts in rural areas[37].

Development in rural areas outside the designations is also controlled by local authorities under the obligations mentioned above and delivered through policies in the Local Plan or Local Development Framework. These will define design and locational criteria for specific forms of development, supporting them with other generic policies restricting development which contributes to dust, noise, traffic to unacceptable levels.

The objective of development controls is to preclude inappropriate development in these areas, where any new development that is not in keeping with existing land use practices, or which is not an extension of any existing land use. As with other designations, local planning authorities can permit development where there is an over-riding requirement (usually on health or safety grounds) or if it can be demonstrated that no suitable and viable site is available. The extent to which these restrictions can be relaxed depends on individual circumstances and will vary with the importance of the designation.

Adverse development impacts from waste on both these designations can include (but are not restricted to) any activities which raise levels of noise and vibration (whether from site-based activities or a significant increase in traffic), activities which can increase the release of dust, odours and pollutants, and any development which intrudes into the landscape due to its size and visibility. These considerations appear to generally preclude medium to large-scale waste facilities of all types, especially those which require an emissions stack or which operate on a scale that will increase levels of noise, light (even outside operating hours) and traffic. Relatively small-scale, low-profile facilities such as composting sites offer more scope to be located in these areas given they complement continuing agricultural land use and provided there is appropriate mitigation and management to prevent the impacts mentioned above.

As with the designations summarised in section 3, there is currently no readily available data identifying the extent of impacts of existing waste management infrastructure on these assets.

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[36] Environment Act 1995, Section 61.
[37] ODPM: Planning Policy Statement 7: Sustainable Development in Rural Areas, 2004. 21-25.

The size of the principal designations means that they include some settlements for which certain types of waste infrastructure (particularly local recycling) are needed. Nevertheless it is expected that the legislative and planning controls summarised above would afford protection to limit the impacts of new waste infrastructure and to locate it within these areas with adequate mitigation, or locate it elsewhere.

In order to monitor the impacts of the waste strategy in the future, the indicators proposed by this SEA – subject to discussion and agreement between stakeholders - include estimating the number of waste management facilities that lie, or are proposed for development, in the principal landscape designations, and this parameter is part of the monitoring proposals detailed in Chapter 8 of the Environmental Report.

4.3 Local environmental quality

Based on surveys conducted in 2003 and 2004, 56% local environments in England were deemed to be of 'unsatisfactory' (52%) or 'poor' (4%) quality. The remaining 44% was classed as 'satisfactory' (1%) or 'good' (28%). The 'unsatisfactory' and 'poor' local environment quality classifications in England have improved from 68% in 2001-2[38]. These trends are summarised in Figure 4.3.

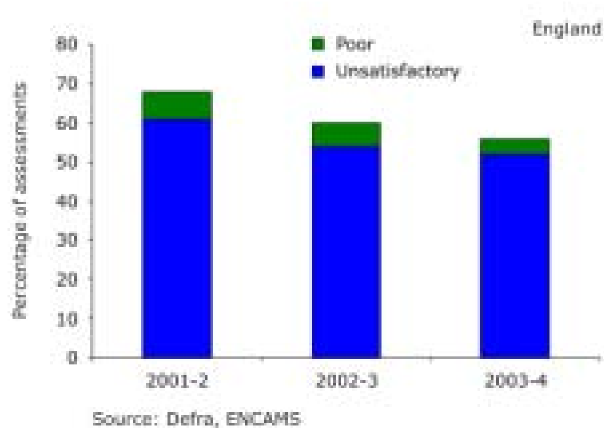

Figure 4.3: Changes in local environmental quality [Encams[39]]

A sample of sites were assessed using opinion surveys to assess residents' levels of satisfaction with levels of litter, detritus and weeds; fly-posting and fly-tipping; graffiti; the physical appearance, condition and maintenance of the public realm; and other factors. The report provides aggregated data for England, but in respect of several parameters (including fly-tipping) it acknowledges wide local variations that are difficult to summarise clearly. However the overall summary suggests

- No problems caused by dissatisfaction with fly-tipping;
- Good levels of satisfaction with municipal waste collection (though poor quality of condition and cleanliness of bins).[40]

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[38] UK Sustainable Development Strategy. See: http://www.sustainable-development.gov.uk/performance/otherinds.xls.
[39] UK Sustainable Development Strategy: http://www.sustainable-development.gov.uk/performance/documents/sdiyp2005_a6.pdf

5 Cultural & heritage assets

This section briefly summarises the nature and extent of the principal conservation designations for the built environment, before identifying the potential impact from waste activities and the key controls.

5.1 Principal designations

World Heritage Sites and scheduled monuments

There are currently 16 established or tentative World Heritage Sites in England and the international status of this designation affords it a high level of protection from inappropriate development nearby. Most sites are compact, limiting the potential constraint imposed by this designation for which the principal considerations are the impact of development in the vicinity on character and setting (particularly in terms of visual intrusion), while subsidiary considerations may include generation of traffic, noise and light levels, and pervasive impacts such as increased dust and litter levels.

Scheduled monuments are the principal national designation in the UK which was introduced in 1979. There are an estimated 19,717 sites in England in 2005[41] and these vary from substantial structures such as large earth forts to small sites perhaps occupying 0.5ha or less. The majority of sites lie in local authority areas which are classified as predominantly rural, which may affect the potential for conflict with new waste management infrastructure.

Listed buildings, registered parks and gardens and conservation areas

All three are further nationally applicable conservations designations with an estimated 372,038 listed structures, 1587 parks and gardens, and 9374 conservation areas. Recent information published by English Heritage indicates an increase of around 2% in the land taken by listed structures since 1999; a comparative statistic for the other types of sites is not currently published.

5.2 Legislation and waste management

The designation and protection of these assets is based on legislation which includes (with regard to England) the Ancient Monuments and Archaeological Areas Act of 1979 (for scheduled monuments) and the Planning (Listed Buildings and Conservation Areas) Act of 1990. Protection is also afforded through the Town and Country Planning Regulations of 1991 and subsequently 2004, which require local planning authorities to take account of environmental considerations including the protection of the historic environment. Planning Policy Guidance 15 (PPG15) requires that local authorities should clearly define their priorities for preserving and enhancing the historic environment and identifies the role of English Heritage as a statutory consultee on development activities affecting sites covered by (or proposed for) these designations[42]. Further controls are provided through other planning guidance including Annex E of PPS10 (which states that when siting waste management facilities waste planning authorities should consider any adverse effect on a site of international importance or a site or building with a nationally recognised

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[40] Encams, First Annual Report on the Local Environmental Quality Survey of England, 2002. See: http://www.encams.org/uploads/publications/leqsurveyofenglandreport_v01.pdf pp.37-38.
[41] See: http://www.english-heritage.org.uk/heritagecounts/report.htm
[42] ODPM (1994), Planning Policy Guidance 15 – Planning and the Historic Environment, section 2.

designation) and more indirectly through the broad priorities established in PPS1 (Delivering Sustainable Development).

As a result Local Plans (and the emerging Local Development Frameworks) specify clear policies towards protection of these assets. These are material considerations in any planning application for a development within or in the vicinity of one of these assets. Evaluation and mitigation of potential impacts would also be required under the Town and Country Planning (EIA) Regulations where the scale or type of development requires this form of assessment.

For waste management facilities, key considerations are likely to include visual intrusion and other impacts affecting the setting, including noise, odours, dust, etc., while consideration may have to be given to the impact of traffic vibration on old buildings. There are no specified separation criteria or restriction zones, but these would apply on a case-by-case basis, taking account of the type of facility, proximity, and the importance and condition of the asset.

In common with other forms of land use, at present there are no readily available sources of information to show the proximity of waste management facilities to cultural and heritage assets, nor is there currently a mechanism for estimating the potential impact on them on a national scale. In the absence of evidence that there is an impact it is concluded that any potential impacts will be dealt with primarily through the spatial planning and environmental impact assessment processes.

6 Water quality

This section summarises current trends in water conditions nationally based on published sources, though as such it cannot identify problems which may be associated with individual sites. Moreover the most recent data on reported pollution incidents affecting water (see section 2.3) shows that waste management activities account for a very small proportion of all reported incidents.

6.1 Chemical and biological river water quality

In England, chemical and biological river water quality has generally been improving since 1990, as expressed by the percentage of river and canal lengths categorised as being of either good or fair quality (Grades A through D). However, chemical river water quality reached a peak in 2001, and has declined slightly subsequently[43]. Figure 6.1 shows this and the parallel trend (generally declining) of proportion of river lengths categorised as being of either poor or bad quality (Grades E and F).

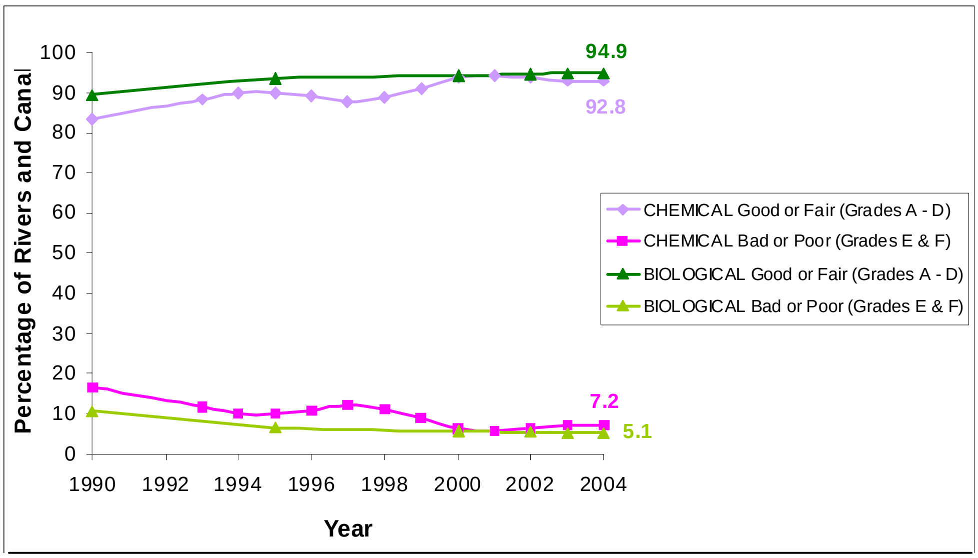

Figure 6.1: Trends in river water quality [Environment Agency[44]]

The national target for both chemical and biological river quality is 94% of river lengths of good or fair quality. Biological river quality has consistently been meeting this target since 2000. Chemical river quality briefly reached this goal in 2001, but has been slightly off-target since, moving slightly further from the target each year.

The contribution waste makes to river quality in the long-term is not evident from the available data. Problems associated with specific sites are largely unknown, but research is developing that could lead to an indicator for the potential contribution of land contaminated by waste management to declines in water quality as a proportion of all contaminated land. Section 6.3 discusses this issue.

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43 Defra: e-Digest Statistics about: Inland Water Quality and Use. Retrieved on 09th November 2005 from the World Wide Web: http://www.defra.gov.uk/environment/ statistics/inlwater/iwquality.htm

44 See: http://www.environment-agency.gov.uk/yourenv/eff/1190084/water/213902/river_qual/?version=1&lang=_e

6.2 Quality of bathing waters

Bathing water in England is monitored at 414 locations as a result of the transposition of the 1976 Bathing Waters Directive (76/160/EEC) into UK law as The Bathing Waters (Classification) Regulations 1991 (SI 1991, No. 1597), which established requirements for bathing water quality. This is expressed in terms of both physio-chemical parameters and microbiological parameters[45].

Over the period 1995-2005 physio-chemical quality improved gently from around 90% to just under 99%, close to the target of 100%; whereas microbiological quality improved more substantially from just over 40% to 74% by 2005, though with some fluctuations over the intervening period and still remains some way off target.

The principal failures in compliance are largely attributed to waste water treatment infrastructure, agricultural runoff and urban runoff after heavy rain[46], suggesting that waste management activities have no significant impact on this type of water resource.

6.3 Effect of waste management activities on inland water quality

Data on water quality are based on pollution incident reports collected by the EA. These detail only the general medium affected (air, water and land) and do not distinguish between impacts on surface waters and groundwater.

Figure 6.3 summarises the trend in the most serious and significant water contamination incidents over the period since Waste Strategy 2000 was published.

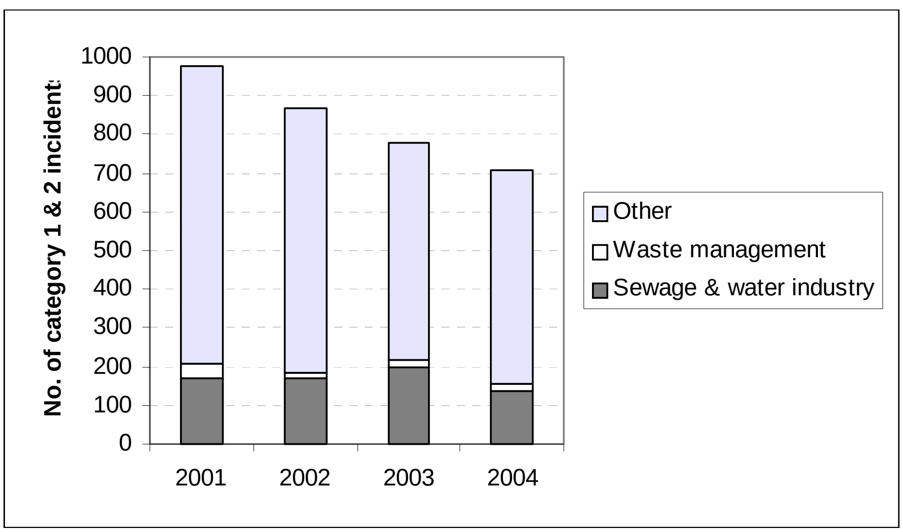

Figure 6.3: Inland water contamination incidents resulting from waste management activities [Environment Agency[47]]

[45] See: http://www.defra.gov.uk/environment/ water/quality/bathing/default.htm.
[46] Ibid.
[47] Environment Agency: data available at:: http://www.environment-agency.gov.uk/yourenv/eff/1190084/pollution/296030/298038/?version=1&lang=_e

Waste-related incidents to water have been declining in absolute terms: the number of major and significant incidents has halved from 38 in 2001 to 19 in 2004. As a result waste-related incidents have fallen from just under 4.5% of all pollution incidents affecting water in 2001 to 2.7% by 2004.

Figure 6.4 shows the distribution of the 19 most serious and significant incidents in 2004 between the different waste management facilities, and it should be noted that the distribution is affected by the small number of reported incidents. In 2001 (not shown) landfill sites accounted for 60% of reported incidents; this share fell to a little over 40% by 2004 but this remains the principal source of these impacts. There were no recorded water contamination incidents related to thermal treatment of waste, while the number of incidents resulting from metal recycling has fallen noticeably. Also, the more serious incidents (categories 1 and 2) accounted for a smaller proportion of all incidents in 2004 compared to 2001 (down from 12% to 7%).

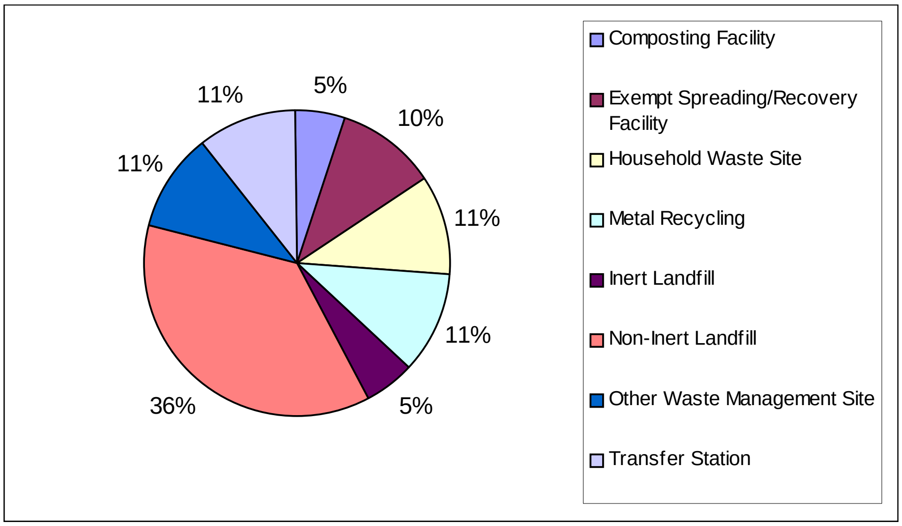

Figure 6.4: Distribution of the most serious water contamination incidents resulting from waste management by type of facility [Environment Agency[48]]

6.4 Summary of legislative and planning controls

Legislative control over activities liable to give rise to water contamination has evolved substantially over the last 15 years, following the publication of the Environmental Protection Act in 1990 and its subsequent revision by the Pollution Prevention and Control Act and corresponding Regulations of 1999 and 2000 respectively. The Environment Act of 1995 established the powers of the Environment Agency in prevention and remediation of water pollution problem and, in principle, its role as a statutory consultee on any planning application with potential impacts on the water environment.

This legislation has established the existing structure of preventative controls based on licensing and prescribed limits for emissions, including discharges to water courses, and the requirement to adopt BATNEEC and SEA principles to minimise environmental damage. The Environment Act also defined the principle of duty of care which establishes the legal responsibility of a site operator to comply with

[48] Ibid.

pollution control legislation and discharge levels, and to report events and infringements to the relevant bodies.

Other relevant UK legislation includes the Water Resources Act of 1991 which established the structure of abstraction and discharge consents and the initial water quality objectives for inland waters. The Groundwater Regulations of 1998 provide controls on discharge of substances to groundwater. Both are therefore relevant to waste facilities requiring water supply for processing, and for landfill sites. Tightening of controls on water quality and emission levels resulted from the EU Water Framework Directive of 2000 has more closely integrated controls on abstraction and discharge with water quality.

The structure above defines the current licensing system to control abstraction and discharge of water and materials in solution into the surrounding environment and based on Emission Limit Values dictated by the type of site or process.

Planning processes exist alongside this and are seen as complementary but separate, however the impact of new development on water quality and resource is a material consideration in planning applications, where appropriate. PPS23 defines the relationship between the processes in outline, however planning controls are again based on the Town and Country Planning Regulations which require local authorities to draw up development plans with reference to public health and other environmental constraints such as the conservation of biodiversity assets (see section 3.1). Local Plans and Waste Development Frameworks must therefore contain policies which maintain and help to improve water quality and supply, while biodiversity policies will mean that proximity to designated natural assets may be a material consideration in the planning application. PPS 10 states that when siting waste management facilities, waste planning authorities should consider the proximity of vulnerable surface and groundwater[49].

6.5 Waste sector impacts

Water consumption varies by type of facility and size of site. It is likely to be greatest at MRFs and MBT plants particularly from the washing of materials as part of the separation or treatment processes. Some of this demand can be provided through water recycling though some discharge of material in solution is likely within permitted levels.

Other potential impacts derive from leachate or runoff from composting sites, and leachate from landfills. It is recognised that in certain circumstances landfill may have long-term impacts on water quality and further research is continuing, particularly into the efficacy of landfill linings in preventing outflow of leachate and other pollutants. It is suggested that this remains a priority given the continuing important role that landfill will play in waste management in the UK[50].

In terms of current evidence of the effectiveness of the controls outlined above, the low level of the most serious categories of water pollution by waste suggests that they are effective. The number has remained roughly static over the past four years during a period when there has been some growth in waste infrastructure following publication of *WS2000.* Nevertheless there remains a need for maintenance of

[49] It also states that for landfill or land-raising, geological conditions and the behaviour of surface water and groundwater should be assessed both for the site under consideration and the surrounding area. The suitability of locations subject to flooding will also need particular care. See footnote 28 above.
[50] See infrastructure forecasts in Chapter 6 of the Environmental Report.

controls to prevent an increase in incidents as a result of bringing new sites on-stream.

6.6 Additional indicators

Two further indicators have been proposed to measure the impact of the waste strategy and the new infrastructure that results from it:

- The number of licensed sites that exceeded authorised discharge levels in the preceding year; and
- The eutrophication of water resources resulting from waste sector activities.

These indicators cannot be calculated at national level from the data available at present, however existing data on pollution incidents and monitoring of river water quality levels by the EA appear to provide a potential source for the data. These indicators are therefore included in the monitoring proposals shown in Chapter 8 of the Environmental Report.

7 Land resource & contamination

The summary of pollution impacts in section 2.2 shows that there were just under 100 serious (i.e. category 1 and 2) reported incidents affecting land resources in 2004 which were associated with waste management sites. The number has remained at roughly this level over the period since Waste Strategy 2000 was published. The relationship between land resources and waste management turns on issues of quality as well as the level of pollution and contamination attributed to waste management, and all these issues are reviewed in this section.

7.1 Land take and land quality

At present there is no information to assess the total land taken by the existing waste management facilities, and estimating this figure is hindered by the wide variation in the size of landfill sites which remain the most numerous type of facility (see section 2.2).

Defra[51] has classified agricultural land in broad terms (Excellent to Very Poor) showing that around 42% is high quality productive greenfield land on which development should be avoided unless there are clear economic and social benefits that outweigh loss of the resource. Care needs to be taken with siting of new waste management facilities and restoration so as not to degrade any of this resource.

Infrastructure requirements will depend on local circumstances and on the overarching requirement to achieve Best Value targets and the broader ones set by the waste strategy. PPS10 (para. 21(ii)) clearly identifies the need to prioritise re-use of previously developed land that is consistent with this theme of other such documents (eg. PPS1, PPG/PPS3). This requirement should also be reflected in local authorities' Waste Plans and emerging Waste Development Frameworks, thereby providing a material consideration used in assessing planning applications.

Notwithstanding, it is considered that the total volume of land taken (and needed in the near future) for waste management infrastructure is very small in comparison to the demands of the housing sector, for example, when considered on a national scale.

7.2 Land contamination

There is currently no reliable figure regarding the number of contaminated sites, but an estimate for England and Wales is that there may be around 100,000 sites which are contaminated to some degree, of which between 5% and 20% may present unacceptable risks to human health or to the environment. A programme is underway to identify all contaminated sites in England and Wales, as defined by Part IIA of the 1990 Environmental Protection Act (introduced in 2000) and the associated Contaminated Land (England) Regulations 2000. In 2002, the majority of Local Authorities had prepared and published a strategy to inspect their land. Many had begun the inspections, with completion expected between 2002 and 2006, but there is currently limited data to assess the impact of waste management activities.

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[51] Defra: *Agricultural Land Classification.* Retrieved on 10th November 2005 from: http://www.defra.gov.uk/environ/landuse/alcleaflet.pdf

Only 33 contaminated sites were confirmed prior to publication of the Environment Agency's 2002 report. The sources of contamination were analysed, considered to provide a rough indication of the distribution of sources in England, as in the section below. An update in September 2004 has reported the number of known contaminated sites in England as 69.

Currently there is no definitive figure of the area of contaminated land in England, with only the broad range for England and Wales of between 50,000 ha. and 300,000 ha. The 111,398 sites of potential contamination risk amount to 218,114 ha. Of these sites, 668 (0.6%) were/are attributed to waste management activities – 9% for metal recycling and the rest being landfill sites[52]. Of the 218,114 hectares the total comprises, waste management makes up 1,483 (0.7%). However, this minute proportion does not have a direct relationship with the proportion of former or current waste management sites that can be attributed to current contamination. This can only be revealed by current land inspections and data will therefore become available when these are completed.

Figure 7.2 shows that contamination at 8 of the 33 identified sites was attributed to waste management in 2002, being 24% of the total number of known contaminated sites in England.

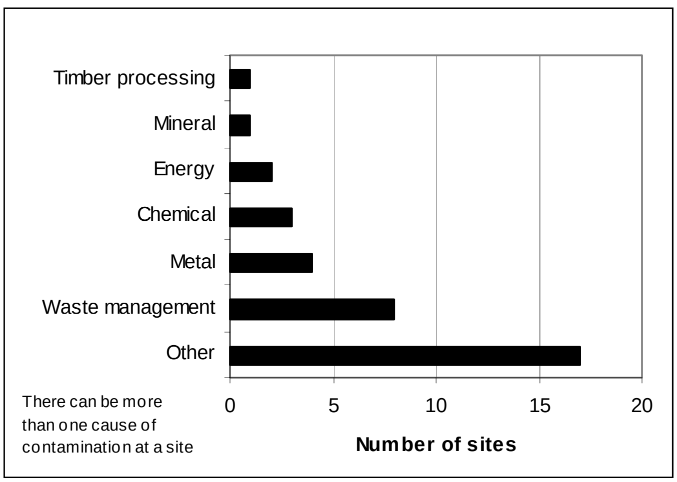

Figure 7.2: Causes of land contamination at Part IIA sites in England in 2002 [Environment Agency][53]

Next to the category "other," waste management is the single largest contributor to contamination known thus far. However it would be inappropriate to draw conclusions from this very small sample.

7.3 Relevant legislation and planning controls

These controls are essentially the same as those identified in section 6.4 and based on the preventative measures of the PPC regime, and the corresponding assessment processes required by PPS23 and the broader requirement of planning authorities to evaluate the impact of new development under the Town and Country Planning Regulations and the corresponding EIA Regulations.

52 http://www.environment-agency.gov.uk/commondata/acrobat/dealing_with_contaminated_land_i (Table 6.1).
53 See: Ibid. Figure 5.3

A broader and more indirect control is applied through the provisions of PPS1 and PPG4[54] in directing new development, including waste infrastructure, to previously developed land, including that remediated from contamination.

7.4 Land pollution incidents attributed to waste management

Data are again collected by the Environment Agency and categorised by severity of impact on people and the natural environment (see section 2.3). Figure 7.3 illustrates the trend in major and significant (Category 1 and 2) events since *WS2000* was published.

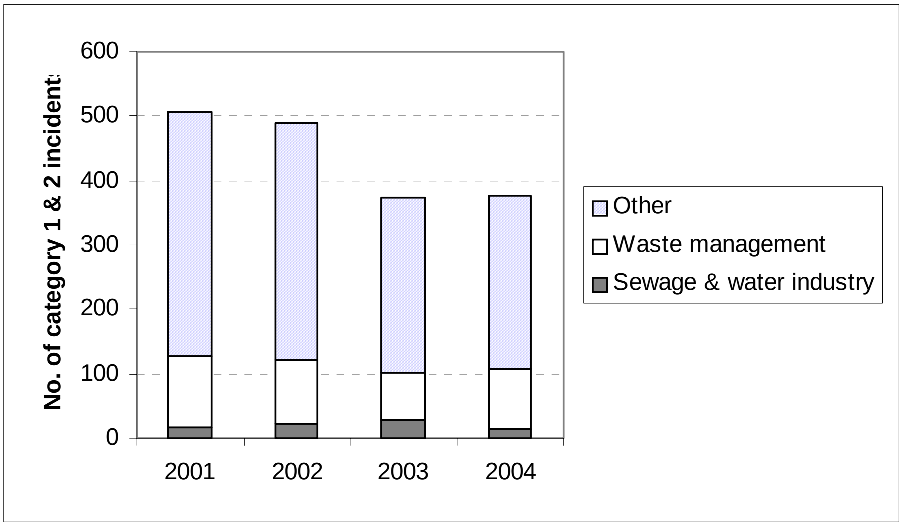

Figure 7.3: Land contamination incidents resulting from waste management activities [Environment Agency[55]]

The number attributable to waste management has declined over the period from 111 to 94, although the proportion has risen slightly to 25% largely as a result of a larger fall in incidents caused by other activities.

Figure 7.4 compares the distribution of these most serious land contamination incidents by waste management facility type. More than 70% of these incidents occurred at waste transfer stations or metal recycling facilities.

Deleted: <sp>

[54] ODPM (both documents): PPS1 – Delivering Sustainable Communities; and PPG4 – Industrial, Commercial Development and Small Firms (paras. 21-23).

[55] Environment Agency: data available at:: http://www.environment-agency.gov.uk/yourenv/eff/1190084/pollution/296030/297986/?version=1&lang=_e

Figure 7.4: Distribution of the most serious land contamination incidents resulting from waste management by type of facility [Environment Agency[56]]

There were no reports of serious incidents involving composting facilities. In 2004 there were 14 reports of minor incidents with the most common problems being pollution by composted material (assumed to be material blown off the site) and from smoke.

The number of incidents per year has declined slightly since 2004 but the persistence of problems suggests that controls are not sufficiently effective, or that site management procedures need to be tightened. This is therefore an area where waste activities have an appreciable impact, and the facility type distribution suggests there is scope for this to increase in line with the growth in certain types of treatment, and without improvement in controls.

[56] Ibid.

8 Air quality & air pollution

8.1 Introduction

For most air pollutants, the main sources of emissions are from fossil-fuel combustion (electricity generation, heating and vehicles).[57]

Sulphur dioxide (SO_2) and nitrogen oxides (NO_x) are the principal acid gases that contribute to acidification and local air pollution, although hydrogen chloride and hydrogen fluoride may give rise to local impacts. Acid gases impact human health, vegetation and the built environment. Sulphur dioxide affects the lining of the nose, throat and airways of the lung, whilst nitrogen dioxide (NO_2) is thought to have both acute and chronic effects on airways and lung function. Nitrogen oxides are also ozone pre-cursors.

Airborne particulate matter is very diverse, including products of combustion, dust, grit, seasalt and biological particles. It has many sources, such as road traffic, construction work and chemical reactions in the atmosphere. Fine particles can be carried into the lungs and can be responsible for causing premature deaths among those with pre-existing lung and heart disease. The most commonly used measurement method is based on the size of particles and collects mainly particles 10µm (10 thousandths of a millimetre) in diameter or smaller – small enough to penetrate deep into the lungs. This material is known as PM_{10}.

Carbon monoxide (CO) is a toxic gas emitted by combustion processes, and is also formed by the oxidation of hydrocarbons and other organic compounds. It affects the transport of oxygen by the blood.

Ground level ozone (O_3) occurs naturally but levels can be increased as a result of reactions between NOx, oxygen and VOCs in the presence of sunlight. Once formed, O_3 can persist for several days and can be transported long distances. It can cause irritation to the eyes and nose, and very high levels can cause damage to the airway lining. Ozone can also damage vegetation.

Volatile organic compounds (VOCs) comprise a wide range of chemical compounds including hydrocarbons, oxygenates and halogen containing species. The major environmental impact of non-methane VOCs lies in their involvement in the formation of ground level ozone, but they may also cause a range of health effects. VOCs include benzene and 1,3-butadiene, which are carcinogens.

Ammonia causes nitrogen enrichment, disrupting the balance of plant species in vulnerable ecosystems. It also contributes to the formation of fine particles through reaction with other chemicals in the atmosphere, and can potentially cause acidification.

Heavy metals, including lead (Pb), have various health effects, the most important of which relate to deterioration of the immune system, the metabolic system and the nervous system. Some are known or suspected to be carcinogenic.

[57] Defra e-Digest of Environmental Statistics: Air Quality (available via www.defra.gov.uk/environment/statistics/index.htm)

Persistent organic pollutants (POPs) are found in trace quantities in all areas of the environment. They do not break down readily and they accumulate in humans and plants. They have varying levels of toxicity. They include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins and furans and pesticides.

Waste management activities can affect air quality as a result of fugitive emissions of materials from the waste itself. The most likely substances to arise in this way are particulate matter, possibly containing trace levels of substances such as metals, and bioaerosols (principally micro-organisms such as fungal spores and bacteria). VOCs could also be released in this way – for example, as a result of the decomposition of biodegradable materials. When waste is burnt, then in common with the combustion of other fuels, substances such as oxides of nitrogen, sulphur dioxide, carbon monoxide and particulate matter are released. Extremely low levels of dioxins and furans may also be emitted.

The Government has adopted a sustainable development strategy indicator for air pollution, based on the air pollution banding system. This describes levels of air pollutants as "low", "moderate", "high" or "very high" on the basis of the measured levels of the most commonly encountered pollutants including ozone and PM_{10}. The indicator is defined as the number of days on which levels of air pollution were recorded as being moderate or higher, and is calculated separately for urban and rural monitoring stations.

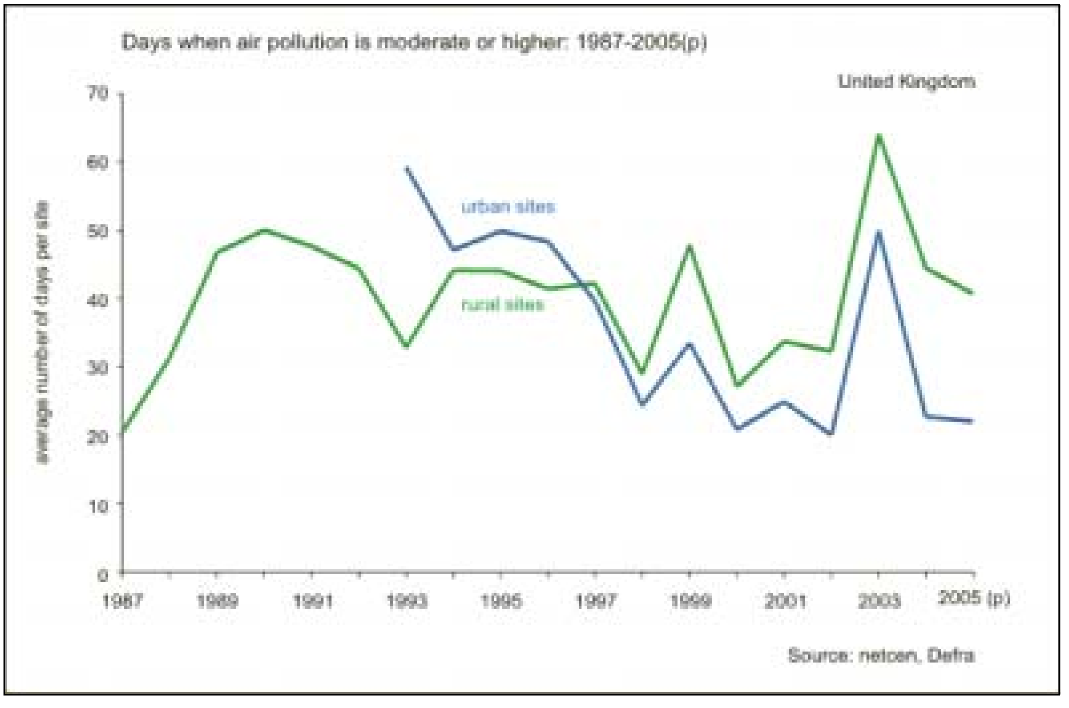

Figure 8.1: UK Government sustainable development strategy indicator: Air Quality[58]

[58] Defra e-Digest of Environmental Statistics: Air Quality (available via www.defra.gov.uk/environment/statistics/index.htm) (2005 data provisional)

In 2005 there was an average of 22 days with moderate or higher pollution in urban areas, and 41 days in rural areas. Days of "moderate" or higher air pollution in rural areas mainly result from levels of ozone, and there has been no clear trend in these areas.

The average number of days with moderate or higher air pollution has in general decreased significantly in urban areas since 1993, largely because of a reduction in particles and sulphur dioxide. However, from year to year there can be significant variations caused by the weather. For example, the hot summer of 2003 was a major factor in the relatively high numbers of days of poor air quality in 2003.

8.2 Air quality issues associated with waste management activities

Appendix A contains a review of the principal issues associated with different waste treatment technologies. This section describes issues common to waste management activities, and then summarises key issues associated with the different types of facility.

8.2.1 Nature of emissions from waste management activities

The nature of emissions from waste management facilities is affected by the type of process being carried out.

All waste management facilities will result in fugitive emissions from waste arriving at the process to a greater or lesser extent. These emissions may include dust, VOCs, micro-organisms and odour. Dusts may potentially include trace organic or inorganic chemicals, or micro-organisms[59]. Facilities receiving a greater proportion of biodegradable or dust-generating material such as ashes are likely to have to pay greater attention to controlling fugitive emissions than other processes.

Some waste management facilities (anaerobic digestion facilities and landfills) result in the generation of bio-gas from the anaerobic decomposition of waste. Attention also needs to be paid to controlling fugitive emissions of these gases as these have a high health risk and global warming potential.

Waste management facilities which include a combustion component will result in emissions of combustion gases. These processes include pyrolysis, gasification, anaerobic digestion, landfill sites with gas collection and flaring or utilisation, and waste to energy/incineration. The substances emitted from waste combustion are primarily oxides of nitrogen, carbon monoxide, sulphur dioxide and fine particulate matter (PM_{10}). Very low levels of metals and dioxins and furans may also be emitted. Emissions of carbon dioxide are discussed in Section 9 below.

8.2.2 Control of combustion processes

Waste combustion processes need to be properly designed and controlled to minimise emissions, and to make sure that there are no significant environmental effects. For example, good mixing will avoid excessive generation of oxides of nitrogen in "hot spots". Rapid cooling of flue gases in waste-to-energy plants will minimise the risk of formation of dioxins and furans. 65

[59] Environment Agency, "*Monitoring of particulate matter in ambient air around waste facilities*," Technical Guidance Document (Monitoring) M17, 2004

End-of-pipe abatement is also likely to be needed for waste combustion processes. These systems may include injection of alkaline materials to absorb acid gases, injection of activated carbon to remove dioxins and furans, and filtration systems to remove particulate matter.

The presence of combustion plant can provide a useful additional control on fugitive emissions. The air demand for the combustion plant can be drawn through areas where fugitive emissions may be generated such as waste reception or sorting areas. This means that fugitive emissions are less likely to be released to the ambient environment.

8.2.3 Control of fugitive emissions

Fugitive emissions can normally be controlled largely by good site management – for example, keeping surfaces clean and free from waste; and minimising the storage time of waste at a facility. If additional controls are needed, these can be provided via building ventilation for operations carried out under cover. Again, if needed, further control can be provided by treating the air extracted – for example, using a biofiltration system.

8.2.4 Abnormal operations

The likelihood and significance of emissions under non-standard operating conditions vary from one type of facility to another. The areas of greatest concern, approximately in decreasing order of significance, are as follows:

(a) Emissions from open windrow composting of waste can increase if the waste is not turned adequately to allow full aeration, resulting in anaerobic conditions. This can result in increased emissions of particulates, micro-organisms, methane and odours. This is less of a concern for in-vessel waste composting because of the improved control on aeration, and opportunities to treat air extracted from in-vessel systems.

(b) Incidents of inappropriate use or disposal of ash residues from waste to energy facilities have led to a risk of increased human exposure to substances in the ash. Investigations of these incidents showed that were no significant health risks associated with these particular incidents, but there is a need for detailed attention to ensure that ash residues are disposed of properly.

(c) Increased emissions from landfill are also a potential cause for concern. Leachate can leak through the lining of a landfill, but this is normally detected and controlled through borehole monitoring, with the result that it is very rare for such releases to affect surface waters. A failure in landfill gas combustion could result in increased emissions of landfill gas. If combustion of gas generated from anaerobic digestion of waste were to fail, this could result in increased emissions of unburnt biogas. The biogas released would be similar in composition to landfill gas.

(d) Increases in emissions from incineration or pyrolysis/gasification of MSW under non-standard operating conditions could potentially be significant in view of the range of substances potentially emitted. However, in practice, emissions of substances of concern from the perspective of potential health or environmental effects above permitted levels occur infrequently – most incidents relate to increased emissions of carbon monoxide, with no consequential health or environmental effects. The lack of consistent evidence of adverse health effects associated with MSW incineration indicates that emissions under both routine and abnormal operating conditions do not give rise to consistently detectable health effects.

(e) Excessive delays before treatment or disposal of waste at any facility could give rise to increased emissions of odour and micro-organisms. The significance of these emissions is lower at facilities equipped with air extraction and treatment systems such as dust filters or bio-filters, or where air can be passed through a combustion system (provided the combustion system is operational).

The occurrence of abnormal operating conditions resulting in increased emissions to air would normally be reported to the regulatory authority for processes subject to regulation by the Environment Agency or local authority. Incidents can also result in complaints from members of the public – for example, as a result of detecting odours.

Figure 8.2 summarises the trend in air pollution incidents reported to the Environment Agency since *Waste Strategy 2000* was published.

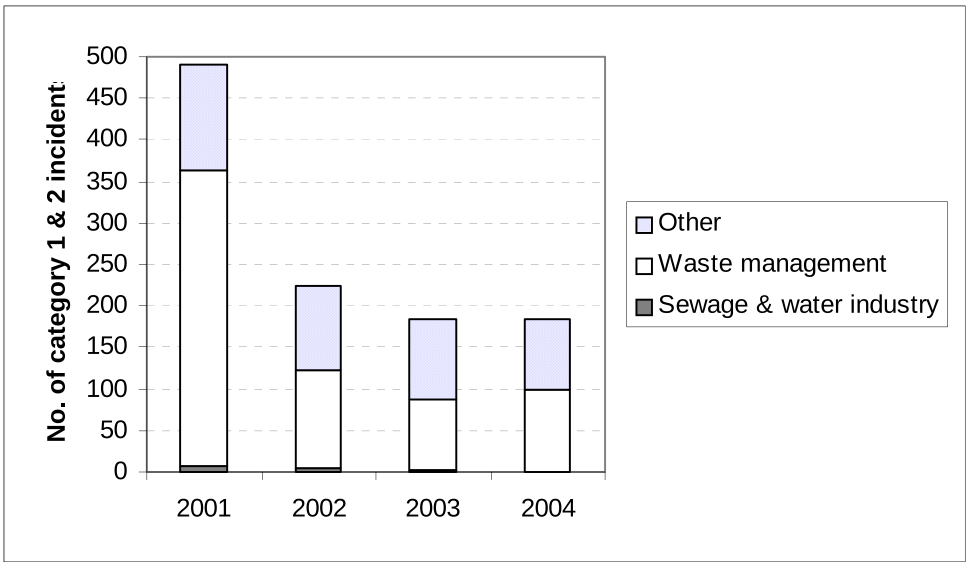

Figure 8.2: Air pollution incidents resulting from waste management activities in England and Wales [Environment Agency[60]]

The most noticeable change is the substantial fall in waste related incidents between 2001 and 2002. This was primarily due to reductions in complaints related to household waste sites and non-inert landfill sites[61]. The total number of incidents has remained roughly static at just over 180 per year during 2002, 2003 and 2004, with waste management activities accounting for approximately 55% of all cases.

[60] Environment Agency: data available at: www.environment-agency.gov.uk/yourenv/eff/1190084/pollution/296030/298038/?version=1&lang=_e

[61] The 2001 figures may also have been inflated by problems associated with burning livestock carcasses following the foot and mouth epidemic.

Figure 8.3 shows the distribution of incidents by waste facility type, indicating that almost half were associated with landfill sites.

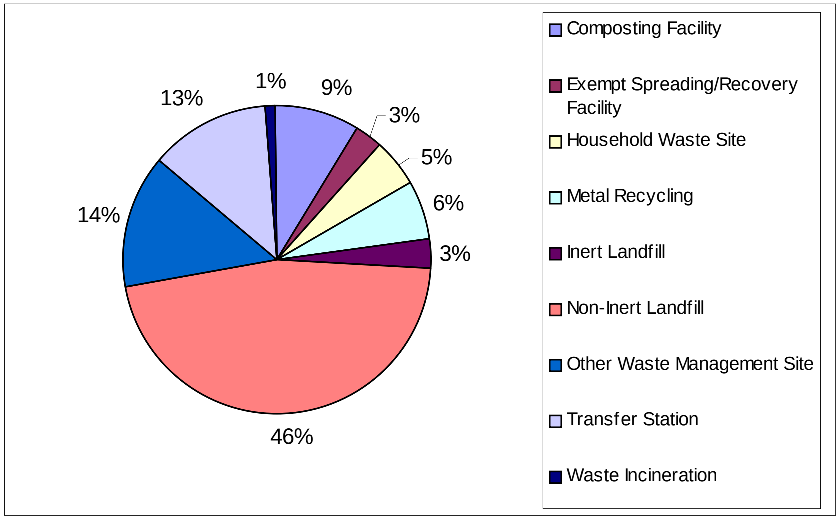

Figure 8.3: Origin of Category 1 and 2 waste related air pollution incidents in 2004 by waste sector activity [Environment Agency[62]]

Additional analysis supplied by the Environment Agency for this SEA indicated that:

- Of all the Category 1 and 2 incidents attributed to waste management activities the single greatest contributor is landfill odours, representing 30% of all reported incidents.
- Other common pollutants associated with Category 1 and 2 incidents include:
  - chemical odours from landfill and unspecified types of waste site;
  - smoke from landfill, metal recycling and unspecified types of site;
  - other atmospheric pollutants, in particular at transfer stations and composting facilities;
- 82% of incidents at non-inert landfill sites were attributed to landfill gas, chemical odours and non-specific "fumes";
- A greater range of pollutants was associated with the relatively minor Category 3 incidents at non-inert landfill sites. However, landfill gas, chemical and similar odours still accounted for 70% of reported incidents; and
- All the most serious incidents at non-inert sites were related to smoke.

8.2.5 Transfer stations and Materials recycling facilities (MRFs)

Air quality issues relating to transfer stations and material recovery facilities generally arise as a result of fugitive emissions from tipping and sorting of waste. Control of odours is likely to be a key issue for minimising emissions to air from MRFs.

[62] Ibid.

Only limited data is available on emissions to air from MRFs. This does not allow emissions to be quantified.

The use of Materials Recycling Facilities provides an opportunity for materials in the waste stream to be recycled. Reprocessing materials in this way could result in increases or decreases in emissions at locations remote from the MRF itself, and potentially a benefit in the overall life-cycle impacts of resource use.

8.2.6 Mechanical Biological Treatment (MBT)

The term MBT covers a variety of processes which use mechanical means to separate and reduce the particle size of the waste, and biological means to begin the composting process to stabilise the waste. MBT systems are usually designed such that emissions are minimised through housing under negative pressure and the use of bio-filters.

Emissions of VOCs from MBT are likely to be more significant than from combustion processes, although no data on VOC emissions from MBT has been identified. Emissions of particulate matter from fugitive and process sources will also need to be controlled. Limited data on emissions from MBT processes is available[63].

8.2.7 Composting

The main air quality issues associated with in-vessel and windrow composting are the production and control of bio-aerosols, VOCs and carbon dioxide. Other factors being equal, better control is possible on emissions from in-vessel systems than on emissions from open windrow composting facilities.

Based on limited poor quality data, emissions of particulates from open windrow composting appear likely to be higher than from other waste management activities[64]. Further research is ongoing in this area, under Defra's waste research programme and other initiatives. In view of the possible increases in waste composting in the future, more information in this area will be valuable.

Emissions of VOCs and micro-organisms are likely to be more significant from open composting processes than from combustion processes.

8.2.8 Anaerobic Digestion

Anaerobic digestion involves the decomposition of waste in the absence of air. This generates biogas, and a digestate material which can be further treated and/or used as a soil improver. The biogas can be burned to generate electricity and/or heat.

Control of odours is very important at anaerobic digestion facilities. Both the digesting waste material and the biogas can be strongly odorous.

The limited data available on emissions from anaerobic digestion processes indicates that emissions of metals to air are generally lower from anaerobic digestion than from other waste management options[65]. Emissions of oxides of nitrogen and sulphur dioxide also appear to be lower from anaerobic digestion than other kinds of facility. More data on emissions from anaerobic digestion processes would be useful.

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[63] Enviros Consulting / University of Birmingham report commissioned by Defra. *Review of environmental and health effects of waste management: municipal solid waste and similar wastes,* May 2004. See: http://www.defra.gov.uk/environment/waste/research/health/index.htm.

[64] Ibid.

[65] Ibid.

8.2.9 Pyrolysis/gasification

Pyrolysis and gasification processes are few in number, and data on emissions is correspondingly limited. These processes involve the heating and combustion of waste under conditions of no air or low air. Waste pyrolysis results in the generation of syngas (carbon monoxide and hydrogen) which can be burnt to generate electricity and/or heat.

Data from a small number of processes indicates that pyrolysis and gasification results in lower emissions of oxides of nitrogen than incineration[66]. Emissions of sulphur dioxide are similar for pyrolysis/gasification processes, incineration processes and landfills with gas combustion.

8.2.10 Waste to energy (incineration)

A considerable body of data is available on emissions to air from waste incineration which allows emissions to be characterised with good confidence.

Incineration generates relatively high emissions of oxides of nitrogen, hydrogen chloride and sulphur dioxide, which therefore require abatement using flue gas cleaning systems, although fugitive emissions of particles, VOCs and odours are generally low. This is because incineration facilities can be operated to provide good control on fugitive emissions resulting from the short residence time of waste, and the use of air from the waste reception area in the combustion process.

Emissions of dioxins and furans and metals from incineration have decreased substantially in recent years driven by increasingly stringent limits on emissions from incineration plant set in European directives. Combustion of municipal solid waste is now estimated to account for around 0.5% of total UK emissions[67].

8.2.11 Landfill

Landfills can result in fugitive emissions of dusts from the landfill surface, and also fugitive emissions of gas generated from decomposing wastes. These emissions can give rise to odour or dust nuisance in local areas, and need to be properly controlled. If landfill gas is collected and burned in flares or electricity generating engines, emissions will also occur from this plant. This means that emissions of methane and VOCs are more significant from landfill than from combustion processes.

Landfill gas engines give rise to relatively high emissions of oxides of nitrogen compared to other options. Emissions of sulphur dioxide can also be relatively high. Emissions of dioxins and furans are similar to other waste management activities. Measuring emissions from landfill gas flares is a difficult and complex procedure and there is little reliable data available.

8.3 Emissions inventories

Emissions data from all forms of waste management was collated by Enviros Consulting Ltd for Defra[68]. A comparison between emissions to air from different waste management options was compiled, as shown in Table 8.1.

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[66] Ibid.
[67] For example, emissions to air from incineration of all forms of waste fell from about 680 g toxic equivalent (TEQ) in 1990 to 100 grams TEQ in 2003.
[68] See footnote 63 above.

Table 8.1 : Emissions to air from waste management options (grams per tonne of waste)

Substance	Windrow composting	MBT	Anaerobic Digestion	Pyrolysis/ gasification	Mass burn Incineration	Small scale Incineration / pre-sorting	Landfill / engines	Landfill/ flaring	Trans-portation
Nitrogen Oxides	Not likely to be emitted	72.3 M(5)	188 M(8)	780 M(8)	1600 G(9)	1587 M(7)	680 M(6)	75 M(6)	31 M(7)
Total Particulates	175 P(3)	No data	No data	12 M(8)	38 G(9)	8 M(7)	5.3 M(6)	6.1 M(6)	1.3 M(7)
Sulphur Dioxide	Not likely to be emitted	28 M(5)	3.0 M(8)	52 M(8)	42 G(9)	20 M(7)	53 M(6)	90 M(6)	0.11 M(7)
Hydrogen Chloride	No data	1.2 M(5)	<0.02 M(8)	32 M(8)	58 G(9)	74 M(7)	3 M(6)	14 M(6)	Not likely to be emitted
Hydrogen Fluoride	Not likely to be emitted	0.4 M(5)	<0.007 M(8)	0.34 M(8)	1 G(9)	1 M(7)	3 M(6)	2.7 M(6)	Not likely to be emitted
Volatile Organic Compounds	No data	36 M(5)	No data	11 M(8)	8 M(8)	33 M(7)	6.4 M(6)	7.6 M(6)	5.1 M(7)
1,1 – Dichloroethane	No data	No data	No data	Not likely to be emitted			0.66 M(6)	0.66 M(6)	Not likely to be emitted
Chloroethane	No data	No data	No data	Not likely to be emitted			0.26 M(6)	0.26 M(6)	Not likely to be emitted
Chlorothene	No data	No data	No data	Not likely to be emitted			0.28 M(6)	0.28 M(6)	Not likely to be emitted
Chlorobenzene	No data	No data	No data	Not likely to be emitted			0.59 M(6)	0.59 M(6)	Not likely to be emitted
Tetrachloroethene	No data	No data	0.0004 M(7)	Not likely to be emitted			0.98 M(6)	0.84 M(6)	Not likely to be emitted
Benzene	No data	No data	No data	Not likely to be emitted			0.00006 M(6)	0.00006 M(6)	0.0029 M(7)
Methane	No data	411 M(5)	No data	No data	19	No data	20,000 M(6)	19,000 M(6)	Not likely to be emitted

Cadmium	Not likely to be emitted	No data	<0.0001 M(8)	0.0069 M(8)	0.005 G(9)	0.007 M(7)	0.071 M(6)	0.071 M(6)	No data
Nickel	Not likely to be emitted	No data	<0.0003 M(8)	0.04 M(8)	0.05 M(8)	0.33 M(7)	0.0095 M(6)	0.0095 M(6)	No data
Arsenic	Not likely to be emitted	No data	<0.0005 M(8)	0.06 M(8)	0.005 M(8)	0.033 M(7)	0.0012 M(6)	0.0012 M(6)	No data
Mercury	No data	No data	<0.0006 M(8)	0.069 M(8)	0.05 M(8)	0.021 M(7)	0.0012 M(6)	0.0012 M(6)	No data
Dioxins and Furans	No data	4.0×10^{-8} M(5)	No data	4.8×10^{-8} M(8)	4.0×10^{-7} G(9)	2.4×10^{-6} M(7)	1.4×10^{-7} M(6)	5.5×10^{-8} M(6)	3.8×10^{-11} M(7)
Polychlorinated Biphenyls	No data	No data	No data	No data	0.0001 M(8)	No data	No data	No data	No data
Carbon Dioxide	No data	181000 M(5)	No data	No data	1000000 G(9)	No data	300000 M(6)	200000 M(6)	1170

Note: Data pedigree: P(1-4): Poor M(5-8): Moderate G(9-12): Good VG(13-16): Very good

The National Atmospheric Admissions Inventory (NAEI) compiles estimates of UK emissions to the atmosphere from all sources, including road traffic, power stations and industrial plant.[69] The NAEI records information on a wide range of air pollutants, including heavy metals and organic substances. This information was used to compile a comparison of emissions to air from management of municipal solid waste with emissions from other sources of pollution, and the estimated UK total.

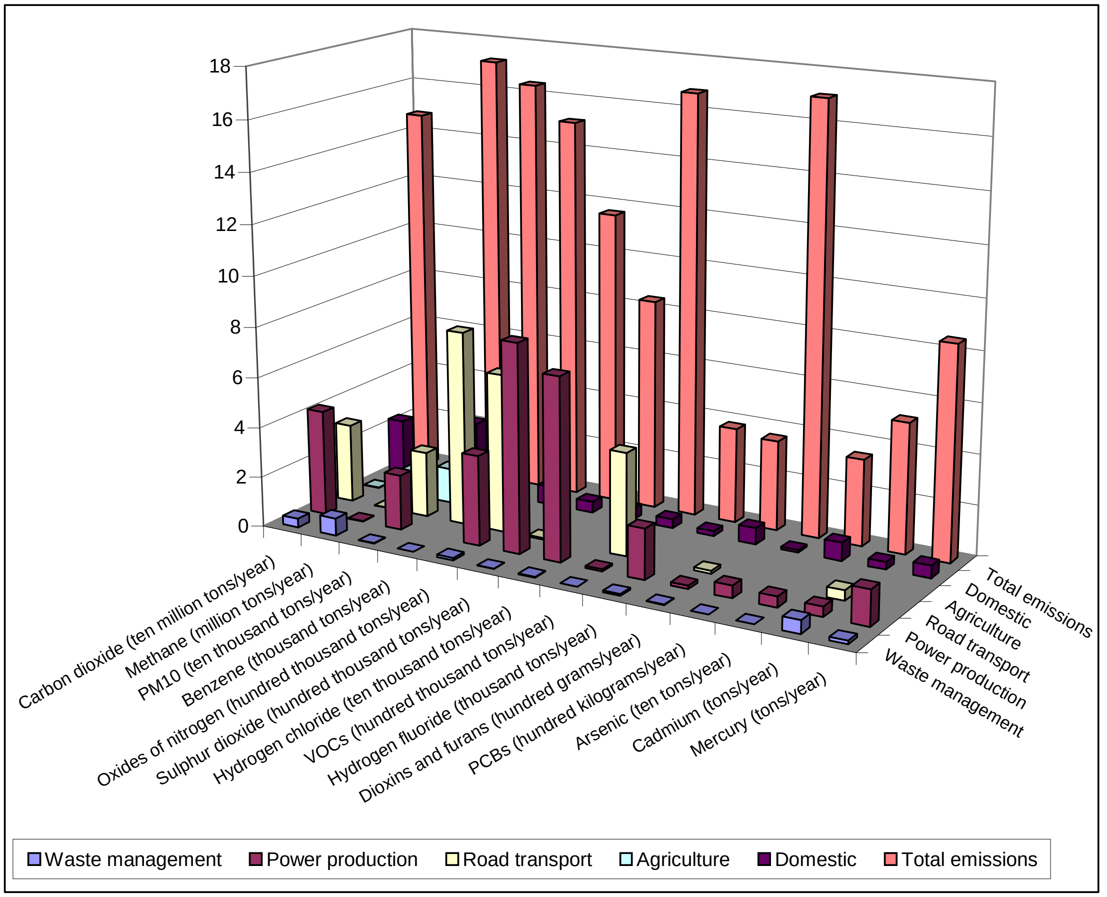

Figure 8.4 : Comparison of emissions to air from management of municipal solid waste with other sources

Waste management is estimated to give rise to a small proportion of emissions to air in the UK, with two exceptions. Emissions of methane from waste, which are overwhelmingly landfill methane, are estimated to account for around 22% of UK total methane emissions, and 27% of England's total methane emissions[70]. Emissions of cadmium are estimated to account for around 10% of UK total emissions, mostly from combustion of landfill gas.

Emissions of dioxins and furans from waste management have become of particular concern. As noted above, emissions have fallen substantially in recent years to the point where emissions from municipal solid waste incineration are no longer a

[69] http://www.naei.org.uk/
[70] See the GHG 2003 Inventory for England at www.naei.org.uk/ and also http://www.defra.gov.uk/environment/statistics/globatmos/download/xls/gatb06.xls

significant source of dioxins and furans in the UK. Estimated emissions of dioxins and furans from management of MSW account for about 1% of the UK total, shared approximately equally between incineration and landfill gas combustion. A number of sources contribute to emissions of dioxins and furans to a similar or greater extent: accidental vehicle fires; small scale waste burning (e.g. on building sites); incineration of other wastes; and the iron and steel industry. However, the most significant sources of dioxins and furans are domestic emissions and fireworks, both of which account for about a sixth of total emissions, although these estimates are subject to considerable uncertainty.

This trend has been driven by the introduction of control measures, with new designs of incinerator plant resulting in significantly lower levels of PCDD/F emissions. The Waste Incineration Directive (Directive 2000/76/EC) sets out requirements which relate (amongst other provisions) to:

- operating conditions, including gas temperatures and residence times, such as 850ºC / 2 seconds for most wastes, and 1100ºC / 2 seconds for hazardous wastes with a chlorine content greater than 1%,
- emission limit values for a range of substance to air and water including dioxins,
- emission monitoring requirements, and,
- derogations that will be available.

There have also been substantial reductions in emissions of metals from incineration plant, again driven by the requirements of the Waste Incineration Directive. For example, emissions of mercury from waste incineration have fallen from 7.1 to 1.5 tonnes per year between 1990 and 2003. Waste incineration now accounts for about 20% of total UK emissions of mercury, which have declined by 80% since 1990 (mainly due to reductions in emissions from fuel combustion as well as the reduction in emissions from waste incineration).

9 Climate change impacts

9.1 Trends in atmospheric emissions

The basket of greenhouse gases

UK trends show a decline of almost 13% in the "basket" of six key greenhouse gases[71] over the period 1990 to 2004 (see Figure 9.1). Total UK emissions of these gases fell from 209 million tonnes carbon equivalent (MTCE) to 183 MTCE (provisional figure). Of the latter figure, carbon dioxide was by far the largest contributor of the basket of gases at 158 MTCE[72]. The fall in carbon dioxide (CO_2) emissions is one of the main reasons for the overall decline over the 13 year period. Methane (CH_4) and nitrous oxide (N_2O) levels fell by almost 50% and 40% respectively over this period. Methane is by far the largest contributor to waste sector emissions. These trends, and the waste sector contribution to them, are described below.

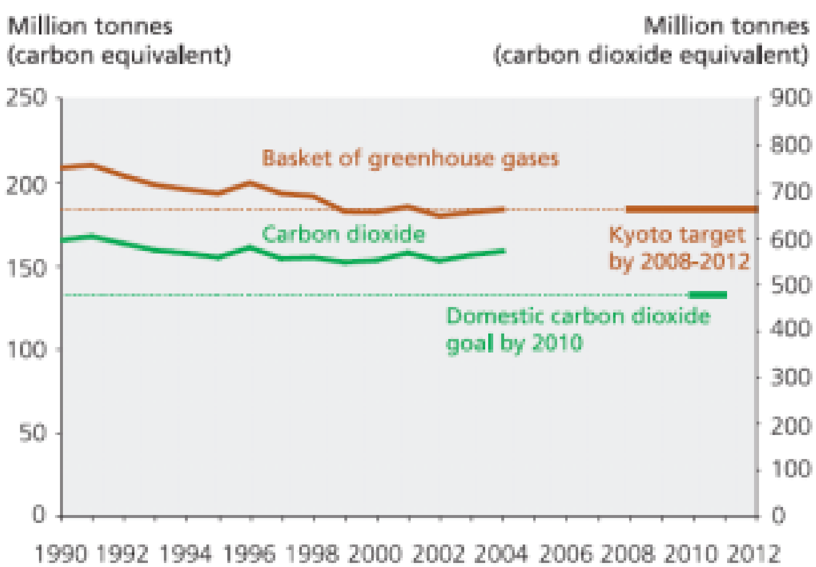

Figure 9.1: Trends in UK emissions of greenhouse gases 1990 – 2004

[DEFRA/DTI[73]]

Figure 9.2 shows the contribution of the sectors which are the principal sources of the basket of gases. The waste sector is a relatively small and declining contributor with the energy sector (including power generation and fuel consumption) accounting for 85% of total emissions in 2003.

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71 Carbon dioxide, methane, nitrous oxides, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.
72 http://www.defra.gov.uk/environment/statistics/eiyp/pdf/eiyp2005.pdf (pp.19)
73 Ibid.

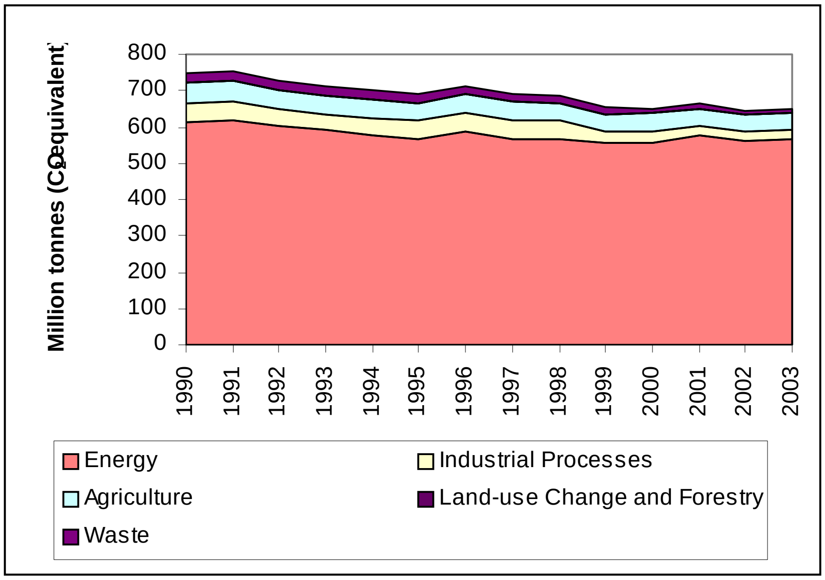

Figure 9.2: Trends in UK emissions of greenhouse gases by sector (million tones carbon dioxide equivalent) [AEA Technology[74]]

UK waste sector emissions have steadily declined over this period, to the extent that emissions in 2003 are estimated to have been 40% of those in 1990. Emissions fell from 7.6 MTCE in 1990 to 3.0 MTCE equivalent in 2003. Methane emissions accounted for approximately 80% of the 2003 total with the rest from carbon dioxide and nitrous oxide, and small amounts of chlorofluorocarbons[75]. The contribution from waste management to UK total greenhouse gas emissions fell from around 5% in 1990 to less than 2% in 2003[76].

This reduction has arisen primarily because of reductions in emissions to air of methane from landfill sites. Methane is a potent greenhouse gas, with a global warming potential over a hundred year timescale some 21 times higher than carbon dioxide. The improved collection and combustion of landfill gas which contains about 50% – 60% methane[77] has resulted in a substantial reduction in the impact of this source on emissions of substances with global warming potential from the waste management sector.

Carbon dioxide emissions

Most of the UK 'basket' of six greenhouse gases is due to emissions of carbon dioxide (86% of the total in 2003). The primary contributors are transport, industry and domestic users, in approximately equal measure. The reported emissions of carbon dioxide from waste have been declining. They fell from 0.6 MTCE in 1990 to

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[74] Baggott SL, et.al., UK Greenhouse Gas Inventory, 1990 to 2003 – Annual report for submission under the Framework Convention on Climate Change, AEA Technology, April 2005, extracted from Figure ES3. Note that this figure excludes the forecast removal of carbon through vegetation fixation, which reduces the contribution of the land use and forestry sector. This applies also to Figure 9.3. See http://www.airquality.co.uk/archive/reports/cat07/0509161559_ukghgi_90-03_Issue_1.1.doc.

[75] Ibid. Table ES3 shows total GHG emissions for waste sector.

[76] See page xiii of the NAEI at http://www.airquality.co.uk/archive/reports/cat07/0509161559_ukghgi_90-03_Issue_1.1.doc

[77] See page 171 of *Planning for Waste Management Facilities: A Research study* by Enviros for ODPM, http://www.odpm.gov.uk/pub/713/PlanningforWasteManagementFacilitiesaresearchstudyPDF1908Kb_id1145713.pdf

about 0.3 MTCE by 2003.[78] These figures exclude CO_2 emissions from MSW incineration: including these gives a total estimated emission in 2003 of 0.5 MTCE.[79] The waste sector remains a very small contributor to total UK CO_2 emissions, accounting for about 0.3% in 2003.

The main source of emissions to air of carbon dioxide from waste management is landfill gas – carbon dioxide accounts for up to half of the volume of landfill gas. This may be increased as landfill gas is burned, converting methane to carbon dioxide.

Waste management processes which generate electricity will result in an offset to direct carbon dioxide emissions due to the avoidance of generation of electricity from fossil fuels. This may result in a net overall benefit in reduced carbon dioxide emissions. Emissions during the transportation of waste during collection, treatment and disposal are accounted for separately. Emissions from waste transportation are estimated to account for only a minor proportion of emissions from waste management (see Table 8.1).

Methane emissions

Overall UK emissions have fallen by 48% between 1990 and 2003, due primarily to significant reductions in methane emissions from landfill and coal mining[80]

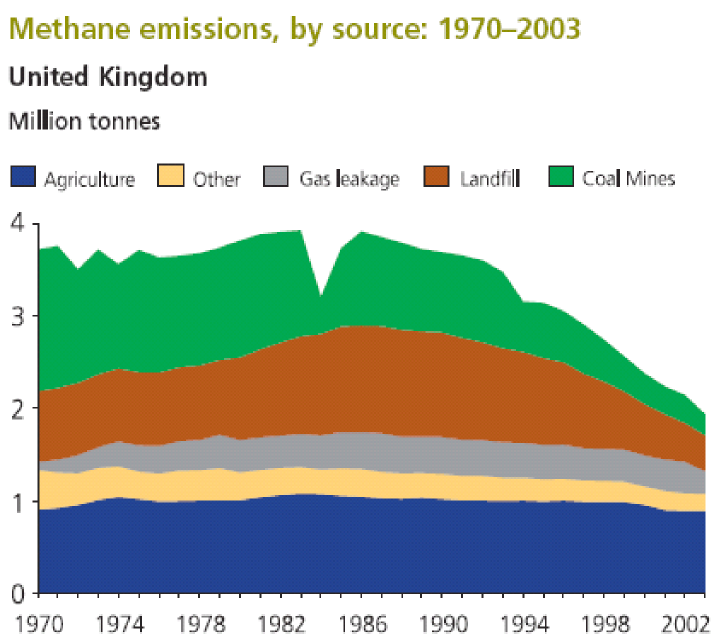

Figure 9.3: Trend in methane emissions by sector [DEFRA/DTI]

[78] See http://www.defra.gov.uk/environment/statistics/globatmos/download/xls/gatb05.xls and also http://www.defra.gov.uk/environment/statistics/globatmos/download/xls/gatb03.xls.
[79] Personal communication from NETCEN which equates to a slight amendment to the sources quoted in the footnote above.
[80] See Executive Summary of the UK Greenhouse Gas Inventory, 1990 to 2003 – Annual report for submission under the Framework Convention on Climate Change, AEA Technology, April 2005, Baggott SL et al vailable at http://www.airquality.co.uk/archive/reports/cat07/_Toc115012975

Emissions of methane from waste, which are overwhelmingly landfill methane, were estimated to account for around 22% of UK total emissions in 2003, and 27% of England's total emissions[81].

The methane emissions from the waste sector were estimated to be 422,000 tonnes in 2003. Landfill gas accounts for nearly all (91%). However, emissions from landfill gas have fallen substantially from 1990 (see Figure 9.3), when this was the largest single source of methane emissions in the UK. Estimated methane emissions from landfill have declined from 1.1 m tonnes per year in 1990 to 552,000 tonnes per year in 2000 and 384,000 tonnes per year in 2003[82]. As noted above, this reduction is due to increased landfill gas collection and combustion[83].

Emissions from home composting and poorly run composting operations may also be significant.

The relatively high global warming potential of methane means that total waste sector emissions in 2003 were equivalent to 2.4 MTCE.

Nitrous oxide emissions

This is the third of the principal components of the greenhouse gas basket. Waste sector emissions have risen by 18% from 3500 tonnes in 1990 to 4100 tonnes in 2003, just over 3% of all emissions of nitrous oxide[84]. Taking account of the global warming potential of nitrous oxide of 310, this is equivalent to 0.35 MTCE. These figures are included within those cited for the waste sector in 9.1 above. Waste water treatment accounts for almost all the UK total of nitrous oxide emissions (consistently around 96%).

Other greenhouse gases

Emissions of other substances make a minor contribution to overall UK emissions of greenhouse gases. No estimates are available for the waste management contribution to emissions of these other substances, but any contribution is unlikely to be significant in the context of UK emissions of global warming gases.

9.2 Contributing to reducing climate change impacts

Resource efficiency

The main contribution of waste management policy on climate change will be through increased resource efficiency and energy savings through waste prevention and recycling. This will have concomitant benefits through longer term reductions in landfill gas emissions. The waste prevention and recycling benefits have been

[81] See the GHG 2003 Inventory for England at www.naei.org.uk/ and also http://www.defra.gov.uk/environment/statistics/globatmos/download/xls/gatb06.xls
[82] See http://www.naei.org.uk/emissions/emissions_2003/summary_tables.php?action=unece&page_name=CH403.html
[83] See p 7 of UK Greenhouse Gas Inventory 1990-2003: http://www.airquality.co.uk/archive/reports/cat07/_Toc115012975
[84] Source: http://www.defra.gov.uk/environment/statistics/globatmos/download/xls/gatb07.xls.

studied in a separate report[85] which provides the basis for the analysis of climate change impacts in the Environmental Report.

Energy generation from waste

The UK has a sustainable development target of generating 10% of its electricity needs from renewable sources by 2010. Figure 9.5 shows growth of almost 64% over the period 1998-2004, with the most recent total representing 3.6% of all electricity consumption.

The waste sector has made the principal contribution, primarily from energy recovery from landfill gas. The contribution from landfill gas rose from 1,185 in 1998 to 4,004 in 2004. The contribution from municipal solid waste combustion (of which only the biodegradable fraction is reported and included within the above figures) rose slightly over the period from 849GWh to 971GWh, while that from sludge digestion fell slightly.

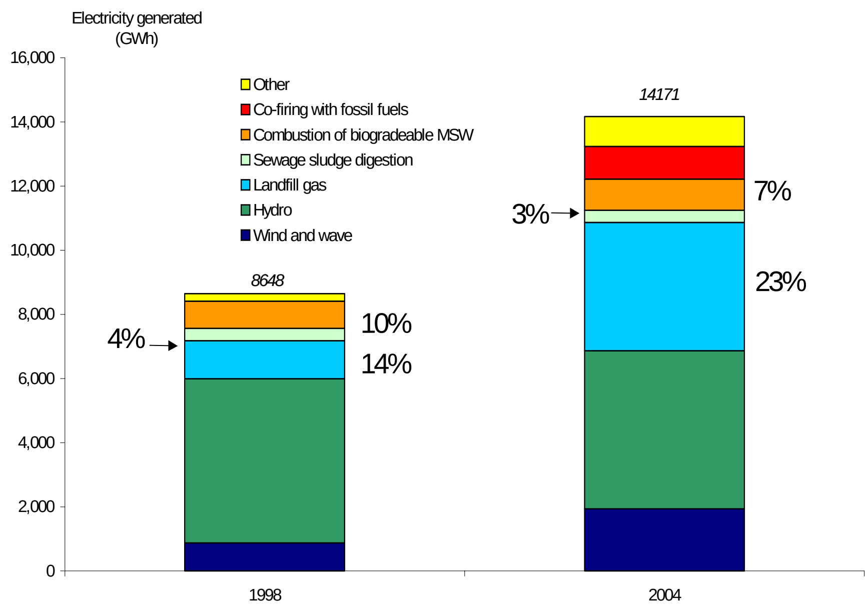

Figure 9.4: Growth in power generated from renewable and secondary sources [DEFRA[86]]

[85] ERM (2006) *Impact of Energy from Waste and Recycling Policy on UK Greenhouse Gas Emissions*. Report for Defra.
[86] Source: http://www.defra.gov.uk/environment/statistics/supp/spkf19.htm.

10 Human health

Enviros Consulting and Birmingham University published the results of an extensive study of the potential health-related impacts of waste management activities in 2004[87] (hereafter referred to as the 'Enviros Study'). An extended summary of the findings, including documentary sources, is provided in Appendix B.

The principal conclusion of the Enviros Study was that the probable impacts of emissions from waste management on human health are very small in comparison to other common hazards to health. In certain instances research has identified health problems in the proximity of waste management facilities, but it has not been possible to determine whether these resulted from wastes being treated, or other causal factors evident locally, illustrating the difficulty of identifying such impacts conclusively. This situation also highlights the limited number of such research studies, and the Enviros Study highlights the paucity of data on certain impacts such as emissions from composting.

The sections below can provide only a concise summary of data on a technically complex issue, and in a number of references are indicated as examples of relevant studies. More detailed information and a fuller set of references are presented in Appendix B, which is a summary of the material presented in the Enviros Study referenced above.

10.1 Potential impacts of landfill sites

Compared to other treatment facilities, many epidemiological studies have been carried out to investigate the health effects of landfill sites[88]. Recent research has investigated the occurrence of birth defects in infants born to families living near landfill sites in the UK[89]. The study showed that people living within 2 km of a landfill site in the UK experienced slightly higher rates of several birth defects than people living further away. The research revealed a small but statistically significant risk for those living close to these sites, especially where these handle special wastes, although for certain conditions the risks were slightly higher around sites handling other wastes. It also investigated incidence of certain cancers and found "no excess risks" associated with living within 2km of such a facility. The data do not, however, allow a conclusion to be reached that the increases in birth defects are caused by landfills or result from another confounding factor. In 2001, the Government's expert advisory Committee on the Toxicity of Chemicals in Food, Consumer Products and the Environment[90] considered that "*… it is inappropriate to draw firm conclusions on the possible health effects of landfill sites from the results of this study*".

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[87] See footnote 63 above.
[88] Redfearn, A. and Roberts, D. (2002). Health Effects and Landfill Sites. In. Environmental and Health Impact of Solid Waste Management Activities. Issues in Environmental Science and Technology 18, Eds: R. E. Hester and R. M. Harrison. Cambridge, Royal Society of Chemistry 103-140.
[89] Elliott, P., Briggs, D., Morris, S., de Hoogh, C., Hurt, C., Jensen, T. K., Maitland, I., Richardson, S., Wakefield, J. and Jarup, L. (2001). Risk of adverse birth outcomes in populations living near landfill sites, BMJ. 323(7309), 363-368.
[90] Small Area Health Statistics Unit on health outcomes in populations living around landfill sites (COT/2001/04). Available at: http://www.advisorybodies.doh.gov.uk/landfill.htm.

10.2 Potential impacts of materials recycling facilities

A limited number of studies to date have been carried out in the workplace at materials recycling facilities[91]. One of these has indicated that flu-like diseases, eye and skin problems, tiredness and sickness are higher in the workers than would be expected in other comparable groups, attributing this to the release of biological materials, particularly bioaerosols[92]. The Enviros Study did not identify studies of health effects in people living near MRFs.

10.3 Potential impacts of composting facilities

Various studies have been conducted to investigate the potential health risks associated with these plants both on residents in surrounding areas and on those working in them. One study provides clearer evidence to the latter[93], but the risks to residents have proved difficult to quantify. In one instance no demonstrable effect was found[94], while another study identified increases in respiratory symptoms which appeared to be the result of other factors, and no indication of increases in allergies or asthma symptoms[95]. However one study has identified a "significantly elevated risk" of complaints including bronchitis, colds and eye irritation[96].

It should also be noted these studies have largely focused on health impacts associated with bioaerosols. The Enviros Study notes there is a need for further work to understand the effects of emissions from composting, including more research into bioaerosols and with additional focus on the effects of particulate matter and VOCs.

10.4 Potential impacts of incinerators

A number of studies have investigated how many cancer cases occur close to incinerators[97, 98, 99], and in the UK these have focused on residents living close to older generation facilities which were updated or have been closed subsequently as a result of implementation of the Waste Incineration Directive. These have considered cancers of the stomach, colorectal, liver, lung, larynx and non-Hodgkins

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91 Gladding, T. (2002). Health Risks of Materials Recycling Facilities. In. Environmental and Health Impact of Solid Waste Management Activities. Issues in Environmental Science and Technology 18, Eds: R. E. Hester and R. M. Harrison. Cambridge, Royal Society of Chemistry 53-72.

92 Marth, E., Reinthaler, F. F., Haas, D., Eibel, U., Feierl, G., Wendelin, I., Jelovcan, S. and Barth, S. (1999). Waste management--health: a longitudinal study, Schriftenr Ver Wasser Boden Lufthyg. 104, 569-83.

93 Wheeler, P. A., Stewart, I., Dumitrean, P. and Donovan, B. (2001) Health Effects of Composting, R & D Technical Report P1-315/TR. Environment Agency, Bristol, UK

94 Cobb, N., Sullivan, P. and Etzel, R. (1995). J. Agromed. 2, 12-25.

95 Browne, M. L., Ju, C. L., Recer, G. M., Kallenbach, L. R., Melius, J. M. and Horn, E. G. (2001). Compost Sci. Util. 9, 242-249.

96 Herr, C. E. W., zur Nieden, A., Jankofsky, M., Stilianakis, N. I., Boedeker, R.-H. and Eikmann, T. F. (2003). Effects of bioaerosol polluted outdoor air on airways of residents: a cross sectional study, Occup. Environ. Med., 60, 336-342.

97 Gatrell, A. C. and Lovett, A. A. - (1992) Burning Questions: Incineration of Wastes and Implications for Human Health, (Research Report No.8). North West Regional Research Laboratory, Lancaster University, Lancaster, UK.

98 Knox, E. G. and Gilman, E. A. (1995). Hazard proximities of childhood cancers, J Epidemiol Community Health. 51, 151-159.

99 Knox, E. (2000). Childhood cancers, birthplaces, incinerators and landfill sites, International J. Epidemiol. 29(3), 391-397.

lymphoma[100], birth effects (prevalence of twins and female births)[101], while effects on respiratory and cardiovascular conditions have also been investigated[102].

The Enviros Study suggests there is no consistent published evidence of a link between exposure to emissions from incinerators and an increased rate of cancer. Where apparently significant effects have been observed, these are often in relation to incinerators close to other sources of potentially hazardous emissions, which makes it much harder to pin down the source of any effect. In 2000, the Government's independent expert advisory Committee on the Carcinogenicity of Chemicals in Food, Consumer Products and the Environment[103] concluded that "*any potential risk of cancer due to residency (for periods in excess of ten years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern techniques*".

In the UK, the Enviros Study notes that emissions of dioxins per tonne of MSW have decreased by 99.8% over the past 20 years. This change has been driven primarily by a series of stringent controls on emissions and which reflect obligations under EU Directives, in particular the Waste Incineration Directive[104]. In some cases these controls resulted in improvements to abatement plant fitted to incinerators, while some sites were shut down.

10.5 Potential impacts of other waste treatment facilities

Studies looking at emissions from other facilities have not found evidence of health effects linked to the emissions.

10.6 Research priorities

The Enviros Study highlights the limitations on the available research, both in terms of the range of studies on a full range of waste treatment facilities, and the ability to determine conclusively the cause of health impacts. Limitations also arise because:

- Research has tended to focus on technologies most likely to be situated close to inhabited areas, and this leads to a shortage of detailed work on the impacts of composting sites, as noted in section 10.3;
- Research has also focused on the types of waste facility which generate greatest public concern, specifically landfill and incineration.
- Research has inevitably focused on the most widely deployed existing technology, and therefore relatively little work has been done to date in the UK on recently-introduced techniques such as MBT, anaerobic digestion and gasification.

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[100] Elliott, P., Shaddick, G., Kleinschmidt, I., Jolley, D., Walls, P., Beresford, J. and Grundy, C. (1996). Cancer incidence near municipal solid waste incinerators in Great Britain., Br. J. Cancer. 73, 702-710.
[101] Lloyd, O. M., Lloyd, M. M., Williams, F. L. R. and Lawson, A. (1988). Twinning in human populations and cattle exposed to air pollution from incinerators, Br J Ind Med. 45, 556-560.
[102] Lee, J. T. and Shy, C. M. (1999). Respiratory function as measured by peak expiratory flow rate and PM10: six communities study, J Expo Anal Environ Epidemiol. 9(4), 293-9.
[103] Committee on Carcinogenicity (2000), *Cancer incidence near municipal solid waste incineration in Great Britain*. Statement COC/00/S1/001, Department of Health.
[104] See: http://europa.eu.int/comm/environment/wasteinc/newdir/2000-76_en.pdf.

It is also important to recognise that the scope of the Enviros Study was restricted in other ways:

- Evaluation of recycling impacts was not included due to the wide range of recovery processes used for different materials within the same waste stream. This implies that any research undertaken to date may not have findings relevant to recycling facilities generically, and the scale of increase in these facilities which is needed to meet continuing growth in targets suggest this is a potential priority for further research.

- The Enviros Study focuses on MSW and it is not evident at this time whether other research has been done on the effects of treatment and disposal of C&I wastes.

- The nature of the effects reported reflects the focus of existing research on emissions to air. There is a need to understand potential impacts to water, and the long-term efficacy of landfill linings in preventing contamination of groundwater resources has been identified as a specific priority.

Environment and health (risk assessment and impact management) is one of the research themes of Defra's Waste R&D strategy, launched in 2004[105]. This provides a mechanism to co-ordinate further research on the impacts of these technologies. In particular, part of the budget has been allocated to address the key data gaps that exist for emerging technologies such as recycling operations, mechanical biological treatment (MBT), anaerobic digestion and composting, as identified in the Enviros Study. See further section 8 of the Environmental Report.

[105] See: http://www.defra.gov.uk/environment/waste/wip/research/pdf/rdstrategy.pdf

11 Waste crime

The principal environmental impact considered here is the illegal and unlicensed disposal of waste materials ('fly-tipping'). Material in other sections of this baseline report addresses incidents where emissions and the release of pollutants is either unlicensed or exceeds permitted levels.

11.1 Trends in fly-tipping from the Flycapture database

The primary source of data on fly-tipping is the Flycapture database, a national record of fly-tipping incidents set up by Defra and the Environment Agency[106]. It combines information collected by both local authorities and the Environment Agency. Fly-tipping dealt with by organisations such as the National Trust, farmers, Forestry Commission are not recorded.

All local authorities are required to submit returns under the Anti-Social Behaviour Act 2003. The data for 2004/05 is the first full year of returns but is not fully complete because only 90% of authorities submitted a return. Subsequent years are expected to be more robust.

Summary data from the database states that 76,260 fly tipping incidents per month were reported in England during 2004/05.

The local authorities reported 915,119 incidents during this period. The majority of these incidents related to clearing black bags or other household waste types. The highest incidence of fly-tipping was in London, with the South West region reporting the least. A regional breakdown by government office is given in Figure 12.1. It cost the local authorities £44 million to clear the incidents reported to them, equivalent to £3.6 million per month. Once the clearance costs to private landowners and enforcing authorities' investigation, prosecution and enforcement costs are included, the real costs could be as high as £100 million a year[107].

[106] Environment Agency, 2005, https://www.environment-agency.gov.uk/apps/flycapture/ (note that this database cannot be accessed directly without prior registration with the Environment Agency).
[107] See Chapter 7 of the Consultation Document at: www.defra.gov.uk/environment/waste/strategy/review/

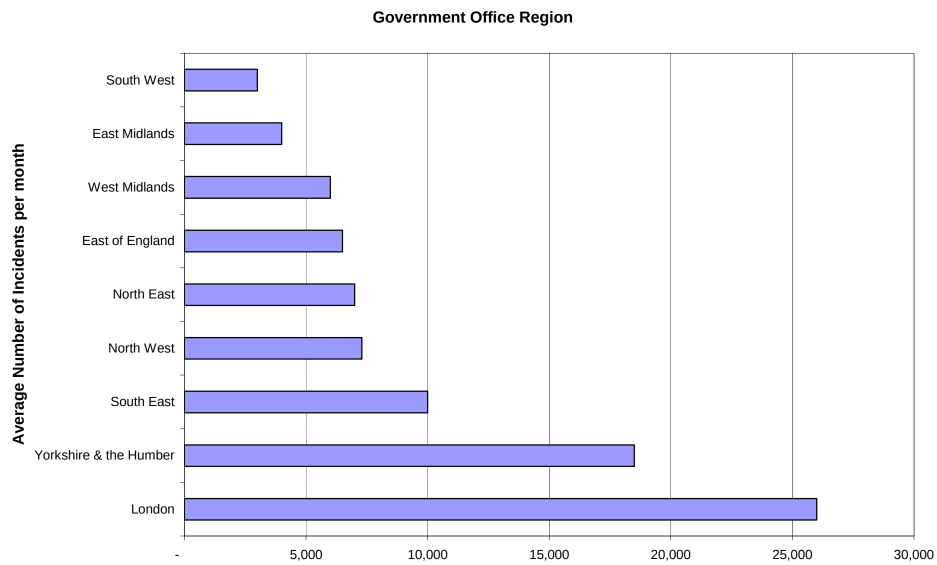

Figure 11.1: Fly-tipping incidents by government region recorded by local authorities in the Flycapture database.

The Environment Agency reported a total of 4,325 incidents in England during the same period (2004/05). Clearing these incidents cost £600,000, approximately £50,000 per month. Approximately 20% of these incidents were related to clearing construction and demolition waste and 25% was associated with waste from households. A regional breakdown of Environment Agency incidents is given in Figure 12.2.

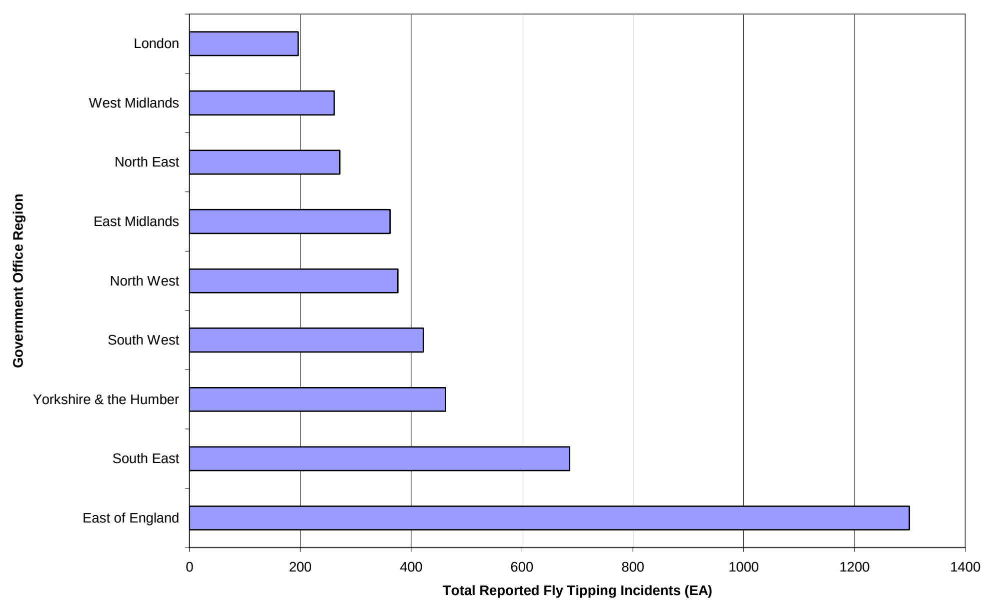

Figure 11.2 Fly-tipping incidents by government region recorded by the Environment Agency in the Flycapture database.

11.2 Trends prior to the Flycapture database

Encams conducted a study[108] on fly-tipping in 2003 which contains data for 2001/02 (pre-dating Flycapture). The study was carried out to provide up to date information on fly-tipping from a landowners' perspective. An assessment of trends was made with reference to a similar Encams study conducted in 1998. All local authorities were surveyed. Other organisations such as the British Waterways, National Trust and Railtrack were also included in the survey.

According to the Encams study 73% of authorities felt that fly-tipping was a 'significant' or 'major problem'. The cost of fly-tipping has increased significantly since 1998. The number of authorities spending over £40,000 per year has increase from 8% in 1998 to 32% in 2001/02.

In terms of the number of complaints, 62% of authorities received complaints for up to 500 incidences of fly-tipping, 5% received complaints relating to over 2,000 incidences. On average, local authorities collect fly-tipped waste around 850 times per year. 18% of authorities collect fly-tipped waste more than 1000 times per year. Abandoned vehicles, small domestic waste and bulky waste were the most common types of waste collected.

The key conclusion from the Encams study is that, since the last survey in 1998, fly-tipping is an issue which has increased significantly. There has been an increase in the amount of money spent in clean-up and the overall number of complaints relating to fly-tipping. Local Authorities are also doing more to tackle the fly-tipping issue through education, enforcement, restricting public access to 'hot spots' for dumping waste and other measures.

11.3 Significance of the Issue

The available data suggests that fly-tipping is a major issue for both local authorities and the Environment Agency and one that is putting increasing pressure on their resources, both in terms of clean-up and disposal costs and manpower. Defra has also recently commissioned the Jill Dando Institute of Crime Science, part of University College London, to conduct a research project that will explore the causes and incentives for fly-tipping. This will result in a good practice guide for local authorities in 2006 on how best to prevent fly-tipping. The study will be published in April 2006. Early indications from the research show a strong link between the type and quality of local waste service provision and levels of fly-tipping. The Clean Neighbourhoods and Environment Act 2005 included measures to raise the maximum penalties for the main offence for illegal waste disposal. Fly-tipping of any kind is now an arrestable offence[109].

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[108] See: http://www.encams.org/uploads/publications/Flytipping2003.pdf
[109] See Chapter 7 of the Consultation Document at: www.defra.gov.uk/environment/waste/strategy/review/

12 Summary: the apparent impact of waste on the environment

This section summarises the principal issues and conclusions identified in assembling the baseline, providing an overview of the extent to which waste management activities affect the wider UK environment based on the available evidence. This summary cannot consider more localised impacts, which are nevertheless captured in summary statistics such as those on pollution incidents.

Biodiversity, flora & fauna

The impacts of waste infrastructure are expected to be localised around new sites. The planning system provides a hierarchy of controls which prioritise conservation at sensitive sites and within zones around them to mitigate such impacts.

Actual and potential risks are not currently measured at a national level on a systematic basis, however the SEA proposes possible indicators (subject to discussions and agreement between stakeholders) which might assist in monitoring and controlling impacts during the development and operation of new facilities.

Landscape character

The nature of waste and its treatment means there is a range of physical and aesthetic impacts (visual intrusion, odour, increased traffic, etc.) which will result from new infrastructure located in rural areas, especially those noted for the quality of their landscape. Impacts will vary according to the type of waste facility and some, such as composting plants, may intrude less than others which have an emissions stack. Although impacts will be localised, the open aspect of rural areas can lead to visual intrusion over greater distances.

These impacts can be mitigated to some degree with good design, however the primary control remains existing legislation to protect landscape designations, and the planning controls which limit or mitigate development in proportion to the quality of the landscape asset.

Again these impacts are not measured nationally and on a systematic basis at present, however this SEA proposes a possible new monitoring indicator for this purpose.

Culture and heritage

The situation is largely the same as for landscape assets, although heritage sites cover less area and therefore any potential impacts from waste management are more localised. Again, the level of impacts is not currently measured nationally on a systematic basis; while the legislative regime and planning controls provide a mechanism for protecting sites from inappropriate development nearby and for preventing physical impacts and those which impair the setting of the site.

Water quality

The Environment Agency monitors all pollution incidents, and the most recent data for 2004 shows that waste management accounted for only 3% of the most serious events; this figure has declined slightly from the level when *WS2000* was published.

While there is a lower proportion of serious water contamination incidents than to other media, continuing risks to surface and groundwater need to be taken into account when assessing requirements for and location of new sites. The existing PPC regime remains the principal technical control to limit these risks, supported by parallel planning controls which treat impact on water resources as a material consideration in assessing development.

Although the nature and number of incidents is recorded, there is an acknowledged need for further research to assess the long-term effects of waste management activities on water resources, particularly in terms of materials leached from landfill sites.

Soil resource & land contamination

Waste related activities currently account for around a quarter of all serious land pollution incidents based on monitoring conducted by the Environment Agency. Although the number of incidents has fallen since 2000, current levels suggest that enforcement is essential to reduce the rate further and to deal any expansion of the waste management infrastructure. The most recent evidence suggests incidents are most common at waste transfer stations and metal recycling plants.

The land taken for landfill is recorded nationally, but that taken by other sites (including waste transfer stations, incinerators and treatment facilities) cannot be identified separately at present. Any expansion of waste infrastructure as a result of the review will be mitigated by adhering to current planning guidance which prioritises the use of previously developed land, and co-location of facilities with existing waste sites and other industrial land uses where feasible.

Air quality

All waste management operations will have some impact on local air quality, whether through transport impacts, fugitive emissions or process releases. These impacts generally diminish rapidly with distance from the site. In particular, significant releases of dust and odour can arise from composting operations and waste handling.

Waste management activities account for almost half of the serious air pollution incidents reported in 2004 as recorded by the Environment Agency. The predominant pollutant in these cases was landfill odour, although other effects evident at several types of site included chemical odours and smoke. Half of all the events occurred at landfill sites, and where the principal cause (82% of incidents) was landfill gas, chemical odour and other fumes.

Contribution to ozone, CFCs and nitrous oxides are small, but may have local impact. At the wider scale it is not possible to separate any contribution to background levels from other sources.

Estimated emissions of dioxins and furans from management of MSW account for about 1% of the UK total, shared approximately between incineration and landfill gas combustion. Generation of dioxins linked to thermal treatment of waste has fallen significantly over the last 10 years with the introduction of control measures and new designs to limit emissions[110].

Emissions of mercury from waste activities have also fallen markedly as a result of improved control measures in thermal treatment processes, from 7.1 to 1.5 tonnes per year between 1990 and 2003. Waste incineration now accounts for about 20% of total UK emissions of mercury.

Climatic factors

Waste sector emissions of all greenhouse gases in 2003 are estimated to have been 40% of those in 1990. The contribution from waste management to UK total greenhouse gas emissions have fallen from around 5% in 1990 to less than 2% in 2003.

Methane is the most important of the greenhouse gases, and its emissions have been cut by around two-thirds since 1990 and continue to fall with increased deployment of capture technology. However emissions are nearly half a million tonnes per annum, and approximately 22% of total UK methane emissions, giving scope for further reductions by capture and diversion from landfill.

The sector currently contributes around a third of the UK's electricity generated by renewable, alternative and secondary sources, most of which is derived from landfill gas.

Waste activities make a very small contribution to UK CO_2 emissions (about 0.3%). However, increased resource efficiency and energy savings through waste prevention and recycling can make significant contributions to reducing climate change burdens throughout product lifecycles. This will have concomitant benefits through longer term reductions in landfill gas emissions. The waste prevention and recycling benefits have been studied in a separate report[111] which provides the basis for the analysis of climate change impacts in the Environmental Report.

Human health impacts

A range of research studies have concluded that there is no conclusive evidence suggesting increased risk of respiratory conditions, birth defects, cancers and other health problems in those living in close proximity to landfill sites. Some empirical evidence suggests higher incidence of skin, eye and other conditions among those working at Materials Recovery Facilities, but currently there are no studies of the impact on those living nearby.

Similar conclusions have been reached from studies of the effects of large-scale composting facilities, and additional research has not revealed any indication of an increased risk in cancers or asthma.

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[110] Defra (2004), *Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes*, (report prepared by Enviros Consulting and the University of Birmingham), p.254.

[111] ERM (2006) *Impact of Energy from Waste and Recycling Policy on UK Greenhouse Gas Emissions*. Report for Defra.

There is no consistent evidence of a link between incineration and an increased risk of cancer and similar health problems, or to respiratory conditions[112]. A government-appointed committee has concluded that any potential risks resulted from prolonged residency near a MSW incinerator is extremely low and may be difficult to measure even with the most current techniques. There is also little evidence of respiratory problems linked to incinerators.

Most of the research to date has focused on older incinerators which were built before stricter emission controls were imposed in the late 1990s as a result of the Waste Incineration Directive and its transposition into UK law which had the specific aim of reducing emissions of potentially harmful materials and other particulate matter. These older facilities were either upgraded to meet the required standards, or closed down. Newer facilities, including those which may result from the review of waste strategy, will be built to meet the current standards.

A major study[113] of the potential health effects of treating and disposing MSW has concluded that the probable impacts of the emission of key pollutants is very small, compared to other potential hazards, and that in some instances health problems might be reasonably attributed to other local causes.

There is little evidence currently of impacts associated with other waste management facilities, although there is a clear requirement for further research, such as in relation to emissions to air and water from composting.

Waste crime

In 2004/05 there were reported in England almost 80,000 fly-tipping incidents costing £4m to remediate each month. There are regional variations with London and the South East, Yorkshire and Humberside faring worst.

Almost half of the incidents involved illegal disposal of household wastes. A quarter of incidents involved small-scale domestic waste, and a further 20% involved construction rubble.

Research conducted since the last survey of fly-tipping in 1998 suggests the problem has worsened in the intervening period. A monitoring system now exists in the form of the Environment Agency's *Flycapture* database. The Clean Neighbourhoods and Environment Act 2005 included measures to raise the maximum penalties for the main offence for illegal waste disposal. Fly-tipping of any kind is now an arrestable offence.

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[112] Where apparently significant effects have been observed, these were often in relation to incinerators close to other sources of potentially hazardous emissions.
[113] Enviros, University of Birmingham, Defra (2004), *Review of the Environment and Health Impacts of Waste: Municipal Solid Waste and Similar Wastes.*

APPENDIX A: REVIEW OF AIR QUALITY ISSUES ASSOCIATED WITH WASTE MANAGEMENT TECHNOLOGIES

Materials Recovery Facilities

Emissions from the plant are likely to be primarily fugitive emissions to air from waste handling and sorting. The key aspects of controlling these emissions relate to the proper management of incoming wastes and ensuring that the storage time is minimised. Extended storage times can give rise to increased emissions of odour, and possibly microorganisms.

Normal practice is that the processing of recyclables occurs in a housed facility which may operate under negative pressure to allow the cleaning of the air emitted from the facility through the use of a bio-filter or other control mechanism.

Composting (In-vessel)

In vessel composting encompasses a wide range of techniques for the composting of organic materials in contained environments. It is suitable for a wider range of organic waste materials, than 'open' composting including food processing and catering waste. This is due to the enclosed nature of the process which can be controlled and monitored to develop a high enough temperature throughout the vessel for a sufficient amount of time to ensure the required level of pathogen kill. The use of in vessel composting is therefore likely to increase.

Gaseous emissions from in-vessel systems consist predominantly of carbon dioxide, water vapour and potentially small quantities of ammonia and some volatile organic compounds and bioaerosols (fungi, bacteria, actinomycetes, endotoxin, mycotoxins, and glucans). Particulates will also be released. Inhalation of bioaerosols can cause a range of immunological respiratory symptoms. Composting systems will also give rise to emissions of methane if aerobic conditions are not maintained.

Quantitative data on emissions from in vessel composting facilities is sparse due to the relatively new expansion into this area for municipal derived organic waste processing. Emissions to air from in-vessel systems will be affected by any systems for abatement and control of emissions. These may control emissions of microorganisms (e.g. via a liquid spray) and/or volatile organic compounds (e.g. via a carbon filter or bio-filtration system). Levels of bacteria recorded in the vicinity of the in-vessel system monitored in the EA[114] study exceeded 10^7 colony forming units per cubic metre of air (cfu/m^3) air. The greatest emissions is generally related to the unloading of the composting vessel. The most significant species of concern are gram negative bacteria, aspergillus and penicillium[115]. Swan et al[116] reviewed ambient levels in the absence of any significant bioaerosol sources and concluded

[114] Environment Agency, Life Cycle Inventory Development for Waste Management Operations: Composting and Anaerobic Digestion, R&D Project Record P1/392/4, 2000

[115] Crook B. *et al*., American Society for Testing and Materials Method E884-82, Standard Practice for Sampling Airborne Micro-organisms at Municipal Solid-Waste Processing Facilities, 2001.

[116] Swan JRM, Crook B, Gilbert EJ, Microobial Emissions from Composting Sites, Issues in Environmental Science and Technology, Vol 18, Environmental Impact of Solid Waste Management Issues, 2002

that ambient levels are about 10 to 10^6 times lower than those recorded during the handling of compost. There is clearly a wide range of variation in this data, this is partly attributable to operational environments and different procedures. The Environment Agency[117] concluded that appropriate conservative ambient levels to aim for to reduce the possibility of health effects are between 300-1000 cfu/m^3. Volatile organic carbons (VOCs) have also been measured at in-vessel system sites, including toluene, ethylbenzene, mp-xylene, o-xylene, and 2-butanone (although this may include a contribution from traffic).

Composting (Windrow)

Windrow composting comprises the aerobic processing of organic wastes placed in rows and either actively aerated or turned to promote aeration and decomposition of the material to form compost. It is a technique now confined to the green (or garden) waste element of MSW due to recent legislation on Animal By-Products. The process may be covered or take place in the open air. There is a lack of accurate measurements for emissions to air from composting processes as environmental emissions are normally fugitive in nature. Environment Agency measurements have indicated the presence of ammonia, particulates, chloride, water vapour and volatile organic compounds for composting processes. Fugitive releases of bioaerosols from windrow composting, and particularly during windrow turning, can give rise to significant air quality and health impacts, as discussed in Appendix B.

Mechanical Biological Treatment (MBT)

Mechanical Biological Treatment (or whole waste composting) is a generic term for an integration of several processes, including mechanical sorting, in-vessel composting and windrow maturation of stabilised residues. MBT systems are usually designed such that emissions are minimised through housing under negative pressure and the use of bio-filters. Due to the variation in systems it is not possible to provide indicative emissions. The fugitive emissions to air from MBT processes are likely to be similar to those from other waste processing facilities such as Materials Recovery Facilities or Windrow Composting plant.

Anaerobic Digestion with Energy Recovery

Anaerobic Digestion is the process by which mixed microbiological cultures degrade organic material in the absence of oxygen resulting in the production of gas (principally methane and carbon dioxide) together with solid and liquid residues. To provide anaerobic conditions, the vessel within which the process takes place is completely closed. Biogas is produced from the digestion process and this is usually used to heat the process and generate electricity, for example, by feeding the gas to an on-site combined heat and power (CHP) plant. Information is readily available on the composition of biogas (for example, Environment Agency[118]) however, biogas is not released direct to air under normal operating conditions. The key emissions to air are therefore those that result from the CHP plant and from any subsequent maturation of the digestate product.

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[117] Environment Agency, Health Effects of Composting A Study of three compost sites and review of past data Technical Repoprt P1-315/TR
[118] Environment Agency, Waste Pre-treatment: A review report, P1-344, 2002.

Incineration with energy recovery

Emissions from incineration have varied as new legislation and technology has been implemented. Emissions to air of dioxins and furans, PCBs and trace metals from MSW incineration have reduced considerably since 1990, largely as a result of increasingly stringent limits on emissions of these substances set in European directives (89/369/EEC; 89/429/EEC; 2000/76/EC)[119]. To meet the emission limits, incinerators now operate an air pollution control system based on the injection of materials to absorb these substances, and a filter system to remove the injected materials with the absorbed contaminants. Activated carbon powder may be injected to further absorb semi-volatile substances including mercury and dioxins and furans. The activated carbon is then trapped in bag filters, and removed as air pollution control residues for disposal, normally at a suitably licensed landfill.

Most information sources on incineration do not reference biohazards. These can arise from the storage and handling of wastes prior to combustion. Storage facilities, both pits and tipping floors, are therefore generally held under negative air pressure, with the extract air being used as furnace air which eliminates any biohazard releases.

Gasification/Pyrolysis with Energy Recovery

There is very little published data on emissions from pyrolysis and gasification systems. However, pyrolysis and gasification plant generally require wastes to be pre-treated, which may include sorting and size reduction. Emissions from these processes will be similar to those from Materials Recovery Facilities. Pyrolysis and gasification plant are subject to the same emissions legislation as waste incinerators, and therefore require comprehensive gas cleaning systems. The air emissions will therefore be similar to those from waste incinerators.

Landfill with Landfill Gas Flaring and/or Energy Recovery

The majority of MSW in England and Wales is disposed of to landfill. The Landfill (England and Wales) Regulations 2002 came into force on 15 June 2002. These regulations implement the Landfill Directive (Council Directive 1999/31/EC), which aims to prevent, or to reduce as far as possible, the negative environmental effects of landfill. The major impact of the Landfill Directive is the change of composition and mass of MSW being landfilled. Currently about 68% of MSW is biodegradable, and landfill is therefore a major contributor to the production of the potent greenhouse gas methane, when landfilled. This will progressively reduce as the Landfill Directive targets are met. This may have the effect of reducing the quantity and changing the composition of the landfill gas produced, with similar changes to leachate production.

Landfill gas (LFG) is the principal component of emissions to air from landfill sites. It is an end product of the degradation of biodegradable wastes by principally anaerobic processes once the waste has been deposited to landfill. The composition of the gas varies according to the type of waste and the phase of degradation of the waste but typically it contains a large proportion of methane (typically 60%) and carbon dioxide (typically 35%) by volume. Small amounts (around 1% in total) of a range of trace components such as organic gases or vapours are also present, a

[119] European Commission, Waste Incineration Directive 2000/76/EC, 2000, accessible at: *www.europa.eu.int*

number of which are potentially harmful to health. There are a number of ways in which landfill gases and products of combustion are released to the atmosphere. These include:

- Fugitive gas emissions from passive venting to atmosphere through purpose built vents, cracks in the capping material, or through active and uncapped areas of the site. These emissions will not experience any pre-treatment before release. Fugitive emissions may also occur via diffusion through the landfill cap. In appropriate circumstances, oxidation of the methane may occur, initially to carbon dioxide and also to biomass. Methane oxidation is widespread but difficult to assess numerically with confidence.
- Collection using a gas extraction system and subsequent burning in flares to destroy flammable constituents and reduce environmental impacts in comparison to fugitive releases.
- Collection using a gas extraction system and utilised to provide heat or power using energy recovery plant which uses the landfill gas as a flammable fuel, therefore also destroying flammable components and reducing environmental impacts.

Emissions from a site will comprise a combination of these routes. Although flaring and gas utilisation destroy flammable constituents, the destruction efficiency is not 100% and hence consideration must be given to the environmental impacts of the release and also possible releases of the resulting combustion products. The assessment of the emissions to air from landfill focuses on the release of landfill gas directly from the landfill, and combustion products and unburnt landfill gas released after flaring or energy utilisation.

There are also differences in emissions according to the combustion technology used. Landfill gas engines (i.e. equipment recovering heat and possibly power from combustion) emit a range of pollutants including CO_2, CO, nitrous and sulphurous oxides, and non-methane VOCs. Emissions vary with the efficiency of the combustion facility. It is recognised that gas engines are generally less efficient than simple flares which recover no energy, and that design of the engine will affect the level of pollutants emitted. In response to this situation the EA has published emissions standards for flaring and landfill gas engines.

APPENDIX B: REVIEW OF RECENT STUDIES OF THE IMPACT OF WASTE MANAGEMENT FACILITIES ON HUMAN HEALTH

This Appendix summarises the findings of the most recent comprehensive study on health impacts arising from waste management: Enviros, University of Birmingham, Defra (2004), *Review of the Environment and Health Impacts of Waste: Municipal Solid Waste and Similar Wastes*. The entire report can be downloaded from the Defra website[120].

Landfills

The majority of published research on the human health effects of landfill relates to landfill sites which accepted either hazardous waste or co-disposal of municipal and hazardous wastes. Redfearn and Roberts[121] have presented a detailed review of the available epidemiological literature on landfill and health. They separate the available epidemiological studies into four categories as follows:

- Single site studies of waste sites including hazardous waste sites, illegal landfills or "in-house" landfills within the curtilage of industry;
- Multi-site studies of sites including hazardous waste sites, illegal landfills or "inhouse" landfills within the curtilage of industry;
- Single site epidemiological studies of potential health effects associated with landfill including some sites accepting hazardous waste;
- Multi-site epidemiological studies of potential health effects associated with waste disposal sites, some accepting hazardous waste.

The first two groups were not included in the study as they concern sites which did not in any way parallel current UK landfill practice, and which were therefore not useful in interpretation of effects. The study identified the majority of the adverse health outcomes studied as birth defects and other pregnancy outcomes, and cancers. Many of the landfill sites studies are toxic waste sites which are known to have caused problems of one kind or another. Sites such as the Nant-y-Gwyddon landfill in Wales which initially gave concern of malodorous emissions has been the subject of a number of studies and adverse health effects remain controversial. Many of the other sites were in North America and had a long history of poorly controlled disposal of hazardous wastes.

The key study in the UK context is that by the Small Area Health Statistics Unit[122]. This was a study of adverse birth outcomes in populations living near landfill sites where the "exposed" population was defined as living within 2 km of one of 9565

[120] http://www.defra.gov.uk/environment/waste/research/health/

[121] Redfearn, A. and Roberts, D. (2002). Health Effects and Landfill Sites. In. Environmental and Health Impact of Solid Waste Management Activities. Issues in Environmental Science and Technology 18, Eds: R. E. Hester and R. M. Harrison. Cambridge, Royal Society of Chemistry 103-140.

[122] Elliott, P., Briggs, D., Morris, S., de Hoogh, C., Hurt, C., Jensen, T. K., Maitland, I., Richardson, S., Wakefield, J. and Jarup, L. (2001). Risk of adverse birth outcomes in populations living near landfill sites, BMJ. 323(7309), 363-368.

landfill sites operational at some time between 1982 and 1997, when compared with those living further away. All of the landfill sites were located in Great Britain and the study examined 124,597 congenital anomalies (including terminations) amongst over 8.2 million live births and 43,471 stillbirths.

The sole criterion used by Elliott in the study for judging exposure to the landfill activity was proximity of residence. For 70% of landfill sites, distances were measured from the site centroid whilst for the remainder the location of the site gateway at the time of reporting was used. A 2 km zone was constructed around each landfill site corresponding to an assumed likely limit of dispersion for landfill emissions. Persons with residential postcodes within the 2 km zone were classified as within the exposed population, whilst people living more than 2 km from all known landfill sites during the study period comprised the reference population. Fifty-five percent of the national population resided within the 2 km zones around the 9565 landfill sites operational between 1982 and 1987, which comprised 774 sites for hazardous waste, 7803 sites for non-hazardous waste and 988 sites which handled unknown wastes. Congenital anomalies and instances of low and very low birth weights defined as less than 2500 g and less than 1500 g respectively were examined.

After adjustment for deprivation, there remains a small but nonetheless statistically significant excess relative risk for those living within 2 km of a landfill site for all congenital anomalies, neural tube defects, hypospadias and epispadias, abdominal wall defects, surgical correction of gastroschisis and exomphalos, low birth weight and very low birth weight.

The results also indicate that for the statistically significant associations of birth outcomes with residence within 2 km of a landfill site, the relative risk appears to be greater for special waste than non-special waste sites. Those birth outcomes which show an excess of disease for non-special waste sites are all congenital anomalies combined, neural tube defects, hypospadias and epispadias, surgical correction of gastroschisis and exomphalos, low birth weight and very low birth weight. For the latter two outcomes the relative risk is marginally higher for non-special waste sites than for special waste sites.

Whilst there are weaknesses in the Small Area Health Statistics Unit (SAHSU) study[123], it is undoubtedly the strongest piece of epidemiological research carried out in the UK and probably internationally on the issue of risks of congenital anomalies in relation to landfill. The small positive association found between certain adverse birth outcomes and residence in proximity to a landfill cannot be stated with certainty to be causal, but provide the best currently available estimate of relative risk.

Although not included in the main published paper, the study also examined a number of cancer outcomes, specifically childhood and adult leukaemias, hepatobiliary cancers and cancers of bladder and brain. After controlling for socioeconomic status, no excess risk for those living within 2 km of a landfill site was found for each of the cancer types studied[124].

[123] Ibid.

[124] Jarup, L., Briggs, D., de Hoogh, C., Morris, S., Hurt, C., Lewin, A., Maitland, I., Richardson, S., Wakefield, J., and Elliott, P. (2002). Cancer risks in populations living near landfill sites in Great Britain, Brit. J. Cancer, 86, 1732-1736.

Materials recycling facilities

The hazard which probably presents the greatest health risk relates to biological materials, and particularly bioaerosols. The associated risks are very similar to those occurring in a composting plant although likely to be of lower magnitude if mainly dry recyclables are handled. Unlike the composting plant, there are also significant chemical and physical hazards to the worker in the MRF, and those chemical hazards including exposure to vapours and suspended particulate matter may extend outside of the plant. Gladding reports measurements of airborne contaminants within plants where unseparated waste is sorted, and in addition to high concentrations of airborne micro-organisms, there are reports of elevated concentrations of toxic trace metals[125]. Such plants do not currently operate in the UK, although a facility is currently under development.

There are no epidemiological studies of populations living near MRFs. To enable the potential health effects in local populations to be assessed, it is possible to consider studies of worker exposures. According to Gladding, the most heavily investigated mixed wastes facility was a sorting plant receiving up to 10,000 tonnes per annum of mixed household and industrial waste. Of 15 exposed operatives, five exhibited symptoms of asthma whilst others presented with flu-like symptoms (possibly allergic alveolitis), eye and skin irritation, fatigue and occasional nausea. A further study of operatives from the same plant showed that eight operatives became ill within seven months of starting work. In total, nine cases of occupational disease among the original 15 exposed operatives were reported.

A subsequent study in Denmark examined the health of 750 operatives in textile mills, recycling plants, a wet paper producing plant and a water supply plant. Within these industries a negative association was found between different markers of atopy and increasing levels of endotoxin, which implies a healthy worker selection due to operatives leaving recycling after a short period of employment because of asthma symptoms. When odds ratios were examined, they showed that chest tightness and organic dust toxic syndrome was significantly elevated amongst waste handling operatives who also had significantly increased rates of work-related chest tightness, influenza, feeling of fever, and mucous membrane irritative symptoms. Gastro-intestinal symptoms such as nausea, work-related vomiting and diarrhoea were also more often reported amongst waste handling operatives than amongst controls. A study conducted in the United States conducted air sampling in six MRFs. Measurements of silica and trace metals including arsenic, aluminium, chromium, lead, nickel and mercury were low compared to occupational standards. Similarly, measurements of metals in downwind communities as well as PCBs and pesticides show little evidence of elevation due to the MRF. Some elevation in concentrations of total suspended particulates and PM_{10} was evident in the measurements. In the case of bioaerosol, no significant difference between upwind and downwind concentrations measurements was evident. The study concluded that there was little evidence that MRFs posed a significant threat to public health or the environment, but drew attention to the possible problems associated with bioaerosols and the lack of widely adopted occupational exposure limits for bioaerosols.

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[125] Gladding, T. (2002). Health Risks of Materials Recycling Facilities. In. Environmental and Health Impact of Solid Waste Management Activities. Issues in Environmental Science and Technology 18, Eds: R. E. Hester and R. M. Harrison. Cambridge, Royal Society of Chemistry 53-72.

Marth et al. studied the health of 256 workers from manual sorting facilities over a period of three years[126]. This showed a decrease in lung function and an increase in total Immunoglobulin E in exposed workers indicative of allergic sensitisation to atmospheric exposures. Gladding reports on the European BIOMED No. 2 project which was designed to provide information on physical and chemical hazards in MRFs and health effects of measured bioaerosol exposures. This is the first clear demonstration of an exposure-response gradient for workers in an MRF. However, there are weaknesses to the study, particularly that the health survey was based on a self-reporting of certain symptoms by questionnaire.

Composting

Specific components of the bioaerosol generated during composting include fungi, bacteria, actinomycetes, endotoxin, mycotoxins and glucans. The effects of exposure to organic dust containing such bioaerosol components on respiratory health may lead to allergic rhinitis, asthma, chronic bronchitis, chronic obstructive pulmonary disease, extrinsic allergic alveolitis, granulomatous pneumonitis, or toxic pneumonitis (organic dust toxic syndrome).

Whilst many measurements of airborne concentrations of organisms have been made within and in the vicinity of composting plants (e.g. *Wheeler et al.*[127]), which give ample evidence for a hazard especially to composting workers, there have been very few studies of health effects from which any quantitative indication of risk can be derived. Cobb *et al.* compared symptoms of ill-health in those living within 900 metres of a site processing mushroom compost with a group with no exposure to compost, finding no demonstrable excess of disease in the exposed group[128]. Browne *et al.* report on a study of health in a population living close to a grass and leaf composting plant in the US[129]. This depended on self-reported symptoms, with 63 subjects living near the site and 82 controls keeping a symptom diary. Bioaerosol concentrations were measured at fixed locations around the site and elevated concentrations were shown to be associated with winds from the composting plant. No significant increase in allergy and asthma symptom prevalence was detectable in people living near the site, although there was an association of increases in respiratory and irritative symptoms with ragweed pollen, ozone and temperature. These are unlikely to be attributable to the composting activity.

A recently published study by Herr et al. provides the most convincing evidence to date of an effect of bioaerosol emitted by a composting plant on respiratory health of community residents[130]. The study used distance between home and the composting site as well as numbers of colony-forming units of bioaerosol as exposure measures. An analysis of prevalence of self-reported health complaints amongst residents in the

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[126] Marth, E., Reinthaler, F. F., Haas, D., Eibel, U., Feierl, G., Wendelin, I., Jelovcan, S. and Barth, S. (1999). Waste management--health: a longitudinal study, Schriftenr Ver Wasser Boden Lufthyg. 104, 569-83.

[127] Wheeler, P. A., Stewart, I., Dumitrean, P. and Donovan, B. (2001) Health Effects of Composting, R & D Technical Report P1-315/TR. Environment Agency, Bristol, UK.

[128] Cobb, N., Sullivan, P. and Etzel, R. (1995). J. Agromed. 2, 12-25.

[129] Browne, M. L., Ju, C. L., Recer, G. M., Kallenbach, L. R., Melius, J. M. and Horn, E. G. (2001). Compost Sci. Util. 9, 242-249

[130] Herr, C. E. W., zur Nieden, A., Jankofsky, M., Stilianakis, N. I., Boedeker, R.-H. and Eikmann, T. F. (2003). Effects of bioaerosol polluted outdoor air on airways of residents: a cross sectional study, Occup. Environ. Med., 60, 336-342.

neighbourhood showed a significantly elevated risk for a number of health complaints including bronchitis, frequency of colds and measures of eye irritation and general health. Whilst the use of self-reported symptoms frequently leads to bias in epidemiological studies, the authors tested this possibility through including odour annoyance as a question in their doctor-administered questionnaire.

The results showed that odour annoyance, which might be expected to be a strong bias on self-reported complaints had no influence on the reporting of irritative airway complaints and this therefore did not appear to be a confounder. The release of volatile organic compounds from composting facilities may present some risk to health however there is no data on the health effects related to exposure to VOCs.

Incineration

There is no doubt that air pollution (from all sources) can have an adverse effect on the health of susceptible people (*i.e.* young children, the elderly and particularly those with pre-existing respiratory disease). Recent work in the UK by the Committee on the Medical Effects of Air Pollutants (COMEAP) has demonstrated that exposure to air pollution can bring forward death in patients with severe pre-existing disease, although the degree of life shortening is typically of the order of a few weeks at most per individual. However, there is currently little convincing evidence that ambient levels of air pollution cause adverse health effects in healthy people.

Whilst incinerators generate a considerable amount of public concern, there have been few published epidemiological studies that examine the health of communities living in close proximity to them. The majority of published studies concentrate on the effects of exposure to emissions from the older generation of incinerators which were phased out in the UK after the introduction of stricter emission controls implemented through the Integrated Pollution Control regime. This is inevitable, in view of the latency period associated with most cancers. The level of public exposure from such facilities was substantially higher than occurs from modern incinerators.

The general public can be exposed to pollutants associated with incinerator emissions through a number of routes, with inhalation and the food chain of particular importance. Most concern has focused on the effects of exposure to dioxins and furans and polycyclic aromatic hydrocarbons (PAHs), substances that are known or suspected carcinogens. It has been hypothesised that exposure to dioxins and furans (either directly via inhalation or indirectly via the food-chain) may be major causes of cancer in communities around incinerators. Whilst older incinerators were often significant sources of dioxins and furans in the local environment, modern incinerators are significantly cleaner.

Several epidemiological studies have suggested a possible association between incinerator emissions and stomach, colorectal and liver cancers. In the UK a possible distance-related link with the old generation of incinerators has been reported[131]. This large study examined cancer incidence in over 14 million people living near to 72 municipal solid waste incinerators between 1974 and 1986 (England), 1974 and 1984 (Wales), and 1975 and 1987 (Scotland). After controlling for social deprivation, a

[131] Elliott, P., Shaddick, G., Kleinschmidt, I., Jolley, D., Walls, P., Beresford, J. and Grundy, C. (1996). Cancer incidence near municipal solid waste incinerators in Great Britain., Br. J. Cancer. 73, 702-710.

significant decline in risk with distance from the incinerators was found for all cancers combined, and particularly for stomach, colorectal and liver cancer. However, incomplete control for socio-economic confounders may have been responsible for these results (Elliott et al., 1996) and once the authors took into account a number of *post hoc* estimates, such as examination of the data before the incinerators were built and estimation of the likely impact of ethnicity, only liver cancer showed a significant association with distance from the incinerators. In this case, it is likely that misclassification of secondary tumours as primary liver cancer may have caused or contributed to the result. Given the uncertainties that surround this reported excess of liver cancers, particularly the possibility that misclassification of primary tumours contributed to the outcome, the data were re-examined and the study could not completely discount the possibility of an association between residential proximity to municipal solid waste incinerators and incidence of liver cancer, confounding from deprivation (primary liver cancers in Great Britain are strongly related to deprivation) appears to be the most likely explanation for the excess.

The waste solvent and oil incinerator at Charnock Richard, Lancashire, which operated between 1972 and 1980, has been much studied. Gatrell and Lovett reported a possible excess of cancer of the stomach and larynx cancer after examining cancer registrations between 1974 and 1983[132]. However, little weight can be given to this study as it did not adequately control for any important confounders. The authors themselves cautioned against making a causal link between cancer incidence and residence near the incinerator. It is also of limited relevance to combustion of municipal waste. The possibility of a cancer cluster, particularly of cancer of the larynx, near to the Charnock Richard incinerator prompted a more detailed study which included the other nine UK incinerators licensed to burn waste solvents and oils (Elliott et al., 1992). Cancer registration data were used to identify cases of cancer of the larynx and lung within 3 km of the sites, and between 3 and 10 km. Expected values were calculated using regionally adjusted national cancer rates to enable age standardised ratios of observed to expected rates to be derived. Cancer of the lung was also included in the study because it shares many of the same epidemiological characteristics as cancer of the larynx, including a strong social class gradient, a strong association with cigarette smoking and similar occupational risks. However, despite initial reports of a cluster, neither cancer of the larynx nor of the lung showed a statistically significant relationship with distance from the site once socioeconomic status was taken into consideration. Correction for confounding by socioeconomic status was carried out by stratifying the analysis using the Carstairs index of material deprivation, based on the 1981 census. The study concluded that the apparent cluster of cases of cancer of the larynx at Charnock Richard, was unlikely to be due to the incinerator.

Several studies by Knox have examined a possible association between childhood cancers and industrial emissions including those from incinerators[133, 134, 135]. These studies employ spatial analysis of postcodes of those diagnosed with childhood cancer but limitations with the methodologies used mean that the results of these

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[132] Gatrell, A. C. and Lovett, A. A. - (1992) Burning Questions: Incineration of Wastes and Implications for Human Health, (Research Report No.8). North West Regional Research Laboratory, Lancaster University, Lancaster, UK.
[133] Knox, E. G. and Gilman, E. A. (1995). Hazard proximities of childhood cancers, J Epidemiol Community Health. 51, 151-159.
[134] Knox, E. G. and Gilman, E. A. (1998). Migration patterns of children with cancer in Britain, J Epidemiol Community Health. 52, 716-726.
[135] Knox, E. (2000). Childhood cancers, birthplaces, incinerators and landfill sites, International J. Epidemiol. 29(3), 391-397.

studies are far from certain. No direct measure of exposure is included in the analysis, with exposure estimates being entirely reliant on using distance from the source as a proxy for exposure. The standardisation technique employed in the earlier studies does not attempt to account for the potential effect of deprivation, which would be a major potential confounding factor[136]. Both of the early studies have been heavily criticised on the basis of lack of proper control for population density and the extreme implausibility of some of the findings, which tentatively linked childhood cancer with a wide range of combustion sources including major highways, but only at considerable distances from the road, at which no elevation in pollutant concentrations from on-road emissions would have occurred. The study by Knox in 2000 differs in that it is based upon an analysis of the birth and death addresses of children diagnosed with cancer. This showed a greater incidence of cancer in children born close to incinerators and moving away than in those who moved closer to an incinerator. As its basis, the study assumes that migration of children who subsequently develop cancer should be essentially random. A comparison was made with non-combustion industrial facilities not necessarily located in the same sort of areas as incinerators. The overall conclusion drawn by authors of the study was that the inferred increased probability of childhood cancer stems from residence near to large-scale combustion processes as a whole, of which incinerators are one component.

Despite reports of cancer clusters, no consistent or convincing evidence of a link between cancer and incineration has been published. In the UK, the large epidemiological studies by Elliott and colleagues of the Small Area Health Statistics Unit (SAHSU) examined an aggregate population of 14 million people living within 7.5km of 72 municipal solid waste incinerators. This included essentially all incineration plants irrespective of age up to 1987. Despite the consequent inclusion of incinerators with emissions of potential carcinogens much higher than would occur from modern incinerators, both studies were unable to convincingly demonstrate an excess of cancers once socio-economic confounding was taken into account[137, 138, 139] (Elliott et al., 1992; 1996; 2000). As a result of these, the Department of Health's Committee on Carcinogenicity published a statement in March 2000 evaluating the evidence linking cancer with proximity to municipal solid waste incinerators in the UK (*Committee on Carcinogenicity, 2000*). The Committee specifically examined the results of these studies and concluded that, "any potential risk of cancer due to residency (for periods in excess of ten years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern techniques". The Committee agreed that the observed excess of all cancers, stomach, lung and colorectal cancers was due to socio-economic confounding and was not associated with emissions from incinerators. The Committee agreed that, at the present time, there was no need for any further epidemiological investigations of cancer incidence near municipal solid waste incinerators. It has been hypothesised that exposure to dioxins and furans (either directly via inhalation or indirectly via the food-chain) is responsible for some cancers in communities around incinerators. However, epidemiological studies on the older generation of incinerators that emitted

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[136] See footnotes above.
[137] Elliott, P., Hills, M., Beresford, J., Kleinschmidt, I., Jolley, D., Pattenden, S., Rodrigues, L., Westlake, A. and Rose, G. (1992). Incidence of cancer of the larynx and lung near incinerators of waste solvents and oils in Great Britain, Lancet. 339, 854-858.
[138] Elliott, P., Shaddick, G., Kleinschmidt, I., Jolley, D., Walls, P., Beresford, J. and Grundy, C. (1996). Cancer incidence near municipal solid waste incinerators in Great Britain, Br. J. Cancer. 73, 702-710.
[139] Elliott, P., Eaton, N., Shaddick, G. and Carter, R. (2000). Cancer incidence near municipal solid waste incinerators in Great Britain. Part 2: histopathological and case-note review of primary liver cancer cases, B. J. Cancer. 82(5), 1103-1106.

significantly greater amounts of dioxins than newer facilities have failed to identify an effect. Given that the emissions of dioxins and furans from modern incinerators are orders of magnitude lower than from older incinerators, it can be said with some confidence that any impacts of dioxin and furan on cancer rates in local people are small or non-existent and unlikely to be quantified through epidemiology.

Several studies have examined possible adverse respiratory health effects among people living near incinerators. Perhaps the most credible studies are those which have examined the respiratory health of six communities in North Carolina, USA, three of which are exposed to emissions from biomedical, municipal or hazardous waste incinerators[140, 141, 142]. The study reported no significant difference of particulate air pollution or overall respiratory health in communities residing near to three waste incinerators from 1992 to 1994. The study found no significant difference in the concentration of PM_{10} in the incinerator communities relative to comparison communities and later analysis of lung function could not confirm any relationship between PM_{10} levels in the communities and lung function[143].

Most studies have typically examined respiratory health around the older generation of incinerators and most are based upon self-reported symptoms and therefore may be subject to bias. Overall, there is little evidence to suggest that waste incinerators are associated with increased prevalence of respiratory symptoms in the surrounding population. This is consistent with the data from risk assessments, emissions and ambient air monitoring in the vicinity of incinerators which indicate that modern, well-managed waste incinerators will only make a very small contribution to background levels of air pollution. In many cases, air monitoring data do not demonstrate that emissions from the incinerators are a major contributor to ambient air pollution.

Dioxins and furans are known to adversely affect the reproductive system, and therefore a number of studies have investigated effects of incinerators on reproductive health. It has been suggested that populations living near waste incinerators have a higher probability of giving birth to twins, possibly due to exposure to dioxins, furans and polychlorinated biphenyls (PCBs) in incinerator emissions. Lloyd et al. reported that during 1980-1983, the incidence of twinning in two areas near to a chemical waste incinerator in Scotland were significantly higher at 20 and 16 per 1,000 when compared with rates in control areas of between 3 and 13 per 1,000[144]. The authors hypothesise that the increased incidence of human twinning rates over the study period was consistent with anecdotal evidence that polychlorinated hydrocarbons and PCB-related compounds were burnt regularly in the late 1970s. However, the study does not specifically link twinning in the exposed human and animal populations to exposure to polychlorinated hydrocarbons and it acknowledges that it would "be premature to attribute causality to this association

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140 Shy, C. M., Degnan, D., Fox, D. L., Mukerjee, S., Hazucha, M. J., Boehlecke, B. A., Rothenbacher, D., Briggs, P. M., Devlin, R. B., Wallace, D. D., Stevens, R. K. and Bromberg, P. A. (1995). Do waste incinerators induce adverse respiratory effects? An air quality and epidemiological study of six communities, Environ. Health Perspect. 103, 714-24.

141 Mohan, A. K., Degnan, D., Feigley, C. E., Shy, C. M., Hornung, C. A., Mustafa, T. and Macera, C. A. (2000). Comparison of respiratory symptoms among community residents near waste disposal incinerators, Int J Environ Health Res. 10, 63-75.

142 Hu, S. W. and Shy, C. M. (2001). Health effects of waste incineration: A review of epidemiologic studies, Journal of the Air & Waste Management Association. 51(7), 1100-1109.

143 Lee, J. T. and Shy, C. M. (1999). Respiratory function as measured by peak expiratory flow rate and PM10: six communities study, J Expo Anal Environ Epidemiol. 9(4), 293-9.

144 Lloyd, O. M., Lloyd, M. M., Williams, F. L. R. and Lawson, A. (1988). Twinning in human populations and cattle exposed to air pollution from incinerators, Br J Ind Med. 45, 556-560.

between air pollution from incinerators and twinning". Furthermore, although maternal age was taken into account in the analysis of human births, several other possible confounding factors were not. No social or personal risk characteristics were included in the study and no data relating to possible hereditary causes of twinning were examined. The study also suffered from a lack of direct exposure data. The strength of these findings has been debated in the medical literature with Jones in particular presenting a sound argument questioning the basis of this study and correctly citing the lack of evidence of any increased environmental (soil) pollution around the incinerator[145]. This incinerator provides an extreme case relative to municipal solid waste incineration since its main function was to burn hazardous industrial waste and emission controls were rudimentary by modern standards. Emissions of dioxins and especially PCBs are likely to have been much greater than for a modern facility.

It has been suggested that airborne pollutants associated with incinerators, particularly dioxins and furans, may be associated with changes in the sex ratio of births. Current statistics indicate that in the UK the proportion of male births has decreased over the last fifty years. Sex ratio is thought to be affected by a wide range of biological and environmental factors including race, birth order, parental age, parental hormone levels, timing of conception, ovulation induction, environmental pollutants and socio-economic status.

In the UK, Williams et al.[146] reported a significant excess of female births around two chemical waste incinerator plants in Central Scotland (same incinerator and study area as in Lloyd et al.[147]). However, confidence in this outcome is weak as the study lacked a direct measure of exposure to environmental pollution and inadequately considers several possible confounding factors. There is also the possibility that some births may have been misclassified with regard to antenatal exposure. As noted above, exposures from this old incineration plant will have greatly exceeded those from a modern municipal waste incinerator.

After adjustment for social class, year of birth, birth order and multiple births, increased risks of lethal congenital anomaly among babies of mothers living close to incinerators (including an industrial hazardous waste incinerator and a sludge incinerator) and crematoria in Cumbria, north west England have been reported in recent research[148]. The authors found a significantly increased risk of spina bifida and heart defects in relation to the proximity of incinerators, but not of stillbirth or neonatal death. The study involved 244,758 births to mothers living in Cumbria between 1956 and 1993 and it is acknowledged by the researchers that changes in medical practices over time may have affected the results. Another limitation of the study is that no actual pollution levels around each site have been measured and therefore a function of distance from the incinerators was used as a surrogate for exposure. The work also relates to the older generation of incinerators and acknowledges possible influences of other industrial sources of emissions.

Published epidemiological studies of the health of communities living in the vicinity of incinerators have failed to establish any convincing links between incinerator emissions and adverse effects on public health; specifically no impact was

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[145] Jones, P. (1989). Twinning in human populations and in cattle exposed to air pollution from incinerators [letter], Br. J. Ind. Med. 46, 2156.
[146] Ibid.
[147] Ibid.
[148] Dummer, T, Dickinson, H, and Parker, L (2003). Adverse Pregnancy Outcomes around Incinerators and Crematoriums in Cumbria, NW England, 1956-93, J Epidemiol Community Health. 57, 456-461.

demonstrated on the incidence of cancer, respiratory health symptoms or reproductive outcomes. Consequently, the epidemiology specific to incinerators gives no basis for developing quantitative health impact functions and no attempt is made to use it in this way.