SUBMISSION

THE ENQUIRY INTO MUNICIPAL WASTE MANAGEMENT IN NSW

Executive Summary

This submission compares some of the environmental consequences of the three major methods of MSW disposal:

1. managed landfill
2. landfill with gas recovery and power generation in an IC engine
3. incineration in a modern installation, with power generation.

It estimates the emission of some important pollutants to air from three waste disposal techniques The pollutants are greenhouse gases, trace compounds (VOCs), particulates, metals and dioxins (PCDD/F), considered on the basis of one tonne of MSW. Energy recovery and the time profile of the emissions are briefly discussed. Emissions to water and land are not considered.

The levels of pollutant emissions from landfill are strongly dependent on the type of waste, the prevailing conditions and its location, whereas the emissions from combustion processes are far less variable. Landfill gases are by far the worst of the three scenarios for causing global warming. Particulate emissions from landfill are difficult to quantify; those from landfill/recovery and incineration are similar. Landfill is comparable to the other two techniques for VOC emissions and is only slightly better for dioxin emissions. The situation with regard to metals is not clear.

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Brisbane, February 2006

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same molar concentration of CO_2 (Scott and McDonald 1990). The organohalogens which are also found in landfill gas and are potent greenhouse gases, are ignored.

Table 1 Greenhouse gas equivalents

System	Carbon dioxide		Methane		Total CO_2 Equivalent ($Nm^3 t^{-1}$)
	Quantity ($Nm^3 t^{-1}$)	CO_2 Equiv	Quantity ($Nm^3 t^{-1}$)	CO_2 Equiv	
Landfill	135	1	110	27	3105
Landfill/recovery	217.5	1	27.5	27	960
Incineration	534	1	0	27	534

The greenhouse effect of the gases generated from incineration is about half that from landfill/recovery and one sixth of that from straight landfill.

Particulates

The emission of particulates from a landfill site will result from the activity of the mobile equipment used for placing, compacting and covering the waste. Diesel exhaust emissions and road dust will account for most of this material. It is difficult to quantify these emissions, as they will be strongly dependent on the site and type of operations.

The landfill/recovery option will experience these emissions, as well as particulate emissions from the gas engines, which will be finer and hence more in the respirable range. The emissions from older-style of reciprocating engines are given by Porteous (1993) as 125 mg Nm^{-3}, while those from a gas turbine are 9 mg Nm^{-3}. These correspond to total emissions of 30 and 2.2 g t^{-1} respectively.

Typical PM_{10} emissions from modern incinerators equipped with fabric filters have been measured at 2 mg Nm^{-3}, i.e. 10 g t^{-1} (Consonni et al 2005).

Trace Compounds (VOCs)

In order to measure trace compound and VOC concentrations, a program of sampling of landfill gases was undertaken at three UK landfill sites by means of a probe with the sampling section located between 0.9 and 4.3 m below the surface (Scott and McDonald 1990). There was a wide variation in values between the samples. Over 100 different compounds were identified, including straight chain and aromatic hydrocarbons, and oxygenated compounds. Maximum and minimum values are listed in Table 2. The values reported by Schweigkofler and Niessner (1999) for two different sites in Germany are 480 and 270 mg Nm^{-3}, and include significant quantities of siloxanes. These result in total emission levels of 120 and 66 g t^{-1}.

The concentrations of VOCs from incineration were measured by Jay et al (1995) in a large commercial German incinerator and found to be 0.5 mg Nm^{-3}. A likely range is given in Table 2. The EU limit is 10 mg Nm^{-3}, but this is rarely ever approached, and modern units can operate at the level of 0.02 – 0.03 mg Nm^{-3}.

Table 2 Emission of VOCs

The extent of dioxin generation in recovery engines has been estimated by Rada et al (2006), who present figures of 79 to 103 $ng_{ITEQ}\ t^{-1}$ for modern installations.

The dioxin emissions from incinerators are controlled by the addition of activated carbon, or by passing the gases over a catalyst. Activated carbon is also useful in removing mercury, and is often used for that reason. The EU limit for dioxins is 0.1 ng_{ITEQ} per Nm^3, but most units operate at values well below this. Abad et al report a mean in Spain of 0.008 ng_{ITEQ} per Nm^3, Erbach in Germany (1988) 0.02 ng_{ITEQ} per Nm^3, and a Seghers plant in Austria 0.04 ng_{ITEQ} per Nm^3. The mean value reported by Consonni et al (2005) for four Italian incinerators was 260 $ng_{ITEQ}\ t^{-1}$.

Table 3 Emission of PCDD/F

System	Concentration ($ng_{ITEQ}\ Nm^{-3}$)		Gas Flow ($Nm^3\ t^{-1}$)	Total emission ($ng_{ITEQ}\ t^{-1}$)	
	Minimum	Maximum		Minimum	Maximum
Landfill	-	-	245	19	43
Landfill/recovery	-	-	-	80	105
Incineration	0.008	0.08	4350	35	350

The emissions of PCDD/F from landfills are less than those of the other two systems, which are similar in magnitude. The values from landfill are likely to reflect the feed values, whereas the other two systems will tend to destroy the input PCDD/F, but reform it during the combustion processes.

Energy recovery

No energy recovery is possible with straight landfill. The conversion efficiency of IC engines used with landfill is approximately 30% (Porteous 1993). Efficiencies of 30% are now possible with large modern incineration plant (Pfeiffer 2004), so that a figure of 22% is conservative (Haneda 1995). The SE of the methane in landfill gas is 35.7 MJ Nm^{-3}, and 110 Nm^3 is produced per tonne of waste. These figures result in a generation of electrical power of a maximum of 250 kWh t^{-1} of MSW via landfill/recovery, compared to 837 kWh t^{-1} via incineration.

The timescale of emissions

Since landfill components take up to 20 years to decompose (Clarke 2000), the rate of emissions entering the atmosphere should be considered. If MSW is sent forward for treatment at a constant rate over a 20 year period, the emission rate of gas, and hence pollutants, for landfill and incineration will of the same form as shown in Figure 1 (in arbitrary emission magnitude). In this figure the area under each curve is the same i.e the total emissions over time are identical in mass t^{-1}. The graph indicates that the output from an incinerator is constant, while that from landfill peaks after 20 years at a value above that of the incinerator, and then continues at a diminishing rate for another 20 years.

Roel J. and **Verstraete W.** (2004) "Occurrence and origin of phosphine in landfill gas" Science of the Total Environ 327, 185-196

Schweigkofler M. and **Niessner R.** (1999) "Determination of siloxanes and VOC in landfill gas and sewage gas by canister sampling and GC-MS/AES analysis" Environ Sci Technol 33, 3680-3685

Scott P. and **Macdonald C.** (1990) "The significance and environmental impact of trace compounds present in gaseous emissions from UK landfill sites" Waste Research Unit, Environmental Safety Centre, AEA Environment and Energy, Harwell Laboratory, 31 pp

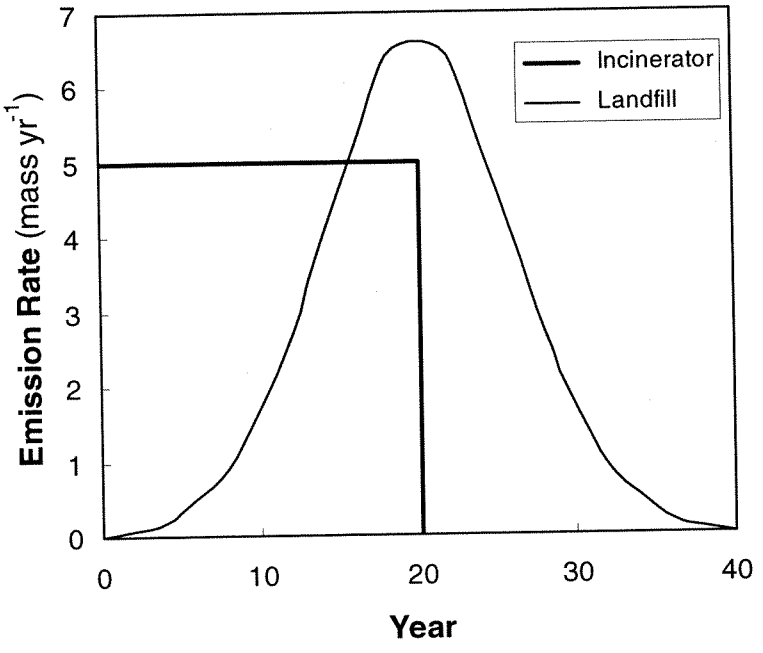

Figure 1 The profiles of emission rates for equal amounts of a nominal pollutant from landfill and an incinerator (arbitrary scale)