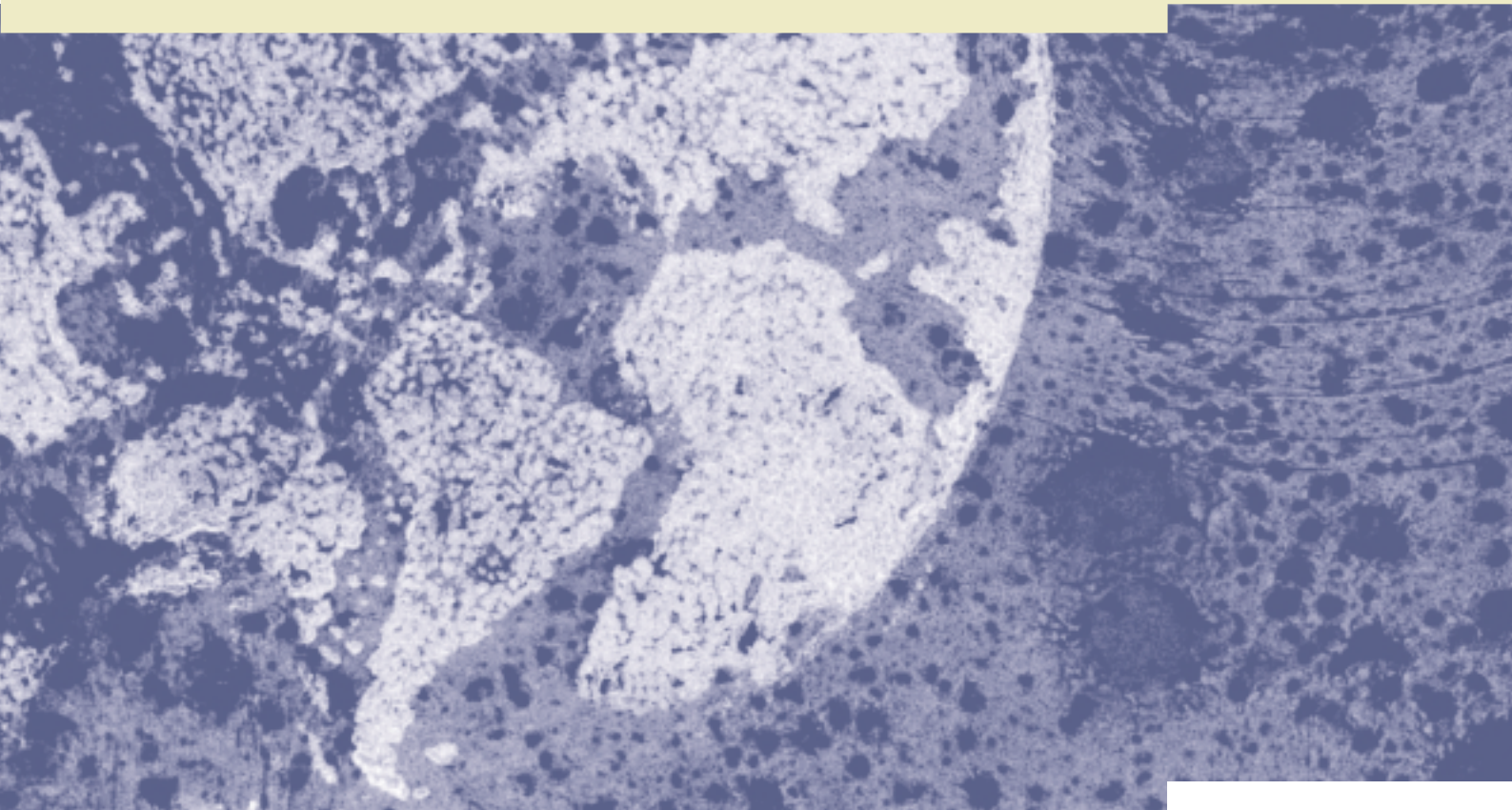


Executive Summary



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This report was commissioned by the Health Research Board, at the request of the Department of the Environment and Local Government. It aims to inform policy makers of (a) the technical aspects of both landfill and incineration practices in Ireland and (b) the adverse effects that these practices may have on the environment and human health. Specifically, this report reviews the national and international literature on risk assessment and the effects of landfill and incineration of waste on humans and the environment, and reviews current practice and recent developments in landfill and incineration technologies.

It is not within the scope of this report to make recommendations on waste management policy. Rather, this report is intended to serve as a resource for people with such interests.

Although waste management strategies are not addressed in this report, the authors acknowledge that an integrated systems approach is required if effective waste management is to be accomplished at both local and national levels. This approach should reflect the waste management hierarchy of prevention, substitution, reuse and recycling, and energy recovery, with environmentally secure disposal of any residual waste (Forfás 2001).

Irish waste – the scale of the problem

Waste arisings in Ireland for 1998 were estimated at approximately 80 million tonnes. Of these, approximately 64.6 million tonnes (80.7%) originated from agricultural sources, mainly animal manure. The municipal and industrial sectors were estimated to have produced over 15 million tonnes (19.3%) of waste in 1998. Municipal waste alone accounted for 2 million tonnes. Compared with the 1.8 million tonnes of municipal waste arisings in 1995, there was a small increase in this category of waste between 1995 and 1998. Approximately 91% of all household and commercial waste collected in 1998 in Ireland was landfilled.

Landfilling of waste

A landfill is a repository for waste that is deposited in a series of compacted layers in specially constructed cells either on the land surface or in excavations into the land surface. The main potential impacts on health arise from inhaled landfill gas and exposure to groundwater contaminated by landfill leachate. Both gaseous and aqueous emissions from landfills are highly complex mixtures whose characteristics vary considerably from site to site and with waste composition and age of the landfill.

Although landfill gas consists mainly of methane and carbon dioxide, it can contain a large number of other gases at low concentrations, some of which are toxic. Combustion of landfill gas consumes a large amount of these but some dangerous gases are still emitted. Current practice in landfill design must consider the construction, operation, closure, restoration and aftercare of the facility. In terms of leachate containment, this requires that a double liner system be put in place to protect groundwater from pollution. Any leaks through the upper protective layer are collected by an intermediate drainage layer that also provides a warning of the leakage. Comprehensive design guidelines have been provided by the Irish Environmental Protection Agency in a series of Landfill Manuals. These design requirements are in line with international best practice.

Incineration of waste

Incineration is the thermal oxidation of waste at temperatures in excess of 850 °C. Industrial hazardous waste incineration is used by a number of pharmaceutical or fine chemical manufacturing plants in Ireland, as there is no central national facility for the incineration of such wastes. In 1998, it was estimated that 65,631 tonnes of Irish hazardous waste were incinerated, of which 47,751 tonnes were incinerated abroad. Most of this was solvents.

Monitoring of the emissions from industrial hazardous waste incinerators is currently carried out as an Integrated Pollution Control (IPC) licence condition. None of the facilities licensed for hazardous waste incineration have been found to be in breach of their IPC licence conditions. Dioxin emissions to the atmosphere from incinerators were estimated to be less than 1% of the total estimated national atmospheric dioxin emissions from all sources. Accidental fires were found to be the primary source of atmospheric dioxin emissions.

Municipal waste is not incinerated in Ireland; however, this is under consideration as part of integrated waste management plans. In the past, municipal waste incinerators world-wide were major sources of dioxins and other environmental pollutants. However, since the early 1990s, the application of stringent emission limit values to a broad range of environmental pollutants has significantly reduced the environmental impacts of municipal waste incineration. A combination of improved combustion practices and staged air pollution control techniques allows modern municipal incinerators, if operated according to the design standards, to meet the environmental requirements embodied in the recent EC *Directive on the Incineration of Waste*.

Liquid effluents from waste incineration are also tightly regulated. Solid residues, such as fly ash, will probably be classified as hazardous waste and will require the provision of suitable landfill sites. Gasification and pyrolysis are novel emerging technologies which have the potential for recovering energy from a range of waste types, and which may see greater application to municipal waste disposal in future years. The environmental impacts of these processes in comparison with modern incinerator plants have not been fully evaluated.

The effects of landfilling and incineration on the environment

As with any human activity, all methods of waste management have an environmental impact. In this report, the emphasis is on the direct site-related effects of landfills and incineration facilities. There are also substantial environmental effects associated with waste transport and collection. However, these are likely to be broadly similar for any facility, whether a landfill or an incinerator or even a recycling plant handling a given volume of waste. The choices made about the size and location of these facilities will greatly influence these impacts.

Landfill

Landfills are a potential threat to the quality of the environment, although the full extent of this threat has not always been scientifically validated. Landfills can produce gas and contaminated water, as well as wind-blown litter and dust, and attract vermin. Transport of waste to landfill sites can also have a significant impact on the environment in terms of noise, vehicular emissions, accidental spillages, etc.

Landfill gas is generated from the decomposition of the organic component of waste, initially under aerobic conditions to produce carbon dioxide, but ultimately under anaerobic conditions to produce larger quantities of methane. Landfill sites contribute 20% of the total global anthropogenic methane emissions.

Leachate management is also a major concern. The volume of leachate directly correlates with the amount of rainfall, and under Irish conditions this may be larger than in similar landfills in other countries. However, the potential impact of leachate on the environment also depends upon the nature of the material from which it derives. For older unlined landfill sites (which typically have no safeguards to prevent or minimise leachate), leachate can migrate to groundwater or even into surface waters. Contamination of groundwater by leachate has already occurred in Ireland, rendering the groundwater and the associated aquifer unreliable for domestic water supply and other beneficial uses. This is far more serious than river pollution because aquifers require extensive time periods for rehabilitation. The risks are considerably reduced for modern double-lined landfills.

Incineration

Municipal solid waste (MSW) incineration produces a range of volatile and gaseous emissions, which, if released to the atmosphere, can compromise environmental quality. Fly ash and dust can carry contaminants from the facility where they can affect sensitive ecosystems. The actual range of emissions depends upon the specific characteristics of the waste stream and engineering considerations such as combustion temperature and ancillary emission abatement techniques.

The Environmental Impact Assessment (EIA) procedures have had a positive effect on the siting and design of waste management facilities, and there is evidence from Irish research that this has led to improved knowledge and attitudes about incinerator operation and waste management among the service providers. The adoption within these organisations of environmental management plans supported by Environmental Management Systems (EMS) has also been helpful in minimising potential environmental impacts.

The effects of landfilling and incineration on public health

The standard process of estimating the likely effects of waste disposal on human health is known as 'risk assessment'. There are four phases in a typical risk assessment, namely hazard identification, dose-response assessment, exposure assessment and risk characterisation. Each phase is difficult, expensive and time consuming, and involves the exercise of professional judgement. Furthermore, the results of each stage have some degree of uncertainty, and these uncertainties are often unavoidable.

Interpretation of the evidence from epidemiological studies is especially difficult. Both for methodological reasons and for fundamental biological reasons, single epidemiological studies seldom provide sufficient evidence for scientific certainty. There is a tension between the requirement for certainty, and the need to protect public health. This tension is traditionally resolved in the 'precautionary principle'. This has been stated in many forms, but the 1992 Rio conference statement is succinct: 'Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation' (UNCED 1992). This principle does not resolve the scientific uncertainty, but it forms a valuable basis for policy makers on which to make decisions. Scientists can decline to make decisions

pending the availability of new evidence, but legislative and administrative decisions are often made to fixed timetables.

Responding to uncertain results is very difficult. It poses immense challenges for politicians, regulatory officials and the public. Evidence from research shows that people make wide-ranging value judgements, incorporating many different aspects of an issue, before reaching their decisions on disputed environmental questions. Traditional risk assessment is often a relatively minor component of this process.

One of the responsibilities of public officials and elected representatives is to communicate clearly with the general public. There is evidence that members of the public can readily understand complex technical reports, but they do not view risk in the same way as many professionals. A prerequisite for communicating clearly with the general public on waste management issues is a real understanding of how people evaluate information, and what is important for people affected by waste disposal planning decisions. Recent studies have shown the complex processes used by members of the general public to process information on environmental hazards, and these findings need to be taken seriously by those charged with risk communication.

Emissions from waste management sites

Emissions from landfill or incinerator sites are not directly related to human exposure. Exposure requires contact. This contact can be by breathing, through skin contact, or by eating food or drinking liquids contaminated by emissions. Much of the existing evidence on emissions relates to sites operated using older technologies, and may not be directly applicable to more recently constructed facilities.

The effect of exposure depends on the level and duration of exposure, but also, crucially, on characteristics of the people exposed. Children may be more susceptible to toxic effects of many chemicals, and may also behave in ways that increase their exposure. As an example, consider how much time small children and adults, respectively, spend in contact with soil.

Epidemiological studies of the health effects of landfilling and incineration

As there is a paucity of literature relating to modern landfill and incineration sites, nearly all of the studies identified in this report relate to older technologies. It can be assumed that as emission controls improve, risks of adverse effects diminish.

Health effects of landfilling

Landfill sites contain many toxic substances. There have been many studies of different potentially adverse effects. These studies show an increased risk of some adverse health effects linked to residence near certain specific sites. However, although a great number of studies have been carried out, evidence of a causal relationship between specific health outcomes and landfill exposures is still inconclusive. For many reasons, it is almost impossible to give definitive answers to questions about these health effects. There is modest evidence for an association between birth defects and residence near some landfill sites. In the future, examination of specific types of defects, possibly related to exposure to specific environmental agents, may serve to clarify this link. This is further complicated by the fact that little is known about the causes of birth defects in general.

At present there is insufficient evidence to demonstrate a clear link between cancer and exposure to a landfill. When residence in proximity to a landfill has been examined as a health risk, excesses of

bladder, lung, leukaemia and stomach cancer have been reported in some studies and not in others. Reports of increased risk of respiratory, skin and gastrointestinal illnesses are based mainly on self-reported symptoms. These studies are hard to interpret when trying to establish causal relationships.

Health effects of incineration

There is some evidence that incinerator emissions may be associated with respiratory morbidity. Acute and chronic respiratory symptoms are associated with incinerator emissions.

A number of well-designed studies have reported associations between developing certain cancers and living close to incinerator sites. Specific cancers identified include primary liver cancer, laryngeal cancer, soft-tissue sarcoma and lung cancer. It is hard to separate the influences of other sources of pollutants, and other causes of cancer and, as a result, the evidence for a link between cancer and proximity to an incinerator is not conclusive.

Further research, using reliable estimates of exposure, over long periods of time, is required to determine whether living near landfill sites or incinerators increases the risk of developing cancer. Studies of specific environmental agents and specific cancers may prove more definitive in the future.

Biomonitoring studies

Biomonitoring studies are valuable tools for risk assessment and can demonstrate exposure of individuals to specific substances. Most studies have examined exposure to trace metals, volatile organic compounds or dioxins. Other markers of adverse health effects have been described, including markers of kidney and liver function and markers of molecular or chromosomal damage. These studies are far more sensitive than studies of disease incidence. However, as pollutants often originate from more than one source, it can be difficult to attribute specific biomarkers to landfill and incineration emissions.

Knowledge and perceptions of waste management options

A series of qualitative studies was conducted, including focus groups and semi-structured interviews, with representatives of service providers, industry, environmental health officers and the general public. Submissions were also invited through an advertisement in the national press. The purpose of this was to document and analyse the knowledge and perceptions of those promoting waste management systems, and members of the general public affected by their operations.

Waste policy

All informants were agreed that waste management in Ireland is currently facing a crisis. The precise nature of this crisis varied depending on the perceptions of the informant. There was virtual unanimity that landfilling of waste no longer offered a medium- to long-term solution; but there was disagreement as to the acceptability of incineration as a replacement means of waste management.

Members of the public participating in our studies favoured greater use of recycling and the introduction of measures to reduce the amounts of waste generated, but it was the 'professional view' that such measures would only have a marginal impact in the medium term, requiring maintenance of substantial

waste disposal capacity for the time being. 'Professionals' tended to favour incineration as the option for this, and saw the major challenge to be increasing its acceptability to the general public.

At the root of this divergence lies a significant difference of opinion (i.e., perception) in relation to the environmental and health hazards of the various options for waste management, the capability of existing structures and institutions to 'police' compliance with the regulation of waste disposal and the likelihood of achieving significant change in public attitudes towards waste generation and waste disposal.

Health and environmental impacts

It was difficult to draw out any distinction between 'health' and 'environmental' impacts in the responses of participants. In the case of landfilling, venting and potential leakage of gases, pests and water contamination were identified as health hazards. In the case of incineration, emissions of dioxins and disposal of waste ash were similarly mentioned.

In general, informants showed little detailed knowledge of epidemiological relationships. Specific health impacts were seldom listed. Informants frequently commented critically on the absence of local studies. There was a tendency from the representatives of the waste management industry to equate this absence of local studies with an absence of impact.

The perception of the general public was that incineration was 'unpalatable'. In contrast, informants from the industrial and commercial sector tended to demonstrate a strong belief in the current state of incineration technology as a safeguard against health impact. This view was generally dependent on a rider concerning the quality of management; this view was even more strongly held about landfill. Service providers believed that the poor public perception of landfill and the consequent suspicion of incineration had their origins in the previous poor management of waste disposal sites.

Representatives of the service providers and of industry were generally optimistic that greater compliance with regulation could be achieved in the future. While it was frequently noted that Ireland exhibited a 'non-compliant' culture, it was felt that, in relation to waste management, this had to change because of pressure from the European Union.

There was little satisfaction with existing agencies and structures. There was a general ambiguity as to whether the primary responsibility for ensuring compliance should rest with central government or locally.

Local authorities were felt to be 'compromised' or to behave erratically, because of the ambiguities arising from their responsibilities for waste management and public representation. Regional plans were perceived as duplicating, or being inconsistent with, local plans.

Health boards were seen as having a potentially greater role to play, with reference being made to the new Health Strategy, and its call for the wider use of health impact assessment and for health proofing of the plans of other sectors, and to the *National Environmental Health Action Plan*. Some ambiguity was also perceived in the role of health boards, given their parallel responsibility as managers of the large quantities of hazardous hospital waste.

Information issues

From their respective positions and perspectives, informants agreed that the key to the resolution of existing disagreements on the future of waste management lay in the production of trustworthy and

trusted information. Not unnaturally, the various parties were generally convinced that this would persuade other parties over to their own particular view. Apart from reservations about some press reports, most informants were confident that the information actually presented to the public was credible. For example, service providers were often complimentary of bodies like Greenpeace as a source of reliable information. Likewise, a number of informants rated the Internet as a valuable information source, yet professionals would argue that there is generally no 'quality control' to assure that information available on the Internet is accurate and unbiased.

The diffusion of better information was never perceived as being sufficient in itself to resolve local fears concerning the location of waste disposal facilities. It was felt that it would assist in giving the general public more ownership of the debate and in facilitating their participation.

Summary of research and development needs identified in this report

(a) Risk assessment

Ireland presently has insufficient resources to carry out adequate risk assessments for proposed waste management facilities. Although the necessary skills are available, neither the personnel nor the dedicated resources have been made available. In addition, there are serious data gaps (addressed under point (c) below). These problems should be rectified urgently.

(b) Detection and monitoring of human health impacts

Irish health information systems cannot support routine monitoring of the health of people living near waste sites. There is an urgent need to develop the skills and resources required to undertake health and environmental risk assessments in Ireland. This should be considered as an important development to build capacity in Ireland to protect public health in relation to potential environmental hazards. The recommendations in the *Proposal for a National Environmental Health Action Plan* (Government of Ireland 1999) could form a basis for this.

(c) Detection and monitoring of environmental impacts

The capacity (in terms of facilities, financial and human resources, data banks, etc.) must be developed for measuring environmental damage, and changes over time in the condition of the environment around proposed waste sites and elsewhere. There is a serious deficiency of baseline environmental information in Ireland, a situation that should be remedied. The lack of baseline data makes it very hard to interpret the results of local studies, for example around a waste management site. Existing research results should be collated and interpreted as a step toward building a baseline data bank. A strategically designed monitoring programme needs to be initiated that can correct deficiencies in current ambient environmental monitoring. In addition, capacity needs to be built in environmental analysis. In particular, Irish facilities for measuring dioxins are required, and should be developed as a priority. However, the high public profile of dioxins should not distract attention from the need for improved monitoring of other potential pollutants.

(d) Risk communication and perception

Qualitative studies about waste management perceptions revealed a diversity of opinion about waste management issues generally, and about the links between waste management and both human health and environmental quality. To facilitate public debate on the issues of waste management policy and effects, a systematic programme of risk communication will be necessary. This should concentrate on providing unbiased and trusted information to all participants (or stakeholders) in waste management issues. Public trust, whether it is placed in the regulators, in compliance with the regulations or in the information provided, will be fundamental in achieving even a modicum of consensus for any future developments in waste policy in Ireland.

References

Forfás (2001) *Key issues in Waste Management in Ireland*. Forfás: Dublin.

Government of Ireland (1999) *Proposal for a national environmental health action plan*. Stationery Office: Dublin.

UNCED (1992). Report of the United Nations Conference on Environment and Development. Annex I Principle 15. Available at <http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>

