NATIONAL STRATEGY, LOCAL PRACTICE AND THE SOLID WASTE MANAGEMENT GAP?

A LOCAL AUTHORITY MANAGEMENT PERSPECTIVE ON SUSTAINABLE SOLID WASTE MANAGEMENT IN THE UK
(APPENDIX)

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A thesis submitted in partial fulfilment
of the requirements of Kingston University
for the degree of Doctor of Philosophy

The research programme was carried out in collaboration
with the Institute of Wastes Management

July 2001

Supporting Materials

Read, Adam David, 2001.
EThOS ID: 555013

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POLICY INSTRUMENTS FOR ACHIEVING SUSTAINABLE WASTE MANAGEMENT IN THE UK

1. INTRODUCTION

Like many countries, waste management policy in the UK has become more sophisticated since the early 1970s when explicit controls were first introduced in response to incidents of hazardous waste dumping. This has gone hand-in-hand with re-definitions of the waste 'problem' in response to better scientific understanding and growing environmental awareness. The development of waste policy can be conceptualised as occurring in three time periods - the control period, the management period and the strategic period [1].

Between about 1970 and 1987, policy-makers saw waste as a problem because its production, storage and disposal posed a risk to human health. Responsibility for waste collection, disposal and regulation was given to local authorities in 1974 and a series of important Acts of Parliament placed controls on disposal sites. The aim of policy interventions was to control the production of pollution, hence the designation control period. Between 1987 and around 1994, policy-makers broadened the way the waste problem was defined to incorporate the 'three evils' of pollution of the environment, harm to human health and local disamenity. The key piece of legislation during this period was the 1990 Environmental Protection Act which introduced the concept of cradle-to-grave management and the Duty of Care, hence the designation management period. From 1995, the UK has moved towards a more strategic approach to waste management policy. The problem has been re-defined within the framework of sustainability to become one of inefficient resource use as well as being a risk to human health, the environment and amenity. The period has witnessed a raft of policy papers, culminating in the three waste strategies [2-4;], and several Parliamentary committees have reviewed the subject [5-6], hence the designation strategic period.

The types of solution offered by policy-makers to the waste problem have developed over time, at least partly in response to these changing problem definitions.

To analyse the changing responses of policy-makers, it is helpful to employ the concept of a *policy instrument* and a short discussion of what is meant by this concept is needed.

2. POLICY INSTRUMENTS

In simplistic terms, an instrument is a means of achieving an end; the Oxford English Dictionary, for example, defines it as "a thing used to or for performing an action; a means". Policy analysts have similarly regarded a policy instrument as a means to an end [7-9]. While undoubtedly true, this definition overlooks the fact that policy instruments can also be an end in themselves, as Doern and Phidd [10] note:

> The mere use of the word 'instruments' suggests that they are 'devices' or 'techniques'. In short, they are seemingly the 'means' through which the 'ends' of political life are achieved. In part, of course, this is what they often are. But to view these basic instruments to be merely matters of technique would be a great mistake. The instruments are also *ends* in themselves. They are the object of political dispute, are embedded with ideas and are valued because they fundamentally affect the *process* and *content* of policy making. In democratic politics, process always matters. Normative content and the choice of governing instrument are always intertwined not only in a 'means-end' chain but also in an 'ends-ends' chain of relationships.

Policy instruments manifest themselves in many different ways; Kirschen *et al* for example, list 63 different types of instrument for achieving economic policy goals [11]. For the sake of comprehensibility, it is necessary to group instruments together into broad types. Many different approaches to grouping have been suggested in the policy analysis literature.

One of the most widely known is the OECD's in which three different types are defined - command and control, economic and (per)suasive [12,13] although Verbruggen has suggested a more useful third category of 'communicative'[14].

Each type of policy instrument can be linked to what Lindblom [15] has called the 'fundamental politico-economic mechanisms which enable humans to improve their condition' - authority, exchange and persuasion - and to Thompson *et al*'s [16] implementation mechanisms - hierarchies, markets and networks (table 1).

Table 1: Types of policy instrument [16]

Fundamental organising mechanism (Lindblom 1979)	**Implementation mechanism (Thompson *et al* 1991)**	**Type of policy instrument (Verbruggen 1994)**
Authority	Hierarchies	Command and control
Exchange	Markets	Economic
Persuasion	Networks	Communicative

Command and Control instruments

Command and control instruments are based on the assumption that the target group needs to be forced to act or refrain from acting since it is not otherwise in their interest to do so. In Schneider and Ingram's terms, policy-makers "assume agents and targets are responsive to the organizational structure of leader-follower relationships and that lower level agents usually will do as they are told" [17, p.514]. Their key characteristics are that they are a) based on the legal authority vested in the government; b) apply to individuals and companies that have a duty to be aware of its content; and c) are implemented by government or an agency which operates under the delegated authority of government. As with most countries, command and control regulation has dominated UK waste management policy, particularly during the 'control' and 'management' periods of policy development. The command and control instrument taken as a case study here is Integrated Pollution Control, a regulatory regime introduced in the UK's Environmental Protection Act of 1990 and subsequently adapted by the European Commission to form the basis of the Integrated Pollution Prevention and Control (IPPC) Directive.

Economic instruments

Economic instruments make use of exchange mechanisms present in markets to incentivise desired behaviour.

They have been described as governments "working with the grain of markets" [18, p.1] rather than against it as is usually the case with command and control instruments. Their use is based on the belief that the target group is composed of rational actors who weigh up the costs of benefits of their actions and choose the action which best balances costs and benefits *for them.* In Schneider and Ingram's terms, economic instruments assume that "individuals are utility maximisers and will not be positively motivated to take policy-relevant action unless they are influenced, encouraged, or coerced by manipulation of money ..." [17, p.515]. Economic instruments are a relatively new addition to the UK government's repertoire of policy instruments. The economic instrument taken as a case study here is the Landfill Tax, introduced in the UK in the 1996 Finance Act and arguably the UK's first truly environmental economic instrument.

Communicative instruments

Communicative instruments work by means of persuasion, making use of networks for conveying policy-relevant messages. In Schneider and Ingram's terms, they may be either capacity tools which assume that "incentives are not an issue but there may be barriers stemming from lack of information, skills or other resources" [17, p.517] or may be symbolic/hortatory tools which assume that "people are motivated from within and decide whether to take policy-relevant actions on the basis of their beliefs and values" [17, p.519]. They may therefore provide 'objective' facts or value-laden messages, depending on how policy-makers perceive the problem. Governments have always made use of communicative instruments, in both their mass and interpersonal. The communicative instrument taken as a case study here is encouraging waste minimisation, a policy which because it is not underpinned by legislation and is implemented by a wide range of organisations is less easy to draw clear boundaries around but nevertheless is a key UK government policy.

3. INTEGRATED POLLUTION CONTROL

Integrated Pollution Control, or IPC, was first conceptualised by the Royal Commission on Environmental Pollution (RCEP) in the mid 1970s.

It was to be an ambitious way of balancing emissions to air, emissions to water and the production of solid waste [19]. However, it has had no discernible impact on industrial waste generation and this section considers why.

The RCEP envisaged a new regulatory regime to be delivered by a newly created unified enforcement agency which would ensure that industry avoided cross-media transfers of pollution by having to consider the 'best practicable environmental option' (BPEO). The government of the day rejected the need for a unified agency, preferring to keep the regulation of air, water and waste under separate organisations, but accepted the principle of IPC. However, as the 1980s went on, a range of diverse pressures led the government to reconsider the need for a unified environment agency and in 1987 Her Majesty's Inspectorate of Pollution (HMIP) was created with a remit to develop, *inter alia*, the BPEO principle. With an implementation agency now in place, Department of the Environment officials pressed ahead with developing a regulatory regime to ensure that BPEO was considered by industrial companies, and the legal foundations were laid in the 1990 Environmental Protection Act although the details of the scheme were left to be included later in secondary legislation, including some key definitions and the emission limits which would be imposed.

When the details of the regime were released, industries which had initially been in favour of it were taken aback by the scope of information they would be required to provide. In April 1991, the first batch of 118 applications from the large combustion plants were submitted and four months later HMIP announced that none of the 118 had included sufficient information to allow a decision to be made and were sent back together with an additional schedule of required information. HMIP's Environment Director commented on the "low level of expectation as to what the Inspectorate would need to make its decisions on applications", adding that the majority had provided only information on releases to air and much less information on releases to water and on waste [20].

One of the main reasons for the lack of attention paid to solid waste is the way in which the legislation was framed.

The purpose of IPC is defined in the Environmental Protection Act 1990 as "preventing or minimising pollution due to the release of substances into any environmental medium". The emphasis on *pollution* as opposed to *waste* demonstrates the control period legacy of the policy, despite the fact it was implemented during the management period and into the strategic period. The emphasis on pollution meant in practice that regulators were unable to impose waste-related conditions in authorisations because pollution resulting from waste disposal was regulated by other legislation at a local authority level. Indeed, section 28(1) of the Environmental Protection Act explicitly stated that "no condition shall ... regulate the final disposal by deposit in or on land of controlled waste". This did not, however, prevent HMIP officials from imposing waste reduction conditions on prescribed substances had they felt it necessary. Emmott has found evidence that not only were no such conditions imposed, but that solid waste was often not quantified at all [21].

He concludes:
'This analysis supports the concern that land is not receiving the same attention as air and water (for which controls were set or releases prohibited in every case in the review). In the few cases where controls were set, the generous quantitative limits appear unlikely to constrain operators in practice, providing no real incentive for waste minimisation. These findings also suggest that HMIP may be failing to meet its statutory duty to prevent, minimise and render harmless releases of prescribed substances to land.'

It is also possible that there was a systematic bias amongst HMIP officials which considered emissions to air and to some extent to water as more serious than emissions to land. This would not be surprising since the majority came from an air pollution regulation background, and there is some evidence to support it [1]. However, it has been denied by one high level ex-member staff who give in evidence the fact that HMIP refused to insist on retrofitting of flue gas desulphurisation equipment on power stations, despite considerable pressure from environmentalists, on the grounds that it would create vast quantities of solid waste.

In summary, then, IPC has had no impact on solid waste generation because a) the legislation was a relic of 1970s thinking, focusing on pollution rather than resource use, b) it explicitly prevented conditions being placed on waste disposal practices, and c) the regulatory agency appears to have been more concerned about emissions to air and water.

4. THE LANDFILL TAX

The Landfill Tax entered the UK statute books as a small but important part of the 1996 Finance Act, an annual piece of legislation which implements the Budget provisions. Unlike most budgetary measures which remain secret until the budget speech, the intention to introduce a tax had been announced in 1994 to enable consultation to take place. Despite much attention before, during and after implementation, it has had only a minimal impact on the generation of industrial waste.

The landfill tax was unusual, although by no means unique, amongst government policies in being a solution in search of a problem. Several policy papers had committed the government to making more use of market mechanisms [18,22] and economists had started to appear in government departments. Economists naturally favoured economic instruments; Kingdon notes that "demonstrating there is indeed a problem to which one's solution can be attached is a very real preoccupation of participants in the policy process" [23, p.98] while Majone terms this tendency 'new toolism' [24, p.62], commenting that participants in the policy process have a favoured solution to problem which they look to apply in all circumstances. At the same time, concerns about over-reliance on landfilling, an option at the bottom of the waste management hierarchy, expressed by groups such as the government's own Advisory Committee on Business and the Environment [25,26] led economists to theorise that landfilling would be reduced if all the costs, including externalities, were to be reflected in landfill gate prices by imposing a tax.

That the landfill tax has not made a significant impact on the quantities of waste generated is due principally to its design.

Firstly, by choosing to apply a tax to change behaviour, policy-makers assumed that the target group was composed of economically rational actors each with sufficient information about the costs of waste to make a balanced judgement about its effects. The evidence is, however, that even quite large companies can be unaware of the direct costs of waste, let alone the true costs of waste taking into account such factors as loss of staff time dealing with it. Secondly, the rate of the tax was considered by many to be too low to lead to behaviour change amongst waste producers.

The two-fold objectives of the tax which initially appeared quite compatible came to be seen as conflicting when a review of the tax was undertaken in 1999; as a result the House of Commons Committee which carried out the investigation recommends [6, paragraph 76]: *in setting the level of future environmental taxes, the Government should decide whether the main aim is to make sure the polluter pays (in which case it will raise money but not necessarily change behaviour) or to change behaviour (in which case a higher rate of tax may be required)*

Thirdly, the policy designers failed to adequately take account of interaction of the tax with existing policies, notably on the prevention of fly tipping (which was expected to increase when the tax was introduced but no additional enforcement resources were allocated) and on the exemption of certain types of sites receiving waste from the need to be licensed (and therefore be subject to landfill tax). The latter meant that large quantities of waste were diverted away from licensed landfill into exempt sites for land reclamation and remediation purposes. While on the face of it this change in behaviour was precisely what was intended by the landfill tax, the lack of any regulatory control over what was going into such sites led to concerns about pollution while severe shortages of material which had previously been used for daily cover, site engineering and restoration at licensed sites were experienced. In summary, then, the landfill tax has failed to reduce the quantities of waste being produced by industry due to the way in which it was designed.

5. WASTE MINIMISATION

Waste minimisation is a methodology for achieving waste reduction. It involves auditing a company's waste, reviewing its waste management practices and implementing process or housekeeping measures to reduce the quantity being produced. The essence of waste minimisation is persuading companies that reducing waste is in their own interests, a message that a wide range of governmental organisations have attempted to convey over the last decade.

The main mechanism used by central government in the UK to promote waste minimisation in industry is the Environmental Technology Best Practice Programme or ETBPP. Its aim is "to promote cost effective waste minimisation strategies and clean technology within industry - in other words to reduce the impact of industry on the environment while, at the same time, helping industry to improve its competitiveness" [27, p.31]. However, a wide range of regional and local organisations became involved in conveying the message, some of which were concerned primarily with increasing the performance of industry and some with protecting the environment, forming an extensive informal network of apparently unlikely allies (Figure 1).

Table 2: Reductions in solid waste achieved by a selection of UK waste minimisation initiatives [29]

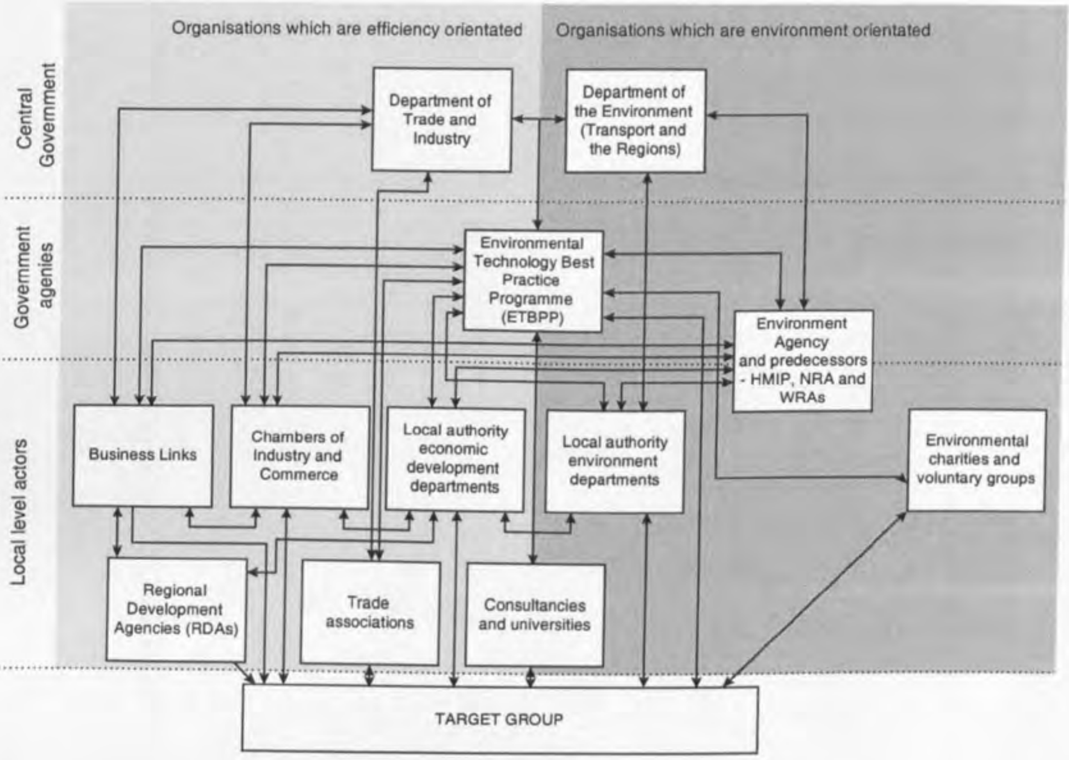
Initiative	Reduction (tonnes per annum except where otherwise stated)	
	Achieved	Potential
Aire and Calder[29]	4,800	623,000
Project Catalyst[29]	-	12,000
Dee[29]	87,000	130,000
Hereford and Worcester[29]	-	2,700
Leicester[29]	23,400	-
West Midlands[29]	1,300	-
Humber[31]	5,350	18,000
Northumbria[40]	-	8,000
Medway and Swale[41]	116,000	-
Don Rother and Dearne[42]	10,000 m^3	-

The effectiveness of waste minimisation on UK companies as a whole is impossible to measure since no information has ever been collected. Even assessing the success of a series of specific schemes is difficult as no standard approaches to measurement have been used [28] although table 2 attempts to do so.

It is clear that there is still considerable scope to reduce industrial waste as new companies entering clubs and schemes are still able to make savings. One of the reasons for this has been the failure of messages to reach the people within a company that need to be persuaded. The structure of most companies militates against easy persuasion since the people who recognise that there may be scope to make savings such as cleaners and maintenance staff are generally low down in the hierarchy. In addition, information on the costs of waste may never be presented to the Board in a manner that allows them to recognise the true costs of waste.

The design of the messages themselves may also be a factor. An analysis of a range of promotional literature from waste minimisation initiatives shows that five main messages have been used - an environmental message 'reducing waste is good for the environment', an economic message 'reducing waste is good for the bottom line', a compliance message 'reducing waste helps you comply with existing and forthcoming legislation', a corporate culture message 'a programme of waste minimisation can positively change corporate culture' and a public relations message 'reducing waste can create a more positive image of the company in the eyes of its stakeholders'. An economic message is the dominant one in both general awareness-raising publicity materials and materials aimed at recruiting companies to specific schemes or clubs, with headlines such as *Reduce Your Waste...Increase Your Profits* and *Minimise Waste - Improve the Bottom Line* commonplace [30,31].

Figure 1. Simplified diagram of the network of organisations involved in conveying waste minimisation messages in the UK



An analysis of a fairly typical (although not statistically representative) selection of publicity brochures shows that more than half of all benefits listed are economic followed by around one-fifth which are compliance-related. Although there is widespread acceptance that an economic message is persuasive to companies, there is some evidence to show that more immediate motivational factors include gaining an environmental management accreditation and complying with legislation [1].

Even in the late 1990s, companies remained sceptical or ignorant of the benefits of waste minimisation. A survey by the ETBPP published in 1996 [32] found that companies who had not undertaken waste reduction believed that an improved company image was the most common benefit of waste minimisation while the most common benefits cited by those companies that had implemented schemes were compliance with legislation, cost reduction and increased efficiency, in that order.

This suggests that focusing on cost savings is actually not the most persuasive message strategy and that they should instead stress compliance-related benefits and the contribution towards achieving environmental management accreditations.

The publicity leaflets tend to make extensive use of rational argument rather than emotional appeals and focus on incentives rather than threats. Trade associations interviewed as part of this research have suggested, however, that companies tend to respond more to threats than to incentives since threats are real and in the present while incentives are nebulous and in the future. This may be particularly true for smaller companies which often spend much of their effort 'fire-fighting' in the belief that they cannot afford to be proactive. However, Hovland *et al* [33] argue that threats must be meaningful ones if they are to be effective and their use should be accompanied by an acceptable means of avoiding the threat if they are not to be evaded by 'it won't ever happen', 'it won't happen for a long time', 'it won't happen to me' or 'it won't be so bad even if it does happen' types of self-reassurance.

Diffusion theory suggests that the nature of the so-called 'change agent' is an important factor in how persuasive the message will be [33,34]. The more the perceived similarities there are between the communicator of the message and the receiver, the more likely it is that the communicator will be perceived as credible and that the message will be accepted. Some of the change agents involved in waste minimisation activities in the UK are more similar to the target group than others. The Environment Agency, the main environmental regulator for England and Wales, for example, would appear to have a disadvantage in this respect since it must put a certain distance between itself and the companies it regulates. However, if compliance with legislation is a major motivating factor for companies as has been suggested above, this may be less of problem than it might appear.

In summary, waste minimisation appears not to have achieved its potential due to the structure of companies, the design of the messages and the choice of message conveyor.

6. CONCLUSIONS

IPC, the landfill tax and waste minimisation are three of the main ways in which the UK government attempted to achieve its objective of reducing waste during the 1990s. Of the three, waste minimisation is the most directly aimed at waste reduction but is the least coercive approach, IPC is only partially aimed at waste minimisation but is the most coercive while the landfill tax is only indirectly aimed at waste reduction and is relatively non-coercive.

The policy initiatives have been beneficial in many ways. IPC ensured that companies became aware of the true scale of their environmental impact and has reduced emissions to air and water; the landfill tax has encouraged inactive waste producers such as construction companies to seek more beneficial uses for their wastes and raised awareness amongst trade associations, local authorities and other umbrella groups of the costs of waste; and waste minimisation has encouraged some companies, admittedly a small number, to reduce their wastes and associated costs. Taken together, however, the three initiatives would appear to have made only a minimal impact on the overall quantity of waste generated in the UK.

IPC has failed to tackle solid waste production due to restrictions imposed by the separate waste management site licensing regime and, initially at least, by the orientation towards air pollution control of implementation agency officials. The landfill tax has not proved a sufficient market signal for producers of waste and, in addition, has resulted in increased fly tipping, an extra cost burden on local authorities, and the proliferation of sites exempt from waste licensing with the risk of uncontrolled burial of inappropriate wastes. Waste minimisation has failed to convince all but a tiny fraction of mainly large companies to reduce waste, leaving the small and medium companies which dominate the UK economy unconvinced of its merits.Although the current mix of policy initiatives has not achieved large scale reduction of wastes, this need not necessarily lead to such pessimistic conclusions as "waste prevention on a large scale is out of the reach of the instruments of waste management" [35, p.1] or to a loss of faith that the institutions of law and government can deliver "solutions to the multiple environmental crises we face" [36, p.69].

It remains the case that the reduction of waste is typically in the commercial interests of waste-producing companies [37]. The evidence from the case studies is that a) the signal is failing to reach appropriate decision-makers within companies, b) when the signal does get through, the costs of most types of waste are perceived as being fairly insignificant, and c) even when consideration is given by companies to waste reduction, the opportunity and transaction costs are often considered to be too great. The UK government has a variety of instruments available to it for tackling these remaining barriers to waste reduction which are discussed below.

Addressing failures in information flows

Government has four main approaches available to it to tackle the apparent failure in the market to convey the message that waste reduction makes commercial sense. Firstly, market signals seem to be taken more seriously by companies if they are conveyed, in surrogate form, by command and control instruments (37, p.133).

Secondly, information could be provided to help those within the company that receive market signals to interpret and act upon them. This might involve directing existing waste minimisation communicative instruments to company accountants, for example, rather than managing directors. Thirdly, companies could be required to prepare 'green' accounts in parallel with conventional accounts. Fourthly, the uptake of environmental accreditations such as EMAS and ISO140001 could be further encouraged by the government either through the supply chain, of which it forms a part, or by making accreditation compulsory as part of other command and control regimes such as IPPC.

Addressing the perceived low costs of waste

Two main approaches are available to the government to tackle the perceived low costs of waste, depending upon which of two possible explanations are regarded as most plausible. Firstly, it may be that companies fail to appreciate the true costs of waste, looking only at disposal costs. The true costs of waste are in the wasted raw materials and the wasted time and energy spent processing materials that at the end of the process are simply thrown away.

This would call for information campaigns, again perhaps directed at company accountants rather than environmental managers or managing directors.

Secondly, it may be that waste truly is an insignificant cost for many companies. This would require further government intervention into the market to increase the cost of waste, perhaps by increasing the rate of the landfill tax, by imposing new command and control instruments perhaps under the Producer Responsibility provisions of the 1995 *Environment Act*, or by increasing the price of primary raw materials through taxation.

Addressing opportunity and transaction costs

Even where companies are aware of the costs of waste and regard them as significant, waste reduction is often perceived to be a costly and time consuming exercise which the pressures of day-to-day survival do not allow. Examples showing short pay-back periods on investments have been widely publicised have largely failed to persuade companies. This may be because many company managers, particularly in traditional industry sectors, are by nature sceptical about new innovations, in which case a prolonged face-to-face persuasion campaign would be required to change their minds. It may be that there are currently insufficient case studies to cover every type and size of company with the result that managers do not perceive the opportunities available to their company in the descriptions of other companies; since every company is different in some small way to every other company, the distribution of case studies alone will never be effective if this is the case. It may also be that the organisations which have tried to persuade companies to join schemes have simply not been credible to companies. Finally, it may be that for some companies, investment in waste reduction would not pay. In such cases subsidies would be required to persuade companies to engage in waste reduction.

Despite statements that command and control regulation is out of date and unsuited to the complex problems of the modern world [38,39], the case studies have suggested that companies are more likely to respond positively to them than to either economic or communicative instruments. It would therefore seem foolhardy to reject such approaches as a matter of principle.

Although in theory economic instruments are more efficient than other forms of government intervention, the case studies have suggested that responses to them can be unpredictable and counterproductive. The case studies suggest that despite poor performance in the past in the UK, all three types of policy instrument will have a role to play in encouraging further reductions of industrial waste.

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APPENDIX 2

LONDON EXAMPLE

APPENDIX 2
WASTE MANAGEMENT IN LONDON

The intention of this paper is to provide an overview and appreciation of the problems and costs facing the capital in it's perpetual struggle of coping with an ever increasing mountain of waste, and to relate this to the new Greater London Assembly and the role of the media.

This review will be structured around 4 central themes; [1] the problems, [2] the policies, [3] the opportunities and [4] the future of waste management in London, and where appropriate different 'media' interpretations of waste and its management will be used for descriptive effect. The paper is concerned with key questions which we should all ask ourselves – [1] Waste generation; how much, by whom, and how to control it? [2] Waste treatment - which approaches, what policy measures and what is appropriate for London? and [3] Waste disposal - void availability, contract requirements, and policy drivers?

1. INTRODUCTION

The management of solid waste is one of the most challenging tasks of our industrial society [1]. Almost everything eventually becomes 'more or less' solid waste, whether we discard our used product or clean the effluents and the flue gases of our production processes, or discard useless raw materials generated in the course of production [2]. Humans and waste are related by definition. According to the EC Directive 75/442/EEC of 1994, "Waste is any substance or object, which the holder disposes of, or is to dispose pursuant to the provisions of national law in force." It appears that waste is simply a thing that humans do not want [3].

Around the world, the natural environment is becoming a primary driver of political action and behavioural change, and it is now impossible to deny the power of 'Green-Logic'. The Environment is a classic example of a policy field that infuses all others, where the targets and language are easy to adopt but achieving them is much harder [3]. Radical environmental progress can be achieved by changing one of the universal and most mundane activities; the way we empty our bins!

The solution is simple; 'developing new household habits and using new materials for doorstep collection' but the systems required to make it work at the right scale are far more complex! [4]

2. LONDON'S HISTORICAL PERSPECTIVE?

Rapid growth of London between the 18th and 19th centuries saw a marked deterioration in the quality of urban life as thoroughfares and watercourses were quickly choked with refuse and sewerage, and the medieval practices of throwing waste into the streets became intolerable [5]. From the mid 18th century there was a growing demand for London-wide public management of essential services including street cleansing. However it wasn't until the scientific advances of the mid 19th century and the rise of the public health movement that there was widespread recognition of the connection between dirt and disease! In 1856 the Metropolitan Board of Works was formed to co-ordinate highway maintenance and sewage, and in 1893 a by-law was passed making it compulsory for household waste to be removed from all premises in London at least once every week [6]. In 1889 the London County Council replaced the Board. During the period of the LCC each Borough assumed responsibility for both refuse collection and disposal.

At the turn of the 20th century there were three main methods of waste disposal; [1] Incineration with energy production, [2] Incineration only, and [3] Disposal by tipping. However, as the century progressed so the cheaper options of export and landfill became the norm.

Between 1940 and 1960 there was a rapid increase in waste generation and an associated increasing pressure on disposal [7]. The Royal Commission on Local Government in Greater London (1960) noted the need for 'immediate reform.' Under the London Government Act (1963) waste disposal was made the responsibility of the unified London wide government for the first time – making the largest Waste Disposal Authority in Europe, and collection became the responsibility of the London Boroughs. During the 1960's access to nearby landfill capacity was quickly exhausted, and waste was being transported over increasing distances.

At the same time only one of five planned incinerators was built, and there were problems being experienced with the use of the river for the transportation of waste [8]. The 1970's saw the beginning of a new approach focussed on the increased use of landfill at more remote sites using bulk transfer by rail, with 2 new rail transfer stations were constructed in West and North London. The 1980s were a more radical decade with an initial emphasis on the employment creation potential of recycling. 1986 saw the demise and abolition of the GLC with 21 London Boroughs grouped into 4 statutory WDAs, with the remaining Boroughs becoming waste collection and disposal authorities [9], as noted in Figure 1.

Figure 1. Waste Groups in London [2]

3. THE ORGANISATIONAL STRUCTURE

Prior to 1965 each of the 90 local authorities in the Greater London area were responsible for both waste collection and waste disposal [7]. This changed as a result of the London Government Act (1963) when the 32 London Boroughs and the City of London were made responsible for waste collection.

At the same time the Greater London Council responsible for waste disposal [8]. In 1986 the GLC was abolished, and with it Europe's largest Waste Disposal Authority.

Under section 10 of the Local Government Act (1985) waste disposal in London became the responsibility of 7 groups of boroughs on a voluntary basis with each borough becoming a disposal authority within their own right [10]. The remaining councils were divided into 4 groups as a result of a decision by the Secretary of State, with each group becoming a statutory WDA [2]. This resulted in 33 London Councils as waste collection authorities (WCAs) being served by 16 waste disposal authorities (WDAs), this makes co-operation and partnerships almost impossible! Currently the average London Borough collects & disposes of 100,000 tonnes at a cost of £10.2 million per annum! [11]. This is indicated in Figure 2.

Figure 2. The public face of waste management – the refuse collectors (source : author)

4. THE GREATER LONDON ASSEMBLY?

One of the shortcomings of London 'governance' inherited from the last government was the ability to plan and deliver a London wide waste strategy [12].

It is widely recognised throughout the industry and local government that the current situation has to change. With the recently appointed Mayor of London and the newly elected Greater London Assembly (GLA) the UK's capital now has a system of power in relation to the environment similar to that which exists in New York – the question is 'will the Mayor be able to deliver an effective waste management strategy for London, which is both environmentally, socially and economically acceptable?'

There is no argument that the existing waste strategy for London must change and that it must become a central part of the environmental policy work of the new Greater London Assembly [13]. For 'sustainability' to become central to the planning, strategic thinking, and daily activity of life in London, the knock-on effects of solid waste management in terms of traffic, air pollution, greenbelt, planning and local communities and economies must all be resolved [14]. It is important that any strategy for waste endeavours to integrate waste management into strategies for employment, economic development, transport and air quality.

The Greater London Assembly's (GLA) role will centre upon making municipal waste a strategic and core issue, whereby targets for the Boroughs will be set, annual 'public' reports on target attainment must be published, a 'Statement of the Environment' report will be produced, and they will have some power over contract decisions. The Mayor will have considerable powers of direction over waste, allowing some opportunity to co-ordinate municipal waste management across all tiers of Government [15].

According to Darren Johnson, holder of the GLA environment portfolio the immediate focus for the GLA on waste will be [13];

- Achieving best practice in waste management
- Promoting public awareness of waste minimisation and recycling
- Establishing new markets for recyclates

5. LONDON'S WASTE CREATION?

Waste production in London varies from borough to borough, with the greatest production in Hillingdon with 1.21 tonnes per household per annum, and Enfield (1.16 tonnes), and the lowest production in Kensington & Chelsea (0.60 tonnes) and Tower Hamlets (0.54 tonnes). In the last 15 years the amounts of waste generated in the capital have increased by nearly 30%, and municipal solid waste is continuing to rise at between 3 and 4% per annum! This resulted in 3.45 million tonnes of MSW being generated in 1998-99, 76% of which was exported to the Home Counties for disposal [16], and 70% of the materials travelled more than 75 miles for its disposal! In the last 5 years the tonnage of Municipal Solid Waste (household and similar commercial wastes) landfilled has increased (although in percentage terms it has decreased from 73% to 69%), Energy from Waste has remained constant (18%), and waste diversion has increased [17] from 9% to 13% (with materials recycling increasing from 7% to 10%, and composting increasing from 2% to 3%).

Variations in Borough waste generation rates [16];

- Hillingdon 1.21 T per household per annum
- Enfield 1.16 T per household per annum
- Hounslow 1.14 T per household per annum
- Havering 1.13 T per household per annum
- Lambeth 0.61 T per household per annum
- Westminster 0.60 T per household per annum
- Kensington 0.60 T per household per annum
- T. Hamlets 0.54 T per household per annum

Historically, the areas around London have understandably objected to being used as a dumping ground for London's waste [18].

Essex as a county has historically been the home for a significant portion of London's waste disposal (approx. 50%) throughout the last 50 years. However, the County's current strategy looks to decrease this amount to only 12% of London's exported waste by 2010! This is another driver forcing London to re-assess its approach towards the management of the capital's waste [19].

Clearly, any effective strategy needs to cut down exports from London to landfill by two-thirds by 2015, by taking stewardship over the resource potential of London's waste for reprocessing [20]. The aim is to establish 'closed-loops', but ones that are local in order to minimise road traffic generation [16]. One approach would be home composting of household organics, which represents the most localised of closed loops, whilst another would be community composting for neighbourhoods. Through organics management and the processing of used paper products up to 60% of household waste could be effectively minimised at close to home locations thus limiting the need to transport waste or dispose of it [21].

6. THE EXISTING INFRASTRUCTURE?

The capital has 500 waste collection vehicles, containers, barges, and specialist transporters in operation every day. There are 17 major MSW transfer stations, 45 CA sites, 2 operating incinerators, 8 Recycling Centres (MRFs), 15 small recycling centres, 2 compost sites, and 18 registered landfill sites. However only 2 landfill sites are actually accepting MSW from the capital! There are also only 2 Energy from Waste plants SELCHP processes 420,000 tonnes of MSW per annum, and Edmonton processes 600,000 tonnes), managing about 10% of the capital's waste stream [22].

This significant infrastructure is clearly not enough to manage adequately the waste generated by the capital's residents and businesses. According to David Streeter (London Borough of Richmond upon Thames) "there is an absolute priority for a waste management strategy because London is reaching crisis point, especially on landfill!"[18]

For every million tonnes of waste generated, 100,000 lorry journeys are required, and this can create serious problems for the capital in terms of atmospheric pollution, congestion and wasted time [22]. The River Thames has a central part to play in the management and transportation of the capital's waste [23].

The Thames is the only inland waterway in the UK carrying significant quantities of waste (about 18% of the capital's MSW is transported by river as noted in Figure 3), and on an average day 2,500 tonnes of MSW is loaded onto barges and pulled by tugs to landfill in Essex, with each tug journey equivalent to 80 or 90 lorry journeys!

Figure 3. Transporting waste from central London to landfill by barge on the Thames [23]

Currently 18% of London's municipal waste stream is taken by barge on the river for disposal in Essex. This should have increased to over 20% by 2005 as new waste contracts are let around the capital [23]. The riparian boroughs (those on the river) currently send 39% of their municipal waste by river for final disposal, and it is expected that this figure will exceed 54% within the next 5 years!

Cory Environmental move 2,500 tonnes of waste every day from Tower Hamlets, the City, Battersea and Wandsworth out to Mucking in Essex, and recently unveiled their new £3 million waste tug ' Regain' which is the first new waste tug for 30 years on the Thames [23].

The Cory fleet currently extends to 9 barges and 47 tugs (Figure 4). It has been suggested that if Cory were to move the 600,000 tonnes of waste it carries every year by road it would require 400 more lorry movements every day!

Cleanaway also transport 100,000 tonnes of industrial waste by the river from Bromley by Bow, and 100,000 tonnes of Westminster's municipal waste from a wharf in Battersea to their Rainham landfill site in Kent [22].

Figure 4. The loading dock in Wandsworth for the Cory fleet of 'waste' barges (source: author)

7. RECYCLING IN LONDON

The average recycling rate across London is about 10% [24]. The best recycling rate is Sutton (29.2%) and the worst is in Hackney (2.2%). The top 6 Recycling Boroughs (in terms of % of waste diverted from landfill) are all in outer-southern London [16]; and 5 of the 6 operate their own disposal facilities (providing them with autonomy over decisions regarding their waste).

These boroughs are also characterised by homes with gardens, space and green waste processing facilities, whilst being reflective of middle-class suburbia where recycling is more likely to be a recognised social habit [24] see Figure 5. The inner London Boroughs have lower recycling rates on average, and of the bottom 13 boroughs 10 are inner London!

Recycling rates also appear lower in Boroughs where there are high levels of deprivation, or so say a recent report from the consultants Oakdene Hollins [24]. Currently 11 London Boroughs send some of their household waste for energy recovery, whilst 21 use landfill only. Using the DETR Deprivation Index (1998) the boroughs using landfills as their primary disposal option have a mean score of 17.6, whilst those boroughs using EfW have a significantly higher deprivation score of 24.4.

There is a strong correlation between deprivation index and recycling rate (0.67) regardless of disposal method as noted in Table 1. This suggests that local authorities in poorer areas give priority to investment in better housing or schools rather than to recycling.

Table 1. Recycling and Deprivation in London

Borough	Deprivation Score	Recycling	Disposal Route
Sutton	0.84	29.16	Landfill
Kingston	2.40	17.26	Landfill
Bromley	3.74	18.07	Landfill
Richmond	5.00	21.99	Landfill
Bexley	5.27	21.55	EfW
Harrow	5.43	8.97	Landfill
Havering	5.52	6.80	Landfill
Barnet	7.35	8.25	Landfill
Merton	8.31	13.38	Landfill
Hillingdon	8.75	8.67	Landfill
Redbridge	12.80	6.11	EfW
Croydon	13.12	21.84	Landfill
Enfield	16.65	8.80	EfW
Kensington	18.54	18.98	Landfill
Hounslow	18.89	11.48	Landfill
Westminster	19.05	14.40	EfW
Ealing	24.48	12.72	Landfill
Wandsworth	25.05	12.06	Landfill
Waltham Forest	26.68	7.83	EfW
Brent	26.95	3.53	Landfill
Hammersmith	28.19	11.57	Landfill
Camden	28.23	11.57	EfW
Barking & Dagenham	28.69	5.11	Landfill
Lewisham	29.44	5.2	EfW
Greenwich	31.35	8.01	EfW
Haringey	31.53	7.30	EfW
Lambeth	31.57	6.99	Landfill

Islington	32.21	5.45	EfW
Southwark	33.74	4.30	Landfill
Tower Hamlets	34.30	2.72	Landfill
Hackney	35.21	2.16	EfW
Newham	38.55	4.81	Landfill

If this were the case then imposing similar recycling targets for all London Boroughs would be an ineffective method of driving recycling in the capital! The data shows that in 1999, those boroughs using EfW plants had an average recycling rate of 8.9% for their MSW, whilst the other boroughs had an average recycling rate of 11.8%

Figure 5. London Borough Municipal Recycling Rates [25]

The most likely reasons for the existence of variation in recycling performance are; CA sites, high rise flats and waste composition.
The Inner London Boroughs have much poorer access to Civic Amenity sites and are thus not able to process the sorting of garden wastes which significantly help increase recycling rates in the leafy green suburbs.

The proliferation of high-rise tenement blocks in the inner city cause a number of problems for recycling programmes. They will not be serviced by the common door to door recycling systems that most suburban residents are offered, and the use of 'chutes' for waste disposal makes recycling and source segregation of material both arduous for the residents in time and effort as there will be limited storage space and limited access to facilities.

Inner London boroughs have less garden acreage per household and thus there is generally less green waste in the bin which could be composted or digested, the inner city bin is more commonly packaging which is harder to process because of the mixed-material nature of most packaging (see Figure 6).

Figure 6. Recycling in London Boroughs cannot keep pace with increasing waste generation [25]

	Sutton		Richmond		Bexley	
	Recycled (%)	Waste to landfill (t)	Recycled (%)	Waste to landfill (t)	Recycled (%)	Waste to landfill (t)
1994-95	15.9	42,950	21.6	48,583	10.3	95,603
1995-96	22.9	42,179	23.3	48,857	11.8	95,077
1996-97	27.5	43,360	23.7	49,572	15.5	94,459
1997-98	28.0	45,901	25.0	48,275	17.2	96,006

Britain has conspicuously failed to take advantage of the economic and social opportunities that recycling and materials recovery [26] offer, with leading European nations recycling 40% of their municipal waste steams whilst we in the UK are struggling to reach 10% (Figure 7). Britain has also been largely by-passed by the secondary materials revolution with it recycling only 16% of steel cans (compared to 80% in Germany), 30% of glass bottles (89% in Switzerland), and 38% of its paper (71% in Germany).

Despite the largest 'urban forest' in Europe, Britain still imports 60% of its paper and 25% of its pulp for the paper industry. Instead of leading the change to recycling and building an industry behind it, the UK has been a follower, with waste remaining as and still treated as waste- the dirty discards of society! [3]

Figure 7. Waste Management Options in London [25]

Recycling has not 'taken off' in the UK for economic reasons- no one can afford it! Local authority budgets have continued to be squeezed and for most councils recycling has remained a marginal service, funding bring-banks and low intensity kerbside paper collections, which have historically paid for themselves [27]. Recycling has also failed to attract private investment because in itself it is not a profitable business!

Thus, it is not surprising that recycling remains low on the business and political agendas. Recycling remains something that people want but can't afford (Figure 8) or something that people have no incentive to want! It is against this backdrop that household waste management issues and concerns in London must be discussed [28].

8. GOVERNMENT WASTE POLICY?

The Draft Waste Strategy for England and Wales- 'A way with waste' was published in July 1999 [29].

At the heart of the draft strategy is implementation of the Best Practicable Environmental Option (BPEO) for wastes (management) which is to be delivered through the application of the waste hierarchy and the proximity principle.

The hierarchy is a guide to the management approaches open to waste and their preferred order (from waste avoidance and minimisation, through recycling, recovery and finally disposal), whilst the proximity principle states that wastes should be management and ultimately disposed of as close to their point of origin as possible.

A number of provisional targets were outlined in this strategy (all of which are non-statutory guides for local authorities);

- Recovering 45% of the 17 million tonnes pa of household waste generated by 2010
- 30% of the total must be recycled or composted
- 40% recovery and 25% recycling and composting by 2005

Figure 8. Waste Management costs in London [25]

However, in June 2000, the Government launched its new Waste Strategy for England and Wales [30] with some minor revisions to the targets suggested.

In order to ensure that the UK complies with the EU landfill directive, the following MSW recovery targets apply;

- To recover 40% by 2005
- To recover 45% by 2010
- To recover 67% by 2015

From these targets statutory targets have been set for Household waste, and these will be the base level, which London must strive towards;

- To recycle or compost at least 25% by 2005
- To recycle or compost at least 30% by 2010
- To recycle or compost at least 33% by 2015

This will mean that London (if the targets are enforced at the regional scale) will have to increase it's recycling and composting levels from the current 13% (in the year 1999-2000) to a minimum of 25% by the year 2000, and in terms of tonnage this will require more than a doubling of throughput because of the average per annum increase in waste generation of approximately 3%. However, of perhaps greater significance for the management of the capital's waste is the Landfill Directive – which has mandatory targets that the UK must achieve [31].

Article 5 of the Landfill Directive requires the progressive diversion of biodegradable municipal waste from landfill in order to reduce the impact of landfill gas emissions on the global atmosphere. There are two major issues; [1] limit the use of landfill, and [2] build up the use of alternatives. Compliance with EU biodegradable waste reduction targets (to 75% of 1995 levels by 2010, to 50% by 2013 and to 35% by 2020) will require intensive development of new facilities across the country as indicated by the DETR [31];

- 28 - 165 new EfW plants (200,000 tpa each)
- 100 - 200 new MRFs at 50,000 tpa each
- 150 - 300 new composting plants at 20,000 tpa each

The implications for London are rather significant. London will need to divert 3.4 million tonnes of biodegradable material from landfill by 2020. This is the equivalent to the diversion of 5.4 million tonnes of crude (unsorted MSW) (assumes that 63% of municipal waste is biodegradable). This would require an additional 10 EfW facilities or another 30 materials processing facilities. London is clearly a long way from this scenario! [22]

In July 1997, the Labour Government confirmed that it intended to replace Compulsory Competitive Tendering with a duty for local authorities to obtain Best Value in providing services to local taxpayers. In March 1998, a consultation paper was issued on the subject of Best Value and this was followed in July 1998 by a White Paper describing the new Modern Local Government, which establishes the key elements of the Best Value framework. Best Value is described in the White Paper as: '...a duty to deliver services to clear standards – covering both cost and quality – by the most effective, economic and efficient means available. In carrying out this duty local authorities will be accountable to local people and have a responsibility to central government in its role as representative of the broader national interest'. [33] Local authorities are required to: [1] Challenge why and how a service is being provided, [2] Invite comparison with other local authorities' performance and the private sector across a range of indicators, [3] Consult with the local taxpayers, service-users and the wider business community on the service, and finally [4] Embrace fair competition as a means of securing efficient and effective services [22].

9. THE APPROACH NEEDED?

In 1965 the GLC proposed three main approaches to London's waste problem [9];

- The use of the Thames as the main conduit for waste disposal for boroughs bordering the rivers
- Direct delivery to controlled landfill sites for boroughs, particularly those in outer London, close enough to landfills for it to be economic
- The building of a new generation of incinerators to replace the 17 older facilities which were inherited by the GLC to service the remaining parts of London

In 1982 the GLC was sending 33% of its MSW to Essex for disposal, 22% to Kent and 13% to Hertfordshire. Only 6% of the MSW generated in the capital going for disposal was being landfilled within the boundary of Greater London! As early as 1985 it was advocated that a waste Disposal Plan for Greater London was essential as an effective basis for liaison between authorities throughout the region [5].

However, 16 authorities in Greater London are currently required to produce a waste disposal plan!

The Greater London Council's (GLC) original waste disposal strategy for London (dating from the late 1970s) was to build 5 or 6 municipal incinerators, of which Edmonton was the first and only one to be built. Each was to have a capacity of 500,000 tpa. However, in comparison to other major cities throughout Europe, London (16%) has a significantly lower proportion of its waste going for recovery (EfW); Paris 43%, Amsterdam 40%.

In 1986 the GLC was disbanded leading to a decade of increasing fragmentation, and the planning of London's waste was left to the London Waste Regulation Authority. They proposed in 1995 [7];

- To promote the concept that London must become more self-sufficient in waste management
- To promote an environmentally optimum waste transport policy for London and to encourage rail and river as the preferred means of transport
- To ensure the reduction of waste requiring final disposal
- To encourage the recycling initiatives of industry, boroughs, voluntary groups and schools
- To encourage the development of WtE facilities and thus reduce the amount of waste disposed of by landfilling
- To encourage the development of land raising, wherever suitable

This expected move away from landfill will place an important role on the planning system in London to deliver the land-use elements of this change.

Land-use planning (in relation to solid waste management) has traditionally been concerned with the provision of sites for the disposal of residue waste. However, in the recent past this emphasis has begun to shift, and the London Planning Advisory Committee (LPAC) strategy proposes an 'about turn' in emphasis towards a proactive policy of support for waste diversion and materials reprocessing, and ensuring that waste management is undertaken in a way which supports rather than runs against the goals of sustainability and road traffic reduction in London [17].

One of the goals of an intensive recycling strategy is that London should take responsibility for its own waste (see Table 2). Throughout the 20th Century, the areas around London have understandably objected to being used as a dumping ground for London's waste. Clearly, any strategy needs to cut down exports to landfill by two-thirds by 2015, by taking stewardship over the resource potential of London's waste for reprocessing [34]. The aim is to establish 'closed-loops', but ones that are local in order to minimise road traffic generation. There will always be a 'trade-off' between locality, specialisation and scale of operation, when discussing any form of industrial manufacturing, and it is no different for solid waste management facilities and infrastructure (noted in Table 3). It would seem logical for Aluminium can recycling to remain 'national' for the time being because of the size of the established processing plants outside of the capital [34], but for organics and paper the sites for processing could be much more localised and centred in and around the capital [22].

10. LOCAL IMPLICATIONS?

Local authorities are holding back from making difficult decisions on new waste plans and facilities so that they can be informed by a London-wide strategy [35]. But for how long can authorities hold-off from making these decisions? Approximately 60% of MSW contracts are due for renewal by 2005, and there is an ever increasing amount of legislation being introduced dictating how waste should be diverted from landfill by 2005 and 2010. Clearly the time for change is now!

Table 2. Waste disposal routes out of London [7]

Route	Method	Tonnes	%
Direct to Landfill in Greater London	Road	27,061	1
To landfill in Greater London via transfer station	Road	9,728	1
To landfill in Greater London via transfer station	Barge	117,222	4
Incinerated at Edmonton	Road	271,148	9
Total deposited in Greater London	-	425,159	13
Direct to Landfill outside Greater London	Road	268,772	8
To landfill outside Greater London via transfer station	Road	1,023,765	32
To landfill outside Greater London via transfer station	Rail	632,125	20
To landfill outside Greater London via transfer station	Barge	550,401	17
To landfill outside Greater London via CA site	Road	284,264	9
Total to Landfill outside Greater London	All-	2,759,327	87

Table 3. Waste Management Planning for London (thousand tonnes) [17]

	1995	2000	2005	2010	2025
Reduction	-	-	169,000	331,000	483,000
Re-use	-	-	85,000	81,000	77,000
Domestic Recycling	200,000	500,000	561,000	643,000	611,000
Composting	86,000	184,000	572,000	594,000	616,000
CA site Recycling	-	162,000	333,000	45,000	605,000
Residual waste	3,100,000	2,540,000	1,666,000	1,287,000	994,000
Total MSW	3,386,000	3,386,000	3,217,000	3,056,000	2,903,000
Diversion	8%	25%	51%	62%	71%

11. A REGIONAL APPROACH?

Every year 32 million tonnes of waste is generated in the South East (of which 75% million waste creation, transfer and disposal which is regional in scale encompassing much of the SE! [36] Thus, there is a clear need for a regional context for the management of waste, if only because London is simply incapable of managing the wastes that it generates on its own! [37]

London generates about 17 million tonnes of waste annually, of which 9.3 million tonnes (55%) are transported for disposal to sites outside London whilst 5.7 million tonnes (34%) are recycled or recovered within London (Figure 9).

However, London's landfill capacity is very small, with only 1.6% of the regional total, yet having to account for 10.6% (1.8 million tonnes) of the capital's waste stream. A regional emphasis would undoubtedly require greater monitoring of landfill availability and waste flows, improved guidance on the regional problem, and more emphasis on greater co-operation (see Figure 10) [22]. But this would all benefit the chaotic and discouraging situation we have today!

12. CONCLUSIONS

There is no argument that the existing waste strategy for London must change and that it must become a central part of the environmental policy work of the new Greater London Assembly (GLA). For 'sustainability' to become central to the planning, strategic thinking, and daily activity of life in London, the knock-on effects of solid waste management in terms of traffic, air pollution, greenbelt, planning and local communities and economies must all be resolved [38]. It is important that any strategy for waste, endeavours to integrate waste management into strategies for employment, economic development, transport and air quality

Figure 9. Waste flows out of London [11]

Figure 10. Options for disposal from London [11]

In principle London ought to become more self-sufficient in dealing with its own waste. However, there has always been a strong symbiotic relationship between London and the rest of the SE and this will need to continue in the short to medium term. Without London there would not be as many employment or market opportunities, or entertainment and other facilities for many in the South east, clearly the rest of the SE needs London and must in turn be prepared to support London as London supports them [39]. However, given the tight geographical constraints within which the waste management system for London is forced to operate I do not foresee a time when it is totally self-sufficient.

There is a clear and urgent need for action to tackle London's waste problem, and strategic planning policies will be important in this. The severity of London's impending waste management crisis demands concerted and imaginative action over the next few years!

The issues that need closest immediate consideration are;

- Finance
- Materials marketing (recycled goods)
- New processing investment (expansion of London reprocessing industry)
- Social marketing (promotion and education)
- Professional development (recycling expertise)

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APPENDIX 3

MSW PLANNING IN NYC

APPENDIX 3

MUNICIPAL SOLID WASTE PLANNING IN NEW YORK CITY

Years of citizen disquiet finally caused the City and State of New York (USA) to recently agree to a legislated closure of the Fresh Kills landfill site by the year 2001. At the time of the decision, this landfill site handled over 80% of the City's non-commercial wastes. Not only this but the City was also in defiance of the local law requiring to recycle 25% of the residential waste stream. However, the closure decision was still made without any prior solid waste management planning. This paper provides some background on the Fresh Kills site, reviews how the closure decision came about and describes the planning process that ensued after the decision was made, including the Borough and City-wide Fresh Kills Closure Task Force reports written since the legislation was enacted. The most notable alternative recommendations came from the Manhattan Solid Waste Management Task Force are also described. The paper illuminates the continuing and often tense debate that exists between six Citizens' Solid Waste Advisory Boards, the City Council, and the City Administration to determine whether and how to expand reduction, recycling and composting. In light of closing the City's only disposal facility the answer the City favours has been to export 80% of its residential and institutional waste streams to other neighbouring States for ultimate disposal. Finally, the paper describes the repercussions that the Administration's announced plans for export have had in the communities in and around New York City that are the most likely destinations for the City's waste in the near future.

1. CONTEXT

The twentieth century and particularly the period since World War II (post 1945) has seen a dramatic increase in the production of waste globally, reflecting unprecedented world-wide levels of economic activity. One estimate for the USA suggests that municipal solid wastes (MSW) have increased five times as quickly as the population during the period 1920 - 1970 [1].

This increase in the MSW stream of western economies can be attributed to a number of factors including; rising levels of affluence, cheaper consumable products, the advent of built-in obsolescence, the proliferation of packaging, changing patterns of taste and consumption, and the demand for convenience goods [2 and 3].

Figure 1. Waste in New York State (source : author)

However, it is not simply the growth of the waste stream and the record levels of consumption for raw materials and energy that has raised concern; there is the environmental impact of the disposal of these wastes through the use of landfill and incineration, the escalating costs of waste collection and disposal, and the changing composition of municipal waste with greater quantities of toxic materials derived from a variety of products which society must adequately deal with [2].

2. UNITED STATES MSW MANAGEMENT PRACTICES

During the 1980's, the 'perceived trash' problem emerged as a potential crisis in many parts of the USA because of increasing amounts of municipal solid waste, shrinking landfill capacity, rising costs, and strong public opposition to new solid waste facility sites (Figure 2). Across the USA the 'trash' problem is a top priority with planners because capacity to 'process' solid waste is declining dramatically (see Table 1). Thus, disposal costs are rapidly escalating, especially for the more crowded urban areas of the USA.

In spacious Nevada communities pay as little as $20 (£14) per ton for disposal, whilst communities on the East Coast may pay in excess of $250 (£170) per ton to ship their waste hundreds of miles for final disposal. Higher transportation and land acquisition costs in the future threaten to exacerbate the situation [4].

In the coming decades, more of the available landfill capacity will have been utilised as landfills reach capacity, become environmentally unsafe, or face closure because of public opposition [5]. This trend is common throughout the USA, but is more evident and particularly acute in the highly urbanised East Coast States, including New York.

According to the EPA [6] *'in 1994 a total of 209 million tons of MSW was generated in the USA, with the per capita generation rate at 4.4 pounds per person per day, compared to 2.65 pounds per person per day in 1960 and 3.58 pounds in 1980.'* By 1996 MSW generation in the US totalled 231.2 million tonnes, reflecting a 20 million ton increase from 1994. This represents a per capita generation rate of 9.48 kg per day. However, recycling and composting recovered 24% of MSW in 1994 (49 million tons), 21% in 1993 and 17% in 1990 [6], as indicated by Figures 2 and 3. This upward trend in recycling rates has helped to offset the continuing rise in waste generation and production that is prevalent in the USA (see Table 1).

This has meant that although the proportion of MSW going for ultimate disposal in landfill has been reduced from 84% (1990) to only 61% (1998) actual tonnages have remained relatively stable; 225,960 tons (1990) compared to 207, 684 tons (1998) which is equivalent to a decrease in MSW being landfilled of only 8%. Clearly landfill sites cannot continue to be infilled at this rate or problems of disposal site availability will become very real in the very near future.

Figure 2. MSW disposal and recovery in the USA [7]

Table 1. MSW generation and treatment in the USA [8]

	1960	1970	1980	1990	1992	1994	1996	1998
Generation ('000s tons)	88,120	121,060	151,460	269,000	280,675	306,886	326,709	340,466
Recycled	6.4%	6.6%	9.6%	6%	11%	15%	22%	24%
Composted	-	-	-	2%	3 %	4%	5%	6%
Combusted	30.7%	20.5%	9.0%	8%	10%	10%	10%	9%
Landfilled	62.9%	72.9%	81.4%	84%	76%	71%	63%	61

2.1 Landfill

Municipal solid waste landfills are used commonly to dispose of the majority of the nation's municipal solid waste (Figure 3), and will continue to be an essential element of sustainable waste management planning and practice in the near future. According to the United States EPA [7] '*Because all landfill have a finite lifetime, and because many are expected to close due to stricter regulation, communities are necessarily faced with the need to site new landfills, which has become increasingly more difficult in many parts of the country because of public opposition, environmental awareness and lack of available space. Modern municipal solid waste landfills are coming under increasing scrutiny, and as a result will be more protective of the environment in future*' [6].

This indicates that landfill will no longer be tolerated as the sole method of waste management for any community.

Figure 3. Breakdown of US Municipal Solid Waste Management Practices [6]

The management of municipal solid waste is changing dramatically in the United States. Landfills are filling up, new sites for landfills and combustion plants are getting harder and harder to find, and disposal costs are rising significantly. In response to these challenges, more and more communities are adding alternative management techniques that do not rely solely on the disposal of waste [9]. The United States must find a safe and permanent way to eliminate the gap between waste generation and available capacity in landfills, incinerators and in secondary materials markets.

Currently, according to Clarke [10], *'State strategies force local governments to look beyond a singular solution of today's problem to a comprehensive waste management plan.'* This situation may sound familiar to audiences in Western Europe where decreasing void availability and increasing environmental concerns have forced a re-examination of MSW management approaches by most nations.

Clearly the problems associated with waste management in the US are beginning to force response and reaction from all tiers of government as noted by the US EPA [7]. 'Our nation has choices as to how we are going to deal with our ever-growing garbage problem. We can continue to create more and more garbage, or we can cut back. We can continue to bury most of our waste, or we can find feasible ways to recycle more of it. We can design products and packaging without considering disposal or we can design for source reduction and recycling. We can wait for local crises to occur or we can plan now to avoid them. In short, we can ignore the issue and hope it goes away, which it will not, or we can act now to deal with it. But whether we like it or not, our garbage is no longer out of sight and out of mind.'

There have been considerable changes in the *'State of Garbage in America'* since 1989, the first time that the journal *'Biocycle'* attempted to draw the baseline of municipal solid waste management in the US. The total number of landfills in the US has continued to decline since the 1960's, and for the first time fell below 3000 in 1998 (2514) with an annual decline of 577 from 1997. Much of this decline is attributed to Alaska, which in 1997 had 700 sites, but in 1998 had only 296. Twenty-three States reported declines in the number of active landfill sites.

However, even as the number of landfills has plunged over the last decade, available capacity has actually increased. This increase in capacity can be explained by the increasing common practice of large regional landfill sites at greater distances from urban centres at the expense of larger numbers of smaller-scale landfill sites on the periphery of the urban fabric. In this time not only has the capacity of landfill increased (counter to predictions in 1989), but so too has the cost of access to it.

A decade ago, tipping fees for much of the US of only $10 (£6) per ton or less were common, but now only Wyoming has a landfill cost that can match this, with the previous national average of $30 [8]. Of the 37 states that provided an estimate, 13 States expected landfill capacity to exceed 20 years. However, there is a clear regional variation in landfill availability and MSW treatment routes as noted in Table 2. As more landfills close, transfer stations will become the primary facility for handling MSW on a local basis.

Table 2. Waste Generation, Disposal and Treatment in the USA [8]

	MSW (thousand tons / yr.)	Recycled (%)	Incinerated (%)	Landfill (%)	No. of Landfill Sites	Remaining Capacity (yr.)	Average tipping fee ($/ton)
Alabama	5,549	23	5	72	30	10	33
Alaska	560	7	15	78	296	-	80
Arizona	5,700	18	0	82	59	-	22
Arkansas	4,287	36	1	63	23	20	27
California	45,000	30	0	70	286	28	33
Colorado	3,084	18	0	82	70	-	-
Connecticut	2,950	23	60	17	3	10	54
Delaware	1,189	31	20	49	3	20	59
D. of Columbia	246	8	92	0	0	-	-
Florida	23,617	40	17	43	101	-	43
Georgia	14,645	33	1	66	95	12	25
Hawaii	2,125	25	27	48	8	-	55
Idaho	886	-	-	-	27	-	22
Illinois	13,386	28	0	72	50	9	-
Indiana	7,171	23	10	67	38	-	28
Iowa	3,462	32	1	67	61	-	33

	MSW (thousand tons / yr.)	Recycled (%)	Incinerated (%)	Landfill (%)	No. of Landfill Sites	Remaining Capacity (yr.)	Average tipping fee ($/ton)
Kansas	4,250	11	0	89	55	-	23
Kentucky	4,418	28	0	72	26	14	28
Louisiana	3,894	14	0	86	24	-	23
Maine	1,339	41	40	19	8	10	-
Maryland	5,329	29	23	48	26	10	-
Massachusetts	7,160	33	45	22	47	6	-
Michigan	13,500	25	10	65	62	18	35
Minnesota	4,780	42	30	28	26	10	50
Mississippi	2,360	13	4	83	23	10	18
Missouri	7,896	33	0	67	27	9	-
Montana	1,039	5	2	93	34	20	35
Nebraska	2,000	27	0	73	23	-	25
Nevada	3,955	15	0	85	23	75	20
New Hampshire	1,200	25	14	61	19	8	50
New Jersey	8,200	45	18	37	11	12	61
New Mexico	1,400	12	0	88	93	20	23
New York	28,800	39	12	49	34	-	-
	MSW (thousand	Recycled (%)	Incinerated (%)	Landfill (%)	No. of Landfill	Remaining	Average tipping

	tons / yr.)				Sites	Capacity (yr.)	fee ($/ton)
North Carolina	9,843	26	1	73	44	10	27
North Dakota	510	21	0	79	15	40	30
Ohio	12,339	19	1	80	54	18	29
Oklahoma	2,500	12	10	78	42	-	19
Oregon	3,836	28	7	65	40	40	25
Pennsylvania	9,440	26	21	53	48	11	49
Rhode Island	477	23	0	77	4	12	35
South Carolina	8,361	26	1	73	30	21	29
South Dakota	510	42	0	58	15	10	30
Tennessee	9,496	40	4	56	34	10	30
Texas	21,738	-	-	-	186	25	25
Utah	3,760	19	8	73	53	20	20
Vermont	600	30	15	55	6	3	55
Virginia	9,000	35	18	47	72	30	35
Washington	6,527	48	4	48	23	-	-
West Virginia	2,000	20	0	80	19	20	35
Wisconsin	3,622	36	3	61	48	8	-
Wyoming	530	5	0	95	70	100	10

Tipping fees at landfill sites are continuing to spiral, with the majority of states reporting increases. The 1992 average rate was $29 per ton, although New Jersey rates soared to $74 per ton (the Mid Atlantic Region average was $53 per ton). In the case of the USA, cities spent some $300 million on waste collection and disposal in 1940, rising to $1 billion by the early 1960s, and by 1984 the total had exceeded $4 billion [8].

2.2 Recycling

The recovery of paper and paperboard accounted for more than half of the total MSW recovered in 1995 (nearly 29 million tons), whilst the composting of yard trimmings contributed the next largest fraction of total recovery at 7 million tons.

The recovery of materials from the MSW stream through recycling and composting reached 27.3% (63.1 million tonnes) in 1996, up from 26.1% in 1995 (60.7 million tonnes). Most importantly paper and paperboard recovery of 35.9 m tonnes reached a 40.8% recycling rate and accounted for 56.9% of the total MSW recovered. Recycling is clearly the greatest element of the material and energy that is recovered [10] and is accounted for by a range of materials (Table 3). However, recycling can only effectively manage some materials within the MSW stream, leaving a still significant proportion of MSW (perhaps 60%) to be disposed of in the diminishing number of available landfill sites.

Perhaps of greater significance has been the rise of recycling since 1989. In terms of recycling, the States of Minnesota, New Jersey, Florida, Arkansas, Tennessee, South Dakota, Maine, Massachusetts, the District of Columbia and Washington reported the highest rates (between 30% and 40%) in 1997 (see Table 2 for greater detail). In terms of regional performance New England led the way with an average recycling rate of 24% for MSW, the Mid Atlantic states came in second at 20%, and the South was third at 17% (Goldstein 1997). However, landfill remains the method of most frequent use and choice for most of America's MSW, but this dominance is eroding (Steuteville and Goldstein 1993).

Table 3. National Recycling Rates for Different Materials [7]

Material	Recovery Rate	Material	Recovery Rate
Aluminium	55%	Yard Trimmings	23%
Steel Containers	53.1%	Textiles	11.7%
Paper	35.3%	Tyres	11.7%
Glass	23.4%	Wood	8.2%
US Recycling Rate	**24%**		

In 1989, the state of Washington claimed the top recycling rate with 22%, but in 1998 this would rank only 33rd in the US. In 1989, only 9 States had a recycling rate in excess of 10%, whilst today only 4 States have a rate below 10% (see Table 2). What is evident is that the US has made great strides to move beyond merely dumping MSW in a hole and forgetting about it [11]. For instance; North Carolina in 1989 had 120 landfills handling 90% of its MSW, costing between $6 and $12 per ton. In 1998 the State had only 40 landfills, handling 73% of its MSW at an average state-wide cost of $26. Even in a State like Washington, which reported the highest recycling rate in 1988 (22%) dramatic development has continued (see Table 2 for a breakdown of State practices). Its recovery rate is now approaching 50% (48%) of which 39% is through recycling and 9% is through composting. In 1998, its 100 plus kerbside programs serve 90% of the population [8], quite astounding recycling statistics!

2.3 Trans-frontier shipment of waste

There is probably no solid waste issue as controversial in the USA as the movement of MSW across State lines [12]. At least 21.3 million tons of MSW moved across State lines in 1997. For example in 1996 Pennsylvania received 6.3 million tons, Indiana 2.7 million, Michigan 1.8 million and Illinois 1.3 million from sources outside of their State. The largest exporters were New York with 4 million tons, New Jersey 2.3 million, Missouri 1.8 million, Maryland 1.2 million and Washington 1 million (see Table 4). Those States not listed in Table 4, either did not import or export MSW or failed to provide sufficient data. This issue will be discussed in greater detail within the following sections which focus on the management of New York City's MSW.

However, at this stage it will suffice to say that the trans-frontier shipment of wastes around the USA is a relatively common practice that has historically occurred from urban centres to States with ample landfill void, although it has not always proved a popular one. This section sets the scene for the discussion which follows of MSW management practices, policy and decision-making in New York City, where the 'exportation' of waste is becoming a key issue for the city's strategic waste management planners as the city has no operational landfill sites within the City, making it heavily reliant upon sites in the rest of the State and upon neighbouring States [13].

Table 4. MSW Imports and Exports from selected US states [4]

Exporters	Imported (Thousand Tons)	Exported (Thousand Tons)	Net Exports (if -ve then importer)
New York	-	4,000	4,000
New Jersey	500	2,300	1,800
Missouri	65	1,756	1,691
Maryland	50	1,200	1,150
Washington	275	989	714
Minnesota	0	412	412
California	21	408	387
Dist. of Columbia	0	235	235
Vermont	-	200	200
North Carolina	150	330	180
Arkansas	-	84	84
Massachusetts	516	549	33
Alaska	0	13	13

Importers	Imported (Thousand Tons)	Exported (Thousand Tons)	Net Imported (Thousand Tons)
Pennsylvania	6,300	300	6,000
Indiana	2,674	-	2,674
Michigan	1,838	-	1,838
Illinois	1,300	-	1,300
Oregon	1,067	17	1,050
Kansas	1,000	-	1,000
Mississippi	800	-	800
Wisconsin	656	-	656
New Hampshire	700	126	574
Kentucky	458	-	458
South Carolina	454	0	454
New Mexico	305	0	305
Nevada	215	-	215
Alabama	205	-	205
Georgia	172	-	172
Iowa	306	182	124
Texas	103	-	103
West Virginia	300	200	100
Tennessee	168	76	92
Ohio	668	600	68
Montana	43	0	43
Utah	10	0	10
Totals	**21,319**	**13,977**	

3. NEW YORK CITY

After its founding in 1625 the City of New York grew rapidly reaching a peak of 7.9 million people in 1950, falling slightly to 7.4 million by the mid 1990s. Politically, the City of New York comprises five Boroughs; Manhattan, the Bronx, Brooklyn, Queens and Staten Island (Figure 3). New Yorkers generate 26,000 tons of MSW every single day, and the average New York City household generates 6.2 pounds of garbage each day, providing New York with one of the highest per capita rates of municipal waste generation recorded globally (Tannenbaum 1992). The city now faces a 'garbage' (MSW) crisis derived from its almost total reliance on just one disposal facility, the largest landfill site in the world, Fresh Kills [2].

Figure 4. New York City 'the 5 boroughs'[2]

As one of the largest cities in the United States, and because of its position under the public spotlight, it has always been a challenge for New York City to effectively dispose of its wastes [15]. When New York City consolidated the Boroughs of Manhattan, the Bronx, Brooklyn, Queens and Staten Island in 1898, there were grand visions of an efficient and rationally-planned metropolis. In the 1880s over 70% of New York City's MSW was dumped in the Atlantic Ocean [16], with the refuse barges usually discharging their cargoes at a midway point between the New York and New Jersey shores (about 15 miles from land). By 1898, Manhattan had begun achieving success with the most forward-looking waste management program of its time. However, as the city's population and waste stream grew in the coming decades, the city supplemented ocean dumping with landfills and incinerators [13].

Eventually, in 1908, as a result of increasing complaints from the summer resorts on the New Jersey shorelines, an investigation into the city's waste disposal was carried out by the Metropolitan Sewerage Commission at the request of the Mayor of New York. The Commission recommended that if sea dumping was to continue the refuse should be carried at least one hundred miles out to sea! This was deemed unacceptable by the City administration who continued with their practices.

However, a successful federal lawsuit brought by a coalition of New Jersey coastal cities forced the city to end ocean dumping in 1935 (accounting for 12% of MSW in 1935). Streets Cleaning Commissioner Col. George Waring had been influential in stopping the dumping the city's 'garbage' in the ocean, by implementing a radical program that included recycling and composting throughout New York City [14].

In 1930, the Commissioner of the newly organised Department of Sanitation announced plans for a city-wide incineration programme involving the construction of 15 plants throughout the 5 boroughs. They were designed to meet the shortfall in waste disposal capacity from the exhaustion of available landfill sites and the growing political restrictions on ocean dumping.

Yet from the late 1930s onwards there was an increasing reliance on landfill for the disposal of the City's waste, due to the inability of incinerators to deal with wastes as cheaply or effectively as the available landfill or had originally been costed. The immediate post-war period was marked by the opening of a major new landfill facility at Fresh Kills, and the construction plan for the building of new incinerators along with the refurbishment of the 11 existing plants to form an integrated system for managing the City's MSW. However, only half of the planned incinerators were built, and it was only through an increasing reliance on landfill that the City coped with the growth of the municipal waste stream, which had increased by 78% from 1955 to 1965. Ambitious plans for new incinerators had to be scaled down during the Great Depression and World War II, so the city's sanitation infrastructure continually lagged behind its needs. Most garbage ended up as landfill for public works projects like Robert Moses' parks and highways [13]. These were often of short-term benefit as they allowed for the reclamation of mineral workings or tidal marshland.

The steady growth of New York's waste stream over the post-war period also coincided with a rapid decline in established recycling activities as demand for recycled products fell in the context of rising labour costs and lower costs for virgin production [4].

The post-war period was also characterised by a steady decline in the number of landfill sites operating in the city as a result of growing awareness of the effects of landfill leachate and gas emissions in the context of increasingly stringent environmental regulations issued by the federal government. In an effort to stem the rising tide of garbage it handled, in 1957 the city stopped collecting commercial waste, instead requiring businesses to hire private companies to dispose of it. This strategy succeeded in diverting some of the waste stream to incinerators and landfills outside the city. But this shift created a business that soon became a Mafia cartel that inflated the cost of private garbage collection by up to ten times the reasonable market price.

By the 1960s, the city was burning almost a third of its trash in its 22 municipal incinerators and over 17,000 apartment building incinerators. Since then, public awareness of the environmental costs of landfilling and incineration have gradually forced the city to shut down its old landfills and incinerators, including those in apartment houses [17]. The last municipal incinerator closed in 1992, leaving only a single waste disposal option for the 14,000 tons of residential and public waste DOS collects each. This resulted in the situation where the city became reliant upon the single landfill site on Staten Island (Figure 4) by the mid 1980s.

4. THE FRESH KILLS LANDFILL SITE

First opened as a "temporary" facility in 1947, today Fresh Kills is the largest landfill in the world [18]. The landfill on Staten Island in New York City is one of the most amazing products of waste in the world. It is undoubtedly the largest man-made object globally, covering 2,100 acres, and is so large it can be seen with the naked eye from space! Its highest mound is only slightly shorter than the Washington Monument, sporting an elevation of 155 feet, an estimated mass of 100 million tons, and a volume of 2.9 billion cubic feet. In total acreage, it is equal to 16,000 baseball diamonds. By the year 2002, when the landfill is projected to close, its elevation will reach 505 feet above sea level, making it the highest point along the Eastern Seaboard (Florida to Maine). At that height, the mound will constitute a hazard to air traffic at Newark airport [18].

Figure 5. Landfill sites in New York City [2]

The amount of waste landfilled at Fresh Kills each day has been reduced, through the City's ambitious solid waste management strategy and its recycling program, from a maximum of 21,200 tons per day in 1986 to the current 13,000 tons per day. Currently, less than 800 Acres are actually used for landfilling, out the 2,200 acres that comprise the Fresh Kills site. The landfill is divided into four sections; two remain active and two are in the final closure stage, as described below:

- Sections 1/9 and 6/7 are the active landfill areas.
- Section 3/4 stopped receiving waste in November 1992, and Section 2/8, in June 1993.

Fresh Kills (Kills is from the Dutch word for creek) was originally a tidal marsh. In 1948, New York City planner Robert Moses developed a highly praised project to deposit municipal garbage in the swamp until the level of the land was above sea level. A study of the area predicted the marsh would be filled by the year 1968. He then planned to develop the area, building houses and attracting light industry.

Mayor Impelliteri issued a report titled *"The Fresh Kills Landfill Project"* in 1951. The report stated, in part, that the enterprise *"cannot fail to affect constructively a wide area around it."* The report ended by stating, "It is at once practical and idealistic". How right he was but for the wrong reasons! One must appreciate the irony in the fact that Robert Moses was, in his day, considered a leading conservationist [13] yet he created the world's most infamous landfill site!

The site is also of dubious legality. Operating under a series of federal consent orders, it is unlined and leaches thousands of pounds of toxic chemicals and heavy metals into nearby estuaries each day. Development following the opening of the Verrazano Narrows Bridge in the 1960s had transformed the once sparsely populated Staten Island into a middle-class residential borough. For the residents in the other boroughs, Fresh Kills was viewed as that magical land called *"away,"* but for Staten Islanders, the landfill's odours and environmental problems were close at hand and became a major issue, yet the City still failed to plan ahead [10].

When the site was first opened for tipping no residents lived within the vicinity of the landfill site, but as the population of metropolitan New York has increased so residential development on Staten Island has followed suit (Figure 6). As population numbers have increased near to the Fresh Kills site so the number and strength of the complaints has risen! [10]. Since the Landfill was commenced nearly fifty years ago there has been a constant level of complaint from the residents of Staten Island. Several federal lawsuits filed by local citizens groups and the Staten Island Borough President also made Fresh Kills' future uncertain. As early as the 1960s, there were predictions that Fresh Kills would soon run out of room. Federal and State estimates predicted it would be full by 2005 [19]. The Department of Sanitation (DOS) eventually conceded Fresh Kills would have to close by 2017, and began planning how to cover and cap the entire landfill after it closes. However, no thought was given to how the city would adapt its waste management infrastructure once Fresh Kills was no longer an option.

Figure 6. The Freshkills Landfill site [15]

4.1 The Fresh Kills Waste Management System

Every day, between 12,000 and 14,000 tons of solid waste are disposed at the Fresh Kills landfill site. MSW from Staten Island households is transported by truck to the site where it is inspected upon arrival. Residential garbage collected from the rest of New York City is transported by truck to marine transfer stations located in the four New York City boroughs other than Staten Island. Garbage is weighed and is loaded onto barges. Most of the 'garbage' arrives at Fresh Kills by barge (carrying 650 tons each), and about 20 filled barges arrive at the landfill each day.

The barges are a very quiet, efficient, and non-polluting method for transporting the city's garbage to the Fresh Kills Landfill. Tugboats guide the barges from marine transfer facilities to the Fresh Kills Landfill. Skimmer boats patrol the waterways around the landfill to collect stray garbage. Booms are floating barriers used to catch any litter in the waterways.

The mechanical boom, a barrier used to control litter, opens only during incoming tides to allow barges to enter and exit. Marine fences prevent debris from escaping the waterway bordering the landfill and keep litter from entering the wetlands. At the two unloading facilities, hydraulic cranes remove garbage from the barges. More than 500 employees, including engineers, crane and tractor operators, office administrators, surveyors, metal workers, chemists, and geologists work as a team to ensure that the landfill operates smoothly 24 hours a day, six days a week. Clearly the site is a major waste management facility for the New York metropolis, and of critical importance for the management and disposal of the City's MSW.

5. THE PLANNING CONTEXT

In order to understand New York City's waste streams better, the Department of Sanitation (DOS) employed a consultant who conducted a 46-sort waste composition study in 1989-1990; this study showed that 40% of the waste fell into categories addressed by the basic recycling program that went citywide in 1993. Another 40% it was suggested could be addressed by intensive recycling programs (e.g., food waste, mixed paper, wax containers, textiles, bulk metal).

As for compostable materials, the waste composition study showed that 3% of the City's solid waste is yard waste, and 13% is food waste. Certain categories (e.g., disposable diapers (3%), and food/yard wastes, to mention two) could also be addressed via waste prevention measures. No discussion of solid waste management planning in New York is complete without mentioning the involvement of the citizens' advisory community.

In the early 1980s the City set up a Citizens' Advisory Committee (CAC) for the Brooklyn Navy Yard Resource Recovery plant, to provide an avenue of input for residents; through which a number of design changes were proposed.

In 1988 four more CAC's were established, each with a budget of $100,000 to fund their own consultants to assist in review of the incinerator Environmental Impact Statements for the other Boroughs. Subsequently, the CAC members and others began to lobby for recycling and waste prevention, culminating in the passage of Local Law 19 of 1989. This law mandated that these institutions become Citizens' Solid Waste Advisory Boards (SWABs) with official duties [10]. For details of the interested planning bodies see Table 5. Starting in 1994 a consortium of environmental advocacy organisations (Natural Resources Defence Council, and the City-wide Recycling Advisory Board -- CRAB) and City Council members challenged the Administration in court for their failure to achieve recycling tonnage diversion rates (i.e., an increase of 5% diversion per year starting in 1989 ending with 25% in 1994), as mandated in Local Law 19 of 1989. Seven times the issue was argued and appealed, each time the City lost, and new dates for achieving recycling mandates were set, yet local performance has failed to be improved.

6. INTEGRATED WASTE MANAGEMENT PLANNING

Contained in the New York State Solid Waste Management Act of 1988 is a requirement that all planning entities in the State (usually municipalities) are required to prepare a 10 year integrated solid waste management plan, designed to meet the State's 1997 goals of 50% reduction, recycling and composting and 50% waste to energy [19]. In the case of New York City, the spectre of a freeze on additional new solid waste facilities was a frightening possibility, since much of the 27,000 tons per day generated by the City is deposited at Fresh Kills. The capacity of this site would probably be exhausted soon after the year 2000, and thus there was a clear need to develop new sites for incinerators, materials recovery facilities, composting sites and transfer stations [19].

Work began on an integrated 20 year plan began in 1990, employing 12 consultancy firms looking at various issues; waste characterisation, exports, incinerator emissions, new technologies, MRFs, composting systems, waste prevention techniques, trucking and transportation and waste generation. By July 1991, after 7 months of intensive research, meetings and reports there were 12 possible solid waste system scenarios being discussed.

For each scenario data was required on; tons managed per day, number and size of facilities, emissions, cost per ton, percentage recovered and recycled, and landfill needed [10]. Half of the scenarios focused on the construction of a 2,250 tons per day waste to energy plant, with a variety of other subsidiary techniques for recycling and composting. The other 6 approaches used a combination of MRFs, mixed waste processing plants, composting sites and landfill. However, these scenarios did not satisfy the Citizens Advisory Boards within the City, and so they arranged a number of meetings and put forward their own ideas for an Integrated Waste Management Plan for New York City [10].

6.1 Alternative Solutions

The Alternative Plan *'Recycle First'* was put forward jointly by the Advisory Boards in the City, suggesting that greater emphasis should be given to source reduction and recycling (Figure 5 and Table 6). A number of the issues raised by this report were formally adopted within the New Waste Management Plan. The Final City Plan was approved on October 28 1992, with the key themes of 9% waste prevention by 2000 (rather than the initial statement of burning 68% of MSW) and a target to recover or recycle 32% of MSW (Figure 7).

The 1992 New York City Solid Waste Management Plan, (two boxes of Plan and appendices) contained numerous milestones of waste prevention, recycling and composting programs, legislation, and other initiatives that DOS committed to achieve in the several years following the Plan's issuance (Clarke 1998). An attempt was made to quantify the costs of a few alternative solid waste management combinations, some with more recycling, some less, some with more or less incineration and landfilling, but little of this has been successfully implemented.

The first few years of integrated solid waste management planning in New York City could be characterised as successful in some respects (namely the production of a plan) but limited in others.

Table 5. Glossary of terms [10]

BSWME	Bureau of Solid Waste Management and Engineering performs several pragmatic functions including long-range solid waste management planning, facility development, regulation and infrastructure maintenance.
BWD	Bureau of Waste Disposal. Responsible for the transportation and disposal of all MSW generated in New York City. Operates the 8 marine transfer stations and 94 barges used to ship waste to Fresh Kills.
CAC	generic term for the Citizens Advisory Committee (the SWABs were CAC's before the 1989 law that established them officially)
CRAB	City-wide Recycling Advisory Board (established by City Charter in 1990; members appointed from SWABs and some Mayoral and City Council appointees)
DEC	New York State Department of Environmental Conservation (they review SWMPs and can deny permits for solid waste facilities if SWMP is seen as deficient). DEC recently approved a private sector conversion of two MRFs (Material Recovery Facility) in Brooklyn to an export transfer station, despite protests from the CRAB and others.
DOS	New York City Department of Sanitation. Responsible for waste prevention, recycling, composting, incineration, landfilling, ash management, collections, marketing, etc. of residential and institutional wastes generated in NYC. Commercial waste is handled privately.
SWAB	Citizens' Solid Waste Advisory Board (there are 5, one for each borough -- MCSWAB is Manhattan's). Members are citizens (but also include professionals) appointed by Borough Presidents and City Council delegations for each borough.
SWMP	Solid Waste Management Plan (required by state law: Solid Waste Management Act of 1988)

Figure 7. Recycle First's Waste Management Plan for New York City in million tonnes [10]

Table 6. 'Recycle First' Action Plan for New York [10]

- Prevent Production of waste
  - Halt Production of Co-Mingled Trash
  - Reduce the Toxic Component and the Difficult to Recycle Element
- Maximise Recycling
  - Budgetary Support for Program expansion
  - Target maximum content of recyclable material in the waste stream
  - Separate recyclables at source
- Minimise costs
  - Aggressive Economic Development Program
  - Enlarge regional markets for recycled materials
  - Support local economic development
- Prudent use of Existing Landfill
  - Don't rush into a decision until recovery programmes are in place
  - Reduce waste going to Fresh Kills
  - Phase out waste exportation

6.2 Incineration

Incineration had been a central part of the City's proposed integrated system in 1992, as the Brooklyn Navy Yard Resource Recovery Plant had been in the planning stages since the late 1970s. However, by the mid-1990s the persistent and vocal public opposition to incineration convinced the City government to all but abandon the idea of siting incinerators in New York City itself. At the same time, federal emission standards for incinerators had strengthened to the point that the three remaining '1960s-era' incinerators that had operated in Brooklyn and Queens were shut down, since retrofit was considered too expensive and politically infeasible. The 2200 apartment house incinerators, remaining from a '1950s-era' Local Law that required new, large apartment buildings to have them, were also phased out in 1993 [10]. Thus the 1992 Waste Management Plan committed the City to proceed with a major new incineration plant at the Brooklyn Navy Yard site. This was due to begin construction in 1996, however this has been blocked by protracted planning and consultation procedures.

It is intended (hoped) that this plant will handle 3000 tonnes of waste per day (15% of the City's MSW). If the other 4 mooted plants in Manhattan, Queens, Bronx and Staten Island were to all be constructed this would account for 60% of the MSW collected by the City. However, there has been a great deal of objection to the Brooklyn site, and to incineration generally, on a number of grounds;

- large scale incineration will worsen an already serious air quality problem.
- the new incinerator and the upgrading of the others could cost $1.66 billion, and the operation of the plant may be more expensive than first suggested, making it potentially more expensive than recycling
- the proposed plant will contribute to global warming
- financing incineration would undermine the recycling agenda

6.3 Recycling

Subsequent to the 1992 Plan, the City expanded its patchwork quilt of recycling pilot programs to a uniform city-wide program where basic recyclables (metal, plastic, and glass containers, foil, newspaper, magazines and corrugated cardboard) were collected on a weekly basis [18]. Regrettably, recycling education mainly took place only at the time the basic recycling program began, and not as an ongoing, multi-media, multi-approach program, so participation rates ranged from moderate to poor [10]. Recycling and garbage collection routes were also modified to optimise costs (i.e., new recycling truck routes were superimposed on existing garbage collection routes, without substitution of garbage for recycling). As a result of the poor capture rates (roughly 40% of targeted recyclables), poor overall recyclables diversion rates (10-15% during this period) and the inefficient collection scheme, the recycling program was extremely expensive on a per ton basis (over $300/ton at one point), making it easy for opponents to attack the program. Every year the Administration attempted to reduce funding for the Bureau of Waste Prevention, Reuse and Recycling (BWPRR), and every year the City Council restored some funding for public outreach and certain composting and waste prevention programs [20].

The City has recently restored $6 million to the recycling budget, and intends to increase the budget further to support education, the development of the recycling collection program and to invest in processing facilities [21]. The City has also set out it's clear commitment to a combined effort of waste reduction, recycling and disposal [17].

To put some of the costs of solid waste management in perspective, the waste collection budget has been on the order of $300 million /year, the waste disposal budget (for Fresh Kills) has been about $50 million/year, and the expenditure on recycling has been slightly less. By comparison, the waste prevention budget has been roughly $1 - 2 million/year. The 1992 Plan estimated that for every year the City prevents the generation of 9% of the waste stream, it saves about $90 million in collection and disposal costs.

Cumulatively, between 1992 and 2010, a 9% waste prevention program would amount to total savings of $700 to $800 million. In addition, waste prevention programs would have enormous environmental benefits, including reduced pollution from trucks and disposal, and reduced depletion of natural resources used to manufacture the products and packaging not generated. Waste prevention programs could also improve the health of the repair and reuse industries in New York City, resulting in economic development benefits. Finally, reducing the quantity of waste generated reduces the need to find disposal capacity for that waste, thus extending the lifetime of existing disposal and treatment facilities [10]. This would be of significant benefit in the case of New York City, with its reliance on a single disposal site.

7. INCREASING RESISTANCE TO FRESH KILLS

Residents in Brooklyn and the Bronx have historically battled the unplanned results of a DOS strategy aimed at keeping Fresh Kills from being infilled 'too soon' wanting the site to remain operational for as long as possible because it afforded these Boroughs with an accessible and cheap disposal option that was not within their Borough! Through the 1980s, many of the city's commercial hauliers were depositing their waste in Fresh Kills site for a small "tipping fee."

At the end of their collection routes, their trucks would simply drive to Staten Island -- a cheaper alternative to driving long distances out of state! In 1988, DOS raised its tipping fees to discourage the commercial hauliers from using Fresh Kills. Chris Boyd, an environmental policy assistant to Brooklyn Borough President Howard Golden, explained *"almost overnight, dozens of waste transfer stations appeared [in low-income communities] in Brooklyn and the Bronx"* [13]. Clearly the Bronx and Brooklyn residents and administrators were far from happy with these developments.

Neighbouring communities on Staten Island that did not exist when the landfill opened, now teem with homes and businesses. Community residents, local elected officials and the City administration all agreed on the need to end New York's dependency on the Landfill.

The Fresh Kills site has been in violation of State Law since 1980 due to the release of millions of gallons of toxic leachate into nearby water courses. The level of local opposition to the site by Staten Island residents reached such proportions that a referendum was passed in 1992 [10] to secede from New York City and become an independent municipality in New York State! (however, this was never implemented.)

When the City Council held hearings in each borough on their initial long-term Solid Waste Management Plan in 1992, the largest outpouring of residents, by far, was in Staten Island, where there was an overflow crowd of 1,000. This was twice as many as at the next most attended hearing, in Brooklyn, where residents were protesting the proposed Brooklyn Navy Yard incinerator. One reason for this was that 90% of the City's residential and institutional waste was being barged and trucked to Fresh Kills (estimates of the total amount of solid waste of all sorts generated by 7.42 million New Yorkers plus 1.47 million commuters and tourists, during a day in 1990, was 87 million pounds!)

In 1994, Conservative Republican George Pataki won a narrow upset victory over Mario Cuomo in the race for Governor of Staten Island. Pataki had greatly benefited from large turn-outs in heavily Republican Staten Island, much as Republican Rudolph Giuliani did in the previous year's mayoral election. For the first time in decades, Republicans held the most important executive position in both the state and the city. By June, 1996 grassroots pressure from Staten Island residents effectively mounted to convince the Staten Island Borough President, the Mayor, and the Governor, all Republicans representing a Republican-dominated area, that Fresh Kills should be closed at the end of 2001. The date of closure was not an accident; due to term limits, Mayor Giuliani would leave office at the same moment as the landfill closed, leaving the consequences of that action to his successor.

In late May of 1996, after several months of quiet negotiations, this Republican power-base held a surprise press conference to announce Fresh Kills would close in 2002. Two days later, a law to close the landfill was passed in the state legislature.

As is evident from the discussion above, the City had not done any planning based on closure of the landfill either in its 1992 Plan or subsequent biennial Plan updates. There were no other landfills in New York City, no incinerators were operating, and the recycling program diverted only about 14% of the City's waste stream from Fresh Kills. This was clearly not a good starting point from which to close the City's only operational disposal facility, without having a clear strategy of how the MSW should be managed or disposed of [10].

8. THE FRESH KILLS CLOSURE AND EXPORTATION ANNOUNCEMENT

According to the New York City Mayor Rudolph W. Giuliani, during his Fresh Kills Closure speech on Thursday, July 1, 1997, [17].

> *"For too long, the Fresh Kills landfill site has weighed on the people of Staten Island. It has been around for nearly fifty years, and since 1991, it has served as the city's only repository of residential solid waste. All of the city's residential waste -- 13,000 tons per day -- has come to this landfill on the west coast of the island. Last June, the Governor and I established a joint task force that developed a waste disposal plan to use other avenues of disposal as we phase out Fresh Kills. We are not looking to the distant future and asking ourselves what we will do with our waste. We are addressing the problem now because we understand that this is a matter of urgency for the people of the island, and really for the city as a whole.Today we take a major step toward our goal. The New York City Department of Sanitation has awarded a three year contract to begin exporting as many as 1,750 tons of solid waste a day -- or over 530,000 tons each year -- from the Bronx. Instead of coming to Fresh Kills, this waste will be transported to a landfill in Waverly, Virginia. The contract is a major victory for two reasons. First of all, it will cost the city $51.72 per ton of waste, less than the experts had anticipated; and secondly, it shows that we are well on the way to meeting our 2001 goal of freeing Staten Island of this burden for good. In the years to come, we will continue building on the city's strong record of recycling and reducing garbage to minimise New Yorkers' daily waste output, and we will proudly close the site forever in 2001. In 2001, images of waste from all five boroughs being dumped on Staten Island will no longer be a daily headache."*

"They will be memories. The City of New York will embark upon a new course of action in the management of its solid waste in wake of the decision to close the Fresh Kills Landfill by December 31 2001."

8.1 Phase Down of Waste Acceptance at Fresh Kills

In fulfilment of the planned goal to seek reduced reliance on Fresh Kills in preparation for closure, the Department launched the Bronx waste export initiative during Fiscal Year 1997 and developed other strategies to achieve the diversion of an additional portion of the waste stream from Fresh Kills landfill.

In connection with the work of the Fresh Kills Task Force, BSWME guided the Department's issuance of a Request For Expressions of Interest in September 1996 which attracted sufficient vendor interest in the continued use of the City's marine solid waste transfer infrastructure to warrant the issuance of a Marine Transfer Station Request for Proposals (MTS RFP).

Issued in June 1997, the RFP for export services seeks proposals to use Sanitation's existing marine transfer stations for the export of residential waste from the City. MTS RFP proposals will be received and evaluated in the current fiscal year.

Since the May 1996 agreement between Mayor Giuliani and Governor Pataki to cease accepting waste at Fresh Kills on December 31, 2001 and subsequent passage of state legislation mandating closure by that date, the Department has been modifying existing plans to assure that Fresh Kills closes on time and in compliance with federal and state regulations, and continues to operate safely through closure (Table 7).

Fresh Kills is divided into four distinct operating sections. Two of these four sections stopped accepting waste in 1992 and 1993. The closure implementation program will lead to the cessation of operations in Section 6/7 by 1999. Landfilling in that section, a total area of 309 acres, has already been reduced by closing out the northern portion and limiting disposal operations to the 107acre area south of Yukon Avenue. The final elevation of 120 feet has already been reached in the northern portion.

Closing Fresh Kills by the end of 2001 requires a gradual reduction of incoming waste, modification of critical components of landfill operations and engineering plans, and transformation of conceptual closure plans into a final closure plan (see Table 7).

- July 1993 - 750 Active Acres
- July 1997 - 300 Active Acres
- July 1999 - 150 Active Acres
- December 31, 2001 No activity!

Table 7. The planned phase-down of Fresh Kills [17]

Year ending	Tons per day accepted
1996	13,000
1997	10,900
1998	8,500
1999	6,500
2000	4,000
2001	0

The transition from full-scale operations to reduced flow of refuse to final closure involves many planning and operational changes (see Figure 6). These include:

- re-engineering the progressive fill plans and drainage
- systems, shifting plans for the placement of garbage within the active sections
- completing the installation of environmental control systems such as leachate containment and collection, stormwater management, and landfill gas emissions control
- refining and annually updating the Department's Operations and Maintenance Manuals and Contingency Plans to accommodate changes in landfill operations associated with reduced tonnage and the earlier closure date.

8.2 Closure Considerations

It has proved necessary to plan for the possible exportation of all residentially generated waste out of the City, in order to ensure that the selected infrastructure will be adequate to fully meet the City's disposal needs. However, it should be noted that even with substantial gains through waste reduction and recycling efforts, a significant amount of waste will need to be disposed of (Clarke 1998).

Some of the alternative options considered included;

- Exportation is considered to be the disposal of waste outside the City of New York, whether it be within New York State or beyond state borders
- Retro-fitting the Fresh Kills as a city-wide marine transfer station
- A single island based transfer station for all the city's waste to be processed at, prior to shipment to its final destination (not feasible)
- A single land based transfer station sited on the waterfront which will accept barges from the marine transfer stations for processing the waste into trucks and rail cars that will be shipped to disposal facilities (improbable)
- Exporting waste from existing marine transfer stations
- Borough based transfer stations intended to allow each borough to become self determinative.

8.3 The Aftermath

After the closure announcement, the Mayor, Governor, and Staten Island Borough President agreed upon a process for evaluating what to do with the waste going to Fresh Kills after its closure. In June 1996, Mayor Giuliani and Governor Pataki established a joint Task Force to explore the options available to manage the City's solid waste without utilising the Fresh Kills Landfill. Mayor Molinari served as chair of the task force, yet representatives from the other boroughs and environmentalists, who had been left out of the previous 'back-room' deal-making, were excluded again from the Mayor's task force.

During the summer the Task Force met in secret, much to the dismay of the other Borough Presidents and the advisory community.

Environmentalists were livid claiming *'how can you create a plan to close the city's landfill without input from the very people who have been working to improve waste management and recycling, they asked?'* After several months of aggressive lobbying, the mayor finally appointed two environmentalists to the task force: SICCA's Warren and Jim Tripp of the Environmental Defence Fund. Even then, Warren and Tripp were kept out of the decision-making loop. Giuliani also called on the boroughs to prepare their own plans for adapting to the absence of Fresh Kills. The apparent reasoning was that the task force would sketch out a guideline and the boroughs would fill in the blanks (Clarke 1998). The advisory members argued for an ambitious acceleration of waste prevention, recycling, and composting, and for annual tonnage phase-out requirements for the landfill, so that the entire 13,500 tons per day of residential and institutional garbage then disposed at the landfill would not shift to another management method (i.e. export) all at once.

The Task Force published the *"Report of the Fresh Kills Task Force"* in November 1996, which reflected this phase-out recommendation, but the proposals on recycling and waste prevention were not ambitious, continuing the status quo of slow evolution. The Report provides the results of nearly six months of research on available solid waste management options, cost implications of these options, and the applicability of the options to New York City's large and densely populated area.

The Report also provides recommendations and a plan for proceeding to restructure the solid waste management system in New York City. By the spring of 1997, the task force had released its report and the City Council was holding hearings to prepare its own response. The task force report was predictably short on details. It called for continued use of the city's marine transfer stations: barges would still carry the garbage, somewhere other than Fresh Kills. There was also a suggested timeline of annual targets, diverting waste from Fresh Kills to phase it down gradually. Warren had managed to exact this concession in the final days before the report was released.

They were all ready to publish the report when I said, *'wait, you've set the date for closing the landfill, but you haven't said anything about how we're going to get there'* she explained, and as a result the annual targets were set.

The report, "Goodbye, Fresh Kills! or How the City Can Stop Worrying and Learn to Reduce, Reuse, and Recycle", issued in April, 1997, recommended a longer-term (40 years) planning horizon for waste management (as compared with the ad hoc process of RFPs), and a reaffirmation of the solid waste management hierarchy, with sufficient funding for prevention, recycling and composting [15]. It was agreed that the three marine transfer stations currently in use to move Manhattan trash to Fresh Kills should continue to be used for exporting garbage, and that barge and rail be prioritised for waste movement. Beyond that, most of the report was dedicated to describing recommendations to reduce by 50% the amount of garbage to be exported. It's 1998 findings reflect the shifts from the scheduled closing of Fresh Kills Landfill.

In the summer of 1997 the Borough reports were completed, and the City Council released its report in October. They all featured a number of suggestions for improving recycling and waste prevention -- ideas DOS had either resisted or ignored since beginning recycling a decade ago. The City Council went a step further, demanding a moratorium on the siting of new transfer stations until acceptable siting regulations were approved. But all of these reports are more notable for what they omit than what they include. None of them proposes any substantively new plan for phasing out the city's reliance on Fresh Kills.

None envisioned any realignment of operations or authority around the new mission of maximising waste prevention, recycling, and composting. None of them offers any specific proposal for de-concentrating the blight of transfer stations so the responsibility would be evenly shared by all parts of the city -- i.e., "fair share" planning.

Whatever wastes were not prevented, recycled or composted would be exported, but the infrastructure and planning required to accomplish this was largely lacking.

A recommendation of this revised ask Force report was that five, borough-wide task forces be established to propose borough-specific programs, methods, and sites for managing and exporting wastes when Fresh Kills closed. Meanwhile, before these task forces began work, DOS began to prepare Requests for Proposals (RFP) for companies to bid on the City's waste for export after 2001. A previously issued RFP for export of 1,700 tons per day of Bronx-generated wastes resulted in bids between $46 and $66/ton, thus reducing the likelihood that export-reducing strategies would be cost-competitive. And at the time these task forces were deliberating, DOS increased the number of recyclables collected (to mixed paper, wax paper containers, and bulk metal), but decreased the frequency of recycling pickups from weekly to biweekly in many districts (not very progressive!).

In theory, this long overdue decision gave the city an excellent opportunity to restructure waste management plans, strategies and practices and adapt to the changing expectations the public placed on the DOS. As long as the mission of DOS had remained straightforward and simple, it seemed to function quite well (Clarke 1998). Indeed, as recently as the mid-1980s, DOS was thought by many observers to be one of the best-run city agencies. However, the decision to close the city's last remaining landfill has not resulted in better planning, efficiency, or greater social equity. Indeed, the closing of Fresh Kills was not a planning decision. Rather, it was a 'politically-biased' deal that did not involve SICCA, the citizen coalition that had fought for years to shut down the landfill, or any similar group. *"It was purely a political decision, and like all purely political decisions, it was made without any forethought and without any planning"* [13].

Waste exports to other States from New York State in 1998 increased by 7.7% totalling approximately 3.8 million tonnes; of which Pennsylvania accepted 2.7 million tons, with 100,000 tons each going to landfills in Connecticut, New Jersey, Virginia and Ohio. Recycling increased by 10.8% (5.1 million tons), whilst landfill in the state decreased accordingly by 8%, with the 35 remaining landfills receiving 9 million tons of refuse. Eleven incineration plants burned 1.2% of waste (3.7 million tons).

The data complied from the municipalities and private disposal sites indicates that 42% of New York's MSW is landfilled, 24% is recycled, 17% is combusted and 17% is exported (quite a significant proportion!). According to Steve Englebright (Chair of the Legislative Commission) the two major issues to address are the effects of flow control and the impending closure of Fresh Kills are; *"The city's answer for the future is export, but realistically that can not be the long term answer for all the city's non-recyclable waste"* [20].

8.4 Export Phase I

In order to accomplish the closure of Fresh Kills by the December 31, 2001 deadline, the City must develop the means to export all non-recycled waste to out-of-City disposal sites: landfills and incinerators. In Fiscal Year 1997, the Department solicited bids for the first phase of waste export. This solicitation resulted in a contract with Waste Management of New York City, to export approximately 1,750 tons per day of City-collected waste from a transfer station in the Bronx to a state-of-the-art landfill in Waverly, Virginia or an incinerator in Bridgeport, Connecticut. The export of the Bronx waste began in July 1997.

8.5 Export Phase II

Following the successful implementation of the Bronx waste export contract, the Department is developing a bid solicitation for the second phase: the export of 2,400 tons per day of City-collected waste from transfer stations in Brooklyn and Queens. The Department expected to receive bids in January 1998, and to award contracts by the summer of 1998, although this has been delayed. At least for the short term, pending the development of a marine-based waste export system; solid waste transfer stations will be a necessary component of the City's plan to close Fresh Kills.

9. THE SOLID WASTE MANAGEMENT PLAN DRAFT MODIFICATION

Because the City was planning to close a waste disposal facility that handled 85% of its waste (Fresh Kills), it was required by the New York State Solid Waste Management Act of 1988 to issue a modification to its Solid Waste Management Plan. The Act required that the Plan address a ten-year planning timeframe.

The draft modification, issued by DOS in April, 1998 was similar to its previous biennial Plan updates; much of the document was descriptive about DOS' accomplishments and past programs, but relatively few pages contained definitive commitments or plan milestones for future activities (Table 8).

Regarding new initiatives, the draft modification spoke mainly about export alternatives, and relatively little about means of expanding its prevention, recycling and composting efforts. For example, there were only six waste prevention milestones in the draft modification (Table 9), most did not deal with the reducing the residential waste stream, and most were continuations of existing limited programs, not new programs for the next ten years.

An important recycling milestone included in the draft modification was to achieve a 25% diversion rate with the kerbside recycling program by FY2001. It is important to remember that Local Law 19 of 1989 had required the City to achieve a 25% recycling rate by 1994, and failing to achieve that rate, the City had been repeatedly ordered by various State Supreme and Appellate courts to make sufficient investments in the recycling programs to achieve the mandated recycling rate. Another Plan milestone was the institution of special waste recycling programs in all five boroughs by FY99. Everything else was a continuation of current programs. City Council hearings on the draft modification were held in spring, 1998, but the Council is yet to act to approve or disapprove the draft due, in part, to budget battles with the Mayor [10].

9.1 The Manhattan Task Force Report

For three months in early 1997 the Manhattan Fresh Kills Closure Task Force met to discuss methods and alternatives to the New York City Plan. The Task Force consisted of about 40 Manhattan residents from various solid waste-related businesses, housing organisations, Community Boards, and the SWAB.

Table 8. Integrated Waste Management Plan Recommendations [15]

1. WASTE PREVENTION

- Reaffirm City's commitment to achieving NYS goal of 9% waste prevention by 2002.
- Increase resources for prevention of DOS-managed waste, initially dedicating $5 per ton for all waste collected by DOS to waste prevention, providing a $17 million budget for waste prevention.
- Establish a NYC Waste Prevention Council, to co-ordinate and promote waste prevention policies and programs. Commissioners would include public officials and others selected by the Mayor, City Council, Borough Presidents, the 6 Advisory Boards, other agencies.
- Develop a Focus on Waste Prevention in the Residential Sector, using funds to prevent wastes.
- Develop and Sustain Multi-Media Waste Prevention Campaigns (Blitzes) and co-ordinate these with recycling and other waste management education efforts.
- Work with the Board of Education to develop waste prevention curriculum modules.
- Establish District waste prevention and recycling information / swap centres.
- Expand school-based "Recycle-A-Bicycle" repair programs to other durable products.
- Offer city economic development benefits for businesses that institute prevention practices
- Offer abatement of the City's General Corporation tax for qualifying waste preventing enterprises.
- Work Towards Establishment of Residential Quantity Based User Fees
- Establish Quantity-Based User Incentives for City Agencies
- Pass Intro. 509, the City Environmental Procurement Bill, the Agency Waste Prevention Practices Bill, and other waste prevention legislation

2. RECYCLING

- Commit to an ongoing waste prevention education. Regularly report the programs' successes.
- Target the lower diversion areas for intensive outreach and assistance and provide resources to equip appropriate community-based organisations to conduct local outreach.
- Develop and implement, in co-operation with the Board of Education, a school recycling/waste prevention curriculum module and sponsor district recycling contests.
- Regularly place ads promoting recycling participation in subways and buses.
- Work with building managers and owners to identify non-recycling individuals.
- Establish an enforcement program for public housing, schools and agencies.
- Co-ordinate enforcement actions with public education.
- Issue and publicise violations at buildings with repeat violations.
- Impose fees for the collection and/or disposal of waste by city agencies receiving city funds by the end of FY98, permitting agencies to share in savings due to waste prevention efforts.
- Conduct a pilot collection program substituting an extra recycling pickup for a refuse pickup, to relieve schools of storage burdens and providing incentives to recycle.
- Conduct a multi-season pilot study to evaluate mixed-waste processing to recover recyclables.
- Form a Recycling Business Council to assist the City in devising ways to stimulate recycling industry investment and expansion.
- Offer increased economic development benefits, such as General Corporation tax credits, for qualifying enterprises located in New York City utilising city-generated secondary materials.
- Increase demand within the city for recycled products by expanding the City's buy-recycled program to be uniform with the federal executive orders.

3. COMPOSTING

- Implement programs to recover and compost 250 tons per day -- two-thirds of the organics in Manhattan's DOS-managed waste stream.
- Adopt regulations banning Department of Parks' yard waste from DOS disposal facilities.
- Promote and educate citizens about vermi-composting (worm-based composting).
- Install a demonstration, on-site residential food waste composting system at one Manhattan apartment building by the end of FY98.
- Establish food waste drop-offs in each Community District and ensure sufficient composting capacity to process materials with a potential to divert 5 to 10 tons per day of food waste.
- Develop a long-term to process and compost 250 to 600 tons per day of mixed DOS waste.

The report, "Goodbye, Fresh Kills! or How the City Can Stop Worrying and Learn to Reduce, Reuse, and Recycle", issued in April, 1997, recommended a longer-term (40 years) planning horizon for waste management (as compared with the ad hoc process of RFPs and the 4-year timeframe of the then current Plan), and a reaffirmation of the solid waste management hierarchy, with sufficient funding for prevention, recycling and composting.

It was agreed that the three marine transfer stations currently in use to move Manhattan trash to Fresh Kills should continue to be used for exporting garbage, and that barge and rail be prioritised for waste movement. Beyond that, most of the report was dedicated to describing recommendations to reduce by 50% the amount of garbage to be exported. The 33 pages of recommendations made in the Manhattan report and the similar efforts from the other four borough task forces were reviewed by the DOS and by the City Council, which subsequently issued its own report and held hearings. The Council's report generally agreed more with the tenor and recommendations made in the Borough reports than with the City/State report.

City Council hearings on the draft modification were held in spring, 1998, but the Council is yet to act to approve or disapprove the draft due, in part, to budget battles with the Mayor.

Table 9. Draft Modifications Proposals for waste Minimisation [15]

1. Achieve City Agency Waste Prevention targets (but there were no specific targets)
2. Continue Current Waste Prevention Research Project (which is scheduled to end in 1999)
3. This is certainly a good idea, but other research is needed during the ten-year planning time frame (e.g., a high-rise pilot to test Quantity-Based User Fees; behavioural research)
4. Continue WA$TEMATCH and WA$TELE$$ Programs. Both are targeted for industrial business waste prevention; the first is an industrial business waste exchange, the second is a waste audit program that targets a small number of businesses.
5. Implement Reuse Hotline. This program would permit householders to dial into a voice mail system and retrieve referrals for repair and reuse businesses. It has been promised for years.
6. Evaluate, Develop, and Foster reasonable City policy initiatives, rules and local laws to promote and, where appropriate, require waste reduction practices. This milestone may result in many initiatives or nothing. There is no specific commitment.
7. Make available to the City Council and the public, the findings of the waste prevention research conducted pursuant to the contract between the City and SAIC. In the past, DOS did not share many of its research studies with the advisory boards, but has routinely done so with outside organisations such as the National Recycling Coalition.
8. Important recycling milestones included in the draft modification were to achieve a 25% diversion rate with the kerbside recycling program by FY2001 and institution of special waste recycling programs in all five boroughs by FY99. Everything else was continuation of current programs.

10. THE CURRENT SITUATION

Despite the recommendations made in the seven task force reports, the DOS is proceeding as it had originally planned, issuing RFPs to export waste and making minor changes to its prevention and recycling programs. Residents of Brooklyn are now fighting the increasing abundance of solid waste transfer stations located there in anticipation of increased exports. In September, 1998 DOS accepted another bid to export some of the waste from Brooklyn and Queens to a landfill in Virginia (part of the landfill phase-out process).

Clearly, the pace of change in New York City is increasing, and with the imminent closure of Fresh Kills in the near future (next 2 years), the pressure for change is rising. However, for all the efforts and reports that have been written, little appears to have changed, and the emphasis will shift from a landfill site in New York City to one in Virginia. This hardly meets the criteria for sustainable waste management, but the economics and local politics of the situation in New York, where space is of a premium, land prices are at their highest, and public opposition is at its greatest [10].

As Fresh Kills prepares to close, large areas of the city will experience a much closer connection or relationship with MSW, both through the transfer stations and the fleets of trucks travelling to them (Martin 1998). In essence, the city is changing its entire system for handling the 3.5 million tons of waste it produces yearly, a tonnage equal to 76 Titanics. Export seemed the only route.

The city took its plans for a huge transfer station at Fresh Kills – behind the scenes, those plans had come to appear politically impossible because of Staten Island opposition --then asked the major waste companies to propose a similar centre somewhere else on New York Harbour. The companies came back with 13 proposals, including building huge stations in Red Hook, Bay Ridge, the South Bronx and Williamsburg. Exporting to other states, at a cost the city estimates may exceed $6 billion over the next 30 years, is the linchpin of the strategy (New York City 1998c).

City Hall has so far sketched a rigid approach. The city would assign huge contracts to large garbage companies to ship trash by rail or barge to Pennsylvania, Virginia and other states, and it would truck trash out until then, reducing the flow to Fresh Kills to nothing in three years. One proposal to MSW in huge containers on barges at the marine transfer stations was rejected as impractical. But the idea has come to dominate recent discussions of MSW strategy. Opponents favour the eight existing marine transfer stations, where white sanitation trucks already go, because they are evenly distributed around the city and are not concentrated in poor neighbourhoods. The bottom line: *'For the first time since the 1930s, when ocean dumping ended, none of New York City's garbage will be disposed of in the city. But more areas of the city will play host to garbage, perhaps permanently'* [10].

11. DISCUSSION

By law, Fresh Kills must close in only two years (by the end of 2001). This is problematic, because City Hall has no realistic alternative place to dump the 4.2 million tons of residential trash collected each year. The plan is simply to export the MSW to wherever it will be accepted - upstate or, more likely, out of state. Obviously the city is throwing away an historic opportunity to plan for a more efficient and equitable system of waste management, and to do it with citizen groups and neighbourhoods. Instead, the mayor is using the opportunity to issue huge contracts industry. Last year DOS issued three Requests for Proposals (RFPs) soliciting bids from waste management companies for handling the city's residential waste once it is diverted from the landfill.

These RFPs are in effect the most important planning documents in the city -- a sign that no serious planning is occurring. The result of the Mayor's effort to close Fresh Kills by the day he leaves office in 2002 has been a secretly developed set of interim and long-term contracts that call for gigantic new waste transfer stations on valuable waterfront property. The sites for these new transfer stations are in the very same neighbourhoods that are already overburdened with clusters of illegal waste transfer stations. These facilities will also be mainly truck-based, bringing thousands more trucks to these neighbourhoods' already congested streets.

Finally, the contracts are going to be expensive, requiring the city to spend $300 million per year for at least the next thirty years -- a total figure in the billions of dollars. There's no plan for increasing or improving recycling, composting, and waste reduction -- proven practices that would save taxpayers money by reducing the cost and the problem of managing our wastes [10].

New York City's centralised decision-making process has resulted in a one-size-fits all method of collection even though the composition of the waste stream is radically different from one neighbourhood to the next. DOS's centralised authority has also proven susceptible to political influence that leads to an unequal distribution of the negative impacts of this city-wide service. DOS was instructed to reject any proposals from companies that would create new waste facilities, including transfer stations, in Staten Island, a largely white, middle-income borough. Instead, white and ethnically diverse working-class neighbourhoods in the other boroughs are the only available targets. Staten Islanders are still nervously waiting for the landfill to actually close and many say they'll only believe it when they see it.

11.1 B.A.R.G.E: New Coalition Offers Hope for United Action

As the city moves towards implementing the next set of interim contracts, community groups and elected officials around the city are changing their tactics and working together. In the last month, they formed an organisation called Boroughs Allied for Recycling and Garbage Equity (B.A.R.G.E.) with the purpose of linking their separate efforts under a single, city-wide umbrella.

This coalition intends to force the city and state administrations to undertake the kind of comprehensive planning process that is needed if the city is ever going to achieve a fairer, safer, cleaner and cheaper system of recycling and waste management. B.A.R.G.E would prefer to focus on long-term visions and planning, but the city administration has forced them to take more short-term action first. B.A.R.G.E. has to stop the city administration from carrying out its contracts.

11.2 The Prospects for Community Planning in Waste Management

The only way the city can reinvent its waste management system for the 21st century is to undertake a serious open planning effort that brings the neighbourhood-based experts together with the department and agency experts to craft new plans and new approaches. The city needs to move beyond secretive and short-sighted decision-making. Sadly, the city administration's "planning" has been a waste of time, leaving us back at square one and requiring that the plans be revised from the ground up. This time, the process will need to involve community groups, individual experts, agency representatives, and elected officials from the beginning -- and involve them as equal stakeholders in the city's future. If B.A.R.G.E is successful in saving the city from an ill-conceived thirty-year plan, it will be in a position to bring all these stakeholders and experts together.

12. SO WHERE WILL ALL THE WASTE GO?

Of the 280 million tons of municipal waste generated in the U.S. (based on 1995 figures), about 25 million tons moves across state lines every year. Pennsylvania receives nearly one-third of this waste. 41% of the 5.2 million tons of waste trucked into Pennsylvania in 1995 came from New York and 39% came from New Jersey, totalling 80% of out of state waste coming to Pennsylvania. New York City in 1995 exported 2.7 million tons of waste to Pennsylvania. New York State is the largest exporter of municipal waste, having had an 87 percent decline in landfills since 1986.

The amount of out-of-state MSW dumped in Pennsylvania landfills generally rose by 25 percent over the past quarter, continuing an eight-year upward trend, a report released by state environmental officials shows.

Pennsylvania took in 6.3 million tons of municipal waste from outside its borders last year, making it by far the nation's leading 'trash importer'. With 2.7 million tons in imports, Virginia came a distant second. As in past years, neighbouring New Jersey and New York continue to be the two largest trash exporters to Pennsylvania, the report found. And exports from New York are expected to grow rapidly with the planned 2001 closure of Staten Island's Fresh Kills landfill.

Pennsylvania's 56 landfills and incinerators took in nearly 2.68 million tons of waste from other states between April and June -- 25 percent, or 535,000 tons, more than the previous quarter.

Pennsylvania's problem with out-of-state waste is in large measure because of its glut of landfill space. The state has enough capacity for the next dozen years and allows landfills state-wide to accept 50,000 more tons each day than need to be dumped. That drives down tipping fees and makes the Keystone State's landfills attractive for other states, even when factoring in the higher transportation costs. Top State MSW exporters to Pennsylvania are (1996 figures);

- New York 3,300,000 tons
- New Jersey 3,100,000
- Maryland 819,000
- Delaware 261,000
- Connecticut T 141,000
- Ohio 130,000

New York City presently sends much of their waste to the Fresh Kills Landfill on Staten Island (the largest landfill in the nation). When this landfill closes in 2001, 4.7 million additional tons of waste will be seeking a home. New York City's plans to shut down their Fresh Kills Landfill on Staten Island by 2002, has meant that the City is looking for a new place to send their 5,000 tons of MSW every day. About 2,000 tons of solid waste now moves from the Bronx to a permitted landfill in Charles City County, Virginia, under a three-year pilot program. The landfills in Lower Bucks County (in nearby Pennsylvania) are prime targets. Bucks County disposes of 544% of the waste which the county generates (almost four-and-a-half times over what the county generates per year.) Waste imported into Bucks County, PA in 1993 (in tons) included;

- Bucks total out-of-state MSW landfilled 1,247,018 T
- Bucks total out-of-county (from Pennsylvania) 991,293 T
- Bucks total imported 2,238,311 T per annum

13. CONCLUSIONS

New York City is spending more than $1 billion to close and monitor its last remaining landfill site, the 3,000-acre Fresh Kills n Staten Island. The task started with a 1990 consent order that the city signed with the state. The timetable calls for the landfill site to cease receiving garbage by Dec. 31, 2001. After that, the city's solid waste plan calls for all its garbage--about 30,000 tons per day from residential, institutional and commercial sources--to be recycled or transported by truck, rail or barge to more modern disposal sites in New York and other states (Lange 1998).
"It's fairly unique in the amount of money involved, the scope and size," says Lucian F. Chalfen, an assistant commissioner with the New York City Dept. of Sanitation. "I don't think there is a larger landfill in the world. The cost of closure is larger than the annual budgets of many countries."

The current budget includes $350 million for engineering and construction, with another $773 million earmarked for 30 years of treatment system operations and maintenance and site monitoring. The cost of placing each ton at Fresh Kills is about $44, while the city pays Waste Management Inc. $51.72 for each ton of MSW headed to Virginia. Most acknowledge that it will cost more to ship garbage out of New York as the last landfill ramps down. The City is negotiating with *"17 or 18 contractors"* to begin trucking about 2,400 tons daily from Brooklyn and Queens by this fall (1999), with processing expected in the range of $49 per ton to $70.

Whatever the mode and cost of New York City's MSW export program may turn out to be, the shutdown program at Fresh Kills is moving steadily forward. Early this month, Tully Construction Inc., a Queens-based contractor, finished placing about 40,000 ft of a slurry wall containment system that is designed to prevent untreated leachate from migrating off site while minimising the inflow of outside water. The wall was built in two segments, each 20,000 ft in circumference. They encompass 776 acres of the landfill's two final segments still receiving garbage. Two smaller sections totalling 278 acres have been idle since 1993 and have already been capped and covered.

The decision-making practices are also evolving all the time! For example, recently (October 1998) after the Council rejected the Mayor's proposed budget and approved its own and went to court over it, the Mayor proceeded to impound funds for re-establishing weekly recycling in those districts that he converted to biweekly a couple of years ago. Last month the Mayor issued its pronouncement on how the City would be exporting its waste (via three new transfer stations -- in Brooklyn and Newark/Carteret, NJ, thus angering the Newark Mayor and NJ Governor). Since they weren't consulted in advance, the two of have vowed to fight any such siting. Lawsuits are clearly on the agenda! Who knows how that one will turn out. Clearly this is a situation that is not easily remedied, and does not bode well for similar problems facing the disposal of waste from major cities across Europe, particularly the problems being faced by London and the surrounding 'Shire' Counties.

The future of solid waste management in New York City post-2001 is uncertain. The evidence is clear that there is still interest in the Congress to restrict interstate exports of solid waste and interest by waste-importing states to thwart the City's attempts to export. For years the City has shown a pattern of fighting City laws and Court rulings (Local Law 40 and Local Law 19), writing Solid Waste Management Plans that lack important details and contingency measures, ignoring the advisory community, and making major decisions on solid waste management without the benefit of advice and consent of affected parties (neighborhoods, other states).

The solid waste management planning process has proceeded along one track, with Task Forces making recommendations on export prevention measures as well as export alternatives, and DOS creating a draft Plan modification that NYS DEC has found lacking in detail and supporting documentation. Meanwhile, along a separate track, the City has proceeded to export thousands of tons per day of waste and develop plans for 20-year contracts for exporting wastes with prevention and recycling potential, without moving aggressively to reduce, recycle and compost as much of that waste as possible. This has spurred the development of corrective legislation by the City Council and lawsuits, and has engendered a backlash from many directions and a feeling of anger and mistrust.

The City has, by its actions, exacerbated a difficult situation (the need to design and implement within five and a half years, a plan to manage 13,000 tons per day that had gone to Fresh Kills), and has risked its export plans for a perceived expediency.

A question to ponder: even if landfill capacity were cheap and available for New York City waste, now and in the future, wouldn't it be unwise to transport and dispose of valuable, already refined materials that took energy, resources, and money to produce, when they can instead be productively recycled? And residents in communities receiving waste wonder, and some demand, that New York reduce, recycle and compost as much waste as possible before exporting.

It would appear that maximising waste prevention programs, doing as much as possible to increase recycling diversion rates, and expanding on-site and centralised composting programs for food and yard waste, and attracting factories to make use of recycled materials would not only reduce export costs, reduce environmental costs, spur economic development in the City, but would also increase the likelihood of finding agreeable host communities for exported waste. The City appears to show no signs of deviating from its established path. The Solid Waste Management Plan Modification revision process and EIS preparation are proceeding towards export of all waste that is not recycled. Whether Fresh Kills closes on time is anyone's guess!

14. LESSONS FOR THE UK

Clearly a lot can be learned from this particular case study. In terms of large cities planning for sustainable waste management there is the fundamental issue of land availability for disposal. As noted in the previous paper, landfill availability is beginning to decline and planning restrictions are making it ever harder to secure suitable land within or near to the urban locations responsible for the waste production. The case of London was presented in Chapter 1, and here is a city with very similar problems to New York, and entirely reliant on exportation of its wastes to neighbouring counties across the South East.

Perhaps there is a need for London to realise before it is too late, that even with a central planning body setting waste related policy and strategy (as we have now with the GLA) little will be implemented without the consent of the residents and the support of neighbouring authorities to support the city's infrastructure whilst it has time to grow and develop on it's way towards greater self-sufficiency in terms of solid waste management.

However, there is another interesting lesson to come from this case study. In terms of dwindling landfill availability and the threats of increased transportation and disposal costs perhaps some form of landfill mining and cyclical process of landfill and re-use of the materials would be a valuable alternative, helping to prolong the length of active sites and turn them into sustainable waste management processing facilities, as opposed to tips, dumps or landfill sites. This topic is considered in greater detail in the coming paper.

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APPENDIX 4

DEMONSTRATION OF AEROBIC LANDFILL

APPENDIX 4

DEMONSTRATION OF AEROBIC LANDFILLING - THE POTENTIAL FOR MORE SUSTAINABLE SOLID WASTE MANAGEMENT

Municipal solid waste (MSW) landfills worldwide are experiencing the consequences of conventional landfilling techniques, whereby anaerobic conditions are created within the landfilled waste. Under anaerobic conditions within a landfill site slow stabilization of the waste mass occurs, producing methane, (an explosive "green house" gas) and leachate (which can pollute groundwater) over long periods of time. As a potential solution, it was demonstrated that the aerobic degradation of MSW within a landfill can significantly increase the rate of waste decomposition and settlement, decrease the methane production and leachate leaving the system, and potentially increase the operational life of the site. Readily integrated into the existing landfill infrastructure, this approach can safely and cost-effectively convert a MSW landfill from anaerobic to aerobic degradation processes, thereby effectively composting much of the organic portions (one of the potentially polluting elements in a conventional landfill site) of the waste. This paper summarizes the successful results of two separate aerobic landfill projects located in Georgia (USA) and discusses the potential economic and environmental impacts to worldwide solid waste management practices.

1. LANDFILLING WASTE

Approximately 62% of the Municipal Solid Waste (MSW) generated in the United States is disposed of by landfilling [1]. Landfilling in the USA (like much of the world) has evolved over the years from 'open dumps' prevalent in across Europe during the period of Roman rule and still dominant in many nations in Africa and Asia to this dry entombment method, which is currently advocated by the US Environmental Protection Agency [2]. Subtitle D requires that land disposal of municipal solid wastes incorporate the use of low-permeability caps to minimize moisture infiltration with the primary intent to minimize subsequent leachate generation.

Subtitle D regulations (in the USA) regulates 'dry entombment' and requires that land disposal of municipal solid wastes incorporate the use of low permeability caps to minimise moisture infiltration from the surface, the primary intent being to minimise subsequent leachate generation. These regulations and approaches were developed during the late 1970s and early 1980s without due consideration of enhanced biological degradation of the waste, when the dry tomb approach was considered 'best practice' at that time [3]. However, over time, anaerobic decomposition of sanitary wastes can have negative effects on landfill operations, which actually increase the potential for risks to human health and the environment. These risks include:

- *the production of leachate, containing concentrations of organic and metals compounds, as well as pathogens, which can pollute water courses and groundwater;*
- *slow stabilization of waste mass, increasing the potential for leachate releases through the landfill's liner systems; and,*
- *the long-term need for costly site remediation.*

The structure of a conventional landfill site will usually consist of an excavated site that has preferably been lined with a conventional lining material to prevent leachate from making its way into the surrounding earth and ground water system. However, there are a substantial number of landfill sites exist where the landfill was never lined [1, 4].

Furthermore, the structure of conventional landfills includes a conventional leachate collection system that collects percolated leachate that has settled to the bottom of the landfill. The leachate collection system may be established in a sand base initially established in the landfill. Typically, municipal solid waste is deposited in the landfill on a daily basis. Layers or cells of the waste material are periodically covered with a layer of earth or dirt generally also on a daily basis. Thus, pockets or cells of the solid waste are established in the landfill.

Once the landfill has been filled to a predetermined amount, the site is covered with a suitable covering material. Covering can be a layer of dirt of earth, typically including a substantial concentration of clay. Alternatively, cover may also include a liner material similar to liner used to line the bottom of the landfill.

1.1 The Consequences of Anaerobic Waste Decomposition

With such conventional landfills, once the site is covered with material, a monitoring process must be established to monitor the site until it has stabilized. With conventional landfills, by regulation, this monitoring process can take up to thirty years [5]. In conventional landfills, the stabilization process takes such a long time due to the fact that the waste material has been essentially entombed in the landfill so that substantially no oxygen or moisture is introduced into the landfill [5, 6]. The reduction that does take place is primarily anaerobic (without oxygen), which produces harmful and objectionable by-products, such as methane gas.

Research involving the mining of wastes from older landfills, especially those with low-permeability caps, has revealed that a significant fraction of the waste mass remains relatively intact, with little evidence of biodegradation, even after several years of residence time within the landfill [4, 7]. It is apparent that the objective to minimize the infiltration of moisture, and the subsequent creation of a dry "tomb" effect for the landfilled waste, lengthens the degradation process over several years, even decades, due to the decrease in the hydrolytic reaction rates and overall biodegradation rates. With this current regulatory approach, a Subtitle D landfill will potentially generate leachate and landfill gas for an extended period of time, perhaps even beyond the current 30 year post-closure monitoring period, due to a low but consistent infiltration of storm water. This poses long-term environmental impacts to the landfill area and increased maintenance cost burdens for municipal and private solid waste management entities [8]. In addition, anaerobic conditions within a landfill result in the production of methane, an explosive, odourless gas, as well as vapour-phase volatile organic compounds (VOCs).

Considered a "greenhouse gas" under US legislation (Clean Air Acts etc.), methane generated in landfills is typically in excess of 45% of the total landfill gases [6]. In some cases, VOCs present in the landfill gas have been identified as a source of groundwater contamination [5].

At many landfills, these gases are required to be collected, controlled (flare or other end use), and monitored to minimize the risks of gas build up and/or fires as well as to comply with specific environmental regulations (see Figure 1). It should, however, be noted that methane generation can be an obvious source of electricity generation, and may cooperating landfill sites in the UK do use the methane to generate electricity, which they feed into the National Grid [5].

Figure 1. Methane and other gaseous emissions coming from a landfill site in Atlanta (source : author)

Although the "dry-tomb" approach is an attempt at reducing potentially polluting emissions from a landfill, this approach is a temporary solution. According to the US Environmental Protection Agency (EPA) as reported by Hudgins [9], "liner and leachate collection [systems] ultimately fail due to natural decomposition..." [6].

The EPA recognizes that *"once the unit is closed, the bottom layer of the landfill will deteriorate over time and consequently, will not prevent leachate transport out of the unit"* [1].

As a result, leachate collection systems and impermeable caps do not decrease the risk that toxic constituents, typically found in ageing landfill leachate, will reach local groundwater, even though these liner systems can prove very effective at containment during the operational lifetime of a landfill site. To prepare for this, landfill owners are required to set aside funds for their own cleanups. Once the landfill begins releasing leachate, remediation must be initiated, and the waste mass is "managed" once again. The net effects of this "dry-tomb" approach can be costly, even beyond the landfill's closure [2]. Nevertheless, many landfills are designed using the "dry-tomb" approach [1]. As a result, landfill owners find themselves using a design approach that will most likely fail, which will, in turn, increase landfill costs and long-term liabilities. Thus, other landfills approaches are being sought [9].

2. LEACHATE RECIRCULATION AS A POTENTIAL SOLUTION

Although rather limited, controlled leachate recirculation has been utilized at several U.S. landfills as a leachate management tool since the 1980s [10, 11]. However, over the last few years, leachate recirculation within landfills has received much more attention due to its potential for addressing landfill environmental issues more cost-effectively [7]. In some cases, leachate recirculation has not only shown to increase the rate of waste decomposition, but also can increase methane production for energy use and reduce the levels of certain toxic organics in landfill leachate. According to one industrial commentator "for now, the practice of leachate recirculation varies from landfill to landfill.

Many run pilot projects with the hope of increasing waste stabilization, reducing volume of leachate to be treated, and enhancing methane generation" [12]. Other leachate recirculation projects, such as those conducted under aerobic conditions, utilize oxygen as nutrient to promote a higher rate of waste decomposition and settlement (as compared to leachate recirculation alone) [13].

For many of the landfills that use leachate recirculation approaches, the landfill leachate that is collected in the landfill's existing leachate collection system is injected (or gravity-fed) through an intermediate cap into the waste mass (under aerobic conditions, oxygen or air is also injected into the waste). Once injected, the indigenous micro-organisms utilize the moisture and nutrients provided to consume the organic fractions of the waste at a higher rate [14]. While leachate recirculation projects depend upon complex biological mechanisms, this approach can be safely incorporated into many new and existing landfills in such a manner as to minimize its impact on the landfill operations and in compliance with current landfill regulations.

The EPA has established a program of awareness and technical assistance, known as the Landfill Methane Outreach Program (LMOP), to encourage waste-to-energy (WTE) projects at candidate landfills [6]. According to the LMOP, of the "approximately 3,700 landfills in the nation, 750 are considered candidate landfills, whereby the methane gas enhancement is economically attractive" (this assessment is based on factors such as the size of U.S. landfills, their location and proximity to a potential LFG user, and potential market conditions). Increased methane production (and recovery) via leachate recirculation could increase the number of candidate landfills [6]. For "non-candidate" landfills or at landfills where WTE may not be economical, federal and state agencies are supporting the idea of aerobically degrading the waste in-place, combined with leachate recirculation [3, 13].

Recently, a number of aerobic leachate recirculation applications have demonstrated that the aerobic degradation of MSW within a landfill can provide significant advantages, even beyond "anaerobic" approaches [13, 14 and 15).

Specifically, the recirculation of leachate combined with the injection of air not only promotes a higher rate of waste decomposition and settlement (as compared to leachate recirculation alone), but also decreases the production of methane gas [16]. This can, in some cases, equate to reduced "end-of-pipe" gas treatment costs, reduced toxic compounds in the leachate, and decreased volumes of landfill leachate that require treatment. Overall, this approach can translate into significant long-term cost savings and liability reduction for many landfills [16].

Whether via aerobic or anaerobic processes, the EPA has recognized that leachate recirculation in landfills can potentially lead to more rapid waste decomposition, stabilization, and settlement, lower landfill operating costs, and an extended life of the landfill [6]. From a life-cycle perspective, a landfill site could be redeveloped, once stabilized, for commercial activities, or if mined, reused as a new landfill, potentially avoiding new landfill sitings [3].

3. AEROBIC SYSTEMS

Active aerobic biodegradation processes, such as composting, have demonstrated for years that the biodegradable portion of Municipal Solid Waste (MSW) can be stabilized [17] in a significantly shorter time frame (as compared to anaerobic conditions) by providing the organic waste fractions the proper proportions of air and moisture [14]. This leads to the idea that, in a landfill environment, the concept of in-situ aerobic biodegradation of MSW should be evaluated worldwide [15].

Laboratory experiments [18], such as those conducted at the University of South Florida [19], have demonstrated that, in an aerobic environment, respiring bacteria convert the biodegradable mass of the waste and other organic compounds to mostly carbon dioxide and water, instead of methane, with a stabilized humus remaining [20]. In addition, the recirculating of the waste's leachate through the waste mass improves degradation, whereby the recycling of moisture and nutrients are continually made available to the respiring micro-organisms indigenous to the waste [21].

Reportedly, several European [22] and Asian countries are evaluating this approach and have begun their own aerobic landfill studies [16]. In these cases, the landfill itself serves as a large closed vessel or aerobic landfill system, is operated as a cell, and is managed to control leachate, landfill gas (LFG), and waste recycling [19].

The concept of the aerobic landfill basically involves the composting of readily and moderately degradable solid waste constituents. The waste undergoing the composting process permits gas exchange, provides its own nutrients, produces water, and utilizes an indigenous and diverse microbial population [23]. At first glance, the enhanced kinetics and rather innocuous end products associated with the degradation of organic waste constituents using oxygen as the primary electron acceptor is very attractive to landfill operators, owners, and regulators.

Enhanced biodegradation rates mean enhanced rates of stabilization of the waste mass. Research [19] concluded that the aeration of MSW incubated in lysimeters, with moisture content sustained via leachate recycling, resulted in an increase in biomass production and greater cellulytic activity, i.e., an increase in the ability of the microbial population to hydrolyse cellulose. The aerobic bioreactor landfill decreases the long-term impacts on the surrounding environment, as well as post-closure maintenance costs. Based on the stoichiometry of the aerobic biodegradation of organic compounds, one would expect a significant reduction in methane production within a landfill's waste mass [16].

International interest and implementation of the aerobic bioreactor landfill technology is increasing. Particular interest and use of the technology has been seen in Japan, which has recently begun to release data regarding their aerobic landfills that they have been investigating over the past several years. The "semi-aerobic" landfill is a standard type of landfill currently used in Japan. In this system, air is allowed to passively move through the headspace of the leachate collection system pipes that are open to the atmosphere. The temperature differential between the interior landfill (high temperatures) and the outside air temperature (lower relative temperatures) produces a "chimney" effect where air is drawn into the pipes and circulated throughout the waste mass [23].

In Germany, aerobic biological pre-treatment of MSW has been carried out since the late 1970s. This pre-treatment process is used to lessen the overall waste mass, increase landfill densities, improve leachate quality, and reduce the attraction to birds. The German system also utilizes the "chimney" effect to passively aerate the waste mass [20].

3.1 Bio-Reactors

One possible method for reducing the demand on declining landfill void is the mass processing of municipal solid waste in 'bioreactor landfills' [24].

Under this model, landfills become a 'bioreactor' processing or digesting the waste rather than the more traditional 'dry tombs' where the waste decomposes slowly or not at all [15]. Using this approach the life of landfills can be greatly extended, perhaps indefinitely [16]. Under this model;

- *landfills become processing facilities - rather than being kept dry, injecting leachate into the waste to accelerate the decomposition actively moistens the waste; additionally air can be actively introduced to the waste, which further hastens the decomposition process through the establishment of aerobic conditions.*
- *landfill construction and engineering are substantially modified with regards to leachate collection, re-circulation and gas collection and management.*
- *the stabilised material resulting from the enhanced decomposition process will be used as daily, intermediate and final cover, and could be potentially used for land reclamation and other applications.*

However, the level to which bioreactor operation as been implemented has most commonly been restricted to some form of leachate re-circulation. Thus, experience is limited with regards to the controlling or monitoring of the treatment processes occurring within the landfill [17], or of the impact of leachate re-circulation on the internal landfill system [18]. In most cases, leachate re-circulation has been practised as a novel approach to managing leachate without much thought to using the landfill as a treatment system [19].

As many wastewater treatment facility operators know, aerobic treatment processes reduce concentrations of organic compounds typically found in wastewater [25, 26]. Compounds such as toluene, vinyl chloride, as well as many odour-causing compounds (e.g. ammonia) can be treated in aerobic lagoons, rotating beds, and fixed media systems [27].

Using the landfill waste as a treatment bed, the aerobic landfill also promotes the aerobic treatment of the leachate in a similar manner, whereby air, moisture, and nutrients are combined together. Since the concentrations of these compounds are reduced the need for subsequent leachate treatment could also be reduced, depending on applicable regulations [28]. As an additional benefit, there is an increase in the rate of waste stabilization (the point at which risks associated with the waste are minimized) as well an increase in the rate of waste subsidence. This creation of landfill *"air space"* or void can maximize the useful life of a landfill and prove a cost-effective method of waste recovery [29].

The 'Fukuoka Method' (see Figure 2) is one such attempt at aerobic landfilling [30], and utilises the self-purifying capacity inherent in 'nature' to stabilise waste materials [31];

- *the quality of leachate improves significantly and more rapidly than in anaerobic conditions; offering considerable cost advantages in not requiring secondary treatment*
- *the generation of methane is reduced thus contributing to the prevention of global warming*
- *stabilisation is enhanced making it possible to return the completed landfill site to another use (agriculture or leisure) in a shorter period of time than for conventional sites*
- *the technology is cost-effective and simple to construct and operate, allowing a high degree of freedom in the selection of materials for pipes and accessories*
- *the overall effectiveness depends on the ability to monitor continuously various performance parameters*

Figure 2. Results from the Fukuoka Method [31]

The aerobic landfill idea has been sporadically investigated over the past thirty years [20]. The first system employed in the United States was located in Santa Clara, California. This was a demonstration project funded by the US EPA in 1969. In this application [32] air was pumped through the under drain leachate collection system [33] into the waste mass. However, the wastes eventually became too dry, due to inadequate moisture addition, yielding limited results [32]. Several facilities have operated quasi-aerobic systems [33], injecting air into the waste mass for two to three months, covering the mass with Posi-Shell, a commercial cement mortar mixture, and allowing the mass to go anaerobic for the remainder of the process [32].

The Interim Landfill in Albany, New York has used a forced aeration pre-treatment system from 1989 to 1995 [34]. The waste was shredded and wetted, prior to placement in loose layers and covered with a Posi-Shell coating. Forced air was injected into the mass for 30 to 60 days and then was turned off. The mass was then allowed to go anaerobic. The effective density of the waste was increased by 50% (minimum) with general waste densities increasing from 1315 to 2142 lbs per cubic yard. Similar systems have been placed in Elmira, New York and Ontario County, New York [35]. This technique has shown promising results as a pre-treatment method for solid wastes and is discussed further in latter sections of this paper [16].

4. DEMONSTRATION OF THE AEROBIC LANDFILL CONCEPT

As presented below (Table 1), separate aerobic landfill systems were demonstrated at two separate Subtitle D landfills in Georgia (USA). Readily integrated into the landfills, these two systems demonstrated that landfills can be cost-effectively converted from anaerobic to aerobic degradation processes, and that aerobic degradation of the MSW can provide short- and long-term benefits for landfill operators [36].

Table 1. Operating conditions at the two test sites

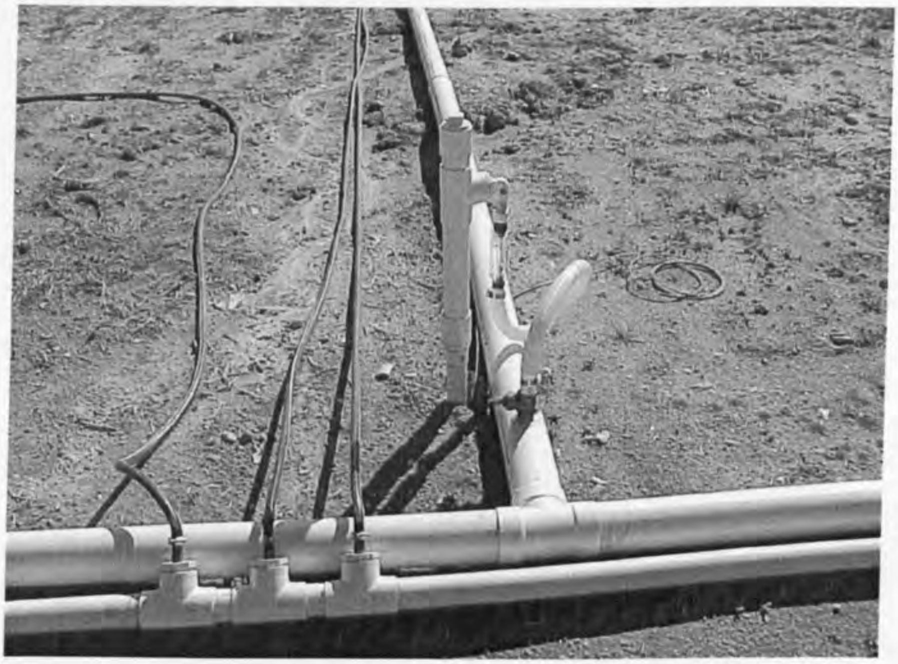
Design Parameter	Columbia County Landfill (No. 1)	Live Oak Landfill (No. 2)
cell size (hectares)	1.6	1.0
average waste depth (meters)	3.0	10.0
total waste volume (m3)	45.2	49.0
age of waste at start of project (months)	18.0	36.0
leachate injection rate (l/day)	13.6	25.2
total leachate injection (l)	over 7 million	6,676,200
air injection rate (m^3/min)	56.0	100.0
duration of study	18 months	9 months
annual rainfall (cm/year)	137.0	114.0

4.1 How the Aerobic Landfill Process Works at the test cells

Both systems rely on natural processes via the addition of air (providing oxygen to the waste mass) and the recirculation of leachate (providing moisture and nutrients for the indigenous, respiring micro-organisms). In both cases, a reliable, flexible system for adding air and leachate was designed based on several leachate recirculation studies conducted to date as well as on practical environmental remediation systems that treat soils and groundwater in-situ [6]. Using readily available materials and equipment, each system was readily integrated into the existing landfill infrastructure (see Figure 3).

The key to the aerobic landfill's effectiveness is the proper control of aerobic conditions, whereby waste mass temperatures and moisture are maintained within optimal ranges. This is accomplished by balancing airflow and leachate recirculation into the waste mass in a manner that effectively stabilizes the waste in a much shorter time frame than under conventional anaerobic conditions [37].

Figure 3. An example of the piping used to feed air to the waste mass within the landfill (source: author)



At each site, the air injection system was comprised of electric blowers (or compressors) and piping, connected into the existing landfill infrastructure. Vertical air injection wells are installed directly into the waste to provide the oxygen required. For landfills with an existing leachate collection system (LCS) (e.g. such as in the floor of the Landfill No. 1 Subtitle D cell), the aerobic landfill system could incorporate the LCS to provide oxygen to the waste mass (At Landfill 1, it was demonstrated that the LCS could still collect leachate during air injection). Landfills with no leachate collection systems, can be readily retrofitted with horizontal and/or vertical air injection wells [37].

One might expect air injection systems into landfills to be fraught with problems due to the dense nature of the material that is being landfilled (MSW) and the inherent soil content of any landfill site – both of which are not ideally suited to the flow of air through them. However, at both the test cells in question target air pressures were achieved without the need for expensive equipment and few problems were encountered. The system has utilised successful 'bio-venting' technologies used for many years for pushing air through sands and clays with only moderate energy costs. In general MSW will be more permeable than sand and clays (due to the mix of material and the irregular shapes of the refuse even after compaction) and so the air injection procedure at the case studies was highly efficient. It is true that landfills could be considered as 'a tough reactor' proving difficult to stir so as to encourage heterogeneous conditions throughout, and this is why a series of vents and pipes are used to control conditions at a variety of points throughout the landfill.

Figure 4. Controls for air and leachate circulation (source: author)

Leachate, collected in a holding tank, was pumped into each system through a leachate recirculation system to the top of the waste.

The system then injected leachate through the intermediate clay cap (which covers the waste) and into the waste mass. The leachate then percolated downward counter-current to air that was forced into the waste by the blowers/compressors. Leachate that is not utilized during aerobic decomposition migrates downward to the landfill's leachate collection system or recovery wells, is pumped to the tank, and recirculated through the waste mass. Landfills with no leachate collection systems, can be retrofitted with horizontal and/or vertical leachate recovery wells at locations where leachate is likely to collect. This "closed-loop" configuration [13] reduces the potential for operator exposure to leachate and minimizes operator involvement.

Aerobic conditions were balanced in each landfill by properly adjusting leachate flow and air delivery into the waste mass to keep the waste mass moisturized and aerated. Improper balancing of air and leachate can lead to poor aerobic landfill performance and, possibly, elevated waste mass temperatures. Technicians closely monitored the aerobic landfill during the start-up period (2 to 5 months) to ensure safe, effective operating conditions were established. Adjustments to each system were made based on key data, as described below. Afterwards, monitoring was readily accomplished by the available site personnel. Automation of system components can be implemented to further minimize the time requirements for landfill operators.

During system operation, waste mass moisture content, temperature and off-gas concentrations (VOCs, CO_2, O_2, and CH_4) were measured in the field to ensure safe, efficient aerobic operations. Using moisture probes, thermocouples, and vapour points that were installed directly into the waste, key operational data were collected from portable monitoring instruments. Leachate analyses included pH, specific conductivity, Biological oxygen demand (BOD), metals, and VOCs. Other data included an inventory of leachate production and measurement of the moisture content of the landfill gas [16].

The primary goal of the aerobic landfill system is to achieve optimum waste stabilization through aerobic degradation. This is defined in terms of a stabilized organic matter, decreased concentrations of leachate contaminants, reduced methane production, and waste mass subsidence.

Laboratory analyses provided the data needed to determine the system's effectiveness on the leachate. Direct measurements of landfill gases were used to determine the volumes of methane production. The subsidence of the landfill waste mass was monitored by physical survey. Although, the biodegradation rate of this process can be determined in various manners, for this application, the biodegradation rate was determined based on oxygen uptake rates, and waste mass temperature measurements. The results from each test cell are discussed in the next section. It should be noted that it is not possible to ensure fully aerobic conditions throughout the entire landfill site test cell, and even more difficult if the system was to be developed for a whole landfill site, but what is important is that the conditions within the site are as close to 'ideal' as possible for the majority of the site. Undoubtedly some of the processing occurring within the test cells will remain anaerobic, but this will be limited in scale and significance by the continual monitoring of the aerobic conditions [38].

Upon complete stabilization of the waste, the temporary soil cover can be stripped back and stockpiled, and replaced on a new lift of waste, thereby minimizing material costs. Two independent aerobic landfill demonstrations were conducted at separate Subtitle D landfills, both beginning in January of 1997. Quite surprisingly, not only did each demonstration showed that aerobic decomposition of MSW in-situ could safely and successfully be accomplished, but the data was almost similar, with respect to LFG reduction and increased waste settlement, despite the fact that each landfill was constructed in a different style and with different waste inputs [16].

The first system (Columbia County Landfill), referred to Aerobic System Number 1, was installed within a 16-acre (6.5-hectare) portion of a landfill near Augusta, Georgia (USA) and operated for approximately 21 months. Through a minor modification of the landfill's operating permit, the Georgia Environmental Protection Division (EPD) within a relatively short timeframe approved the aerobic landfill (30 days). The system was then installed in approximately two weeks and has been operational ever since. Presently, designs are being developed for expansion of the system within the site and also to a nearby-unlined landfill that lies adjacent to the site.

The second system (Live Oak Landfill), Aerobic Landfill Number 2, was conducted at a larger landfill site in north-central Georgia, which operated for nine months only. This 2.5-acre (1 hectare) landfill cell contained approximately 75,000 cubic yards (57,000 cubic metres) of waste and an average depth of 30 feet (9 metres). Critical operation data was monitored using a comprehensive system of real-time instruments connected to remote sensing equipment. Upon completion of the project, the degraded waste was excavated to evaluate the effectiveness of the process. In addition, the waste was characterized to determine potential future uses of the recovered waste [29, 36].

4.2 Site Methodology

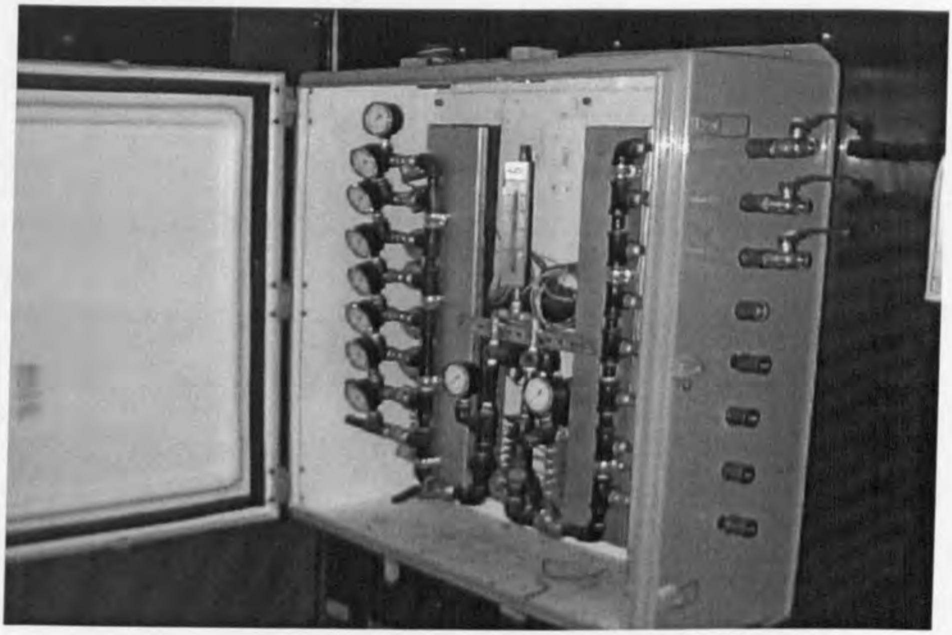
In order to complete the transfer from anaerobic conditions to aerobic a number of stages are required [21, 16];

1. *covering the waste material;*
2. *increasing and maintaining the moisture content in the landfill in a range from about 40% to about 70%;*
3. *injecting a source of oxygen into the landfill to drive and maintain microbic activity aerobic;*
4. *increasing the temperature in the landfill to a level and for a duration of time sufficient to substantially eliminate pathogens from the landfill;*
5. *controlling the temperature in the landfill in a range of about 130.degree. F. to about 150.degree. F. to sustain aerobic degradation; and*
6. *monitoring combinations of oxygen content, moisture content, and temperature in the landfill and varying combinations thereof to maintain aerobic degradation in the landfill.*

4.3 Detailed Control Conditions

The aerobic landfill process includes establishing a grid of air injection wells and moisture or water injection wells throughout the landfill [21].

Figure 5. Automatic air flow control monitoring box (source: author)

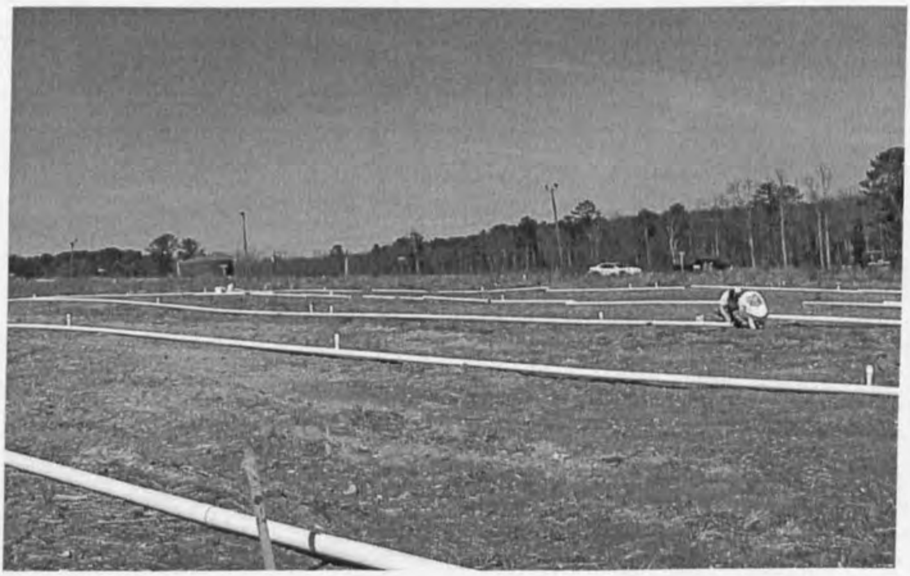


A substantially automated system controls the amount of water and oxygen (in the form of compressed air) injected into the landfill mass in response to a monitoring system that monitors temperature, oxygen content, and moisture content (Figures 5 and 6). The monitoring system also may monitor the generation or production of gases within the landfill as an indication of the type of degradation occurring. For example, the presence and concentration of methane gas generated in the landfill mass is a strong indication of the type of microbial activity.

There is a need to establish conditions within the landfill that promote and maintain primarily only aerobic degradation of the waste material. Moisture content in the landfill mass is monitored and maintained between about 40% to about 70% by adding additional water or the like into the landfill. Preferably, the water added into the landfill comprises leachate collected from the landfill. Thus, the leachate is continuously recycled back into the landfill thereby significantly reducing the concern and expense of treating or disposing of the collected leachate (Figure 6). An additional make-up supply of water is also available to ensure that sufficient moisture is maintained in the landfill mass.

Figure 6. Automated Control Centre for Landfill Site Number 1 (source: author)

Figure 7. Laying out the piping prior to landfill operations at the new cell at Landfill Number 1 (source: author)



Oxygen content of the landfill mass is also monitored and oxygen is injected into the landfill to promote and maintain primarily aerobic degradation of the waste material. Preferably, compressed air is the source of oxygen and is injected into the landfill mass through injection wells to ensure that the oxygen content remains above 0%. In this manner, it is ensured that sufficient oxygen is being supplied to sustain aerobic degradation. So long as oxygen is being supplied into the landfill and the oxygen concentration in the landfill remains relatively low, generally just above 0%, it is ensured that sufficient oxygen is being supplied to promote and maintain primarily aerobic degradation.

The capability to deliver air to individual zones within the landfill is an important control mechanism of the present process. Thus, the injection of ambient air serves two purposes in the aerobic landfill process. First, the air supplies oxygen to the landfill in concentrations sufficient to establish and maintain aerobic degradation. Secondly, controlling the rate of air injection into the landfill is a preferred method to control the temperature in the landfill. The air has a dual affect on temperature. The flow of air into the landfill mass acts as a medium to carry off heat generated in the landfill as it escapes the landfill. This heat is generated primarily by the microbial activity in the waste material. Thus, more air is injected into the landfill to lower the temperature. Additionally, the additional oxygen injected into the landfill tends to kill off remaining anaerobic microbes since these microbes cannot live in the presence of oxygen. As the anaerobic microbes are eliminated, the heat they were generating is also eliminated. Thus, the injection of air further lowers the temperature in this regard [21].

The capability to deliver moisture to individual zones within the landfill is also an important control mechanism for the aerobic degradation. Moisture content of generally about 40% is essential for rapid aerobic degradation. Microbial activity, and therefore degradation, slows by several orders of magnitude below moisture content of around 40%. Below 20%, degradation essentially ceases. ECS has determined that an ideal moisture content in the landfill for aerobic degradation is about 60%.

This moisture content allows for adequate oxygen diffusion through the waste material to support the rapid aerobic degradation. If the moisture content is too low, the landfill is dry and aerobic decomposition will cease. Conversely, if the moisture content is to high, diffusion of oxygen is hampered thereby limiting aerobic activity.

Moisture measurements may be made by direct sampling of the landfill material through sampling wells, as discussed in more detail below, and calculations can be made to determine the amount of leachate and water to be added back to the landfill to maintain the moisture content within the desired range. Monitoring leachate generation rate and the moisture content of the evolving gases can also give a rough estimate of the moisture content of the landfill.

Moisture injection wells do not extend as far into the landfill and have a relatively long diffuser section so that the moisture or water injected there from can percolate or seep substantially uniformly throughout the landfill mass on the other hand, the air injection wells are substantially long and extend to relatively near the bottom of the landfill and include a relatively short diffuser section so that the air is initially injected near the bottom of the landfill mass and allowed to uniformly diffuse and escape through the top of the landfill. As discussed above, this characteristic of the injected air allows for heat generated in the landfill to be carried off by the escaping air. The wells are preferably formed of a lightweight material, such as PVC and are substantially hollow. Sections of PVC piping can define a well casing. The wells are capped by a cap member. The injection wells, particularly the moisture injection wells, can also house sensors, such as temperature sensing devices. For example, a thermocouple can be housed in the wells to monitor the temperature of the landfill mass. Likewise, conventional gas sensors can be housed in the air injection wells to monitor particular gas concentrations in the landfill mass. The injection wells are not limited to any particular type of material or configuration. For example, metal wells are just as applicable in the aerobic landfill process. Likewise, the wells can comprise any shape or configuration.

Temperature within the landfill mass is a critical element in promoting and maintaining the aerobic degradation. The ideal range of about 130 degrees Fahrenheit to about 150 degrees Fahrenheit can be controlled by a combination of factors, but preferably is controlled primarily by the injection of air into the landfill [17]. The temperature can also be controlled by the moisture content. However, the system reacts much faster to changes in oxygen or air content. It is also preferred to elevate and maintain the temperature in the landfill at a level sufficient to kill off harmful pathogens in the waste material; for example, temperatures above 135 degrees Fahrenheit are generally required to eliminate the pathogens, whilst at a temperature of 155 degrees Fahrenheit the pathogens are killed off in days.

It is believed that the additional air acts as a medium to carry off excess heat generated by the microbial activity. It is also believed that the additional oxygen reduces any remaining anaerobic degradation activity since the anaerobic microbes cannot live in the presence of oxygen. Thus, the heat being generated by such anaerobic activity is also eliminated. If temperature in the system is too low, the amount of air injected into the system is decreased so that the heat generated by the microbial activity (aerobic or anaerobic) is not dissipated as fast and therefore increases the temperature within the landfill mass.

Temperature is also monitored as an indication of complete or stabilized degradation. A decrease in temperature in the landfill despite an increase in oxygen levels is a strong indication that the degradation process is nearly complete and that the biodegradable material has stabilized. At this point, the waste material has been essentially composted and the landfill is stabilized. Additional monitoring of the landfill may no longer be needed [20].

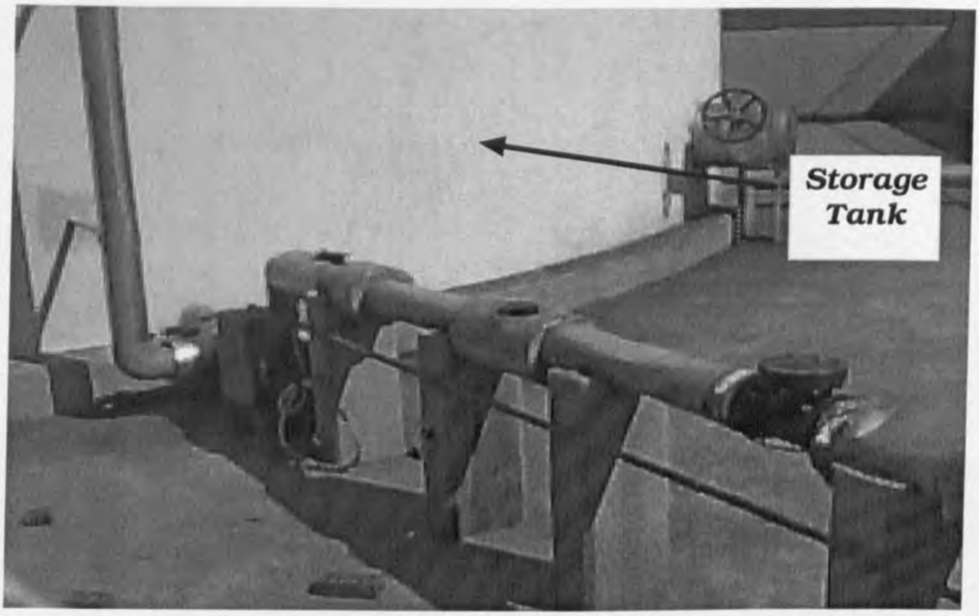
Methane is a primary by-product of anaerobic degradation. If methane is maintained generally less than 10% by volume and no strong odours are detected from the by-products, this is a strong indication that aerobic degradation is being maintained, particularly if air or oxygen is being injected into the system and oxygen concentrations are maintained greater than 0% by volume.

Methane concentrations approaching 50% is a strong indication that the microbial activity is primarily anaerobic.

The aerobic landfill process also includes adding additional nutrients into the landfill by way of the injection wells to further promote the aerobic degradation. For example, any combination of nitrogen, phosphates, and carbon source may be injected into the system to maintain optimal levels of microbial growth for the aerobic degradation. Also, the aerobic microbes may also be supplemented through the injection system. It has been found that a preferred concentration ratio of carbon to nitrogen in the range of about 20:1 to about 50:1 is desired [16].

The method allows for variably adding moisture into the landfill to maintain moisture content within a range of about 40% to about 70%. One example of a moisture injection system is that the source of moisture is preferably leachate collected from the leachate collection system and supplied to a holding tank through a supply line. Control devices, such as electric solenoid valves, may be supplied in this line to automatically fill the holding tank when necessary. In this regard, the tank may include high and/or low level sensors to automatically initiate and stop filling thereof. An addition line is provided into the tank so that other liquids, such as liquid nutrients, can be added into the system via the holding tank. A make-up supply of water can also be interfaced with the system in the event that the leachate collection system does not generate adequate leachate to maintain the moisture content in the landfill within the desired range. It may be preferred that the alternate make-up supply comprise a pond or reservoir established for this purposes. A make-up pump is used to supply the make-up water supply to the holding tank. An electronic control device, such as a solenoid valve, can also be utilized with the make-up supply source to automatically add make-up water when necessary [16]. A leachate addition pump takes suction from the holding tank and distributes the leachate and/or water to a main header. A relief valve can be included in the line so that the pump will recirculate back into the holding tank in an overpressure condition. A pressure gage can be included to monitor system pressure (see Figure 8).

Figure 8. Leachate pump and storage tank (source: author)



5. THE CASE STUDY DATA

The analyses of vapour samples, leachate chemistry, biological activity, and inspection of waste samples confirmed that each aerobic landfill system was extremely effective at stabilizing the waste. Moreover, each system functions as an in-situ leachate treatment system, whereby leachate volumes, as well as contaminant concentrations, are reduced [29].

Specifically, each aerobic landfill system demonstrated: 1) a significant increase in the biodegradation rate of the MSW over anaerobic processes; 2) a reduction in the volume of leachate as well as organic concentrations in leachate; and 3) significantly reduced methane generation. In addition, waste settlement was observed as each system stabilized the organic portions of the waste mass. These benefits were obtained while maintaining optimum moisture content of the waste mass and stabilized waste mass temperatures. Table 2 provides a summary of the results.

5.1 Landfill Gas Measurements

Within both aerobic landfill systems, O_2 initially increased in many of the vapour points inserted in the waste mass, at system start-up.

In conjuncture with this, CO_2 fell initially and then rose in close correlation with O_2 consumption. When observed with the methane levels, these gas readings indicated a transformation from anaerobic to at least partial aerobic metabolism: CO2 rises as O_2 is consumed and CH_4 production falls off. Based on direct measurements from thermocouples inserted in the waste, waste mass temperatures remained stable between 40° C and 60° C after aerobic conditions had been reached. Waste mass moisture was above 50% (w/w) in the most active areas. Overall, these data indicated that aerobic conditions within the waste were attained [3].

Table 2. Summary of Final Results [21]

Parameter	**Columbia County Landfill** (No. 1)	**Live Oak Landfill** (No. 2)
Biodegradation rate (1)	increased by 50%	increased by 110% from 0.167 to 0.351 mg of O_2 / hour
MSW settlement (m/m) (2)	greatest = 9% (23 cm) average = 4.5%	greatest = 10%
Methane generation (3)	reduced by 50-90%	reduced by 50-90%
Leachate BOD	reduced by 70% 1,100 to 300 ppm (3 months)	reduced by 70%
Leachate VOCs	reduced by 75-99% (4) (5)	reduced by 50%
Odours	noticeable reduction on site	some success noted by staff
Landfill mining	some mining took place	compost and soil use as landfill cover
Leachate volume	reduced by 86%	reduced by 50%

(1) Based on CO_2 production, O_2 uptake, and waste mass temperatures.

(2) Based on physical survey, future overburden not considered

(3) Methane reduced by 50 to 90% for 80% of the points; 70 to 90% for the row of points closest to air injection.

(4) Iron reduced by 75% to 90%; Lead was reduced to background levels

(5) e.g. toluene, acetone, etc.

At aerobic landfill system Number 2, the landfill gas treatment results were similar. Methane concentrations decreased by at least 80% in three weeks after system start-up and remained consistently below 15% (v/v) for most of the project. Oxygen consumption rose in close correlation with methane decreases (see Figure 9). It should be noted that CO_2 is also a greenhouse gas, but is less potent than methane.

Figure 9. Landfill Gas Emissions (%) – indicative of aerobic conditions [16, 27]

5.2 Leachate Quality

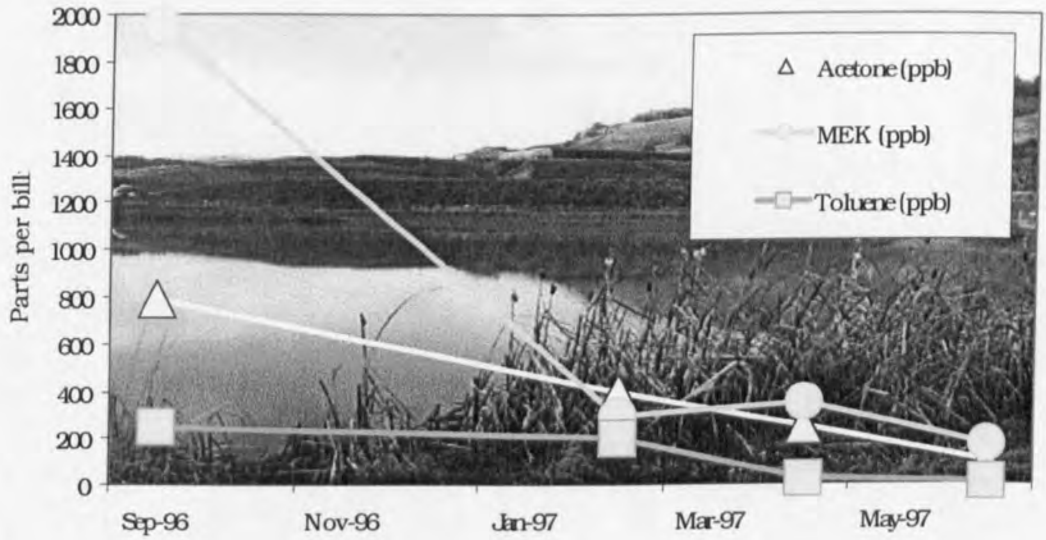
Laboratory analyses of Biochemical Oxygen Demand (BOD) and Volatile Organic Compound (VOC) concentrations in the leachate at each site indicated significant reduction by the aerobic process, as shown in Table 2. At Site 1, BOD in the "Sump One" samples was reduced by at least 70%.

Organics such as methyl-ethyl ketone (MEK) and acetone were reduced significantly; also faecal coliform was eliminated from the leachate. Total VOC concentrations in many of the vapour samples collected were less than 1 part per million (ppm). At Site Number 2, iron concentrations in the leachate indicated significant reduction by the aerobic process, from 61 ppm to 23.03 ppm.

5.3 Leachate Volume Reduction

Prior to the aerobic system's start-up in January 1997, Landfill No. 1 Landfill No. 1 sent approximately 120,000 gallons (535,000 litres) of leachate each month to the local treatment plant. This leachate was pumped through the landfill's new lift station (a capital investment of approximately $100,000 or £67,000) with no pre-treatment. During the first six months after system start-up, the Landfill No. 1 did not pump any leachate to the treatment plant. As of March 1998 (14 months after start-up), Landfill No. 1 has only pumped a total of 250,000 gallons (950,000 litres) to the treatment plant. Figure 10 provides an indication of the changing chemical nature of the leachate after the initiation of the aerobic process, providing additional evidence of the benefits of this approach; decreasing organic components across the samples.

Figure 10. Leachate Compositional Analysis



If a leachate production rate of 120,000 gallons per month (480,000 litres) were maintained (the norm at the site prior to the test cells inception), approximately 1.68 million gallons (120,000 gallons x 14 months) or 6.6 million litres would have required treatment. As a result, Landfill No. 1's leachate treatment needs were reduced by over 85%.

It is estimated that this reduction of leachate is caused, in part, by the evaporative effects of the higher waste mass temperatures and the effects of air-drying out the waste. Additional studies associated to this effect are ongoing, including evaluations of waste mass field capacity.

5.4 Waste Excavation Results

In November, 1997, "aerobic" and "anaerobic" areas of the Landfill No. 1 were excavated to examine the results of the aerobic landfill. In most of the areas excavated, the waste appeared to be MSW typical of the U.S. southeast, bagged and unbagged food, paper, plastic, and miscellaneous wastes. However, an abundant percentage of large, inert and recalcitrant materials such as C&D wastes (construction and demolition), treated lumber, wood wastes, and thick plastics were observed in the waste excavations. This had not been anticipated, for waste surveys conducted prior to this project reported [37] that the Landfill No. 1 had been accepting MSW with a high organic content (over 60%).

Despite the presence of these recalcitrant materials, however, inspection of the various types of organic wastes collected in the "aerobic" areas confirmed that the aerobic landfill rapidly degraded much of the organic fractions of MSW, similar to other aerobic composting operations (see Figure 11). The waste inspections indicated that the readily degradable materials, such as food wastes, vegetation, and paper products, had been significantly composted to a brown, rich humic material [16].

In comparison, inspection of the waste samples collected from the excavations in the "anaerobic" areas confirmed little to no degradation of the organic wastes present. Also, odours from the excavations in the "anaerobic" areas had significant ammonia and sulphur components. MSW examined in these two areas had been placed into the landfill at approximately the same time. In addition, it was noted during the excavations that the large, recalcitrant landfill materials were arranged in a matrix, containing large void spaces that were filled with organic materials, as described above.

It is likely that, although the aerobic process did little to reduce the structural strength of the matrix materials (attributable to the minor settlement of intermediate clay cap), this matrix still allowed the injected air and leachate to be introduced to the more easily degradable organic matter. As a result, the aerobic landfill data presented indicates the composting of, mostly, the readily degradable materials (Figure 12). Over a longer period, however, it is estimated that the system could ultimately degrade much of these recalcitrant woody materials, further reducing their structural strength [39].

Figure 11. Excavated material showing clear signs of ongoing decomposition (source: author)

Figure 12. Recently excavated (and partially composted) waste (source: author)

At Aerobic Landfill Number 2, the degraded waste was excavated and separated with trommels. The finest fraction of the waste appeared as a suitable soil/compost material and contained sufficient moisture content. The compost was stable, with no curing needed before use. Soluble salts, metals, and pH were within safe ranges. No pathogens were detected in the materials. Lignin-containing materials, especially, wood and paper, did not completely degrade.

5.5 Waste Settlement

Waste settlement is a function of waste types, compaction density, moisture, landfill heights, and time[40, 41]. Physical waste surveys, taken before and during the project, indicated cover settlement at several locations in the aerobic test area of up to 9 inches (23 cm) from a waste depth of 10 feet (3 metres).

Although it is apparent that the aerobic landfill can compost readily degradable landfill wastes despite these limitations, it is recommended that inert and recalcitrant materials such as treated lumber, concrete, wood wastes, and thick plastics be placed into C&D-type landfills or recycled, where appropriate. This would allow the aerobic landfill to compost a larger percentage of landfill materials in a more efficient manner [41].

Figure 13. Settlement after aerobic treatment [13]

For system Number 2, there was in excess of 12 inches (30 cm) of settlement in most areas (10%), as measured by physical survey (see Figure 13). Combined with the likelihood that much of the wastes that can be excavated can be used as compost and/or soil cover, indications are that the landfill will be able to recapture almost 50% of the available area space. If materials such as plastics, metals, and glass are recovered and markets developed, this figure could increase to 70% or more. This is a very important consideration for many parts of the world where available landfill void is rapidly declining, as in the northeast USA, and the southeast of the UK [29].

Landfill No.1 and No. 2 waste depths were 10 and 30 feet, respectively. It is estimated that the aerobic landfill system will increase the predicted landfill waste settlement as a result of the overburden from future waste lifts as the landfill height increases. Meanwhile, the aerobic landfill continues to aerobically degrade and reduce the strength of the waste. While the aerobic landfill depends upon complex biological mechanisms, this technology can easily be incorporated into new and existing landfills in such a manner as to minimize its impact on the landfill operations. Since the degraded waste at these two landfill sites is relatively similar in composition to the waste in many other landfills, the benefits realized by each landfill using the aerobic landfill process can repeated worldwide. As this technology develops, additional system data can be evaluated to optimise performance of future aerobic landfill systems [13, 29, 37].

6. PROJECTED COST BENEFITS OF USING THE AEROBIC LANDFILL

Either for use in developing countries with environmental concerns or for use to gain additional airspace to lengthen landfill life, the potential benefits of this approach include: 1) increased revenues through airspace recovery, 2) reduction in leachate contaminants and volumes, 3) reduction in methane gas generation, 4) reduced closure and post-closure costs, and 5) reduced environmental liabilities. In addition, this design incorporates a practical, cost-effective approach to providing air and moisture to the waste mass [13].

6.1 Recapturing of Air Space/ Extension of Landfill Life

In previous laboratory and bench-scale studies [19, 20, 39], MSW settlement by aerobic degradation has been observed to be 30% and greater. Assuming a waste mass settlement of 15% is achieved at an MSW landfill site with fill capacity of 1 million cubic yards (1.32 million cubic metres) could potentially be extended by 150,000 cubic yards (or 200,000 cubic metres).

Using an average tipping fee of $24.50 (£15) per ton ($32.50 / ton gross fee minus $8 / ton operational & maintenance costs) and a compacted waste density of 0.65 tons per cubic yard (or 0.5 tons per cubic metre), additional revenues to the landfill could be worth over $2.3 million [23] or (£1.5 million).

This amount does not account for future value of the revenues, which could yield a much higher net value through the sale of recovered materials from landfill mining. Additionally, this 15% increase in air space could extend the life of this landfill by over a year's worth of operational void (assuming waste is accepted at a rate of approximately 250 tons per day [6, 16, and 29].

6.2 Reduced Landfill Leachate Management Costs

With an aerobic system in place, concentrations of organic compounds typically found in aging leachate streams, such as toluene, methylene chloride, and methyl-ethyl ketone (MEK), as well as BOD (a measurement of leachate strength), can be more rapidly reduced (as compared with anaerobic conditions) as the result of the aerobic landfill. In addition, the overall volume of landfill leachate can be reduced. Based on this benefit, a landfill with leachate generation of 120,000 gallons per month (450,000 litres) and a treatment cost of 3 cents per gallon (1p per 2 litres) could save at least $21,600 per year (1997 dollars) assuming the aerobic landfill system process reduced leachate by only 50% (equivalent to £14,000). At a 6% interest rate, future value savings would be over $222,000 (£150,000) over 40 years (10 years of landfill operations plus 30 years of post-closure leachate treatment), which would be significant savings for any site [29].

6.3 Methane Gas Management Cost Savings

There has been much focus on the earth's environment since the 1980's, including extensive studies on its atmosphere. Fuelled by discussions on "global warming" and the possible effects of "greenhouse gases" on the earth and human population, many governments are setting reduction goals, and encouraging the development of new methods for reducing these gases. In the U.S., recent changes to the Clean Air Act (CAA) regulations require specific controls and monitoring provisions to be implemented for methane production from landfills, also a "greenhouse-gas". According to the US EPA, MSW landfills are the largest anthropogenic source of methane [6].

One methane management approach is landfill gas (LFG) for energy recovery, otherwise known as "waste-to-energy" (WtE). At several landfills, the LFG is produced under mostly anaerobic conditions and the methane captured, cleaned, and used for combustion and/or supplemental fuel. However, although WtE is feasible, this methane management approach does not offer attractive economic advantages for many other landfills. The EPA's 'Methane Outreach Program' [6] estimates that of the approximately 3,700 landfills in the nation, only 750 are considered candidate WtE landfills [6], because of their size and structure. This leaves approximately 3,000 non-candidate landfills, many of which may face methane gas compliance with few low-cost LFG management options. This assessment is based on factors such as the size of U.S. landfills, their location and proximity to a potential LFG user, and potential market conditions.

In an attempt to increase the production of LFG to make WtE possibly more economically attractive, a number of studies have been conducted using leachate recirculation technologies under anaerobic conditions to increase the production of methane and other gases. In these cases, increased LFG is produced, captured, cleaned, and used for combustion and/or supplemental fuel. However, there are several issues of potential concern with respect to WtE: increased production of methane could increase, if not create, new CAA regulatory compliance requirements for certain landfills. Not only could capital and 'O&M' (operating and maintenance) costs increase, but regulatory compliance costs may as well. Also, the size of the landfill, its location, and proximity to a potential LFG user, and market conditions may still not offer attractive economic advantages even with an increase in electricity/usable gas production; At many landfills, there can be significant gas recovery inefficiencies with respect to the capture of landfill methane landfill (i.e. fugitive methane emissions). If there were an increased methane gas production via enhanced-WtE with no improvements in gas recovery efficiency, there would most likely be a high potential for increases in fugitive methane emissions from the landfill. This could have significant regulatory impacts and/or increase gas collection/recovery capital costs; and WtE and 'enhanced-WtE' projects still operate under anaerobic conditions, which have been identified as potentially environmentally damaging [25].

Although certain organic compounds can be degraded under anaerobic conditions, there remains the potential, over the long term, not to decrease the overall toxicity of certain landfill leachate contaminants (particularly heavy metals). As a result, the costs, environmental risks, and liabilities associated with anaerobic waste conditions within a landfill, as described earlier, could remain issues for WtE landfills [16].

In contrast, by minimizing the production of methane gas from landfills, the aerobic landfill provides an alternative, natural, approach to reducing "greenhouse gases" that may be more cost-effective. As presented above, both systems demonstrated that methane gas was reduced up to 90% in many of the "aerobic" areas. At many landfills, one of the short-term cost savings associated with this benefit could be the costs that would, otherwise, be directed to methane gas collection, treatment, and management options [29]. The long-term cost savings of reduced methane production (where WtE is not economical) may be significant where reductions in regulatory monitoring and compliance efforts are allowed. This would lower methane management costs and associated methane-related risks. In the U.S., landfills could seek regulatory relief of certain landfill monitoring requirements, based on this benefit [16].

In this light, the EPA has recognized the aerobic landfill as an emerging Tier II methane control technology and that this approach "is expected to become a prime candidate technology for landfills in the U.S. and elsewhere that can not generate LFG in sufficient quality or quantity to economically recover the associated energy [1, 6]. As this technology develops further, additional performance data will be available to measure the impact of the aerobic landfill on reducing "greenhouse" gases. Discussions are continuing with other state and federal regulatory agencies on possible relief under the CAA using the aerobic landfill. Other cost benefits are being evaluated with respect to: 1) possible relief of certain financial obligations, 2) emission "shares", and 3) the impact of meeting "greenhouse gas" reduction goals. Overall, this natural approach to methane control could be very beneficial to landfills.

7. THE AEROBIC LANDFILL AS A REMEDIATION OPTION

There are many landfills world-wide that pose threats to local groundwater and surface water resources [42]. At many landfills, it is predicted that toxic compounds typically found in aging leachate streams will ultimately leak through cracks that will develop in the landfill's protective liner systems and be released into nearby water resources at elevated concentrations. Once released, these contaminants can migrate through the subsurface and into groundwater and surface water, causing severe health effects. This is evident due to the increasing number of landfills that have (and are planning) to initiate remediation activities associated with landfill leachate releases [6].

Of the numerous groundwater remediation technologies available, many leaking landfills with related groundwater problems look toward conventional "pump-and-treat" or ex-situ systems as a solution [43]. These type systems recover the contaminated ground and/or surface water through a series of pumping wells or surface intakes, and treat the influent using a variety of physical, chemical, and/or biological systems [41]. However, this type of treatment approach is initiated only after the release has been identified. In addition, they can be expensive, and require extensive laboratory analyses, monitoring, and regulatory compliance. Furthermore, using only a "pump-and-treat" approach for groundwater remediation can add years to a landfill cleanup.

These types of system, once installed, rely on subsurface hydrogeology to transport impacted groundwater to well intakes. Assuming there is a high-efficiency recovery of impacted groundwater, this approach still could take many years to meet groundwater quality standards. Overall, this is an indirect response to leaking landfills that will inevitably extend the cost of site remediation. A more pro-active approach is needed, one that not only addresses present groundwater impacts at landfills, but one that also addresses the landfill waste mass, before it becomes a source of groundwater contamination [25, 36].

By treating the waste aerobically and in-situ, the leachate is directly treated, before it can leak through any cracks in the landfill liner.

At landfills undergoing (or preparing for) groundwater remediation, this method of directly treating the waste could lessen the toxicity of the escaping leachate, thereby reducing the toxicity of the impacted groundwater and decreasing "downstream" groundwater remediation efforts, saving potentially significant system operating and monitoring costs. Furthermore, both aerobic systems were shown to reduce VOCs [44]. Since many of these compounds can migrate through the subsurface in the liquid and gas phases and impact groundwater, early deployment of aerobic landfill systems at landfills that are impacting the environment (e.g. off-site VOC migration) could minimize the production of VOCs, thereby reducing risks and associated remediation costs [9].

7.1 Odour Control

In the "aerobic areas" of both systems, strong NH_3 and H_2S odours associated with conventional landfill operations were minimal throughout aerobic landfill operations. Instead, less pungent, organic odours indicative of composted waste were detected. From a public acceptance perspective, this benefit can be important to solid waste planners during the siting of new landfills or to address odour complaints at existing ones.

7.2 Reduced Closure and Post-Closure Costs

Potential cost savings could also be realized with respect to site closure. A recent study conducted by the University of Ohio found that the mean cost of closing a sanitary landfill (in Ohio) was $67,112 per acre or £100,000 per hectare [16, 20]. Post-closure care for landfills include, at a minimum, groundwater, surface water and methane monitoring, as well as maintenance of the landfill cap. For many landfills, closure and post-closure costs are in the millions of dollars [1, 5].

Upon waste stabilization and reaching full landfill capacity, the aerobic system presents the opportunity for landfills to seek regulatory relief of closure and post-closure monitoring requirements. Since portions of waste at Landfill Number 1 and 2 have been stabilized and the leachate quality improved via the aerobic landfill system, the potential for groundwater impact by leachate as well as the production of VOCs and methane has been reduced.

As each system is expanded, operated, and monitored, the potential to stabilize more of the waste increases. As supporting data is obtained, these landfills may have an opportunity to demonstrate further reductions in risks to the environment and seek regulatory relief from certain closure activities. Discussions have already begun with state and federal regulators regarding relief with respect to Landfill No. 1's closure and post-closure requirements, starting with a focus on a reduced landfill-monitoring program [3].

Additionally, landfills can consider the option of landfill mining as part of a post-aerobic landfill strategy. In these cases, the waste is rapidly stabilized in a more timely manner and the humus removed, analysed, and possibly used for agricultural purposes or as landfill daily cover. The remaining non-degraded matter (plastics, glass, and metal) could have some market value, providing additional income for the landfill and reducing "up-front" recycling efforts (costs). Moreover, a less-expensive, temporary cap would be used instead to cover the waste while it degrades, and then removed to allow mining activities. New waste would be placed back into the landfill and the previously mined humus reused as a cover, prior to re-starting of the aerobic process.

Under this option, a significant portion of the costs associated with the cover, closure and post-closure, as described earlier, as well as siting new landfills could be avoided. Altogether, this approach lends itself to a continuous, or "perpetual" landfill, precluding the need for a costly permanent cap and the siting of new landfills, altogether saving millions of dollars [9].

8. AEROBIC LANDFILL SYSTEM COSTS

Overall costs for an aerobic landfill can be significantly lower than the costs owners and operators will face during the operation and maintenance of a landfill. Although, there are many landfill design and operational factors to consider as part of the implementation of an aerobic landfill at a particular landfill, it is estimated that an aerobic landfill would provide an attractive return on investment for many landfills.

The design of an aerobic landfill system should, at a minimum, consider the landfill's current design and waste operations, waste height and placement, environmental regulations, and site conditions. As presented in this paper, three possible aerobic landfill approaches have been identified: 1) aerobic landfill applications on successive lifts of waste landfills (landfills under construction); 2) aerobic landfill applications on existing landfills; and 3) aerobic landfill applications with cell mining [16, 45].

The initial capital cost for an aerobic landfill in these cases would be similar to the costs for the piping requirements for a methane gas collection system. However, since the aerobic landfill could re-use much of its original air and leachate injection equipment on each lift, the net increased capital cost would be minimal. Gas monitoring system(s) would still be required with or without the aerobic landfill. Any capital investment in gas filter/combustion would be significantly reduced. Estimates for a complete system are in the range of \$3 to \$5 per ton (£2 - £3).

An aerobic landfill application in a cell approach whereby the waste is mined could provide significant savings. Once the waste is degraded and stabilized, the aerobic landfill equipment is then moved to an adjacent cell and this process repeated. The previously degraded wastes are then mined and recovered for market or for re-use. It is estimated that only a few cell areas would be required to perform this cycle of waste placement, aerobic degradation, mining, and cell re-use, rather than an entire landfill. This approach could significantly reduce landfill footprint requirements and construction/capital costs in the millions of dollars. This would offset mining costs [16].

In each of the three cases (or modifications thereof), operational and monitoring costs would be moderate for each aerobic landfill cell start-up (2 to 6 months) and would include monthly leachate and landfill gas analyses as well as daily system monitoring by a technician. After the start-up period, monitoring requirements (and costs) would be reduced, and the system possibly turned over to landfill personnel.

Depending on the type of landfills (under construction, existing), its construction, and regulatory requirements, operational and maintenance costs would most likely vary from site to site. Compared to the costs of expensive site cleanups, methane gas and leachate management, closure and post-closure O&M, and the risks associated with landfill operations, it is estimated that the aerobic landfill approach provides potentially significant savings for many landfills.

8.1 The Cost Model – a hypothetical example of potential savings

For a hypothetical landfill site, which receives 73,082 tons of MSW and has pre-separation of 0 tons the following savings could be achieved through the aerobic processing of the MSW (based on extrapolated data from Landfill No.1). Through the development of aerobic conditions and careful site management additional waste degradation of 10,962 tons (15% of the mass) is expected, whilst an additional 49,696 tons (68%) could be recovered through landfill mining for recoverable materials. Thus a total of 60,658 tons (space saving of 83%) could be made through this approach. The costs of this approach (aerobic processing alone) would be in the order of $2.25 (£1.50) per ton (total cost of $164,435) [27, 29, 37].

However, the air space in a landfill site (the void) is valued at $20.10 per ton and thus total air space value savings of $220,329 could be made in aerobic conditions are encouraged. In summary this would result in savings per ton (as compared to simple landfilling) of $0.76 (or $55,894 in total). If the site were to utilise landfill mining as well, the mining costs on remaining 62,120 tons would be of the order of $8 per ton (or $496,958 in total). Of the recovered landfill material; the soil fraction 31,060 tons (50%) would go to landfill as top cover or to market for sale recyclables of 18,636 tons (30%) which goes to market; the non-recoverable 12,424 tons (20%) would then be re-landfilled. Thus, through aerobic degradation and mining a total space reduction of 49,696 tons (80%) could be achieved with an associated air space saving worth $998,824 ($20.10 per ton) [29]. Figure 14 is a screen dump from the model in operation.

Figure 14. The Cost Model (source: ECS Lndfill)

8.2 The Company's interpretations.

Environmental Control Systems Inc. (ECS) applies a unique solid waste approach to new and ageing landfills - rapid solid waste stabilisation followed by site redevelopment. Through a patented aerobic process, ECS directly treats landfill waste in-situ by the injection of air and moisture into the waste mass [16]. ECS engineers have shown that a practical, state-of-the-art aerobic landfill system not only achieves rapid waste stabilisation, but also improves leachate quality and reduces landfill leachate treatment costs. The waste mass itself serves as an efficient treatment media for reducing volatile organic compounds (VOCs) as well as odours including hydrogen sulphide. In addition because the process is exothermic (heat generating), large quantities of moisture (mostly leachate) can be evaporated thus reducing leachate management and disposal needs and costs.

Combining rapid waste stabilisation with site redevelopment and re-use promotes the idea of 'sustainable landfill' an approach to solid waste management that many landfills and environmental regulators will find environmentally and economically attractive [27]. According to researchers [40];

'Landfills world-wide are seeking sustainable solid waste management approaches, as well as remediation technologies that are timely. We believe an aerobic landfill approach can, in many cases, accomplish both. This technology not only can provide the possibility for a "perpetual landfill" (accelerated waste stabilisation combined with landfill mining), but could also address many of the environmental concerns associated with MSW landfills (e.g. groundwater impact, "greenhouse gases".) From a life cycle analysis, this approach could yield significant cost savings and greatly reduce environmental liabilities. Professional solid waste organisations, such as SWANA, are so interested in the potential of this technology that they have established technology forums, such as SWANA's Aerobic Bioreactor Subcommittee, to focus on the development of this technology.'

As more anaerobic and aerobic leachate recirculation projects are conducted, additional performance data will be evaluated by EPA to measure overall impact on the protection of the environment. Discussions are also continuing with the EPA agencies the possible impact these approaches may have on current and future environmental regulations.

In summary, according to the US EPA [6];

'The aerobic technology is expected to become a prime candidate technology for landfills in the US and elsewhere that can not generate landfill gas in sufficient quality or quantity to economically recover the associated energy. In addition this technology could also be considered as a follow-on technology for energy recovery projects at landfills that are no longer producing methane at economically valuable levels.'

8.3 Proposed plan for the Williamson County Aerobic Bioreactor Landfill

The Williamson County Landfill facility (Tennessee) is located in a remote area off Pinewood Road in western Williamson County, Tennessee, immediately west of Leiper's Fork. The overall landfill facility has been in operation since the early 1970s, accepting Class I non-hazardous solid waste materials, including domestic wastes, commercial and institutional wastes, farming wastes, tires, landscaping debris, and construction/demolition wastes. The proposed project site involves a six (6) acre waste mound commonly referred to as the "pyramid", which was operated from October 1995 to January 1998. The mound is a Subtitle D facility that is lined with a composite liner system and also has an under drain leachate collection system (LCS). The system drains leachate by gravity to two existing 10,000-gallon storage tanks located immediately to the south of the waste footprint. The mound currently has no active or passive gas collection.

Based on a review of the landfill gate records from October 1995 to January 1998, a total of 69,880 tons of municipal solid waste (MSW) was placed into the subject waste mound. The mound was constructed in a truncated pyramid shape consisting of steep side slopes (two in one gradient) with an average waste height of 40 feet. Mr. Lewis Bumpus, Solid Waste Management Director for Williamson County, expressed concern over proceeding with a final cap, knowing the high probability that the cap would severely fail due to differential settlement and result in the additional costs to the County for cap reconstruction (personal communication). In addition, Mr. Bumpus faced a high cost for leachate treatment at an off-site facility. The high volume of leachate yet to be extracted from all of the waste areas on-site presented a long-term cost issue for the County. After a thorough investigation of the County's options, Mr. Bumpus decided to implement the aerobic bioreactor process to enhance the stabilization of the waste, utilize and potentially lower leachate volumes to be treated and handled off-site, and to minimize landfill gas generation.

The proposed project will involve the construction of a full-scale aerobic landfill facility installed at the Williamson County landfill, just west of Franklin, Tennessee.

This will be one of the first full-scale, "real-world" applications of a total aerobic bioreactor landfill in the United States. This proposed project will take place within the 6-acre subject mound that is geographically isolated from the rest of the waste cells on-site. The bioreactor system will consist of an array of wells placed into the mass, at varying depths, to facilitate the injection of compressed air, leachate (and/or make-up water from a near-by pond), and other amendments, if needed. The system will be operated under aerobic conditions for a maximum of two years beyond the system start-up date, based on budgetary constraints, or until the biodegradation process appears to have "run its course" as defined by the return to steady-state and near ambient temperature conditions and minimal changes in organic mass content and oxygen uptake throughout the waste mound, whichever comes first. The waste mass is typically considered to be fully stabilized by when the internal temperatures return to ambient conditions, additional air and water application does not increase the temperature, and there is no evidence of landfill gases and their associated odours [16].

9. CONCLUSIONS

While the aerobic landfill depends upon complex biological mechanisms, this technology can easily be incorporated into new and existing landfills in such a manner as to minimise its impact on the landfill operations. Since the degraded waste at these two landfill sites are relatively similar in composition to the waste in many other landfills, the benefits realised by each landfill using the aerobic landfill process can be repeated world-wide. As this technology develops, additional system data can be evaluated to optimise performance of future aerobic landfill systems [3, 13].

Overall the aerobic landfill system demonstrated that aerobic decomposition of MSW in-situ could safely and successfully be accomplished. The analyses of vapour samples, leachate chemistry, biological activity and the inspection of waste samples confirmed that the aerobic system was extremely effective at stabilising the waste mass. Moreover the aerobic landfill system can function as an in-situ leachate treatment system, reducing both volume and toxic contaminant concentrations of the leachate.

Specifically the aerobic landfill system demonstrated; [a] a significant increase in the biodegradation rate of the MSW over anaerobic processes; [b] a reduction in the volume of leachate as well as organic concentrations within the leachate, and [c] significantly reduced methane generation.

Undoubtedly, there will be problems with this approach, and the data discussed relates to only 2 'test' cells in the USA. What is important is that the findings from these experiments suggest that aerobic processing of landfilled wastes can help achieve rapid stabilisation and reduced environmental risk, whilst enabling the opportunity for landfill mining for recyclable materials. These examples should act as a spur for new projects around the rest of the world to test this approach under different conditions; the company have just started some test cells in Spain and are looking for locations in the UK [16]. When more data from new cells becomes available, then the real benefit of this approach will become more evident.

Based on the data collected, the following conclusions can be made:

1. *By the controlled addition of air and leachate to the waste mass, the aerobic systems demonstrated their ability to effectively convert the waste degradation process from anaerobic to aerobic, thereby accelerating waste mass stabilisation and settlement, reducing methane and carbon dioxide, and reducing the amount of leachate, which required treatment.*
2. *Vapour and temperature data clearly support rapid aerobic waste degradation occurring at these sites. It is highly unlikely that temperatures reported in the "aerobic areas" of each cell could have occurred without significant degradation of the waste mass. The stoichiometric relationship between aerobic carbon utilisation and heat release indicates that a significant amount of carbon had been converted to cellular products via aerobic metabolism. In addition, off-gas vapour sample analyses, the reduction of "anaerobic" odours, and degraded waste samples support aerobic degradation.*

3. *With respect to both aerobic systems, the volumes of air supplied were sufficient enough to aerobically degrade waste. However, although the increase in airflow degraded more of the organic waste, there were still areas of anaerobic conditions at both sites.*
4. *As a result of these two projects, there have been discussions among many in the solid waste industry as well as state and federal regulatory agencies on the possible benefits this approach could have on future solid waste management in the U.S. These include the potential for LFG reduction and associated management costs, ease of system integration, life-cycle benefits, regulatory relief, and possible revenues from LFG emission credit trading.*
5. *For landfills that would use this leachate re-circulation approach, there are important design considerations for both the landfill and aerobic system, including leachate head on the liner, liquids management, waste mass temperature, increasing solid waste densities, landfill gas control, health aspects, costs, LFG management, waste mass temperature, and moisture control.*
6. *Further study is needed to support this technology as a long-term, sustainable approach to solid waste and LFG management.*

10. FUTURE DEVELOPMENTS

Globally, landfill remains the most commonly used (and often the cheapest) method for the disposal of MSW [42]. However, the condition of many of these sites particularly the older ones, and those in developing nations are of a poor standard, and are thus a significant environmental risk due to the anaerobic degradation of the organic fraction of the waste stream. Without eliminating organic waste from landfills (as is being attempted in the European Union through the Landfill Directive) an alternative to anaerobic landfills must be considered [4650]. For landfills worldwide, the aerobic landfill promotes a change in the overall management of solid waste disposal. In many cases, the aerobic landfill serves as means to operate landfills more efficiently. Additionally, the aerobic landfill serves as a cost-effective, aerobic remediation solution for landfills that are adversely impacting the environment. In all, this technology could evolve itself into a cost-effective approach to sustainable solid waste management [40].

This topic is of great potential value for the future effective management of society's waste, and a means of safely closing existing landfill sites without the need for long aftercare programmes [16]. This paper details 2 examples of how aerobic conditions can improve the environmental and economic performance of landfill sites. However, the aerobic approach is not 'the answer' to all of society's waste related problems, but is a positive part of any sustainable system [45].

It is unlikely that regulators would be prepared to free 'aerobic' landfills from the need for caps and liners due to the risk of contamination resulting from a failure in the in-situ processing of the waste mass. This might well prove to be a stumbling block for the full-scale development of aerobic systems, as the economics of aerobic processing combined with the traditional requirements of landfill caps and liners might prove prohibitive. However, when the length of the site's life is considered along with the potential use of the composted material and the recovery of valuable materials from the site, there may still be an economic argument for developing this approach [29]. This approach to landfill may not replace the dominance of the 'dry tomb' style, but might prove an effective form of remediation applied to unlined sites that have a high potential pollution factor for local groundwater sources. Perhaps further study and large-scale experimental sites would help prove this argument one way or the other.

However, through the continued development of this technology, the aerobic landfill system could foster a new perspective on landfilling waste, and, at the same time, reduce the cost burdens of landfill operations and/or site remediation [16]. In addition, the long-term liability and costs associated with landfill operation and closure will be greatly reduced. The aerobic landfill serves as a cost-effective, aerobic remediation solution for landfills that are adversely impacting the environment.

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APPENDIX 5

SURVEY LITERATURE
&
SUPPORTING MATERIAL

APPENDIX 5.1

PILOT SURVEY LETTER

APPENDIX 5.2

MAIN SURVEY LETTER

APPENDIX 5.3

SURVEY LEAFLET

BACKGROUND

Society has always produced waste, and to a growing proportion of society this reflects a squandering of resources which cannot go unchecked. It has been widely acknowledged that the UK is facing a disposal crisis due to the growing volume of solid waste generated in the UK and the diminishing availability of landfill void which can be utilised to dispose of these wastes. Thus, part of any sustainable waste management objective must be the careful management of such resources by minimising waste generation, and limiting the need for disposal.

The waste hierarchy was initially introduced by the EU 4th Action Program on the Environment (1987) and was accorded greater emphasis in the EU 5th Action Program 'Towards Sustainability' (1993). The fundamental aim of the hierarchy is to guide waste policy so that minimisation, re-use and recovery become more attractive management options for waste producers and local authorities who are obliged to manage these wastes. The emphasis is on local action and policies in response to national strategy, and thus there is an opportunity for closer ties to be generated between waste management initiatives and the work of Local Agenda 21. Current waste management practices concentrate on the bottom rung of the ladder where landfill accounts for in excess of 84% of all municipal waste treatment and disposal in England and Wales. Only 7% of municipal waste is recycled and energy recovered from another 8%, yet up to 50% of all household waste is potentially recyclable or recoverable, whilst a further 30% is compostable.

Past decisions on waste management strategy and practice at the local level have traditionally relied upon economic considerations, although more recently choice has been increasingly influenced by the central concepts of sustainability and the waste management hierarchy. However, both have been poorly defined and are generally misunderstood by policy makers and waste management practitioners and thus research into these issues is essential for future positive local policy action and development.

RESEARCH CONTENT

The intention of this research is to assess how Government policy has encouraged waste management services to move up the hierarchy, and to assess its operationalisation at the local level, in light of the Local Agenda 21 process and the launch of 'Making Waste Work' (1995). At present there is a clear need to investigate what the driving factors are for local authority policy and practice with regard to municipal solid waste management. This will enable a framework to be developed within which future local waste management strategy and policy can be developed based upon accurate data and adequate analysis of the factors most successful in encouraging the movement of local government practices up the hierarchy.

Research Objectives -:

I. To analyse the municipal solid waste hierarchy and provide an assessment of its role as a waste management priority for local government waste collection and disposal authorities.

II. To discuss of how the individual choice of local authorities is constrained within an economic and political environment from which their activities can not be detached, and to determine whether there is a policy implementation gap with regards to waste management practices.

III. To investigate the movement of local government waste management services, towards recycling, composting, waste to energy and minimisation over the last 20 years, and to highlight the reasons for these trends.

IV. To identify the mechanisms, factors and barriers currently in operation on the choice of waste management service provided by local collection and disposal authorities.

V. To investigate the integration of waste management strategy and Agenda 21 processes as a means of encouraging more sustainable waste management practices at the local scale.

THE QUESTIONNAIRE

This survey is intended to enable the investigation of these three key issues-

I. How the principles of the hierarchy have been implemented at the local level.
II. To assess historical trends in MSW management practices, and the underlying reasons for these changes.
III. To indicate the success of Government policy in shifting local government behaviour up the hierarchy, in light of other influential factors to provide the base line from which the case studies can be developed and understood.

Research methodology -:

1. *Review of waste and environmental management literature.*
2. *Collation of secondary data from Local Authority, Government Legislation, Private Sector and Conference Documentation.*
3. ***Local Government Survey**, to determine those factors currently governing local authority waste management practices.*
4. *A sample of authorities will be selected to enable a more detailed investigation of current policy and practice to be made, using statistical analysis and interviews with policy officers.*
5. *Case study analysis of 2/3 authorities to assess the genesis and development of local government waste strategy.*
6. *Reporting of findings, presentation of results and submission of thesis.*

The results of this work will be made available to authorities who express an interest in the report, whilst a research paper on the provisional results will be written for publication. If you and your authority would be interested in the results or would like to get involved in the case study exercise please state so on the survey return.

It would be appreciated if the completed questionnaire could be returned in the pre-paid and self addressed envelope by 6th February 1998.

APPENDIX 5.4

QUESTIONNAIRE

LOCAL GOVERNMENT SURVEY: 'PERSPECTIVES ON THE WASTE HIERARCHY'

Please do not write in this margin as it is for Office use only in coding your responses so that they can be analysed.

This is a survey of local government municipal solid waste management Authorities in the United Kingdom. The questionnaire has been designed in collaboration with Professor Guy Robinson, School of Geography, Kingston University, Dr Chris Coggins of the Waste Management and Technology Centre, Sheffield University, and the Institute of Wastes Management to make it as simple and concise as possible for officers to complete. Your Authority has been chosen as part of a representative sample of local waste management service providers and policy developers, designed to provide an accurate assessment of local government opinion on the implementation of the principles of the waste management hierarchy at the local level, and the factors central to the design and implementation of local government municipal solid waste management strategy and policy.

Please try to answer all questions as fully as possible thus providing a truly representative assessment of current waste management practices in the UK. For those questions where there are no instructions on how to respond, please tick the most appropriate answer in the box provided. [√]. If you do not wish to disclose any data then you can leave those questions blank, but this will affect the quality of the data and the final results. Some questions may not apply to your authority, could you please complete these with N/A. If you have any comments to make then please continue on additional sheets or use the blank page at the end of the survey.

Reference Number: 1 [ ][ ][ ][ ] 4

1. AUTHORITY DETAILS

This series of questions provides background data on your authority, including data about its demographic and political make-up.

1.1 Which Environment Agency region is your Authority located in?

NORTH WEST [ ] 01
NORTH EAST [ ] 02
WEST MIDLANDS [ ] 03
MIDLANDS [ ] 04
ANGLIAN [ ] 05
THAMES [ ] 06
SOUTHERN [ ] 07
SOUTH WEST [ ] 08
WELSH [ ] 09
SCOTLAND [ ] 10
IRELAND [ ] 11

5 [ ][ ] 6

1.2 Which definition best describes your Authority?

COLLECTION [ ] 1
DISPOSAL [ ] 2
UNITARY [ ] 3
NEITHER [ ] 9

[ ] 7

1.3 How would you describe the area within your Authority?

URBAN [ ] 1
RURAL [ ] 2
MIXTURE [ ] 3

[ ] 8

1.4 Number of Households in your Authority (1995 Census to the nearest thousand)?

____

9 [ ][ ][ ][ ][ ][ ] 14

1.5 Which is the lead (or majority) political party in your Authority at the Council level?

CONSERVATIVE [ ] 1
LABOUR [ ] 2
LIBERAL [ ] 3
INDEPENDENT [ ] 4
GREEN [ ] 5
OTHER [ ] 6 ____________________
NO OVERALL MAJORITY [ ] 9

[ ] 15

1.6 Which political party has been the lead (or dominant) party in your Authority at the Council level during the last decade?

CONSERVATIVE [ ] 1
LABOUR [ ] 2
LIBERAL [ ] 3
INDEPENDENT [ ] 4
GREEN [ ] 5
OTHER (please specify) [ ] 6 ____________________

[ ] 16

2. Comparative Waste Statistics

This section will focus on comparing waste management statistics over a 20 year period, to indicate trends in past, present and future. waste management practices in your Authority.

2.1 Municipal Solid Waste Collected in your Authority?

	1985 / 86 Estimate	1995 / 96 Actual	2005 / 06 Predicted
a. TOTAL? (Tonnes)	______	______	______
b. HOUSEHOLD? (Tonnes)	______	______	______
c. COMMERCIAL? (Tonnes)	______	______	______

2.2 Municipal Solid Waste Treatment and Disposal Routes used by your Authority?

	1985 / 86 Estimate	1995 / 96 Actual	2005 / 06 Predicted
a. TOTAL? (Tonnes)	______	______	______
b. LANDFILL? (Tonnes)	______	______	______
c. INCINERATION? (Tonnes)	______	______	______
d. WASTE TO ENERGY? (Tonnes)	______	______	______
e. RECYCLING? (Tonnes)	______	______	______
f. COMPOSTING? (Tonnes)	______	______	______
g. OTHER? please specify (Method)	______	______	______
(Tonnes)	______	______	______

3. Changing Patterns

If your Authority's involvement with any of the following treatment options has changed, then please indicate below which factors have influenced your Authority's decisions in relation to each of these waste management options.

Your authority's involvement with each treatment method has changed in response to which of these factors, please tick the appropriate statement for each factor?

3.1 LANDFILL

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Local Government Policy & Politics					
Environmental Issues					
European Policy and Legislation					
Government Policy and Legislation					
Public Relations					
NIMBY issues					
Economics					
Landfill Availability					
Tighter standards & specifications					
Other (please specify)					

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3.2 INCINERATION (WITHOUT ENERGY RECOVERY)

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	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Local Government Policy & Politics					
Environmental Issues					
European Policy and Legislation					
Government Policy and Legislation					
Public Relations					
NIMBY issues					
Economics					
Landfill Availability					
Tighter standards and specifications					
Other (please specify)					

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3.3 WASTE TO ENERGY

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Local Government Policy & Politics					
Environmental Issues					
European Policy and Legislation					
Government Policy and Legislation					
Public Relations					
NIMBY issues					
Economics					
Landfill Availability					
Tighter standards & specifications					
Other (please specify)					

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3.4 RECYCLING

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	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Local Government Policy & Politics					
Environmental Issues					
European Policy and Legislation					
Government Policy and Legislation					
Public Relations					
NIMBY issues					
Economics					
Landfill Availability					
Tighter standards and specifications					
Other (please specify)					

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3.5 COMPOSTING

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Local Government Policy & Politics					
Environmental Issues					
European Policy and Legislation					
Government Policy and Legislation					
Public Relations					
NIMBY issues					
Economics					
Landfill Availability					
Tighter standards and specifications					
Other (please specify)					

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4. Policy Documentation

This group of questions are designed to provide an idea of the types of waste management policy documentation that are available to residents of your authority, providing an indication of your Municipal Solid Waste policies, strategies and systems.

4.1 Does your Authority currently have any of the following forms of waste documentation?

	Yes (1)	Under Development (2)	No (3)
Waste Management Strategy			
Waste Information Handbook for Businesses and Residents			
Recycling Plan			
Other (please specify)			

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4.2 Please summarise the 5 main points of your Authority's municipal solid waste management strategy (in order of importance).

1. ______________________________ 166
2. ______________________________ 167
3. ______________________________ 168
4. ______________________________ 169
5. ______________________________ 170

4.3 Do your waste management plans and strategies incorporate any of the following themes? Please tick the most appropriate statement for each management option.

	Definite Strategies for (1)	General Policies about (2)	Referenced to within text (3)	No mention of (4)
Minimisation				
Re-use				
Recycling				
Composting				
Energy Recovery				
Controlled				

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5. Waste Management Policy

The following questions are designed to discuss the current municipal solid waste management policies of your Authority, their development and the governing factors surrounding their implementation.

5.1 Who is responsible for the development of waste policy in your Authority?

	Very Strong Influence(1)	Strong Influence (2)	Medium Influence (3)	Weak Influence (4)	Very Weak Influence (5)
Councillors					
Local Government Officers					
Public Pressure					
National Government					
Environment Agency					
Other (please specify)					

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5.2 From what sources are the key policy directions of your waste management strategies being generated?

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	Very Strong Influence (1)	Strong Influence (2)	Medium Influence (3)	Weak Influence (4)	Very Weak Influence (5)	
Councillors						183
Local Government Officers						184
International Examples						185
UK Examples						186
Public Pressure						187
UK Policy						188
EU Policy						189
Environment Agency						190
Other (please specify)						191

5.3 Has your Authority actively encouraged any of these alternative waste management treatment options to landfill disposal during the last decade?

	Very Strongly Encouraged (1)	Strongly Encouraged (2)	Some Encourage (3)	Weakly Encouraged (4)	No Encourage-ment (5)	
Incineration						192
Waste to Energy						193
Recycling						194
Composting						195
Minimisation						196
Other (please specify)						197

5.4 Is your Authority currently promoting any of these waste management options as a means of reducing landfill requirements?

	Agree Strongly (1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly (5)	
Incineration						198
Waste to Energy						199
Recycling						200
Composting						201
Minimisation						202
Other (please specify)						203

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5.5 Which of these methods are your Authority using to promote alternative waste management options?

	Very Strongly (1)	Strongly (2)	Medium (3)	Weakly (4)	Very Weakly (5)
Policies					
Incentives					
Subsidies					
Education					
Home Visits					
Publicity					
Seminars					
Training					
Sponsorship					
Telephone Line					
Contractor Arrangements					
Other (please specify)					

____

204 205 206 207 208 209 210 211 212 213 214 215

5.6 What are the reasons for your Authority promoting the following alternatives to landfill?

a. MINIMISATION

	Agree Strongly (1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly(5)
Reduced Landfill Requirement					
Environmental Concerns					
Public Relations					
Government Pressure & Policy					
Cost of Options					
Landfill Availability					
Income savings					
Other (please specify)					

____

216 217 218 219 220 221 222 223

b. RECYCLING

	Agree Strongly(1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly (5)
Reduced Landfill Requirement					
Environmental Concerns					
Public Relations					
Government Pressure & Policy					
Cost of Options					
Landfill Availability					
Income savings					
Other (please specify)					

c. COMPOSTING

	Agree Strongly(1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly(5)
Reduced Landfill Requirement					
Environmental Concerns					
Public Relations					
Government Pressure & Policy					
Cost of Options					
Landfill Availability					
Income savings					
Other (please specify)					

d. WASTE TO ENERGY

	Agree Strongly(1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly(5)
Reduced Landfill Requirement					
Environmental Concerns					
Public Relations					
Government Pressure & Policy					
Cost of Options					
Landfill Availability					
Income savings					
Other (please specify)					

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5.7 What are your Authority's decision priorities when selecting the following waste treatment options?

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a. MINIMISATION

	Agree Strongly (1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly (5)	
Market Availability						248
Landfill Availability						249
Environmental Issues						250
Government Targets						251
Costs						252
Other (please specify)						253

b. RECYCLING

	Agree Strongly (1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly (5)	
Market Availability						254
Landfill Availability						255
Environmental Issues						256
Government Targets						257
Costs						258
Other (please specify)						259

c. COMPOSTING

	Agree Strongly (1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly (5)	
Market Availability						260
Landfill Availability						261
Environmental Issues						262
Government Targets						263
Costs						264
Other (please specify)						265

d. WASTE TO ENERGY

	Agree Strongly (1)	Agree (2)	Not an issue (3)	Disagree (4)	Disagree Strongly (5)	
Market Availability						266
Landfill Availability						267
Environmental Issues						268
Government Targets						269
Costs						270
Other (please specify)						271

6. SERVICE PROVISION

This section of questions focuses on the types of services and programmes implemented by your Authority, to provide an indication of their impact upon waste management and disposal practices.

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6. a. RECYCLING

6.1 Does your Authority have a recycling scheme? 272

YES	[ ] 1	(go to Q. 6.2)
NO	[ ] 2	(go to Q. 6.11)

273 278

6.2 Number of Recycling Bring Sites in your Authority? ____________

279 284

6.3 Number of Recycling Banks in your Authority? ____________

285

6.4 Does your Authority have Doorstep Recycling Collection? 286

YES	[ ] 1	(go to Q. 6.5)
NO	[ ] 2	(go to Q. 6.11)

6.5 How often are recyclables collected from the kerbside in your Authority?

TWICE PER WEEK	[ ] 1
ONCE PER WEEK	[ ] 2
ONCE EVERY OTHER WEEK	[ ] 3
LESS FREQUENTLY	[ ] 4

287

6.6 What type of system is used for the kerbside collection?

BAGS FOR MIXED RECYCLABLES	[ ] 1
2 BINS	[ ] 2
BLUE / GREEN BOX	[ ] 3
SERIES OF COLOURED BAGS	[ ] 4
WHEELIE BINS	[ ] 5

288 294

6.7 Total cost per tonne of Recycling (excluding initial capital costs) in your Authority?

____

295 300

6.8 Total cost per household of Recycling (excluding initial capital costs) in your Authority?

____

301 306

6.9 Total Annual Recycling Budget (not including staffing)?

____

307 312

6.10 Tonnes Recycled by your Authority (1995 / 96)? ____________

6. b. COMPOSTING

6.11 Does your Authority have a Composting System? 313

HOME	[ ] 1	
CENTRALISED	[ ] 2	
BOTH	[ ] 3	
NO	[ ] 4	(go to Q. 6. 19)

6.12 Estimated take up rate of Composting in your authority (numbers per 1000hhs)?

314 319

a. Home Composting ____________

320 325

b. Centralised Composting ____________

6.13 Diversion rate of the Composting system? Please express clearly how the diversion rate is calculated and which categories are used in this calculation.

a. Home Composting ____________________

b. Centralised Composting ____________________

6.14 Method of collection for green waste (to be composted) in your Authority? (most significant method only)

CIVIC AMENITY SITE	[ ] 1
KERBSIDE COLLECTION	[ ] 2
MATERIALS RECOVERY FACILITY	[ ] 3
OTHER (please specify)	[ ] 4

____

6.15 Cost per tonne of Composting system used?

____

6.16 Cost per household of Composting? ____________________

6.17 Total Composting Budget (per annum)?

____

6.18 Tonnes Composted, which has been diverted from landfill disposal (1995 / 96)?

____

6. c. MINIMISATION

6.19 Is there a specific municipal solid waste minimisation strategy in your authority?

YES	[ ] 1	(go to Q 6.20)
NO	[ ] 2	(go to Q. 7.1)

6.20 Budget devoted to Minimisation (per annum)?

____

6.21. Estimated tonnes removed from the waste chain (1995 / 96)?

____

7. FUTURE DIRECTIONS IN POLICY AND PRACTICE

7.1 How is your Authority responding to the following issues?

	New Policy & Activity (1)	Literature & Promotion (2)	Financial Arrange-ments (3)	No Response intended (4)	Other (please specify) (5)
Landfill Tax					
NFFO Credits					
Recycling Credits					
National Waste Strategy					
Government Targets					
Producer Responsibility					
EU Landfill Directive					
Minimisation Trials					

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332–337
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339–344
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357–362
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364–369
370–375
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383

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7.2 Does your Authority intend to encourage or develop any of these forms of municipal waste treatment between now and the year 2005?

	Definitely (1)	Probably (2)	Potentially (3)	Unlikely (4)	No (5)
Minimisation					
Re-use					
Recycling					
Composting					
Waste to Energy					
Incineration					
Controlled Landfill					

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☐ 390

7.3 If any of these methods of waste management are **potentially unsuitable** for use in or implementation by your Authority please indicate the reasons why?

a. MINIMISATION

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Costs					
Space					
Political Considerations					
Environmental Concerns					
Current policy					
Other (specify)					

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b. RECYCLING

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Costs					
Space					
Political Considerations					
Environmental Concerns					
Current policy					
Other (specify)					

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c. COMPOSTING

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Costs					
Space					
Political considerations					
Environmental Concerns					
Current policy					
Other (specify)					

403 404 405 406 407 408

d. WASTE TO ENERGY

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Costs					
Space					
Political considerations					
Environmental Concerns					
Current policy					
Other (please specify)					

409 410 411 412 413 414

e. INCINERATION

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Costs					
Space					
Political considerations					
Environmental Concerns					
Current policy					
Other (please specify)					

415 416 417 418 419 420

f. CONTROLLED LANDFILL

	Agree Strongly (1)	Agree (2)	Not an Issue (3)	Disagree (4)	Disagree Strongly (5)
Costs					
Space					
Political considerations					
Environmental Concerns					
Current policy					
Other (specify please)					

422 423 424 425 426 427

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7.4 Has your authority experienced a policy implementation gap with regard to national waste management policies and strategies, and your local waste management programmes?

YES (go to Q. 7.5) [ ] 1
NO (go to Q. 7.6) [ ] 2

428

7.5 What are the reasons for this policy implementation gap?

COSTS OF OPTIONS [ ] 1
LOCAL POLICY [ ] 2
SPACE AVAILABLE [ ] 3
DISAGREE WITH NATIONAL POLICY [ ] 4
UNSUITABLE TECHNOLOGY [ ] 5
OTHER (PLEASE SPECIFY) [ ] 6

429

7.6 Has your Authority's waste management policy moved its solid waste management practices towards more sustainable practices by encouraging movement up the hierarchy, away from landfill during the last 5 years?

NO SUCCESS [ ] 1
LITTLE SUCCESS [ ] 2
MEDIOCRE SUCCESS [ ] 3
GOOD SUCCESS [ ] 4
VERY SUCCESSFUL [ ] 5

430

7.7 Will your Authority attempt to encourage waste management practices to move towards management options higher up the hierarchy during the next 10 years?

YES [ ] 1
NO [ ] 2
NOT AN ISSUE [ ] 3

431

7.8 Do you think your Authority will successfully achieve the following Government targets which have been set for the year 2000?

	Definitely (1)	Probably (2)	Potentially (3)	Unlikely (4)	Definitely not (5)
Home Composting					
Recycling Rate					
Recycling Bank Provision					
Recovery Rate					
Waste Production Stabilisation					
Landfill Disposal Reduction					

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7.9 Do you think your authority will successfully achieve the following Government targets which have been set for the year 2005?

	Definitely (1)	Probably (2)	Potentially (3)	Unlikely (4)	Definitely not (5)
Home Composting					
Recycling Rate					
Recycling Bank Provision					
Recovery Rate					
Waste Production Stabilisation					
Landfill Disposal Reduction					

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443

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7.10 Does your Authority actively apply the principles of the hierarchy in the management of your municipal solid waste, or is the hierarchy of little practical significance?

YES [ ] 1
LITTLE SIGNIFICANCE [ ] 2

444

7.11 How successful has government policy been in encouraging the local implementation of the hierarchical
concept in your area?

VERY SUCCESSFUL [ ] 1
SOME SUCCESS [ ] 2
LITTLE SUCCESS [ ] 3
NONE [ ] 4

445

7.12 How successful has government policy been in encouraging the local implementation of the hierarchical
concept across the UK in general?

VERY SUCCESSFUL [ ] 1
SOME SUCCESS [ ] 2
LITTLE SUCCESS [ ] 3
NONE [ ] 4

446

8. Background Details

These final questions relate to whoever completed the survey, and the structure of waste management in your authority, in order to maintain the representative nature of the research.

8.1 Your position (job title) ? ______________________ 447

8.2 Directorate (Service Group) within which waste management is located? 448

____

8.3 Telephone Number (for reference purposes)

____

8.4 Number of staff devoted to Waste Management Duties in your Authority? 449

____

Are you interested in receiving a summary of the results? (please tick)

If you have any documentation that you think would be of interest to my research then do not hesitate to forward them to me when you return the survey. If you have a current waste management plan then I would appreciate a copy for my records.

Once you have checked that no questions have been left unanswered, please return the survey as soon as possible in the envelope provided. Many thanks for taking the time to complete the survey.

A. Read

Postgraduate Research Student
Kingston University

Please use the available space to make any comments that you may have on the research topic or the survey in general.

APPENDIX 5.5

REMINDER LETTERS

Adam Read
Postgraduate Research Student

0181 547 7509 (Tel)
0181 437 7497 (Fax)
k968048@kingston.ac.uk (E-mail)

Friday 17th October 1997

Last week a questionnaire seeking your views on ***'The Waste Hierarchy and the Implementation of Local Government Waste Strategies'*** was mailed to you. Your authority has been drawn from a small but representative sample of waste management authorities in the UK, in order that the results are to accurately represent the industry's opinions it is extremely important that your data also be included. If you have already returned the completed survey then please accept my sincere thanks for your swift response. If not, I would be grateful if you could complete the survey and return it as soon as possible.

If by some chance you did not receive the questionnaire, or have mislaid it please call me immediately on 0181 547 7509 or leave your details on 0181 399 1371, and I will send you a copy today.

Sincerely,

Adam Read
Postgraduate Research Student

APPENDIX 5.6

CASE STUDY INVITE LETTERS

I have undertaken this study because of the belief (sustained during my time as Recycling Officer at the Royal Borough of Kensington and Chelsea) *'that local government waste officer opinions should be taken into account in the formation of public policies for the planning of waste management in the UK.'*

For greater background detail about myself please refer to the enclosed brochure which details my professional and academic experience and highlights my current research post at Kingston University.

For a more in depth discussion of the research programme please refer to the other accompanying brochure which provides detail on the background to the study, discusses the development of the research, and discusses in some length the provisional results that have come from the analysis of the survey results, which you kindly took part in. The provisional results of the work (derived from the survey) have created interest at the DETR, the DTI and the Environment Agency, with numerous correspondence from these authorities requesting clarification of issues and detailed data relating to the achievement of Government targets at the local scale and the success of recycling policies on local MSW flows. The information provided will be used solely in the preparation of my PhD thesis, where the completed interview texts will form the second stage of the research programme. You can be assured that all information will be held in complete confidence and will remain anonymous under the regulations of the Data Protection Act, being used solely for the purpose of the research.

Your authority has been drawn from a small but representative sample of waste management authorities in the UK, and in order that the results of my research are to represent accurately the industry's opinions it is extremely important that your detailed local data and experiences be included. Your authority has the opportunity to be one of the research programme's ***'case studies'*** to investigate issues relating to municipal waste service provision in the UK, and your authority and the data you provide will test the provisional results of my recently completed survey of English authority MSW management practices. In order to obtain a realistic and representative assessment of local government organisations involved in waste management policy development and implementation it is not only important that you allow me to use your authority as a case study, but that you consider this as an opportunity to comment directly upon the research programme, the initial results and most importantly influence the future direction and end-use of the work.

The case studies will operate through a number of short interviews with policy makers and local waste management officers, often at the same time so that the full breadth of authority response can be attained. It is intended that each case study will involve a 4 stage process;

1. Provision of waste management documentation for your area and authority for a period of the last 5 years relating to policy goals and statements, targets, contracts and performance. This should include published waste management plans, recycling plans, information booklets, performance details and text from Environmental Committee meetings relating to waste management policy decisions.
2. A two hour interview where the Recycling / Waste Management Officer, the Waste Planning Officer and the Local Agenda 21 Officer will be interviewed (together if possible), so findings from the English authority survey can be discussed, specific responses from the authority to certain questions can be investigated and general policy decisions are reviewed. The format will involve;
   - *A presentation of some of the key findings from the English survey.*
   - *A general discussion of the results and how they relate to the local context.*
   - *A semi-structured interview.*
   - *An informal discussion relating to the research goals, its output and MSW management generally.*
3. I will then pull together the findings of these interviews, and produce a short resume relating the initial survey findings to your authority's policy documents and interview responses. Each authority will have a summary of these findings, as a personal record of their polices and practices.
4. To use these case studies to emphasise the survey results, to develop the research ideas concerning policy barriers and opportunities to overcome them, and to assess national achievement of Government MSW Targets in light of local circumstance and environmental criteria.

I am well aware that you are extremely busy at present, but I would be most grateful if you could kindly spare a few hours (a maximum of 2) to allow me to interview you and associate officers with regard to local policy directions and problems with policy implementation.

APPENDIX 5.7

CASE STUDY BROCHURE

SUMMARY

Waste management policy is fast becoming a major social and political issue around the globe. However, little work has been carried out on the ways in which local government are responding to the new waste management agenda being set by EU and UK legislation, regulation and policy development. This research investigates the adoption of national UK MSW policy at the local level, where it appears that local administration is inadequate to manage the policies proposed, identify and collect the relevant data and ensure the implementation of strategies. The paper focuses upon the translation and adoption of national strategy goals within local practices, measured through the achievement of targets as defined in the current MSW strategy for England and Wales 'Making Waste Work (1995). This paper uses the data from a national survey of English authorities (67% response rate) investigating the adoption of national Municipal Solid Waste (MSW) policy at the local level and the barriers that exist to its progress and the development of MSW technology and practice.

Some of the more significant results to date include a discussion of the 'regionalism' of MSW management in England, where sustainable practices are more advanced in the South West, Thames and Southern regions, which may in part reflect the political dominance of 'Liberal' authorities in these regions, or the limited availability of landfill void. Local practices are usually a response to a number of key parameters operating on a local authority, namely availability of landfill, relative costs of MSW management options, funding and staffing levels (political bias) and historical trends in the management of waste (existing markets and processing facilities). Currently 40% of authorities in England are experiencing a policy implementation gap, with 70% claiming to suffer from local implementation failure, with costs of options, staffing levels, local government cut-backs and the introduction of privatisation being cited as the key reasons for this failure. These results are also reflected in the discussion which centres upon achievement of MSW targets by the years 2000 and 2005 as laid out in the Government's White Paper (1995).

It appears that in the UK, administration at the local level is inadequate to manage the general policies proposed, identify and collect the relevant data and ensure the successful implementation of MSW management strategies at the local level. This failure is in part due to the decentralisation of waste management issues to local authorities, without substantive budgetary additions (a common problem following privatisation), resulting in local activity remaining distinct and isolated from national strategies, causing significant implementation problems. Clearly, further work needs to be carried out into policy development and implementation processes.

PROPOSED PUBLICATIONS FROM THE RESEARCH

These articles are currently being submitted to a range of academic and practical journals, putting the current research, the ongoing elements and the provisional results into the public domain, and providing the author with feedback and peer review on the research work carried out to date;

⇒ *Municipal solid waste management policy and practice in the UK regions*
(based upon pilot survey work)

⇒ *MSW policy implementation, a review of Scotland, Ireland and Wales*
(pilot work, along with material from UWIC Cardiff on waste behaviour)

⇒ *Local government waste minimisation: the UK state of play?*
(pilot work, main survey results and material from Nene College)

⇒ *Policy, Practice and MSW: a review*
(main survey results, along with the literature review)

⇒ *The policy process: MSW and local authorities?*
(literature review work and waste planning documentation)

⇒ *Local MSW management surveys: how to get the desired result?*
(the survey process, with pilot results, and responses to the main survey)

⇒ *Policy Translation; success stories for Waste Management*
(main survey analysis)

⇒ *Which authority are you? How to determine if you will achieve Government MSW targets.*
(data analysis of survey results and material on authority typologies)

⇒ *Policy Recommendation for MSW management in the UK*
(conclusions and summary points from the PhD thesis)

The Practitioner Journals being considered include; [1] Proceedings of the IWM, [2] Proceedings of the CIWEM, [3] Materials Recycling Week, [4] Local Authority Waste and Environment, [5] WARMER and [6] The Planner. Some of the Academic Journals under consideration are; [1] Journal of Waste and Environmental Management, [2] Journal of Environmental Management, [3] Journal of Solid Waste Technology and Management, [4] Journal of Environmental Planning, [5] Transactions of the IBG, and [6] Local Government Policy and Planning.

PRESENTATIONS AT CONFERENCE

1. *The Waste Hierarchy*, at the Human Geography Postgraduate Research Forum, Egham, April 1997
2. *The Waste Hierarchy: the local government role in driving national policy*, at the School of Geography Research Seminar, Kingston University, May 1997
3. *The Waste Hierarchy: a local authority perspective, preliminary survey findings*, at the IBG-RGS 1998 Conference, Surrey University, January 1998
4. *The Environmental History of Waste Management in the UK*, at the European Association of Environmental History Annual Conference, Northampton, May 1998
5. *National Strategies and Local Practices; MSW Policy Implementation by Local Government in the UK*, Advances in European Environmental Policy, LSE, London, September 1998
6. *National strategy and local MSW management practice, a policy implementation problem in the UK?* 14th International Solid Waste Technology and Management Conference, Philadelphia, November 1998
7. *Crossing the divide, national strategy and local practice? MSW policy implementation by local government in the UK*, R'99-Recovery, Recycling, Re-integration, Geneva, February 1999
8. *Waste Policy or a Waste of Policy?*, at the IBG-RGS Annual Conference, Leicester, January 1999

PROPOSED PRESENTATIONS

⇒ Institute of Wastes Management Annual Conference, Jun. 1999
⇒ ISWA International Conference, Paris, France, Oct. 1999
⇒ Int. Solid Waste Tech. & Management Conf., Philadelphia, Nov. 1999
⇒ RGS-IBG Annual Conference, Jan. 2000
⇒ Recovery, Recycling, and Re-integration, 5th World Congress, Feb. 2000
⇒ Institute of Wastes Management Annual Conference, Torbay, Jun. 2000
⇒ MEL Waste Planning Conference, Birmingham, Jul. 2000
⇒ 5th Conf. on Advances in European Policy, London, Sep. 2000
⇒ Annual Conf. of Business & the Environment, Leeds, Sep. 2000

DEFINITIONS and CONTEXT

There are numerous definitions for what constitutes waste, and many classifications exist which attempt to segregate and categorise waste materials, the most common of which focus upon the source of the waste generated. According to the Environmental Protection Act (1990),

"waste is any substance which constitutes scrap material or an effluent or other unwanted surplus substance arising from the application of a process, or any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled."

However, for the purposes of this work only 'Municipal Solid Waste' (MSW) will be discussed, MSW comprises primarily household collected waste, but also includes light commercial and industrial waste collected by or on behalf of local authorities. There are good reasons for addressing MSW, because as the waste that the general public have most contact with the management of MSW has achieved a high political profile. Additionally, household waste is an element of MSW which by nature is one of the hardest sources of waste to manage effectively, due to the diverse nature of its material.

The ***'geography of waste'*** (types, quantities, spatial variations, management methods, and environmental impacts) is not a well defined field, but is one that is increasingly important. This is because waste is growing in quantity, has potential for polluting land, water and air, and is expensive to deal with properly. Society has always produced waste, but to a growing proportion of society this reflects a squandering of resources which cannot go unchecked. Waste production is increasingly being regarded as an antisocial activity rather than as the necessary and inevitable consequence of the demands of a consumer society. Transposed to the political stage, this view has spawned a new generation of waste management strategies which emphasise waste minimisation, waste re-use and waste recycling as the primary objectives.

The practical difficulties facing urban waste management associated with increased waste generation, lack of storage space and access problems, are further compounded by the financial difficulties facing many urban municipalities since the 1970's.

MSW MANAGEMENT POLICY

During the past century the environment has periodically become a significant issue on both the political and social agendas. However, during the last few years there has been an unparalleled interest in environmental issues among consumers, voters and the media. Yet relatively little work has been carried out on the ways in which local government are responding to the new waste management agenda being set by EU and UK legislation and policy developments. The general neglect of this field, and the recent development of academic research, enhances the need for this investigation to be carried out at a time of considerable policy activity in England and Wales, and this is the rationale behind this research.

Perhaps the most important single publication to change all this was the Brundtland Report (1987), which placed the notion of Sustainability firmly and immovably on the policy agenda, internationally, nationally and locally. However, it is clear that Sustainability and sustainable development are contested concepts, and there are a wide range of interpretations as to their meaning. If environmental Sustainability is the policy goal, however defined, environmental planning remains the mechanism for getting us there Sustainability has now been accepted and adopted at an international level as a framework for guiding future development within which, social, economic and environmental goals must be adopted which are consistent with each other and mutually attainable. In Britain, sustainable development has now been formally established as a policy goal at national and local levels. The 1992 Earth Summit in Rio (UNCED 1992) set a series of Agenda 21 objectives for waste management. These included:

⇒ *Minimising waste, stabilising waste production, quantifying waste flows, implementing waste minimisation policies, and developing national waste minimisation plans.*

⇒ *Maximising environmentally sound waste re-use and recycling, by providing information, implementing policy instruments, developing national programmes, and raising public awareness.*

⇒ *Promoting environmentally sound waste disposal, through the development of national waste plans and the application of the polluter pays principle to wastes.*

These goals have been translated through national policy in the UK into targets and strategies which local government must achieve and strive toward for recycling, reuse and energy recovery. The Government's strategic approach to solid waste management aims to ensure that valuable raw materials are used efficiently and not discarded unnecessarily, and that unavoidable waste is disposed of safely and efficiently, and when appropriate locally.

CONCLUSIONS

Traditionally, a number of important issues have been overlooked when discussing environmental policies and MSW, particularly policy development and the implementation of MSW strategy, and this is the rationale behind the research. There remains an obvious need for local government to test proposed planning strategies and management systems against their suitability within the local context (environmental, social and political) and their effectiveness once implemented, as many policies have negligible impact once they are documented. This requires some form of evaluation of the planning process.

The thesis is intends both to contribute to the development of theory on sustainable waste management strategies, and be of use to local authorities and waste management companies in developing and achieving strategies for sustainable waste management in theory and practice. The finished research should prove of great value to the waste industry in its broadest sense, due in part to the real practical element under investigation, and the controversy that surrounds national policy acceptance by local government, policy translation and implementation, and the effectiveness of local policy and activity. The research findings should provide detailed data on those factors that influence the successful implementation of sustainable waste management strategies, providing useful information for all local authority departments involved in waste collection and disposal. The data obtained will be used to help local government MSW managers to base their decision-making on sound scientific data, detailing those authorities that will struggle to achieve government targets due to their local context, and providing examples of 'good' practice so that authorities can learn from each other. The key challenge to this research is obviously to implement the methodology for effective implementation of policy and the proposals made into policy and practice at the local scale.

Research carried out to date has identified that a policy implementation gap for MSW policy is a real problem for local government officers, who are striving to achieve Government targets but are falling short. What this research to date shows is that no matter how radical, rapid or innovative policy change and direction are from both the EU and UK policy dictators and legislators, they will fail to alter practices at the local scale in the short term. Policy that is driven by the centre often fails to adequately take account of local circumstances, funding problems, staffing issues and organisational barriers to change. These are the issues that must be faced by policy makers in the coming Millennium if MSW management practices are to move towards Sustainability.

The results of this work will be made available to authorities who express an interest in the report. If you and your authority would be interested in the results or would like to get involved in the case study exercise please doe so.

4. Develop a Generic model of Policy Implementation

This will be based upon accurate data from the survey and subsequent analysis of the factors most successful in encouraging the movement of local government practices, thus providing a practical tool for use by local authorities. Once the key barriers and constraints are identified from the survey, and their significance for local policy activity determined, a model for successful national MSW policy implementation will be detailed. It is intended that this model will be of practical worth, enabling local MSW policy officers to become aware of the key variables and constraints that operate on local practice and determine local policy choice and implementation.

5. Test the Model

The model suggested cannot be considered valid until it has been rigorously tested using a number of techniques This testing will occur initially through the case study work, and will then build upon this through the use of a network of authorities who have already expressed an interest in testing the model. This will provide an opportunity to discuss and investigate the implications of decision-making at the local scale, and potentially inform the policy process, based on the survey analysis and the derived model. As the PhD level of the research focuses upon a greater understanding of the *'policy process'*, the constraints that govern choice of MSW strategy at the local scale, there will be a need to interview authorities to investigate the worth of the model and the research findings as practical tools.

6. Provide Local Authorities with Information on Good Practice

This will to help them to understand the processes and forces acting upon their operation and policy processes mechanisms. By informing them of the structures within which they operate, they may be able to make more fully informed decisions, which should increase the efficiency of their implementation and their potential for achieving national MSW management targets. The real proof of the research will come through validation and evaluation in the real world, and this will occur through the case studies, research evaluation and most importantly through dissemination of the results and the model at both academic and more importantly practitioner conferences, seminars and local government association meetings.

7. Inform Central Government Decision Making

This will be an aid to their policy development process, and potentially indicate where previous administrations have failed to date in trying to influence local MSW practice.

To this end the Conservative Government stated they would: [i] encourage the minimisation of waste, [ii] promote recycling of waste, including recovery of materials and energy, [iii] tighten controls over waste disposal standards, and [iv] take action to curb litter, focusing upon the application of the waste management hierarchy at the local scale. The waste hierarchy was initially introduced by the EU 4th Action Program on the Environment (1987) and was promoted more centrally through the 5th Action Programme *'Towards Sustainability'*. The fundamental aim of the hierarchy is to guide waste policy so that minimisation, re-use and recovery become more attractive management options for waste producers and local authorities.

Since ***'This Common Inheritance'*** (1990) there has been a general recycling target of 50% of the recyclable element of the household dustbin (25% of household waste) which local government should strive towards, and this proved to be the first element of Government support for recycling in the UK. The central objective of the UK waste strategy ***'Making Waste Work'*** (1995), which remains the principal strategic policy framework for MSW in England and Wales, in common with many other developed countries, is to make waste management more sustainable by moving local practices up the hierarchy of options.

This White Paper sets out the current strategy for waste management in England and Wales, *developing the ideas initially put forward in* ***'Sustainable Development: The UK Strategy'*** (1994). The focus of the strategy is on increasing the emphasis on the options towards the top of the waste hierarchy through the setting of targets. This research is using these targets to measure local government performance and the impact of central government policy are the local scale. 'Making Waste Work' (1995) remains the guiding principle for MSW strategy decisions, setting a number of targets relating to landfill diversion, recycling and recovery rates, home composting and recycling bank provision, and provided guidance on waste planning, licensing and gave examples of best practice.

TARGETS FOR MSW MANAGEMENT FROM MAKING WASTE WORK

1. to reduce the proportion of controlled waste going to landfill from 70% to 60% by 2005
2. to recover 40% of MSW waste by 2005
3. to recycle or compost 25% of household waste by the year 2000
4. 40% of domestic properties with a garden to carry out home composting by the year 2000
5. all WDAs to cost & consider central composting schemes
6. easily accessible recycling facilities for 80% of households by 2000

This legislative emphasis has simply raised the profile of MSW and encouraged the movement of its management up the hierarchy away from landfill, without adequately supporting the development of alternative options through funding or legislative provisions. More recently there has also been the launch of the ***'Landfill Tax'*** (1996) to make landfill disposal more expensive (relative to other waste management options) by taking into account the environmental costs associated with methane production and leachates. This has provided a new impetus for the development of alternative routes of waste treatment and management in the UK. However, the success of all of these measures to adequately shift the nation's reliance away from landfill has been negligible and thus the new Labour Administration launched their Consultation Document ***'Less Waste More Value'*** (1998) to review and revise national waste policy. The new 'National Waste Strategy for England and Wales' will be published in 1999, which should prove interesting reading to see how far MSW targets have been revised and policy frameworks altered. According to the Environment Minister (Michael Meacher) the UK *is 'highly unlikely' to meet the government recycling target of 25% by the year 2000'*, but also stated that *'I am determined that we get to it as soon as possible thereafter'*.

MSW MANAGEMENT PRACTICES IN THE UK

Current waste management practices concentrate on the bottom rung of the ladder where landfill accounts for in excess of 84% of all municipal waste treatment and disposal in England and Wales. Only 7% of municipal waste is recycled and energy recovered from another 8%, yet up to 50% of all household waste is potentially recyclable or recoverable, whilst a further 30% is compostable. The regional dimension to MSW management and treatment is identified in the table below, indicating the clear differentiation that exists between the use of landfill in the Midlands and North West, recycling in the South West and Wales, and Waste to Energy in the Midlands and the South East.

TREATMENT ROUTES USED IN THE REGIONS (BY %)

Region	*Landfill*	*Incinerate*	*WtE*	*RDF*	*Recycled*
North East	69	25	0	4	2
South West	73	10	0	0	17
West Midlands	77	9	11	0	3
South East	80	1	11	4	4
Yorkshire	90	1	6	0	3
Wales	91	0	0	0	9
East Midlands	93	4	0	0	3
East Anglia	93	0	0	0	7
North West	95	2	0	0	3

THE NEXT STAGE?

The following issues will need to be addressed in greater detail within the case study exercise and the ongoing research;

- ⇒ Identify the mechanisms, factors and barriers operating on local MSW management provision 'operational difficulties'
- ⇒ Assess the effectiveness of these factors for policy implementation 'barriers to success'
- ⇒ Develop a generic model of MSW Policy Implementation 'how does it work?'
- ⇒ Case studies to evaluate the work 'observe policy at first hand'
- ⇒ Testing of the model 'networking with authorities, in the policy process'
- ⇒ Provide local government with information on good practice 'informed decision makers'
- ⇒ Inform central government of local concerns 'improved policy development'

1. TO IDENTIFY THE BARRIERS OPERATING ON LOCAL MSW MANAGEMENT

The identification of the barriers and mechanisms will be achieved principally through an analysis of the survey results, and through directed and specific literature searching. The data obtained from the survey of English waste management authorities will be used through SPSSx (a statistical manipulation and retrieval computer package) to test variables against one another for correlations, and to produce regional differentiation tables and comparisons of historical performance. Perhaps the most important outcome of this stage of the work, other than the hard data on practices and policy decisions, will be the derivation of authority typologies.

2. TO ASSESS THE EFFECTIVENESS (SIGNIFICANCE) OF THESE FACTORS FOR POLICY IMPLEMENTATION

Once the barriers, constraints and opportunities have been adequately defined through a continuation of the literature work, discussions with policy officers, and analysis of the survey returns, there will be a need for a detailed statistical evaluation and series of tests to analyse the significance of each variable upon the policy translation and implementation process.

3. LITERATURE REVIEW

There will be a need for a continuation of the literature analysis and review element of the research, representing the shifting emphasis of the work further towards the constraints and barriers that exists for the local implementation of environmental policy.

Section E: Themes for Informal Chat

The final section of the interviews will involve a more general discussion of issues relating to local MSW management and national policy, guidance, frameworks and targets, to ascertain how the local implementors are responding.

- State of MSW management in the UK?
- New policy?
- Local action & Agenda 21?
- Best Practice?
- CIPFA / Audit Commission League Tables?
- The Way forward?
- The role of Education (Universities)?

The previous Government's aim, and current Central Government policy supports this, is to shift management activity and practices towards the options presented at the top rungs of the hierarchy, as has occurred in a number of other developed nations, where recycling, composting and waste from energy, all of which are more significant throughout Western Europe. However, to date, it appears that *'people, officers and policy makers have merely paid lip service to this hierarchy, acknowledging the supremacy of waste avoidance, minimisation and recycling and recovery, whilst in practice the vast majority of wastes still go to landfill or incineration for treatment and disposal'*. The reasoning for this failure in policy translation and implementation is the key theme under investigation within this research program.

THE ROLE OF LOCAL GOVERNMENT?

The London Government Act (1963) and the Local Government Act (1972) established a full two tier system of local government throughout England and Wales. This system maintained a division of functions between the two levels of authority and incorporated an important difference in the system operated in the more rural areas of the country as opposed to the metropolitan areas. In the rural areas the top tier of local government (County Council) was, and is, politically and functionally dominate, by contrast in the metropolitan areas, the lower tier of authority (Metropolitan Boroughs) was the strongest tier, and is the only tier operating today.

An English county council has two statutory roles related to waste management; [i] as the local planning authority for land use planning issues and [ii] as the Waste Disposal Authority (WDA) via waste contracts for the district collection authorities. District level authorities have two key departments with a concern for waste matters. The first is the Waste Collection Authority, charged with the responsibility for collecting all waste under Schedules 1 and 2 of the Controlled Waste Regulations (household waste). The second comes under the Local Agenda 21 process. District level planners many also have some role in waste planning but this is generally limited.

Local government is responsible for the collection and disposal of MSW in the UK at an annual cost of around £850 million. The collection of municipal waste is typically a service provided by local government, which can either directly employ labour or can use private sector companies on a contractual basis, and since the 1970's the use of private companies has been rapidly increasing in developed economies. A key dimension to waste collection is the administrative and organisational relationship between the collection and disposal of waste and the inter-relationship between the practice of waste management and the structure of local government. In London, for example, there have been 33 separate authorities for waste collection and sixteen for waste disposal since the abolition of the Greater London Council in 1986, making economies of scale and co-operation somewhat difficult to achieve.

Since the Environmental Protection Act (1990) there has been a further restructuring of local government MSW management with the national division of waste responsibilities between Waste Collection, Waste Disposal and Waste Regulatory Authorities. Under section 32 of the Environmental Protection Act (1990), the operational aspects of waste disposal are now separated from the administrative duties, with emphasis on contracting-out to the private sector. Since the 1995 Environment Act the regulatory functions were removed from the County Councils and have been added to the function of the newly created Environment Agency, with its regional approach to environmental regulation.

LOCAL GOVERNMENT MSW MANAGEMENT RESPONSIBILITIES

Authority	Principal Duties
Waste Collection Authorities	collection of household and commercial wastes, street cleansing and associated services.
Waste Disposal Authorities	disposal of collected WCA wastes through competitive tender, and nor permitted to dispose of waste itself.
Waste Regulation Authority (now Environment Agency)	site licensing and enforcement, and production of waste disposal plans
Local Authority Waste Disposal Company	arms length operation of all waste disposal and treatment facilities, formerly part of the WDA.

THE CASE STUDY INTERVIEW

Section A: Presentation of Research Ideas and Provisional Findings

This initial section will allow me to present some of the more interesting and key findings of the research to date, to allow the officers to get a feel for the research.

- The Policy Diagram
- MSW Treatment Routes
- The Policy Implementation Gap
- Achieving Government Targets
- Develop Authority Typologies (Groups) based on performance criteria

Section B Response to Particular Questions form the Survey

This section will involve the discussion of specific responses given to the initial survey, to provide greater detail, further explanation and if necessary some of the historical criteria required to understand fully and appreciate the responses given. For each case study this will be the most 'personal' element determined by earlier responses.

- MSW Treatment Rates
- Policy Implementation Problems
- Available Policy Documentation
- Policy Development (Drivers, Personnel and Directions)
- Achievement of Targets (Setting of Localised Targets)

Section C: General Policy Document Questions

This section will focus solely upon the types of policy being used and implemented within the authority, and the available policy statement, plans and information booklets used to promote sustainable waste management.

- What Local Policy Documentation is available?
- What are the local targets, and how are the policies being implemented?
- Staffing structures and approaches?
- Discuss my policy document (model)?

Section D: Standard Questions relating to Policy Development & Implementation

This series of questions will focus upon the localised activity of policy making, translation through documentation and final implementation.

- Key Drivers and Targets?
- Current operating statistics?
- Predicted Improvements?

THE CASE STUDY EXERCISE

At present there is a clear need to investigate what the driving factors are for local authority policy and practice with regard to municipal solid waste management. The views of local authority waste managers are thus an essential element within this ongoing study, and your role (as a waste management officer) in policy development and implementation provides an invaluable source of information on sustainable waste management strategies which has previously been untapped. I have undertaken this study because of the belief that local government waste officer opinions should be taken into account in the formation of public policies for the planning of waste management in the UK.

The case studies will allow municipal waste service provision and local practice to be directly related to your authority and the data you provide will test the provisional results of my recently completed survey of English authority MSW management practices. The format for the case study interviews is still being revised but it is intended that each case study will involve a 4 stage process;

1. Provision of waste management documentation for your area and authority for a period of the last 5 years relating to policy goals and statements, targets, contracts and performance. This should include published waste management plans, recycling plans, information books, performance details and text from Environmental Committees.
2. A couple of hours where the Recycling / Waste Management Officer, the Waste Planning Officer and the Local Agenda 21 Officer will be interviewed (together if possible), so findings from the English authority survey can be discussed, and specific responses from the authority to certain questions will be investigated. The format will involve;
   - ⇒ *Presentation of the key findings from the English survey.*
   - ⇒ *Discussion of the results and how they relate to the local context.*
   - ⇒ *A semi-structured interview.*
   - ⇒ *An informal chat relating to the research goals and programme.*
3. I will then pull together the findings of these interviews, and produce a short resume relating the initial survey findings to your authority's policy documents and interview responses.
4. To use these case studies to emphasise the survey results, to develop the research ideas concerning policy barriers and opportunities to overcome them, and to assess national achievement of Government MSW Targets in light of local circumstance.

LOCAL MSW POLICY IMPLEMENTATION

In the field of environmental policy there is little doubt that there is current interest in local policy and practice, through a recognition that both local policy and practice at the level of local government, are an important determinant of environmental outcomes. The analysis of public policy has been one of the fastest growing fields of political science during the last decade, a branch of empirical political theory which is concerned primarily with explaining the factors that affect decision making to enable models to understand political phenomena .

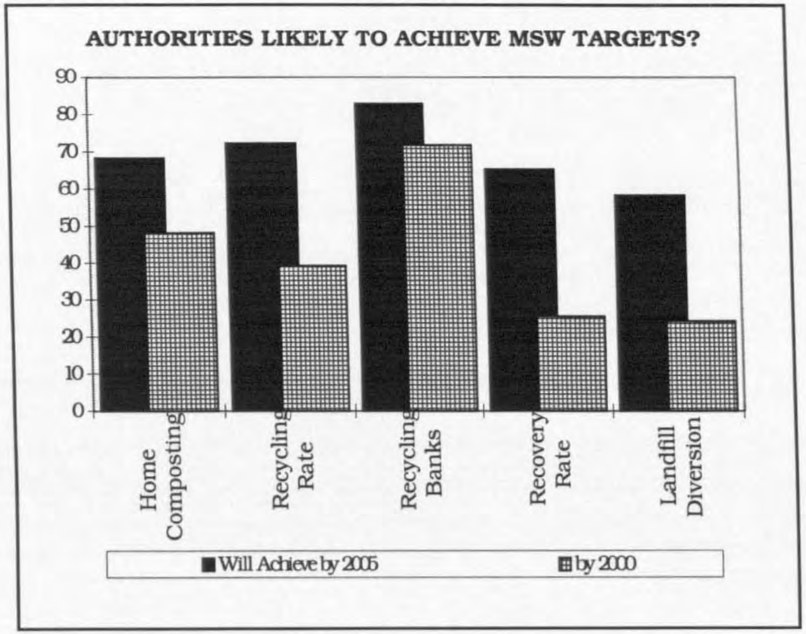
In the UK broad outlines of environmental policy are determined nationally, whilst local authorities play a substantial part in interpreting those policies and mobilising the resources needed to bring them to fruition. Thus, there is a fundamental need to understand the more localised mechanisms by which policies are made and enacted. This is important because national policy and strategy may not always give rise to the desired outcomes at the local scale, due to a number of factors and constraints, which are currently under investigation. Traditionally the UK has employed a top-down approach to policy making in which legislative decisions are taken at the centre and then executed with little or no discretion locally, hence the National MSW Strategy (1995) is transformed into local waste practice by local authorities who have to respond to their own local resource base, environmental concerns and economic situation. If an implementation problem exists, then better techniques of implementation should be devised which adequately deal with the planning problems which arise from social and economic issues at all levels of Government.

Local authorities are working to deliver a national strategy for sustainable waste management that seeks to reduce the quantity of waste generated and make the best use of the waste that is produced. Both waste collection and disposal authorities have a vital role to play in moving towards the performance targets set in the Waste Strategy (1995), and liaison and co-operation between these authorities is essential in developing fully integrated solutions which minimise economic costs and maximise environmental benefits. However, it would appear that the existence of different tiers of authority with different functions places obstacles in the way of achieving an integrated approach to waste management .

Local government has a vital role to play for environmental stewardship, being able to translate debate at supra-national and national level into practical local action, and this translation and implementation processes are the key issues under investigation. However, in the UK administration at the local level appears inadequate to manage the policies proposed identify and collect the relevant data and ensure the implementation of recycling strategies at the local level. Activity at the local scale remains distinct and isolated from national strategies, causing significant implementation problems. This effectively blocks the bottom up approach, and means that local practices do not match national MSW policy or targets.

On the subject of achieving Government MSW targets, the general picture was quite poor;

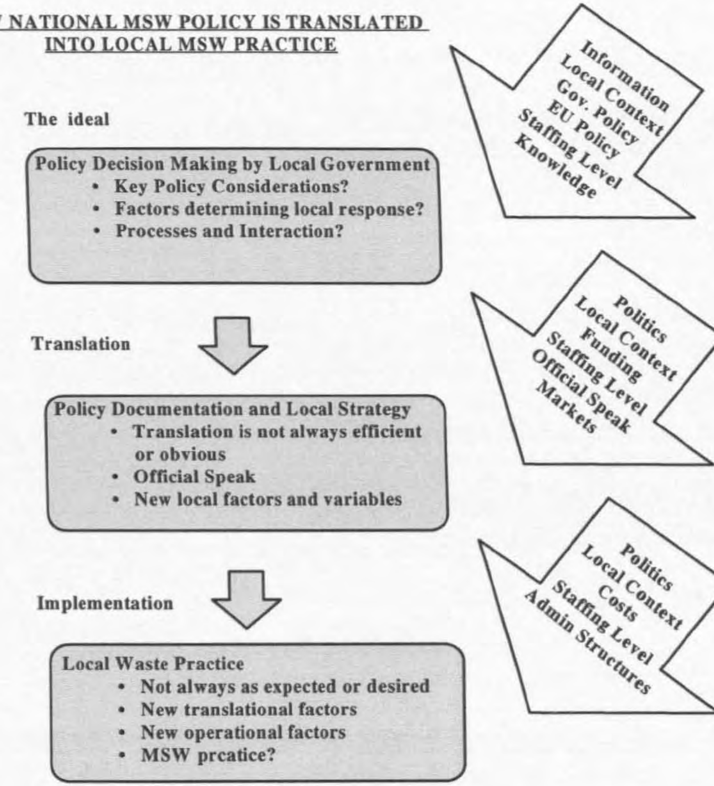
- 22% of authorities will achieve Recovery Target by 2000
- 64% will achieve Recovery Target by 2005
- 38% will reach the Recycling Target by 2000
- 73% will reach the Recycling Figure by 2005
- 22% of authorities will attain the Landfill Diversion Target by 2000
- 57% will reach the Landfill Diversion Target by 2005



These figures suggest that current MSW management practices are generally landfill dependent with only pockets of activity with Recycling, Composting and WtE. However, a number of authorities intend to improve their performance, although upto 30% of authorities may fail to achieve any of the Government's targets. The reasons for this failure, and the responses regarding policy implementation barriers will from the central focus for the case study exercise, allowing the survey findings to be tested and analysed within the local context, which after all is the key determinant of successful policy implementation.

Governments are increasingly implementing policies that are intended to impact on waste management practice, and many new initiatives have been taken in countries around the world over the last few years. A common problem has emerged in countries that have embarked on policies promoting greater Sustainability in waste management through recycling and reduction. The pace of policy making has not been matched by an equal effort to provide mechanisms for effective policy implementation.

HOW NATIONAL MSW POLICY IS TRANSLATED INTO LOCAL MSW PRACTICE



On a practical level the research addresses English MSW, as a specific geographical unit, with very different regions allowing comparisons of environmental and locational factors to be considered as variables governing local policy implementation. The research also focuses upon local government policy translation, documentation, implementation and management, discounting the role of both voluntary organisations, which can be important for recycling collections, and the role of the private sector companies who actually carry out the waste management services. This focus has been determined because local authorities remain the facilitators, regulators and managers of local MSW services, as collection and disposal authorities, and are thus they key bodies in the policy adoption, translation and implementation phases, which are of key consideration within this research, although they no longer have a regulatory role which now resides

The aim of this work is to assess the impact of national MSW management policy on local practices by using the Hierarchy to assess changes in performance. There is also a need to determine the driving factors for local authority policy and practice with regard to municipal solid waste management This research is currently assessing how Government policy has encouraged waste management services to move up this hierarchy of options, and to assess the operationalisation of policy at the local level. In order to achieve the overall aim of modelling MSW policy implementation by local government and inform the management decision-making process about constraints to successful implementation, a series of specific aims have been identified;

1. *to understand national MSW policy development & translation at the local scale*
2. *to assess the significance of Government policy in shaping local waste practices*
3. *to devise a model to explain successful policy implementation*
4. *to validate the proposed model in the field*

The intended outcome of the work is to provide examples of Best Practice of successful implementation of national policy and achievement of policy targets which will be achieved through the development of authority typologies ([i]high performers, [ii]those improving local performance, and [ii]those that are struggling to alter local practice). More importantly is the intention to inform both the national and local policy processes, so that local circumstances are more readily accounted for in the decision process. Thus, the objectives of this study are

1. *To identify changing practices in UK MSW management*
2. *Investigate barriers to policy translation and implementation at the local scale*
3. *To identify authorities which will have inherent difficulties in achieving movement of MSW practices up the hierarchy*
4. *To provide local authorities with information on good practice to help them to understand the processes and forces acting upon them*

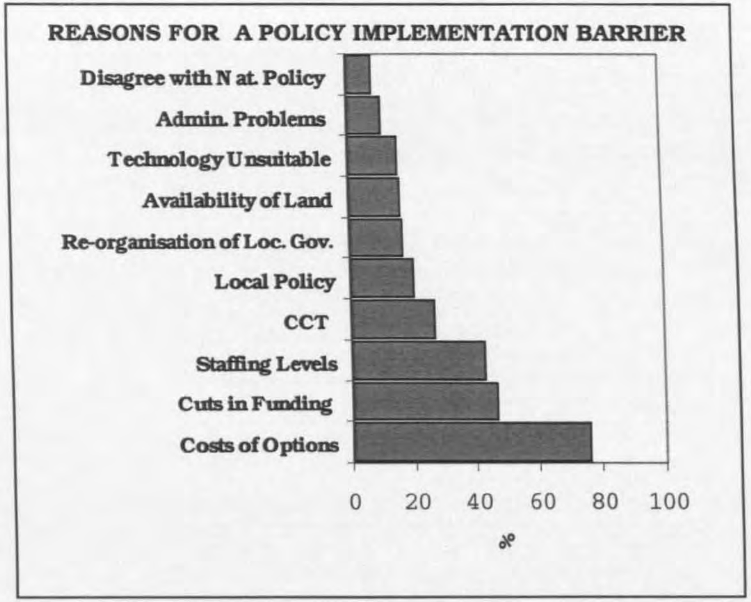
AUTHORITIES EXPERIENCING A POLICY IMPLEMENTATION GAP?

WCAs	CONSERVATIVE	LABOUR	LIBERAL
% experiencing a policy implementation gap	50	73	60
% experiencing a local policy gap	25	46	31
UAs	CONSERVATIVE	LABOUR	LIBERAL
% experiencing a policy implementation gap	50	71	33
% experiencing a local policy gap	0	45	20
WDAs	CONSERVATIVE	LABOUR	LIBERAL
% experiencing a policy implementation gap	38	80	75
% experiencing a local policy gap	17	29	33

EXPERIENCING A POLICY IMPLEMENTATION GAP?

WCAs	URBAN	URBAN FRINGE	RURAL	MIXED
% experiencing a policy implementation gap	82	80	54	63
% experiencing a local policy gap	50	75	25	41
UAs	URBAN	URBAN FRINGE	RURAL	MIXED
% experiencing a policy implementation gap	63	33	0	71
% experiencing a local policy gap	100	50	0	0
WDAs	URBAN	URBAN FRINGE	RURAL	MIXED
% experiencing a policy implementation gap	0	0	40	68
% experiencing a local policy gap	0	0	33	21

The survey suggests that 62% of WCAs are experiencing a Policy Implementation Gap, whilst 37% are experiencing a more localised policy translation barrier. The key reasons for these policy problems are (in order of importance) (i) Costs, (ii) Staffing Levels, (iii) Privatisation and Contracting out, (iv) Cuts in Local Government Funding, and (v) Local Government Re-organisation.



There was also an interesting breakdown of authorities experiencing policy implementation problems;

- 81% of Urban authorities have experienced a policy implementation gap
- only 50% of Rural authorities agreed
- 78% of Urban Fringe authorities have experienced a local policy barrier
- only 23% of Rural authorities agreed
- 73% of Labour authorities have experienced policy translation problems
- only 50% of Conservative authorities agreed
- 80% of authorities in the West Midlands have suffered form policy barriers only 58% of authorities in NE and Thames regions agreed

THE PILOT SURVEY

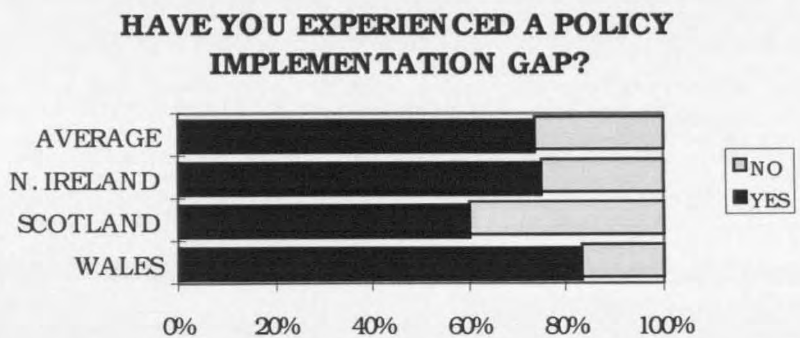
The justification for this research is the obvious failure of national MSW policy to alter local government practice in line with sustainable development and the targets laid down in Making Waste Work (DoE 1995). This failure has been acknowledged by the current Government, who have begun a review of MSW policy in the UK. However, local level implementation of national environmental strategies has been a generally ignored area of investigation, and in order to successfully carry out this analysis those responsible for the development and implementation of local waste management policy and services must be surveyed, and this is why the different tiers of local government have been selected. Local authorities are an invaluable source of information on the success of national waste strategy and policy which have previously been ignored as merely a practical element of the service provision chain .

The pilot survey was carried out during August and September 1997, testing the survey on authorities in Scotland, Wales and Northern Ireland. The purpose of the pilot work was to test the research methodology, and assess whether the research themes identified in the desk research were suitable as research avenues for the Ph.D. English local authorities were chosen to be the full sample to be investigated by the research, because they have historically been the most progressive section of local government in the UK with regards MSW management, whilst providing a substantial number of replies from which to draw statistical relationships and detailed analysis. The survey was designed with a number of specific sub-sections;

1	Background details	The data collected about MSW m will be referenced by typology
2	Waste collection and disposal statistics	Discuss trends in the management of MSW
3	Involvement with specific MSW treatments	Investigate changing practices, and reasons for shift in treatment policy and practice
4	MSW policy documentation	What exists & what is being prepared, as an indication of local policy translation
5	Current waste management policies	Who are the policy makers, and what are the governing factors for local decision-making
6	Available waste management services	Details on the provision of minimisation, composting and recycling services (budgets)
7	Achieving Government Targets	Analyse success in reaching the targets laid out in Making Waste Work (1995)

The response rates from the survey were too low (average of 25%), particularly from Scotland (16%) for any real conclusions to be made regarding MSW policy and practice in these regions. However, this pilot phase remains a useful and essential part of the research programme, and the data collected will be used within the thesis to indicate trends in UK waste management and suggest ideas for further analysis of the English authority survey. The proposed development of new treatment options between 1995 and 2005 by the sampled authorities provided some interesting findings. The most striking results were that 80% of all authorities would probably or definitely develop minimisation, 60% would encourage composting and 100% recycling due to its statutory nature, yet only 12% would support WtE, 6% incineration, and 52% landfill. These figures suggest that the options nearer the top of the hierarchy will be supported (if only by lip service) whilst the traditional approaches of disposal are not being as openly supported.

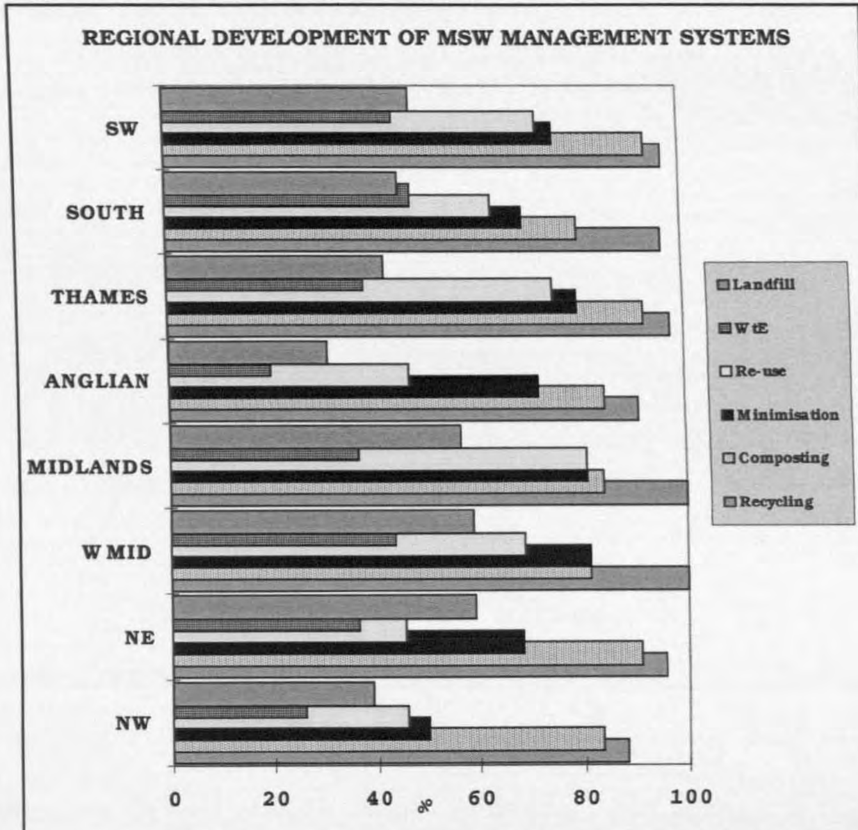
Landfill dominates MSW practices in the 3 regions of the UK, accounting for 97% of all MSW treatment and disposal, with recycling accounting for the other 3%. These figures do bear a close resemblance to published data on MSW practices (DETR or CIPFA) suggesting the validity of the research to date. The reasons for this pattern are quite obvious with economic considerations being the most significant issue for the continuing use and dominance of landfill, although resistance was raised in the guise of NIMBY issues and local policy considerations. Minimisation strategies are very poorly provided for according to the sampled authorities with only 10% of authorities in Northern Ireland and Wales having one. Kerbside recycling programmes do not fair much better with 40% of authorities in Wales, 20% in Scotland and 40% in Ireland operating a service, with very similar results for composting systems. Most important was the obvious existence of a policy implementation gap (74% of sample) being experienced in the three regions.

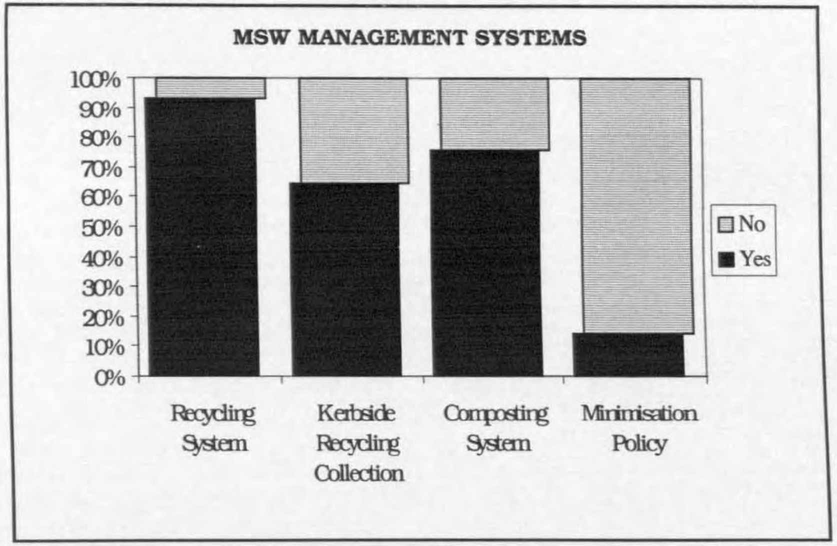


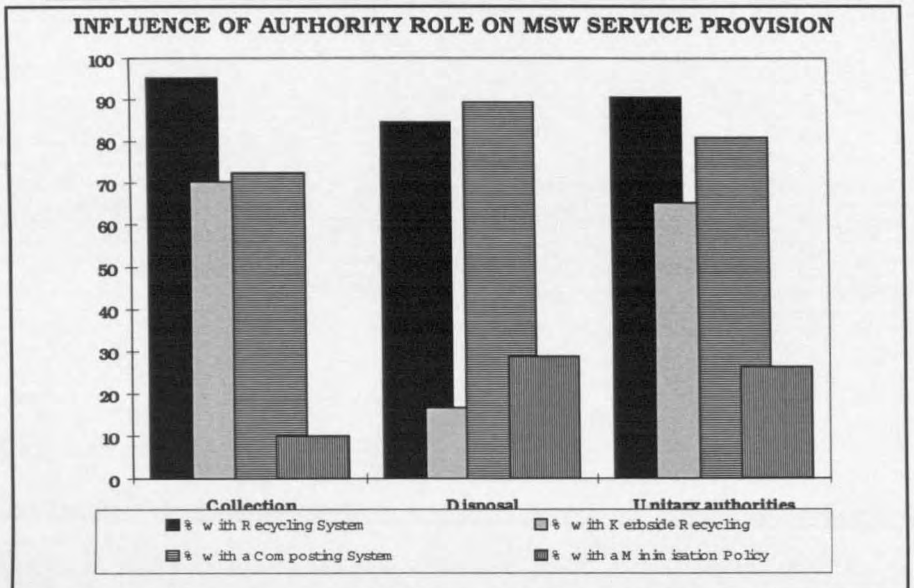
When considering the main thrusts of waste management policy by WCAs, the responses were reasonably uniform;

- 90% are focusing on Education
- 82% on Achieving Targets (national and local)
- 80% intend to Limit Waste Production

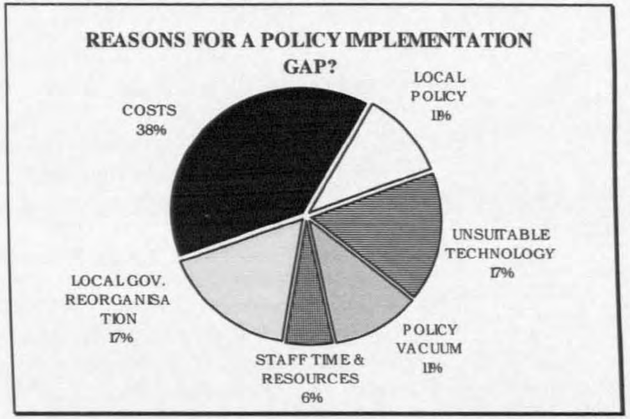
There is also a clear regional bias to be noted, with the Midlands regions promoting (60%) the future use of landfill more than the rest of England (40%), perhaps due to greater availability of void in these regions or because of the poor infrastructure that currently exists to recover and recycle material and energy. Recycling is uniformly supported for further development by over 80% of all authorities, although of note is the response of the North west which is less supportive generally of recycling and other recovery options.







As expected WCAs have a recycling system, with a great deal of attention being paid to Kerbside recycling collections (70%) compared to only 10% of WDAs who have no such statutory responsibility.



It also appears highly unlikely that any of the targets set in Making Waste Work (1995) will be met by the year 2000, whilst by the year 2005, the majority of those surveyed are expecting to reach targets for [1] landfill reduction, [2] home composting and [3] recycling banks, but falling short for [a] recycling rate and [b] recovery rate, which are perhaps the two most important targets for shaping MSW management practices and conserving landfill void. This suggests that a lot of work at the local level is required if National policy and strategy is going to lead to the desired changes in local practice.

WILL AUTHORITIES ACHIEVE UK GOVERNMENT MSW TARGETS?

	By 2000 Yes	By 2005 Yes
Home composting from 40% of households with a garden	16	52
Recycling Rate of 25% by 2000	10	45
Recycling Banks in easy access for 80% of households by 2000	61	77
Recovery Rate of 40% by 2005	10	43
Landfill Use Reduction from 70% of controlled waste to 60%	37	62
Average Attainment of Targets	27%	56%

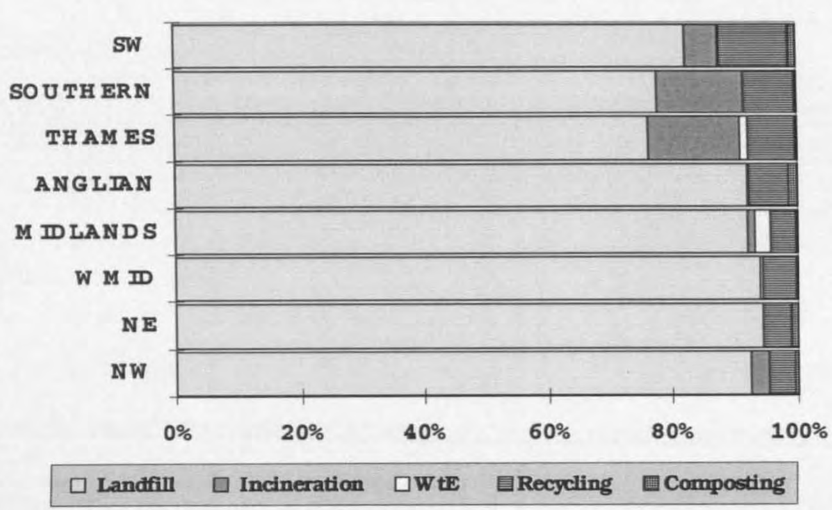
Research carried out to date has identified that a policy implementation gap for MSW policy is a real problem for local government officers who are striving to achieve Government targets but are falling short. These preliminary results indicate that in Scotland, Wales and Ireland there are some interesting problems relating to the implementation at the local level of national MSW policy and the achievement of MSW targets. This survey provides a backdrop for the more detailed discussion of MSW service provision and performance in England.

PROVISIONAL ENGLISH AUTHORITY SURVEY RESULTS

The initial analysis of the survey data suggests a clear regionalism of MSW management practices in England. However, one needs to consider the reasons for this pattern? It may be due to local landfill availability, political decisions, links with traditional industries or due to the people living in these regions. This clearly needs closer attention.;

- Landfill dominates in NW, Midlands and Anglian regions
- Recycling is successful in SW, South and Thames regions
- Waste to Energy is popular in Midlands, South and Thames regions

REGIONAL MSW PRACTICES IN 1995

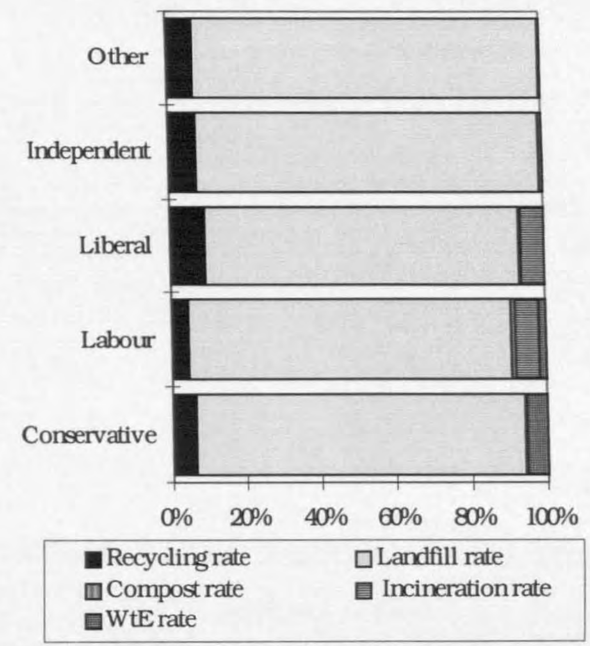


There also appears to be a slight 'political bias' in the choice and adoption of MSW management treatment options, and again there is a need to ask why this is? Liberal authorities are considered to be the most progressive for the development of recycling but this may have more to do with the residents who vote liberal than the party manifesto.

The Labour strongholds are also the older industrial zones where derelict land and old incineration plants are available for refurbishment for WtE, whilst Conservative authorities may be primarily concerned with cost savings and thus promote minimisation ideals. Only more detailed analysis will find the underlying reasons for this pattern.;

- Liberal authorities favour Recycling and Composting
- Labour authorities have supported Incineration and now support WtE
- Conservative authorities are actively pushing Wastes Minimisation

LOCAL MSW MANAGEMENT ROUTES ACCORDING TO LOCAL AUTHORITY POLITICAL CONTROL



APPENDIX 5.8

CASE STUDY MATERIALS

QUESTIONS & THEMES FOR CASE STUDY INTERVIEWS

Section A: Presentation of Research Ideas and Provisional Findings

This initial section will allow me to present some of the more interesting and key findings of the research to date, to allow the officers to get a feel for the research and to set the scene for the interviews.

- The Policy Diagram
- MSW Treatment Routes
- The Policy Implementation Gap
- Achieving Government Targets
- Authority Typologies

Section B: Response to Particular Questions form the Survey

This section will involve the discussion of specific responses given to the initial survey, to provide greater detail, further explanation and if necessary some of the historical criteria required to fully understand and appreciate the responses given. For each case study this will be the most 'personal' element being determined almost wholly by their earlier responses.

- MSW Treatment Rates
- Policy Implementation Problems
- Available Policy Documentation
- Policy Development (Drivers, Personnel and Directions)
- Achievement of Targets (Setting of Localised Targets)
- Referral to 'odd' responses, or 'non' responses

Section C: General Policy Document Questions

This section will focus solely upon the types of policy being used and implemented within the authority, and the available policy statement, plans and information booklets used to promote sustainable waste management.

- What Local Policy Documentation is available?
- What are the targets?
- How are the policies being implemented?
- Staffing structures and approaches?
- Who does what?
- Discuss my policy document (model)?
- New (or intended) Policy and Documentation?
- Guidance from what sources?
- Improvements?

Section D: Standard Questions relating to Policy Development & Implementation

This series of questions will focus upon the localised activity of policy making, translation through documentation and final implementation. This section will utilise the initial survey results as a framework to discuss the existence of barriers at the local scale to policy translation and the inability to successfully achieve Government MSW targets.

- Key Drivers?
- Key Development Plans?
- Key Targets to be achieved?
- Current operating statistics?
- Predicted Improvements?
- Existence of Policy Problems?
- A Policy Implementation Gap?
- Barriers to Operation?
- Success stories?
- How to overcome the local problem?
- Regional Organisations?
- New Government Policy?
- The Government Consultation Phase?

Section E: Themes for Informal Chat

The final section of the interviews will involve a more general discussion of issues relating to local MSW management and national policy, guidance, frameworks and targets, to ascertain how the local implementors are responding to the National agenda, and assess what positive impacts or contributions they would like to make on MSW management policy development.

- State of MSW management in the UK?
- Areas of Improvement?
- New techniques or technology?
- New policy?
- Local action?
- Agenda 21?
- Best Practice?
- CIPFA / Audit Commission League Tables?
- Who is the best?
- The Way forward?
- The role of Education (Universities)?

APPENDIX 6

SOURCE REDUCTION IN MASSACHUSETTS (USA)

APPENDIX 6

SOURCE REDUCTION AND ITS ROLE IN INTEGRATED SOLID WASTE MANAGEMENT PLANNING FOR MASSACHUSETTS (USA)

1. INTRODUCTION

In February 1989, The U.S. Environmental Protection Agency (EPA) published the report The Solid Waste Dilemma: An Agenda for Action. This report called for the adoption of "a new solid waste management ethic" reflected in what has come to be referred to as the solid waste management 'hierarchy'. Subsequently, the State of Massachusetts followed by establishing goals and objectives related to this hierarchy in its 1990 Master Plan entitled "Toward A System of Integrated Solid Waste Management".

The hierarchy for integrated solid waste management laid out as the heart of this plan consists of: reduce, recycle and dispose of wastes either through combustion or landfilling. Policies and programs stipulated in the plan and in updates which followed in 1994, 1995 and 1997, were designed to minimize the amount of waste requiring disposal at landfills and combustion facilities through source reduction, reuse and recycling. Another objective of policies pursued by Massachusetts Department of Environmental Protection (MA DEP) and promoted through the 1990 plan was to ensure that adequate and environmentally sound solid waste disposal capacity was made available.

The first priority goal of the plan was to achieve 10% volume reduction for the 1990 per capita generation rate for MSW by the year 2000. The net result of the Massachusetts source reduction program was to be a nearly level solid waste generation rate for the state over the next ten years as population and economic activity continued to grow. The second goal of the plan was to divert 46% of the MSW stream through statewide recycling and composting programs.

As Massachusetts reassesses its policies and revises its master plan for the year 2000 while looking back on the past source goals that were set, several important observations can be made regarding source reduction. Programs implemented were not specifically aimed at achieving the 10% source reduction goal and any source reduction that was achieved was not measured as such. Also, while recycling rates grew substantially during the first few years after 1990, recycling has stagnated in the past 4 years (1994-1998), despite continued investments in programs and incentives throughout the state. Furthermore, as more work is done on source reduction both nationally and internationally, the importance and difficulty of its measurement has been recognized as a significant impediment to its planning and achievement.

An important element of current planning efforts for Master Plan 2000 and beyond, is drawing links between planned activities and expected results. Two essentials for such an approach are concise measurement methodology and program potential evaluation. Through work with an outside consultant, the MA DEP has been able to anticipate desired achievements linked to specific goals. Source reduction efforts can therefore be planned and directed with much more clarity than in the past. This paper will describe this new approach within the context of solid waste management planning in Massachusetts.

2. THE SOURCE REDUCTION GOAL OF 1990

The goal of 10% reduction of waste generated by the year 2000 was unclear. Although there were milestones set forth to check the towards goals in source reduction -- for example, a benchmark 3% reduction in the per capita rate of the MSW stream in 1992 -- it is unclear as to how this would be measured. In calculating future disposal capacity needs, any achievements in source reduction have been incorporated by not making adjustments for yearly increases in population in the state. Effects of population growth were assumed to be balanced out by increasing source reduction.

Falling short of goals and difficulty in waste accounting has contributed to shortfall of disposal capacity in the state. Without source reduction efforts, it was predicted in 1990 that by the year 2000, 7.5 million tons of MSW and 10.6 million tons of waste would be generated. With achievement of the 10% source reduction goal, 10 million tons of total wastes were expected including 6.75 million tons of MSW. These estimated figures formed the basis for quantities of disposal capacity permitted up to 1995 when a moratorium on permitting of new disposal capacity was instituted.

In reviewing annual data in 1998, it became apparent that expected quantities had surpassed original estimates and a disposal capacity crisis was looming – due to flailing recycling rates, unexpected closure of two disposal facilities and greater than expected waste generation. The 1998 total waste generation figure was 11.9 million tons including 7.47 million tons of MSW. These figures indicate a shortfall in disposal capacity that will most likely continue to grow unless there are significant gains in source reduction, recycling or increased permitting of in-state disposal capacity. Without these measures or a combination thereof, shortfall amounts will end up being exported to neighboring states. Considering that Massachusetts has maintained a policy of disposing of waste generated statewide within its own borders over the years, growing export rates pose a substantial policy dilemma.

3. SOURCE REDUCTION EFFORTS FROM 1990-1999

The 1990 Master Plan advocated source reduction programs that would reverse the trend toward increasing volume and toxicity of the waste stream through "improvements in the production and manufacturing processes, shifts in manufacturer and consumer preference to items that have longer life spans, and direct re-use of materials on-site". Two principal driving forces were to bring about progress in source reduction: 1) manufacturer's re-design of products and packaging to minimize both waste and the use of virgin material, prompted by regulatory guidelines and economic incentives, and 2) the power of consumers to effect such change, including both public education at the state and local levels.[1]

Actually, the programs that have significantly contributed to source reduction over the 10-year period following initiation of the master plan have been mainly composting and Pay-as-You Throw (PAYT) or unit-based pricing systems in which residents are charged for the amount of trash disposed. Neither of these two programs were categorized or counted as source reduction in solid waste management analyses (although, the former is formally considered source reduction as defined by the EPA[2]). Amounts composted have traditionally been lumped together with amounts recycled to constitute the state MSW 'recycling rate'.

Future disposal capacity needs have been estimated assuming that the recycling rate (including composting) milestones would be achieved throughout the years eventually reaching the goal of 46% in the year 2000. By 1998 it was acknowledged that this goal would not be reached and additional capacity would need to be made available as a short-term relief measure for disposal of the estimated 2,300 tons MSW shortfall expected by the year 2000. (The calculated shortfall assumes a 2% yearly increase in the recycling rate for 1998-2000). Recent waste accounting efforts (1996, 1997 and 1998) and disposal capacity projections did not include estimates of source reduction that was occurring. However, in a study done under contract for MA DEP, Tellus Institute estimated that source reduction achieved in 1997 in Massachusetts totaled 550,000 tons or 7.5 % of MSW.[3]

4. MEASURING STATEWIDE SOURCE REDUCTION

In March 1999, DEP contracted with Tellus Institute to perform a study on source reduction in Massachusetts. The objectives of the study were threefold:

1. *to quantify the impact of source reduction on tonnage of MSW generated in Massachusetts in the past.*
2. *describe and to the extent data permits, quantify the contribution that specific programs, such as backyard composting, have made to source reduction in the state.*
3. *Identify and document successful source reduction programs or related efforts implemented elsewhere which might be appropriate for adoption in Massachusetts.*

Tellus' method of quantification is based on the premise that waste generation is directly linked to the economy. Quantities of waste that would have been generated without source reduction can be estimated using a 'driver' which reflects economic activity. The difference between the amounts calculated using the driver and actual amounts generated constitute quantities of waste reduced at the source.

This method can be applied to data for the period 1990 to 1997. 1990 is referred to as the base year. Measurement of source reduction for a waste stream, W, requires data on the annual tonnage in 1990, in 1997 and also the introduction of the concept of a driver, D. The term "driver" captures the idea that D causes observed changes in W. If a driver is used which reflects the state's economy, then the "expected waste generation" will rise if the economy grows after the base year and will fall if it declines. In this way, source reduction is assessed against the correct baseline as follows:

Source Reduction in 1997 =

Expected 1997 Waste Generation (Using 1990 Generation Rate) minus Actual 1997 Waste Generation

Tellus used gross state product (GSP) as the 'driver' in the calculation of source reduction in Massachusetts for the years 1990-7. The GSP seems more closely related to the waste stream than other possible drivers (such as 'personal consumption expenditure' used in a national study) because commercial waste dominates MSW in Massachusetts. GSP reflects the commercial sector better and is also readily available annually from public sources such as The Statistical Abstract of the United States; data for other 'drivers' would be more difficult to obtain each year.

Specific source reduction efforts that were quantified in the study include home diversion of yard trimmings, Pay-as-you-Throw programs, newspaper light-weighting, computer networking, and reuse of wood pallets (see Table 1: Impacts of Specific Source Reduction Efforts below).

Also, future target areas for source reduction initiatives applicable to Massachusetts were researched by Tellus Institute and a method for the evaluation of program potential is proposed.

Table 1: Impacts of Specific Source Reduction Efforts

Effort	*Source Reduction (in tons)*	*Year*
Home Diversion of Yard Trimmings	419,151	1996
Pay as You Throw (PAYT)	39,500	1996
Newspaper Light-weighting	54,900	1997
Computer Networking and Electronic Filing Systems	NA	NA
Wooden Pallets	71,000	1997

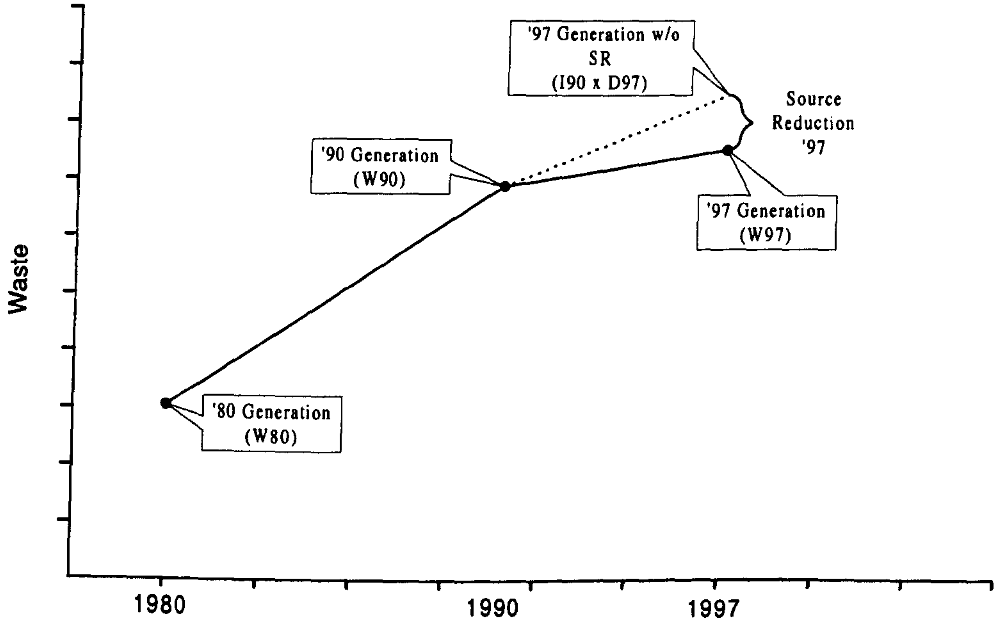
Methods of quantification proposed in the report are based on the following assumptions:

- Waste generation is directly linked to the economy
- Quantities of waste that would have been generated without source reduction can be estimated using a 'driver' which reflects economic activity.
- The difference between the amounts calculated using the driver and actual amounts measured constitute source reduction
- For Massachusetts, 1990 is the best year to use as the "base year" in calculating source reduction quantities in subsequent years.
- Gross state product (GSP) is the best 'driver' to use for calculating source reduction in Massachusetts.

Figure 1 below, illustrates the approach to source reduction measurement to be used. The annual tonnage of the waste stream is presented as a function of time. The solid line represents actual waste generation over time, with the values for 1980, 1990, and 1997 labeled. The dotted line shows the waste generated if, beginning in 1990 the waste generation rate remained constant at the 1990 level while the driver continued to grow.

The end point of the dotted line is the projected 1997 waste generation based on a 1990 generation rate (i.e., 1997 waste generation assuming no change in behavior since 1990). It is greater than the actual waste generation in 1997, reflecting a decline in the waste generation rate associated with source reduction.

Figure 1: Illustration of Source Reduction (source: author)



In addition to source reduction, it is useful to quantify progress in source reduction (PSR). PSR is the percentage of potential generation that is avoided by source reduction. The following equation is used to compute PSR:

$$\boxed{\mathrm{PSR}\ 97 = \left(\frac{\mathrm{SR}\ 97}{\mathrm{W}97 + \mathrm{SR}\ 97} \right) \times 100}$$

5. PLANNING FOR SOURCE REDUCTION IN MASTER PLAN 2000

The Solid Waste Master Plan 2000 planning process involved soliciting input from stakeholders – representatives from industry, trade associations, environmental advocacy groups and concerned citizens. Interested stakeholders participated in the Solid Waste Advisory Committee and particularly in a sub-committee on the subject of source reduction. Once the sub-committee adopted a definition of source reduction and the proposed measurement method had been adopted, specific programs were discussed. Criteria for the selection of the preferred programs were established and recommendations for source reduction goals were made.

6. PROGRAM CHOICES AND GOAL SETTING

The process for selecting preferred program options consisted of:

1) *brainstorming on program options;*
2) *brainstorming possible criteria for judging programs considered;*
3) *ranking the importance of the criteria;*
4) *ranking the programs based on priority criteria - the highest-ranking programs would be recommended to the SWAC for inclusion in the SWMP.*

The sub-committee recommended that programs that would merit the highest ranking were those that would achieve the greatest qualitative and quantitative source reduction benefits. Qualitative benefits would include establishing a foundation for long-term source reduction achievement, high visibility and significant environmental and health advantages. Quantitative benefits would be based on expected amounts of source reduction that could be accomplished through the program. Other criteria that were chosen, in order of importance, were: programs costs and efficiency, variety of programs, ability to measure achievements of programs and program feasibility. The goal setting process was more complex. Types of goals considered were a source reduction goal based on expected shortfall in disposal capacity, goals for specific materials (e.g. paper, construction and demolition waste, organics), a goal based on maximum source reduction thought feasible and goals related to or based on available funding.

The sub-committee preferred to set an overall goal that would be the aggregate amount of source reduction that could be achieved from the programs chosen.

7. POTENTIAL ACHIEVEMENTS AND COSTS

It was clear to planners that a high waste reduction rate is needed to avoid significant shortfall in disposal capacity in the state. (The Advisory Committee chose the term 'waste reduction' to refer to both recycling and source reduction). A discussion of costs for reducing disposal capacity needs through waste reduction efforts ensued. During this process, a matrix was created, called the Diversion Options Table. Information was compiled regarding waste reduction increases that could be achieved, estimated costs to the state, costs to others, the time frame needed for implementation and limitations of these actions.

While this was by no means a comprehensive list, actions considered were:

- *expanding Pay As You Throw ('unit based pricing') to all communities in the state either through voluntary implementation or mandated through legislation;*
- *expanding home composting;*
- *promoting source reduction at businesses through technical assistance, grants, financial incentives, etc.;*
- *enacting a packaging reduction/labeling law;*
- *requiring two-way office paper shipping containers in state contracts.*

Estimates based on numbers found mostly in literature or based on MA DEP program staff's past experience, indicated that over a ten-year period a 19% reduction of MSW or an 11% reduction in total waste could be achieved. This would cost $12 million dollars over a 10-year period if Pay-As-You-Throw was mandated statewide and $25 million if Pay-As-You-Throw was adopted voluntarily by all 351 communities in the state (assuming that more state money would be required as an incentive in this case).[4]

8. OUTSTANDING SOURCE REDUCTION ISSUES

It is unclear how much source reduction can be relied on (or can achieve) to alleviate disposal capacity shortfall. It is also unclear if expected achievement should be the ultimate driving factor in source reduction planning. Efforts in recycling have shown that despite large investments and planning, rates rise initially and then taper off. If this were true also for source reduction it would be unwise to plan disposal capacity based on achievements expected from source reduction programs.

Source reduction planning based on reducing disposal capacity needs may look quite different than planning based on life cycle analyses. Since recycling rates influences disposal capacity needs, source reduction of recyclable materials would not be particularly helpful (because these materials should be recycled and not landfilled). When overall environmental impacts or life-cycle analyses are considered, impacts of source reduction on recycling are insignificant. The types of programs preferred based on input from stakeholders in the Advisory Committee, are those that have both the greatest environmental benefits and do not impact recycling. It remains to be seen, however, how these types of programs will fair over time in terms of the criteria by which they were chosen.

Ideally, past and expected source reduction (or lack thereof) could be clearly measured and considered in overall waste disposal planning. However, since there has been little experience in relating measurable source reduction goals to measured results, there is reluctance to include expected source reduction achievements in disposal capacity planning. An alternative approach links source reduction goals to program plans and commitments. In any case, a consideration when deciding on source reduction program investments should be measurability. Although measurement is sometimes difficult and tracking can be costly and time consuming, it will allow for adjustment and direction of programs over time.

REFERENCES

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[1] *Massachusetts Department of Environmental Protection (1990), Toward A System of Integrated Solid Waste Management. pg. 3*

[2] *In Environmental Protection Agency (1997), Measuring Recycling - A Guide for State and Local Governments, source reduction is defined as " the design, manufacture, purchase or use of materials, such as products and packaging, to reduce the amount or toxicity of materials before they enter the municipal solid waste management system, such as redesigning products or packaging to reduce the quantity of materials or the toxicity of the materials used; reusing products or packaging already manufactured; and lengthening the life of products to postpone disposal.*

[3] *Tellus Institute (1999), Massachusetts Source Reduction Report, pg. 1.*

[4] *The information is based on figures that are very rough estimates. Source reduction achievement potentials are probably higher than the actual number would be since the possibility of double counting cannot be excluded in this analysis.*

APPENDIX 7

INITIATING WASTE MINIMISATION IN SURREY

APPENDIX 7

INITIATING ENVIRONMENTAL MANAGEMENT SYSTEMS AND WASTE MINIMISATION IN SME'S IN SURREY

The focus for environmental management programmes and industrial and commercial waste minimisation campaigns has historically centred on medium to large sized companies; however in the UK in excess of 90% of companies employ less than 10 employees. These companies have been largely unaffected by the key environmental and legislative drivers that have come to the fore over the last decade. In order to correct this 2 local authorities in Surrey (SE England) in partnership with the County Council, Government and local environmental organisations have established schemes to promote environmentally-friendly activity in small businesses; with the general aim of raising environmental awareness and generating environmental improvements in the SME sector by using financial savings as the motivating factor for company enrolment. The approaches, problem and benefits of these two environmental schemes will be discussed in more detail within the paper, which also draws on experience from a range of other waste minimisation project clubs from the UK. The bottom line is that environmental improvements can lead to increased business efficiency and potential profit!

1. INTRODUCTION

Recent surveys [1 and 2] demonstrate that 99.8% of businesses in the UK employ less than 10 employees (micro-sized companies) and contribute approximately 40% (excluding agriculture) of GDP. The majority of these companies are not directly affected by key environmental legislation passed in the last 10 years that has had such an important role in raising awareness in larger companies [3]. Despite this, SMEs ranked 'the environment' fifth in a list of 11 issues facing SMEs, with competitiveness being ranked first, suggesting some desire in the SME sector to address environmental issues. Local and Regional Authorities, through Agenda21 commitments, Strategic, Local Development and Unitary Development Plans are also keen to promote environmental awareness and increase activity so that waste clubs and waste minimisation schemes are becoming increasingly common [4].

Despite the figures given above, however, the main focus is on medium- to larger-sized companies [4 and 5] with relatively little activity focussing on micro- to small-sized companies [6].

In this context, two local authorities in Surrey, financially supported by the County Council (also the waste disposal authority), and Government environment organisations, have established schemes to promote environmental activity in small businesses. One, established by Mole Valley District Council (MVDC), is an environmental award scheme (MVEBA) for small businesses, the other, initiated by Woking Borough Council (WIEWM project), is an industrial estate project which sought to establish individual and joint solutions to environmentally related issues for geographically linked SMEs. Surrey County Council (SCC) has supported both schemes as pilots to the establishment of a countywide scheme to be launched in autumn 1999. These two schemes are described, evaluated and compared in terms of their key outcomes and in relation to what these schemes tell us about the development of future schemes.

2. GENERAL OVERVIEW OF THE TWO SCHEMES

Both schemes had the same general aims of raising environmental awareness and generating environmental improvements in the SME sector. They arose out of local authority initiatives forming steering groups made up of representatives from key sectors of their respective communities (i.e. Local and Regional Authority, Business, NGOs, Government Environmental Organisations, and Higher Education/Research).

Both schemes used financial savings as the motivating factor for enrolment of participating companies, offered environmental audits and advice to participants and encouraged adoption of improvements incorporating cost savings with environmental benefits. Brief overviews of the 2 schemes are given below followed by presentations of their key outcomes. Finally the schemes are compared and discussed in terms of real and potential benefits and implications for the future.

3.THE MOLE VALLEY ENVIRONMENTAL BUSINESS AWARD SCHEME (MVEBAS)

The MVEBAS, launched in May 1996 and managed by the MVDC Environmental Health Technician, aimed to provide annual community recognition to companies demonstrating environmental activity. Companies were enrolled from an existing company database derived from a survey of environmental awareness in small businesses in MVDC.

3.1 Structure of the Award Scheme

- *Enrol Companies: companies selected from contact database and offered a place in the scheme; the target was to enrol 12 companies annually.*
- *Baseline Audit: each company offered a baseline environmental audit, carried out by a trained environmental consultant.*
- *Audit Reports: these identified for each company a small (selected) number of specific issues related to combined environmental and business improvement together with specific advice as to potential solutions.*
- *Follow-up visits: approximately 6 months after the initial visit, participating companies were offered a follow-up visit.*
- *The Award Event: there were 3 possible outcomes: overall winner; highly commended; or no award.*
- *Resources: approximately £9000 + 1 (or 2) man-days management and administrative support by the MVDC Environmental Health Technician.*

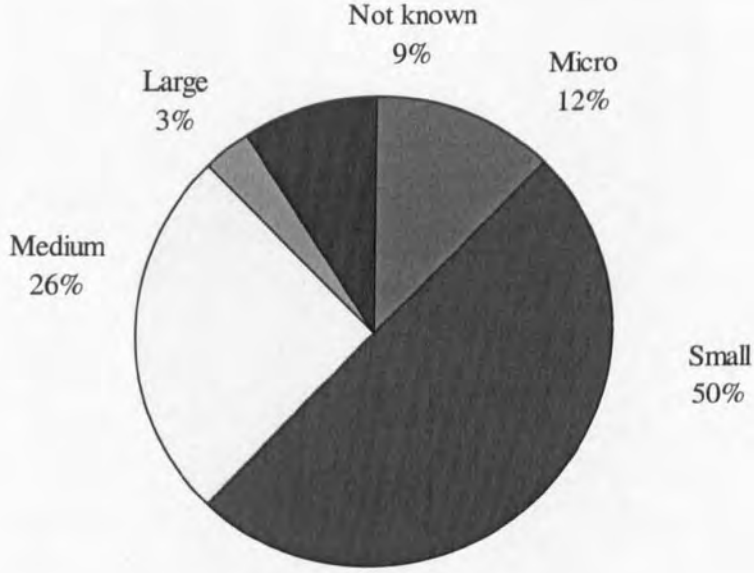
3.2 Major Outcomes of the MVEBA Scheme

Key observable outcomes of the scheme are presented below including participation, recommendations of audits, company responses and eventual outcomes. Other outcomes, including the success of workshops/seminar events, are not discussed here. The results of a survey of businesses in MVDC is presented that was designed to provide additional information about the impact of the scheme on the business community.

3.2.1 Participating companies

Participating companies are those that received an initial baseline audit in any given year. During the three years of the MVEBA scheme's operation, 31 companies took part in the scheme. Ten companies participated in 1996/7, 9 companies in 1997/8 and 12 in 1998/9. AS can be seen, approximately 50% of participating companies were small-sized companies, and just less than a quarter being medium-sized companies. Almost 60% of participants had a company turnover over £1 million. Of those participating, almost 55% went on to receive a follow-up audit and as such were formally considered for an award. Companies did not receive a follow-up for a range of reasons, not necessarily attributable to lack of environmental activity since the baseline audit, such as changes in personnel or insufficient time for second visit (see Figure 1).

Figure 1. Distribution of companies in MVEBAS



3.2.2 Response to audits

The initial baseline audits revealed a range of environmental improvements (with a clear emphasis on energy) that could be achieved at relatively low overall cost within the relevant time-scale.

Table 1 provides a summary of the areas in which actions were recommended over the three-year period and in which solutions were successfully implemented. Table 1 identifies that 45% of participating companies were awarded for their efforts/achievements.

3.3 Mole Valley Small Business Survey

The information given above relates to the immediate and observable outcomes of the MVEBA scheme between 1996 to 1999. Of additional interest are the less tangible but more sustainable benefits that the scheme may have brought to the MVDC Business Community. This is of particular interest as it was one of the key objectives of the scheme. Such information is also important in the development of similar schemes at either the local or regional level. Issues considered of particular interest were businesses' perception of the MVEBA (cost/benefit) and business activity and environmental awareness following involvement in the MVEBA.

Table 1. Summary of MVEBA scheme outcomes

Year	No. of companies	Areas of Recommendations			Audits	Solutions Audited			Awards	
		Energy	Water	Waste		Energy	Water	Waste	HC	OW
1996/7	10	9	5	5	7	3	2	2	6	1
1997/8	9	6	1	6	4	2	2	-	1	1
1998/9	12	10	4	5	6	5	1	-	3	2
Totals	31	25	10	16	17	10	5	2	10	4

Key: HC - Highly commended OW - Overall Winner

A survey of businesses was conducted in June/July of 1999 to obtain feedback from participating and non-participating companies in the Mole Valley region. Businesses were divided into three groups and sent a short questionnaire relating either to MVEBAS and/or environmental issues in general.

The three groups were identified as follows:

- *Group A: Companies involved in the scheme (31 companies)*
- *Group B: Companies on the MVEB contact database but not involved (141 Companies)*
- *Group C: Random selection of companies with no known environmental contact (300 Companies)*

3.3.1 Results

Of the 472 questionnaires sent out, 71 were returned representing a 15% return rate: 32.3% Group A companies, 17.7% Group B companies and 12% Group C companies responded.

Group A

In terms of the participating businesses perception of their involvement in the award scheme the following information can be obtained from the questionnaire.

- *60% of respondents thought the estimated cost (to MVDC) of the scheme (£300/company) to be good value for money;*
- *50% considered involvement to be a good use of business time (see Figure 2);*
- *No companies thought the cost to be poor value for money;*
- *Only 10% were negative about the award scheme's use of their time;*
- *70% found the personal visits and advice helpful, 20% were neutral on this issue and 10% did not find their visit of value (Figure 3).*

Companies recognised a range of perceived benefits of involvement in the scheme with a clear focus on the cost savings that such activity brings (90% of respondents – Figure 4). It is also interesting to note that employee motivation and legislative pressures were also considered important issues by approximately a third of the companies involved.

In relation to questions regarding real outcomes of their involvement in the scheme, the following information has been obtained:

- *All respondents claimed to have made some improvements related to the environment*
- *70% of respondents made improvements related to energy use*
- *50% of respondents made improvements related to the use of gas and water*

- *30% reduced their waste to landfill*
- *10% made improvements to company transport*
- *40% of companies had saved more than £1000*
- *40% had saved between £500-£1000*

Figure 2. Group A – were audits useful?

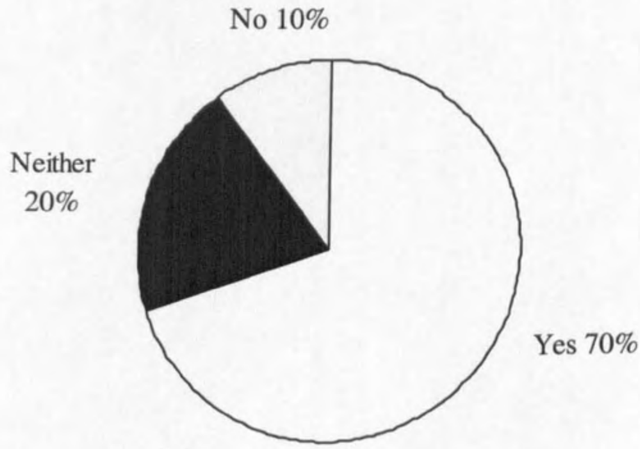


Figure 3. Group A – was participation worthwhile?

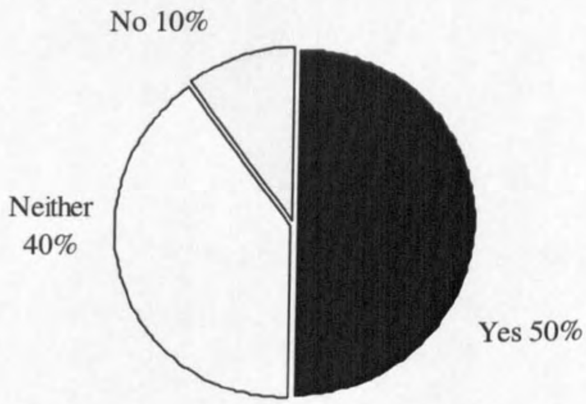
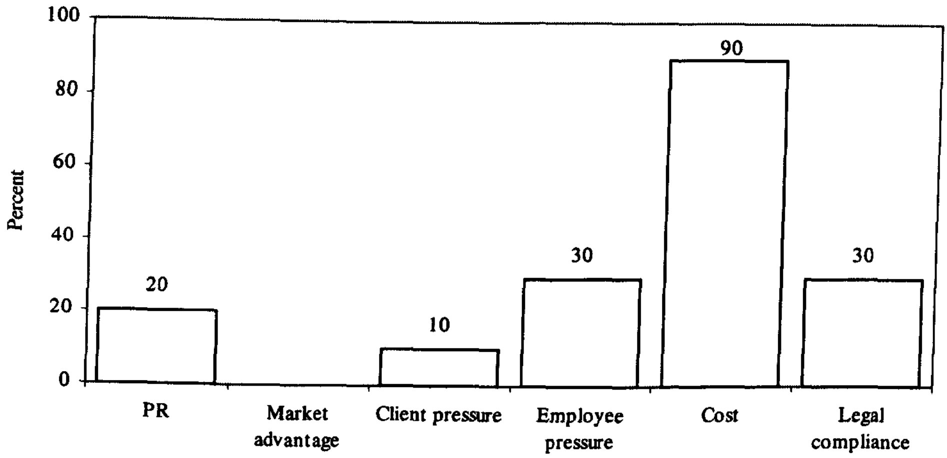


Figure 4. Group A – perceived benefits of participation?



Looking to activity beyond the companies' direct involvement in the scheme, 25% of companies which participated in either the 1996/7 or 1997/8 awards reported further activity (those in the 1998/9 cohort have only just completed their years participation). Ongoing activity was more common in the areas of Water and Transport (80% of those reporting further activity) and Gas (60% of those reporting further activity) with 20% of companies reporting ongoing activity in relation to waste. Finally 20% of respondents had an environmental policy in place or in development. No companies completely ruled out the possibility of developing one although 80% did not foresee developing one in the near future.

Group B

Group B companies act, to some extent, as a control to those companies that participated in the scheme. The following information was obtained.

- *72% of respondents claimed to have made resource/waste consumption reductions over the last three years.*
- *45% of companies claimed to have made savings greater than £1000, 22% between £500 and £1000 and 33% less than £500.*
- *Issues of particular concern to companies focus on energy and waste as being priorities for over 2/3rds of respondents.*
- *Just under 30% of companies also identified water and transport as being of concern.*

- *Some 60% of companies recognised good environmental practice as an essential and integral element of good business practice, 36% considered it to be important whilst none believed that it was not an issue at all.*
- *Public perception, reduced costs and ethical/moral reasons were the three most popular considerations.*
- *Nearly a quarter of companies believed that good environmental practice was being driven by customer demands.*
- *Finally 52% of respondents claimed to have some kind of environmental policy either in place or being developed. No companies believed that they would never develop one in the future.*

Group C

This group represented a random selection of companies in the Mole Valley area with which the authority had had no known contact in relation to environmentally related issues. Of the respondents, almost 1 in 5 had heard of the MVDC Award Scheme. Environmentally related issues of concern to companies again focus on energy and waste for 30% of respondents, whilst 22% of companies also recognised water and transport as being important. In addition 11% of companies had experienced questions from clients regarding environmental issues and 15% had an environmental policy either already formulated or being developed. 39% of companies did not foresee the likelihood of ever having to develop an environmental policy. About 28% of companies were interested in becoming involved in the MVEBA Scheme.

4. THE WOKING INDUSTRIAL ESTATE PROJECT

The Woking Industrial Estate Waste Minimisation Project (WIEWMP) was initiated in spring 1998. The estate, made up of approximately 40 companies of sizes ranging from single staff operations (micro companies) to one company with approximately 100 employees (medium sized), covers mainly light manufacturing, distribution and service sector activities.

4.1 Structure of the Project

The basic elements of the scheme were as follows, the distribution of a newsletter and occasional workshop/seminars are not considered:

- *Enrol companies: the launch event, held in June 1998, took the form of presentations from key members of the steering group setting out the potential business benefits of addressing environmental issues in the work-place; companies signing up to the scheme were asked for a nominal contribution based upon number of employees (ranging from £20– £250).*
- *Baseline Audit: two recently graduated environmental scientists carried out the baseline environmental audits; the audits were carried out over a period of 2 months in the autumn 1998.*
- *Baseline Audit Reports: these covered a broad range of issues identifying general areas of improvement, together with appendices of fact sheets, supplementary information and contact points; the action plans were general and wide-ranging in nature as it was hoped that companies would respond to suggestions by independently developing an appropriate company-specific environmental improvement strategy.*
- *Estate wide audit: an overview of the site, particularly focussing on solid waste management, site management, energy, water and transport.*
- *Resources: approximately £5600 & the time commitment of the Surrey County Council Business and Environment Officer.*

4.2 Major Outcomes of the WIEWM Project

In this project (unlike the MVEBAS) there was no specific motivation (other than those usually identified) to respond to the audit reports and action plans. The sections below describe the observable outcomes of the project in the form of participating companies and recommendations made. The results of a survey of companies on the estate gives information on reported actions taken and determines company perceptions of the project.

4.2.1 Participating companies

Seventeen companies participated in the WIEWM project representing approximately 50% of companies on the estate. SIC activity distribution (DTI 1997, ONS 1999) was predominantly category K (general business) at 81% with 13% in category D (manufacturing) and 6% category J (financial intermediation).

4.2.2 Audit Recommendations

The company-specific baseline audits revealed the potential for a wide range of general low-cost, low technology improvements in environmentally related issues in the companies, typical of office-based activities. The main potential focus for improvement identified in the action plans was in the management of office equipment and lighting and the control of centrally provided office heating (relevant to approximately 88% of participants). A small number of companies (18%) had the potential to make specific waste management improvements (disposal/recycling of particular wastes) whilst the majority of companies (82%) had the potential to make general waste-minimisation and recycling initiatives. Approximately 24% of companies had the potential to improve water management on site. Company transport was a key issue for one organisation.

In terms of estate-wide developments, a range of measures was recommended. These included: separate collection facilities for cardboard/paper, polystyrene, glass ware, metals and textiles; the installation of a waste compactor which would reduce waste volume leaving the estate by at least 40%; establishment of an estate-wide company transport scheme; gradual improvement in building insulation and general energy saving features; and change in electricity supply contract.

It was interesting to note that many companies considered office lighting and energy use solutions to be the responsibility of the estate Management Company despite being separately metered for electricity use. Central provision for heating, with cost being based on floor space, was clearly not conducive to companies adopting simple office-heating management solutions despite assurances that cost savings would be passed down.

4.2.3 Actions Taken

No quantitative information is available concerning specific company action in response to the preliminary audits and action plans delivered in January 1999. A questionnaire survey, discussed below, does however provide qualitative information about company responses to and perceptions of the scheme. Specific site-wide actions are yet to be implemented but are certain to include the provision of centralised waste minimisation and recycling facilities. A Company transport scheme is also in the process of being finalised which is expected to provide site-wide co-ordination of staff travel to and from the estate. Finally the Estate Management Company is also implementing (as a matter of course) many of the building related recommendations in an ongoing site improvement programme.

4.3 Woking Industrial Estate Small Business Survey

Two simple questionnaires were distributed on the estate during July 1999 to survey the opinion of participating and non-participating companies. The aims were as follows:

- *To establish the practical response to the audit and recommended action plans*
- *To determine other outcomes/perceptions from involvement in the project*
- *To determine development in awareness/activity in non-participating companies.*

4.3.1 Results

There was a 29% response to the survey, representing 31% of participants and 28% of non-participants. Of participating companies, 20% were positive and 20% neutral about involvement in the project. 40% found the audit reports useful with only 20% finding them not useful. 20% of respondents claimed to have acted on the recommendations based in the report (saving between £0-£500) but there was wider acknowledgement of the potential benefits of involvement in the scheme). Some 20% of respondents also claimed to have gone on to make improvements in waste management beyond those recommended in the action plans linked to the audit report. Of those companies on-site not involved in the project 80% did not regard any key environmental issues of relevance to their activities and were negative about future involvement in the project.

5. COMPARISON AND DISCUSSION OF THE PROJECTS

Whilst both the MVEBA scheme and WIEWM project had similar aims and sought to target a very similar section of the business community, the schemes experienced different outcomes in several key areas. Table 2 shows key identifiers of the two schemes. The comparison suggests the MVEBA scheme has been more successful in achieving real improvements in companies (45% of participants were given an achievement award). In addition, the survey of businesses involved in the 2 schemes also suggests that participants were more positive about their participation in the MVEBA scheme. It is possible that the follow-up audit and the potential for receiving local recognition of participation through a publicised award encouraged companies to implement recommended improvements. In addition, the less wide-ranging, but more specific and detailed (some might argue, prescriptive) advice given to MVEBAS participants appears to have been more useful.

A quarter of participating companies in the MVEBAS also claim to have made continued improvements after ceasing to be involved in the scheme. Environmental awareness also seems to correlate well with involvement in the MVEBAS. The environmental implications are clear.

The WIEWM project does not appear to have achieved clear tangible outcomes, with few companies claiming to have taken any action during participation and less than ½ considering participation worthwhile. Less obvious benefits, that may still effect real improvements in environmental performance, may however, yet be realised. Estate-wide solutions (e.g. in centralised waste management), which may act as a catalyst to independent company activity, have yet to be implemented. Despite an apparent lack of activity by participating companies, their recognition of the potential value of the audit reports may also yet realise observable benefits. The absence of a clearly defined marker for improvements to be implemented (the award in the MVEBA scheme) has possibly encouraged managers to postpone improvements in deference to other apparently more pressing business issues.

Table 2. Summary comparison of MVEBA scheme and WIEWM project.

	MVEBA Scheme	*WIEWM Project*
Length of project	3 years	1 year
Approximate Cost / Company	£300	£330
Actual cost of participation to companies	Zero	£20-£250 (based on nos of employees)
Key benefits communicated to companies	Cost Savings and Award	Cost savings
Additional potential motivators		Joint solutions
Preliminary Audit	Yes	Yes
Nature of Audit	Focus on Energy	General Environmental
Report to company: Nature and content	Yes: Short (2 pages) Identifying a limited number of company specific solutions	Yes: Long. (20 pages) Identifying general issues and recommended solutions.
Nature of ongoing support to companies.	Active: Support linked to specific improvements (as required)	Passive: General advice given in reports. Companies to select and independently implement.
Follow-up audit	Offered	None
No. companies involved	31 over 3 years	17 in 1 year
Predominant Size-class	Small	Micro
Audited improvements achieved	Yes: 40-50% of participants	None

It should also be recognised that the WIEWM project enrolled mainly micro-sized companies involved in predominantly office-based activities. Any environmental improvements, whilst real and linked to cost savings, tend to be more mundane and require the ongoing efforts of personnel rather than technical solutions. Analysis of the improvements made in the MVEBA scheme shows that nearly all involved technological solutions. The WIEWM project also required token financial contribution from the participating companies for which they received a detailed, wide-ranging report.

It was hoped these factors would encourage companies to respond independently to the associated recommendations. On the other hand, expectations of estate-wide improvements, only just being implemented, may have affected companies' willingness to take independent action.

The WIEWM project engaged 17 companies in, albeit limited, environmental activity within less than a year, which compares well with the average of 10 companies/year of the MVEBA scheme. Direct costs of the two schemes also compare well although it should be noted that the WIEWM project did not commit significant indirect human resource costs beyond those accounted for in the project costs. Proximity of companies on the estate made a significant contribution to facilitating enrolment and reducing general administrative costs that should not be underestimated. MVDC made a substantial manpower commitment to administration of the MVEBA scheme, which has not been included in an estimate of the project's costs.

6. CONCLUSIONS

The two waste-minimisation projects described in this paper are remarkable in that they focus on waste-minimisation/environmental improvement in predominantly Micro- to Small-sized enterprises (MiSEs). One (MVEBAS) has seen marked success in realising audited improvements in companies' environmental performance. The other (WIEWMP) has taken advantage of the proximity provided by an industrial estate to engage companies in preliminary environmental activity where real improvements are yet to be realised. Experience of these projects suggests that MiSEs require specific guidance on making environmental improvements in limited areas of activity with clear cost savings and that specific time-scales/rewards are important to encourage implementation. The failure of many companies to independently design and implement waste minimisation / resource-use reduction strategies might suggest lack of engagement of such organisations in the longer term.

One of the projects (MVEBAS), however, indicates that a small proportion of companies, involved in such schemes, may go on to make continued environmentally linked cost savings but few are likely to develop ongoing environmental improvement strategies leading to more formal environmental policies and management systems.

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APPENDIX 8

PUBLIC EDUCATION AND PUBLICITY CAMPAIGNS

APPENDIX 8
LOCAL AUTHORITY RECYCLING AWARENESS CAMPAIGNS

1. RECYCLING IN THE UK

In the UK recycling of household waste is currently one of the main foci of attention in terms of waste policies and strategies, emphasised by the designation of national targets [1]. In the 1990 White Paper 'This Common Inheritance' the government set a target of recycling 25% of all household waste by the year 2000, and furthermore Section 49 of the 1990 Environmental Protection Act requires every waste collection authority to prepare a waste-recycling plan [2].

Since 2000, there has been a revision of the recycling targets set for local authorities in England and Wales with levels increasing from 25% of household waste recycled or composted by 2005 to 33% of household waste by 2015. To ensure that all local authorities contribute to these targets statutory recycling targets will be introduced [1].

There should be different standards for different groups of authorities, in recognition of differing local circumstances and current performance figures [3]. The standards for 2003 should be set at the following levels;

- *waste disposal authority areas with a recycling & composting rate below 5% in 1998-99 must increase their rate to a minimum of 10%*
- *waste disposal authority areas with a rate of between 5% and 15% in 1998-99 must double their recycling rate*
- *the remaining 'higher achieving' authority areas must achieve a recycling & composting rate of 33% or better*

Although managing waste is something that affects not only local authorities but everyone in the community, it is the council that must take the lead through proper consultation and communications [4].

Getting across a coherent environmental message will be one of the critical success factors of local government in the next decade, in response to the agenda being set by central government policy and strategy. There has also been a considerable growth in publicity for local recycling activities in recent years, but there has been a general neglect of issues concerning public participation and the need for effective social marketing and communication [5]. With more and more people concerned about their environment and what happens to their refuse once it has been collected from their house, local authorities have become more concerned about getting the message across on sustainability issues [4].

There are a wide range of measures that councils can adopt, but increasingly the rate of diversion from landfill and treating recovered materials in an environmentally friendly manner will require increased levels of investment, expenditure and public participation [6]. Councils therefore need to make strategic decisions about the level of recovery they wish to pursue, and hence the scale of investment required.

It is apparent that the level of participation in recycling schemes can be very variable, the reasons for which are still unclear [7]. Published scheme performance figures show wide variations in household participation amongst different schemes with respect to individual participation levels and to the average per household weights recovered [8]. This suggests the need to investigate forms of residential education and awareness raising to assess their benefit in improving participation rates in local government services.

2. ENVIRONMENTAL ATTITUDES

The environment remains a public concern, but the general public appears much less concerned about household waste disposal than many other environmental issues including traffic congestion, loss of wildlife and chemicals in food.

According to a survey by the Onyx Environmental Trust [9] of 1000 people, when consumers were asked about their major concerns 'the environment' did not rank as highly as perhaps we would think with only 9% of the survey acknowledging the environment and pollution as important. This should be compared with health and social services (39%), or education (34%) which were considered much more significant. However the survey of residents living close to an incinerator did have a different response with 18% noting the environment as an important concern for them. This was in stark contrast to the survey of Council Leaders where waste management specifically came only second to traffic congestion as the major concern facing their authority. Perhaps this is indicative of the costs involved in the management of waste for a local authority, and reflects the fact that waste management in the UK is done for the public with little real need for public involvement or understanding; an 'out of sight – out of mind' philosophy. Of those surveyed 35% claim to recycle every week, whilst at the other extreme 21% never recycle!

A related survey by Waste Watch [10] of 1000 people suggests that the vast majority of people consider themselves environmentally conscious (79%), and 98% consider recycling to be an acceptable method of waste treatment. However, only 41% of respondents recycled some products every week and 9% recycled less than 4 times per year and 11% never recycled! The main reasons for not recycling were laziness (30%) and lack of convenience (19%) or inadequate local facilities (12%), whilst 20% claimed that they recycled as much as they could, and 6% claimed they had received inadequate information! 88% of households without a kerbside collection claimed that they would recycle more if such a service was provided. 90% knew the location of their nearest recycling facility or drop-off site, with only 44% remembering local publicity about recycling during the previous 12 months. However only 33% thought that recycling facilities in their area were adequately publicised, and 35% thought they were inadequately signposted! 11% wanted more recycling sites, 14% wanted a separate recycling collection, 16% acknowledged a need for further publicity and information!

When the public were questioned as to why they recycle the strongest message to come back was 'on environmental grounds' (64%), whilst 24% recycle because 'it makes sense' and another 10% were recycling because it 'had become a habit'. Of those not recycling the most common barriers to participation were difficulty of separation and transportation to a recycling site (26%), distance to the nearest site (24%) or inability to carry the materials (13%); only 8% could not be bothered and 12% had not given the topic any thought. It would appear that addressing these logistical problems could potentially improve the ease of recycling for a community and thus improve participation. Of those sampled 37% claimed that a 'door to door' recycling scheme would persuade them to recycle, and 44% wanted better and more accessible facilities [10].

Waste Minimisation and Recycling Officer for Essex County [11], Paula Brooks said; *"It is not enough to provide local recycling facilities and expect recycling tonnages to rise. We also need commitment from the public, both in recycling their waste and providing secure markets for the recycled products."*

It would appear that the environment is not the most important consideration for the general public, although there is a high 'feel-good' factor associated with recycling [12]. The public because of its associated environmental benefits often uses recycling and this reflects the success of marketing and advertising practices from around the world, which have offered recycling as the 'environmentally acceptable alternative to landfill and incineration.' Perhaps more significantly though, the major concerns of residents relating to recycling and the barriers that they encounter in trying to recycle centre upon facility availability and ease of use. If recycling is to be adequately developed, as an effective alternative to landfill disposal public participation must be increased. To do this will require specific attention to the problems and barriers noted from these surveys – after all if recycling isn't made simple and easy for the householder then throwing everything into a black sack will remain the norm! However, according to Wolfe [13] public information programming remains fundamental to the success of recycling programmes, but is often a last minute consideration by municipal decision makers.

3. COMMUNICATION PROGRAMMES

Recycling, and other forms of waste management, needs to be adequately communicated to the public, so that resident's habits, behaviour and traditions can be changed for the better, enabling local authorities to achieve Government goals of recycling and recovery [5]. Published recycling scheme performance figures show wide variations in household participation in household participation amongst different schemes with respect to individual participation levels and to the average per household weights recovered [14]. A successful refuse collection and recycling scheme needs to be both user and operator friendly [15]. This will require both the scheme and its promotional material to be both simple to operate, participate in and understand, and free for the residents.

Several techniques have been regularly used to try to motivate or 'prompt' individuals to participate in recycling programs, including adverts, newsletters and special events. According to social research [16], communication and education play a vital role in increasing the effectiveness and recovery levels of residential recycling programs. Their study of consumer attitudes and recycling behaviour proved that the use of mass-media to promote multi-material recycling positively impacted on the recovery of all materials. The study also found that promoting the recovery of targeted individual materials was equally effective for stimulating overall recovery rates.

Kevin Maple, Recycling Officer at Tower Hamlets has commented [17] that; *"there is a knock-on effect of increased publicity on recycling. "Evidence has shown that if we do make people think about waste then they are more likely to take more care. There should be some positive effects on estates. If you change peoples attitudes on this you will find they will take more care with other issues such as litter."*

The work of Reams and Ray [18] has been central to the debate on promoting participation in recycling programs. They note that residential participation in recycling schemes is a fundamental element in the success of any schemes, noting that a general information only approach to recycling promotion was ineffective in changing behaviour.

Their premise was that 'direct and personal contact is a more effective method of gaining pledges to participate in recycling than indirect and impersonal efforts. Their results do support this premise with statistical support to corroborate their findings. They explain this through increased awareness and peer pressure effects!

4. THE CHALLENGE

With the introduction of the Landfill Tax, Recycling Targets and the Packaging Directive, (and the imminent Landfill Directive), local authorities are being faced with a vast waste management problem, and yet the population is largely unaware of what is going on [19]. It has been suggested that some local authorities do not adequately promote and advertise waste minimisation and recycling [20]. In a great number of cases, the small amount of publicity that is produced has little or no effect. Some of the more important considerations to take account of when designing and implementing a waste management promotional campaign include targeting the audience, the need for quality materials, a clear message and the use of a range of different media [21].

Throughout 1997 and 1998 many local authorities around the UK have started (or re-launched) a variety of recycling initiatives. Much of their press coverage has been limited to describing the activities of collecting the material, with little attention given to the need for on-going messages about waste minimisation and recycling. According to Delbridge [22] *"one of the surprising facts that we found in our work on the waste strategy in Hampshire and talking to the ordinary householder is that they are almost totally unaware that a crisis situation is beginning to emerge in the waste field, but they also see themselves as the victims of that crisis - forced to purchase and dispose of an increasing amount of waste that they feel have no option but to buy."*

The work of Evison [19] has much to offer in this field, suggesting that with the recent introduction of new legislation local authorities are faced with a vast problem - the population is largely unaware of what is going on.

Evison's work was founded on the belief that *'those authorities that produce and use good quality education and promotional material on a regular basis will have better recycling and waste minimisation results, than those authorities that don't.'* He suggests that some local authorities do not adequately promote and advertise waste minimisation and recycling to the general public.

5. RESEARCH METHODOLOGY

In order to evaluate the importance of local recycling publicity campaigns, it was decided to investigate three authorities with differing recycling performances (from low through to high diversion rates), utilising Audit Commission [4] figures to identify a range of suitable authorities. From a list of acceptable authorities, Luton, Shepway and Sutton Councils responded quickly and positively, and representing the statistical range of recycling rates on offer across the UK. Within each of the 3 local authorities selected as case studies, the random selection of addresses for distribution of questionnaires was based on the street names within each authority. In alphabetical order, every 'n' th street was selected to achieve an even spread throughout the list to gain 150 streets; with one property from each being surveyed directly. To ensure suitable properties, distribution and collection of the questionnaires was by hand. Collected data was inputted onto separate spreadsheets to create a picture of;

- *respondent's recycling habits,*
- *what facilities were available and how respondents knew about them,*
- *what facilities they had been, and would like to be informed about,*
- *their opinion of the local authority, and*
- *the effect of the local authority's promotional literature.*

Literature about waste minimisation, recycling and other environmental issues was obtained directly from the recycling officer within each authority. The initial recycling performance figures were taken from the Audit Commission database, and subsequently checked through interviews with the waste management officers in each authority.

To be effective, the local authority's promotional literature and support for recycling, has to be shown to be an encouraging factor in the respondents decision to participate. The Audit Commission's recycling performance figures [4] could not be attributed to the promotional literature alone. Thus respondents were asked to consider the authority's support for recycling and waste management in terms of its; provision of facilities (kerbside collection, drop-off sites, etc.); availability of promotional material; and publicising of the authority's recycling performance. They were then asked to grade these three criteria using a scale from very poor (1) through to very good (5). The 'effectiveness' score is arrived at by multiplying the number of responses for each category of support, by that category's grade (1 is very poor through to 5 for very good). The subtotals (for each category) are then added together, divided by the number of respondents, and multiplied by 150, (the number of households originally questioned in each authority). This is reported as 'The Respondents Perception Score.' The formula is completed by dividing 'The Respondents Perception Score', by the figure given as being recycled within each authority. This gives an impression of the public's acceptance and knowledge of the recycling services on offer. A figure of zero is indicative of 'no awareness' , a figure of 100 would be indicative of half of the residents thinking the services were adequate, whilst a figure of 750 is the maximum figure where all residents respond thinking the services and publicity are marvellous.

Multiplying the score by the recycling performance figure, means that the higher the figure, the better the effectiveness of the local authority - a simplistic gauge of the success achieved through the promotions campaigns.

Formulae;

Sub-total = (Grade x number of respondent's votes)

'The Respondents Perception Score (PS) $= \dfrac{(\text{Sub-totals } 1+2+3+4+5.\ ) * \text{ number of questionnaires}}{\text{Total number of questionnaires originally sent out}}$

*'The Effectiveness formula' = PS * The Recycling Performance figure.*

6. RESULTS

The results for the 3 case study authorities provide a valuable insight to the need for effective publicity material in achieving sustainable waste management and local participation in recycling schemes.

6.1 Luton

The kerbside recycling scheme began in Luton during May 1996, in selected streets throughout the borough, collecting cans and tins, paper (newspaper and magazines only), plastic bottles, and aluminium foil. 30,000 homes are now on a 'recycling route', and kerbside collections are now the primary means of collecting recyclable material. Half of the households selected to participate in this research were on the recycling routes. There are also 31 bring centres of varying size, for the collection of newspaper, cans, glass, textiles, books, and foil. One of these centres is situated at the council's Tidy Tip (Civic Amenity site), with others located at supermarkets and local neighbourhood shopping areas.

Promotional material in use by the authority includes a series of educational leaflets, a map of recycling centres, and a twice-yearly newsletter for those on the kerbside scheme, and a directory explaining what householders can do with their waste items. However, the authority was recycling less than 4% in 1996. The residents were asked to grade the publicity from 'Very Poor '(1), to 'Very Good' (5). The majority of votes were cast for either 'Poor' or 'Adequate' support, with only one respondent opting for 'Very Good' (Table 1).

Table 1. Perceived support of Luton's support for recycling

score	1	2	3	4	5	Didn't know	no reply
A	1	7	10	6	1	4	5
provision of facilities (kerbside, drop-off sites, etc).							
B	4	12	8	1	0	2	7
provision of literature (kerbside, drop-off sites, etc).							
C	8	11	5	1	0	3	6
publicising the authority's recycling performance.							
totals	*13*	*60*	*69*	*32*	*5*	***PS***	***101.4***
						Effectiveness	***405.7***

Where promotional literature was made available, it had little or no effect on changing the respondent's attitudes or willingness to become recyclers. The majority of non-recyclers, including 'don't know' and non-responders, would not change their habits on the basis of the local authority's promotional material. It would appear that in summary, Luton's recycling performance figure is low and the quality and quantity of promotional literature is equally bad, as is the public's perception of it. The situation is compounded by a general sense of apathy amongst the residents. The authority as a whole only has a recycling rate of 3.62%, well below the national average, and the 25% target to be reached in two years time.

6.2 Shepway

Collections of waste in Shepway are made weekly by the authority's contractor, Cleanaway, from approximately 45,000 households and 2000 businesses by trade sacks. In addition to this, 2500 - 3000 commercial and industrial units are visited for the collection of cardboard. Household waste is collected in black plastic bags, and paper and cardboard are collected separately at the kerbside, and placed into a cage towed behind the refuse vehicle. One of the ways in which recycling and waste minimisation is publicised in the authority is by means of a quarterly tabloid-sized newspaper 'Shepway Environment News' in partnership with 'Shepway Today'. There are 21 bring recycling centres throughout the authority, seven of which have recently had Recycling Point Information boards installed, and the borough has a recycling rate of 10%.

Approximately half of the respondents knew that Shepway District Council ran a kerbside collection scheme, but only 40% knew about the drop-off sites. Considering the Council's efforts to include up-to-date recycling information at these centres, it is a shame that so few know of them. This low number would also point to a lower than anticipated use of the centres, but despite this, 50% of respondents claimed to be within 5 miles of their nearest drop-off site. As with the residents surveyed in Luton, the majority of responses were not favourable, with few residents thinking the authority had done enough to develop or promote recycling (Table 2).

Table 2. Residential perception of Shepway's support for recycling

score	1	2	3	4	5	Didn't know	no reply
A provision of facilities (kerbside, drop-off sites, etc).	4	6	12	8	4	8	6
B provision of literature (kerbside, drop-off sites, etc).	9	13	8	1	0	9	8
C publicising the authority's recycling performance.	10	15	5	1	0	9	7
totals	*23*	*70*	*75*	*40*	*20*	***PS***	***145.9***
						Effectiveness	***1459.2***

The authority has a recycling rate of 9.63%, better than the national average, but still short of the 25% target to be reached in two years time [1]. Promotion, like any other form of advertising is a continual process, and needs to be up dated regularly. Whilst Shepway has created a very secure platform for disseminating environment and recycling news and information, it has failed to build upon it. Overall, the results in Shepway show a very encouraging picture of an authority moving forward, promoting the waste minimisation and recycling message, and having a good success rate. Nevertheless, the authority should consider the usefulness of its 'Shepway Environment News.' Though a laudable means of informing the public, the authority should re-evaluate this newssheet, as it is not having a satisfactory impact, such that respondents to the questionnaire failed to recall receiving a copy during the previous year.

6.3 Sutton

The London Borough of Sutton is reputed to be one of the best authorities in the country for waste minimisation and recycling [4, 23]. Collections of waste and recyclables are made weekly by the authority's Direct Services Organisation, from approximately 73,000 households. Paper and cardboard are collected separately at the kerbside and this accounts for the majority of Sutton's recyclable material by weight. Drop-off centres are located around the authority for depositing of other materials.

One means of publicising recycling and waste minimisation in the authority is by use of a half-yearly tabloid-sized newspaper 'Sutton Environmental News'. It covers a wide range of issues, including; Local Agenda 21, Waste Minimisation, Recycling, Environmental Issues, and Conservation, and it also provides feedback on tonnage for the materials collected. The Borough's recycling rate is currently 27% of household wastes. Other recycling and waste minimisation publications are generally available from the council offices and libraries. These have covered a number of issues over the past two years, including; 'Waste - What is it and What to do with it in Sutton'; 'Waste Minimisation & Recycling - a schools information pack'; 'Wake up and Recycle'; 'How to Recycle in Sutton'; and 'Think before you bin it.' With so many leaflets and newspapers being published by the authority, it easy to see why Sutton's recycling rate is so high (see Figure 1).

Sutton's standing as one of the country's top authorities for recycling is highlighted by the percentage of respondents separating out different materials; 100% of recycling respondents recycle newspapers. There were also high percentages for cardboard (88%), other papers (75%), and glass (78%). The kerbside collection is well known throughout the borough, as indicated by the 89.8% of respondents. The civic amenity and drop-off sites are also quite prominent. Only one respondent claimed not to know of any recycling facilities made available by the authority, although this respondent had also ticked the other three categories. The promotion of such schemes and facilities is very important (Table 3). Even when free or reduced price composting bins are made available, advertising is necessary to inform the public. Sutton's residents obviously rely on the local authority's promotional material to inform them of new innovations and forthcoming schemes. Despite having a good record, the council must continue in the same manner to improve its figures.

Figure 1. Promotional Literature available in Sutton

Table 3. Perceived support for recycling in Sutton

score	1	2	3	4	5	Didn't know	no reply
A	1	5	5	6	20	11	1
provision of facilities (kerbside, drop-off sites, etc).							
B	2	5	10	11	8	11	2
provision of literature (kerbside, drop-off sites, etc).							
C	2	5	9	11	8	12	2
publicising the authority's recycling performance.							
totals	*5*	*30*	*72*	*11*	*18*	***PS***	***300.6***
				2	*0*		
						Effectiveness	***8115.7***

The success of any recycling scheme is dependant upon; [a] the actual recycling performance figures; [b] the publicity and promotion of recycling; [c] the public's willingness to participate; and [d] the public's perception of the local authority to support such recycling measures.

In all four categories, Sutton Borough Council performs well. A recycling rate of 27% is well above the national average of 6% [4], and there is a continual process of up dating and re-informing the householders. In addition to the work of the local authority, the public are willing and have a very good perception of the council's commitment to reducing the amount of waste sent to landfill for disposal. Despite this good work so far, much can still be done, and Sutton have already set themselves some very high targets. Promotion of recycling, and educating the public needs to be continued. Both leaflets and newspaper articles have proved very successful, and need to be built upon to maintain the strong position that Sutton has created.

6.4 Comparison of Performance in the three authorities

Residents in Sutton are far more aware of the kerbside recycling collection offered by their authority (Table 4), than those in Shepway, despite the south Kent authority's scheme being offered to all households. Luton residents were less likely to know of the scheme, as it was not operational throughout the whole borough.

Although, the use of kerbside schemes for most materials may reduce the need to know the whereabouts of drop-off sites, there was only a 12% difference in awareness between Sutton (who offer a kerbside scheme borough-wide) and Luton (who rely more heavily on their recycling banks).

Table 4. Respondents who knew of the available recycling facilities

	% of respondents		
Facility	***Luton***	***Shepway***	***Sutton***
Kerbside collection	38.2	49.0	89.8
Drop-off sites	47.1	38.8	59.2
Civic Amenity sites	76.5	83.7	75.5
None known	11.8	2.0	2.0
No response	2.9	0.0	2.0

All local authorities in the UK have a responsibility to promote and advertise their recycling facilities, and this is usually done by means of local authority produced leaflets or articles in the local newspapers. As this information becomes common knowledge, people will rely less upon published materials. Up-dated information must therefore strike with sufficient impact to have a memorable, if not positive effect, other than relying on more traditional communication channels (Table 5).

Table 5. How residents received information about recycling

	% of respondents		
Information received via . . .	***Luton***	***Shepway***	***Sutton***
Council leaflet	50.0	10.2	81.6
Local knowledge	64.7	85.7	55.1
Newspaper article	11.8	12.2	34.7
Neighbour	0.0	24.5	8.2
Yellow pages/ Telephone Directory	5.9	0.0	0.0
Radio / Television	2.9	2.0	4.1

In Shepway where 'local knowledge' was claimed to be the main means of finding out about recycling schemes, the local authority appears top have relied on work that they had already done; or their publicity was failing to be noticed. Despite Shepway's efforts, its residents generally knew of no promotional literature during the previous two years, whereas 73.5% of Sutton residents had received something during the previous twelve months (Table 6).

The majority of Luton residents did not receive information, but most of the remainder (44.1%) acknowledged receiving something over the previous two years. The research indicates that local knowledge appeared as the dominant means of acquiring information. Alternatively, radio and television are rarely used as a means of communicating to the public by local authorities, and those newspaper articles that are produced attract little response or attention.

The apparent lack of regularly up-dated information in Shepway and Luton, prompted respondents to overwhelmingly request it more frequently as shown in the table of 'Information to be received' (Table 7).

Table 6. How recent had the residents received information about recycling

Recycling Promotion Received	***% of respondents***		
	Luton	***Shepway***	***Sutton***
In the last month	5.9	0.0	36.7
In the last six months	2.9	2.0	18.4
In the last year	23.5	4.1	18.4
In the last two years	11.8	2.0	6.1
None that you know of	52.9	83.7	10.2
No response	2.9	8.2	10.2

Table 7. Resident's thoughts on frequency of recycling information

Information to be received	***% of respondents***		
	Luton	***Shepway***	***Sutton***
More often	55.9	73.5	28.6
No change	20.6	16.3	57.1
Less often	0.0	0.0	2.0
None at all	17.6	8.2	8.2
No response	5.9	2.0	4.1

By far the most popular piece of information produced by the local authorities was the location of recycling sites with both Luton and Shepway residents receiving little else (Table 8). Whereas in Sutton (arguably the best performing authority of the three), the respondents noted information on a wide range of waste subjects.

The effect of a local authority's recycling and waste minimisation promotions can prove positive on residential behaviour (Table 9).

Sutton, had a very good catalogue of recycling and waste minimisation material, and this helped to encourage high participation rates amongst its residents (according to residential feedback to the survey). Meanwhile in Shepway, more than half of the respondents claimed that promotion had had little effect because they already recycled their waste.

Table 8. Information requested by residents

		% of respondents	
Types of information wanted	*Luton*	*Shepway*	*Sutton*
Waste reduction	41.2	44.9	40.8
Local sites for recycling	38.2	49.0	34.7
The Local Authority's performance figures	23.5	46.9	26.5
Re-using materials	32.4	40.8	36.7
Composting	20.6	49.0	16.3
Recycling of all materials	38.2	44.9	36.7
No response	41.2	20.4	14.3

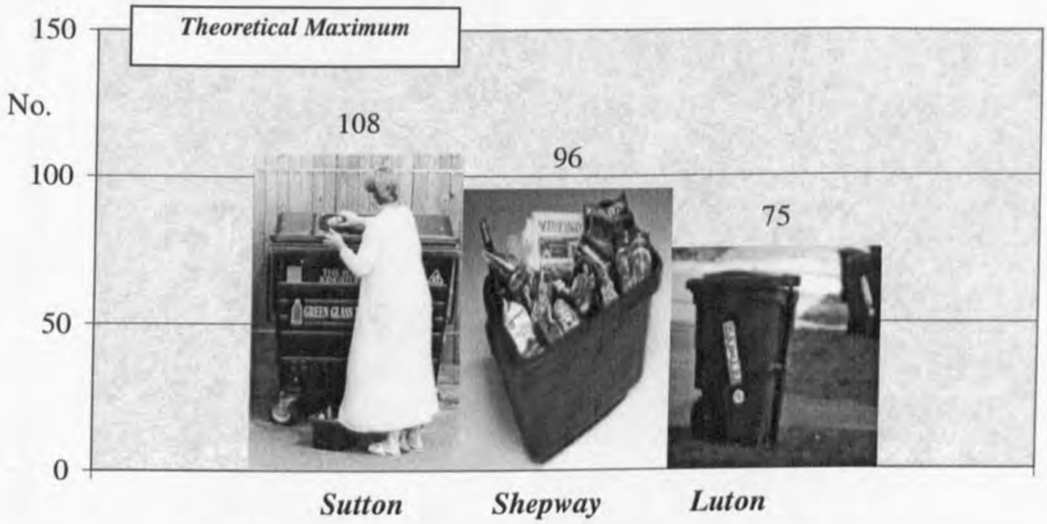
Table 9. Effect of Local Authority Promotions

Effect of Local Authority promotions		*% of respondents*	
	Luton	*Shepway*	*Sutton*
Yes, increase participation	14.7	2.0	38.8
Yes, decrease participation	2.9	0.0	2.0
No, already recycle	32.4	53.1	38.8
No, don't recycle	20.6	10.2	8.2
Don't know	20.6	18.4	10.2
No response	8.8	16.3	2.0

In summary, it would be fair to conclude from the data presented that the most effective authority in terms of recycling, publicity and residential support is Sutton (see Figure 2). This is in stark contrast to the problems being experienced in Luton (with limited facility development) and in Medway (where the scheme appears to have stagnated).

Clearly, continual promotions and publicity campaigns are essential (Figure 3) if high participation and satisfaction with the service are to be maintained (Figure 4).

Figure 2. Number of respondents to survey (indicative of happiness with service)



7. DISCUSSION

As a result of the research, a series of issues were identified as being fundamental to the development of a local authorities' waste awareness campaign. There is often a need to target publicity information especially for the lower-recycling groups in society. Education, publicity and promotion are essential for the success of any recycling scheme. Quality promotion and publicity on a regular basis, will produce better recycling performance figures, whilst poor quality promotion, or none at all, will result in low recycling rates, thus when planning the provision of a recycling service it should include full education and publicity elements. When considering which media to use for promotions, local newspapers are not always the best means of informing the public, whilst a Local Authority environmental newspaper can effectively put forward policies and strategies.

Figure 3. Summary of Perceived Authority Support for recycling according to Residential Feedback

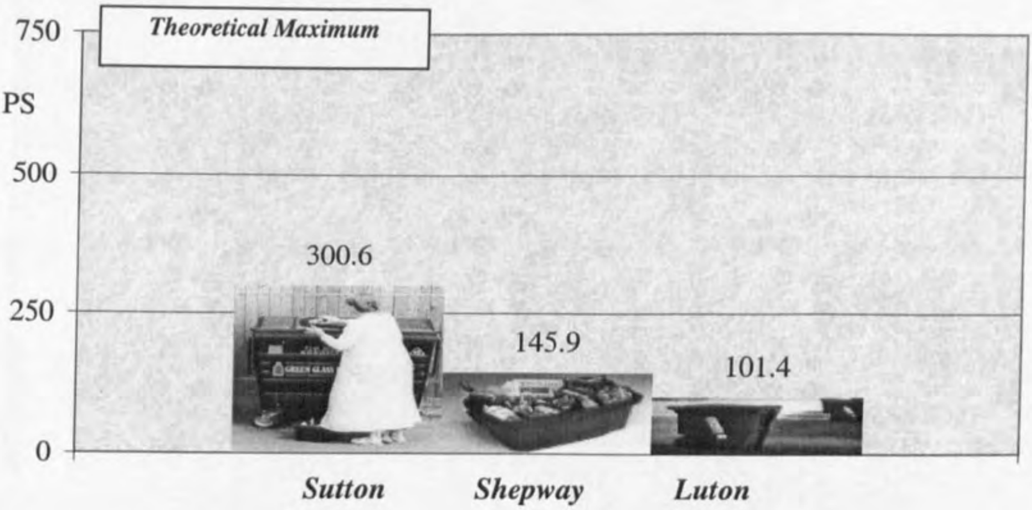
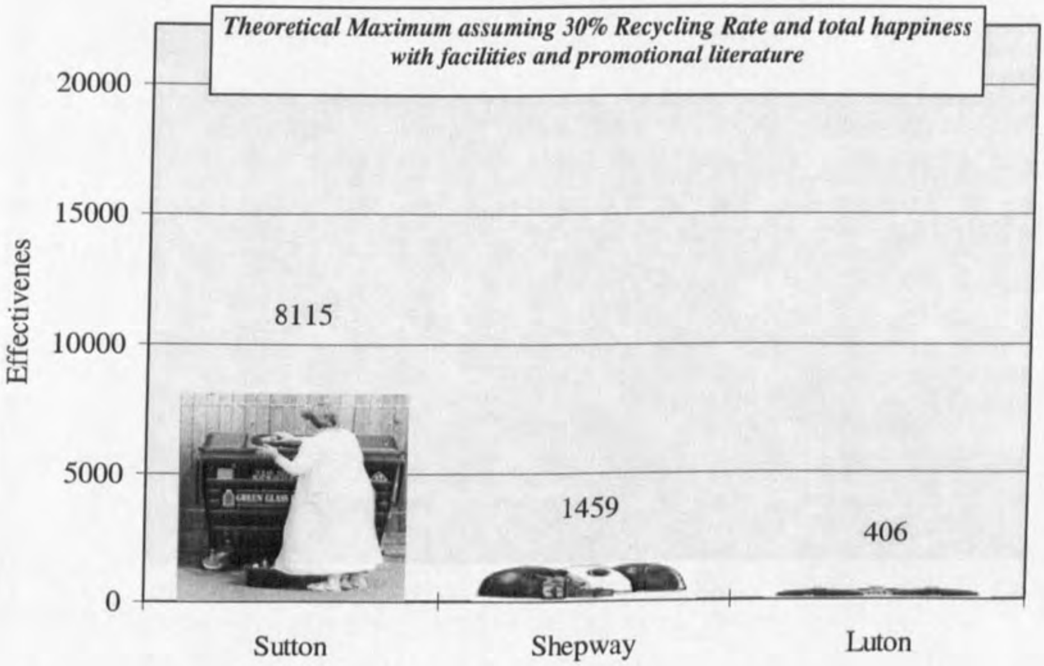


Figure 4. Effectiveness of Local Authority Promotions

'The Effectiveness formula' = 'The Respondents Perception Score'

**** The Recycling Performance figure (%).***



More importantly, regular leaflets help to maintain public awareness, and knowledge will decline if frequent reminders are not utilised.

There are many that believe that public education about waste management and recycling should be *initiated by central government* or a *national body*. The Government launched their new campaign 'Doing you Bit?' in May 1999 to raise awareness in recycling and waste management. The 2-year campaign is being funded by £7 million of Government money as a means of driving the UK towards more sustainable lifestyles. The TV and Radio campaigns will feature a series of high profile celebrities in a range of witty adverts covering issues from transport and energy efficiency to water use and recycling.

Those covering recycling include Black Lace's song Agadoo, stating that if the group achieved success in re-releasing such a number *we can all gain from recycling our rubbish!* George Best can be seen putting old bottles into a recycling bank! This will tie in with the Going for Green waste campaign and the new National Waste Awareness Initiative to deliver a uniform waste management message to the general public in the hope of delivering more responsible personal attitudes and behaviours.

Three years after conducting this research there have been many changes in the waste management industry. Landfill Tax, EU Packaging Regulations, the EU Landfill Directive, and last July, Waste Strategy 2000. Has Waste Awareness been awoken in members of the public? Has the promotional and publicity material improved? May be not, but changes can be see over the waste horizon, and perhaps the National Waste Awareness Initiative launched in October 2000 may offer the unified voice promoting a single and simple message that appeals to all of the public in the UK, but only time will tell.

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APPENDIX 9

LANDFILL TAX & ENVIRONMENTAL BODIES

APPENDIX 9

THE LANDFILL TAX AND THE ROLE OF ENVIRONMENTAL BODIES

1. INTRODUCTION

This research is a direct development of earlier work, carried out by the author, which investigated the future role of landfill as a waste management option in the UK [1]. The research concluded that landfill dominates the municipal waste industry, accounting for in excess of 80% of all treatment and disposal in England, as noted in Figure 1. This contrasts with the situation in several other European countries where alternative practices including recycling, composting and incineration play much more significant roles, (Figure 2). However, the majority of active landfill sites in England will be infilled and returned to agricultural or recreational use within the next 15 years, whilst landfill use has decreased during the last 5 years, in response to a range of Government initiatives. The industry, both private and public sectors, is aware of the Government's attempts at discouraging the use of landfill, and cited the landfill tax and general recycling policy as being the main thrusts for this change of emphasis. This current research was initiated to investigate the role of the landfill tax in shaping the practices of UK municipal waste management in the UK.

Figure 1: Waste treatment and disposal practices (by %) in the UK [2]

	Landfill	Incineration	Recycling
Household	90	5	5
Commercial	85	7.5	7.5
Construction	65	0	35
Other Industrial	75	2	23

In the Government's White Paper on the Environment *'This Common Inheritance'* (1990) the Government stated that the waste industry should seek to reduce waste at source in order to prevent pollution and decrease the need for landfill.

The central theme of all recent Government policy and legislation has been the need for waste management activities to be forcefully encouraged to move further up the hierarchy of available waste management options, as laid out in their National Strategy for Waste Management [2]. However, the success of these measures in reducing the UK's dependence on landfill remains relatively un-impressive, when compared to waste management figures from other European nations, as quoted in Figure 2.

Figure 2: A comparison of Municipal Waste Management Practices (%) in Europe [3, 4, and 5]

Nation	Landfill	Incinerator	Recycling
Sweden	13	49	38
France	30	35	35
Denmark	45	45	10
Austria	55	20	25
Netherlands	65	20	15
UK	85	8	7

2. THEORETICAL CONSIDERATIONS

In the Government White Paper *'This Common Inheritance'* (1990) it was stated that the Government was setting the challenging target of recycling half our recyclable household waste by the end of the century, and introduced the Recycling Credit System as a means of encouraging the adoption of recycling programmes by local authorities. Coggins and Evans [6] proposed a number of alternative measures to the recycling credit scheme which could be adopted to further encourage waste management activity to move up the waste hierarchy (Figure 3).

Figure 3: Potential mechanisms for reducing dependence on landfill and for implementing Government priorities regarding the waste hierarchy [6]

Management Level	Incentives (financial)	Polluter pays penalties
Production	Tradable permits Tax incentives Investment Allowances	Minimum percentage of recycled content Product levies / bans Input material levies / taxes Excess packaging levies / bans
Consumption	Differential VAT Deposits Eco-labelling	Deposits Green dot levy Dual stocking Trade description act
Collection	Diversion credit Rateable value Adjustments for drop-off sites	Mandatory recycling Direct charges / local taxes Mandatory retail drop off sites True costs of collection
Recycling	Recycling credit Investment allowance Redemption allowances Mandatory purchasing Hole in the wall processing Rateable value adjustments	Redefinition of waste Higher prices for recyclables Ban on landfilling recyclables Recycling targets and penalties
Disposal	Diversion credit Tradable permits	Direct charges Surcharge on recyclables Landfill Tax NIMBY True costs of landfill

Regulation and economic instruments are like the proverbial 'stick and carrot' - the general idea behind economic instruments is to give producers and consumers an (economic) incentive to act in accordance with society's ends. In a research programme [7] thirteen economic instruments were identified which had the potential to stimulate the recycling of materials from waste, and they included some of the measures listed below.

1. Product Charges (charges levied on products made from non-recycled materials)
2. *Raw materials charges (a charge levied on raw materials where there are recycled substitutes available to encourage the use of recycled material)*
3. *Deposit refund schemes (refundable charges on potentially recyclable products)*
4. *Waste Collection Charges (a charge levied on households for the collection and disposal of waste)*
5. *Waste disposal charges (a charge levied on all household waste at the point of disposal)*
6. *Transferable recycling target (for industry and waste collection authorities)*
7. *Property rights (imposing responsibilities for packaging waste collection and recycling)*
8. *Direct subsidies (direct payments to waste collection authorities to invest in recycling facilities)*
9. *Tax concessions (increasing tax allowances for recycled materials)*
10. *VAT differentiation (VAT exemptions or reductions for goods containing recycled inputs)*
11. *Market support schemes (price stabilisation and price support mechanisms)*
12. *Preferential purchase (public sector purchasing systems which discriminate in favour of goods with recycled inputs or which are recyclable.*
13. *Removal of tax allowances (changing allowances, removal of waste disposal costs from tax relief)*

However, tax concessions, VAT differentiation, price support mechanisms, preferential purchase, and removal of waste disposal costs from tax relief were considered as having less potential, following qualitative analysis based on effectiveness and coverage of the policy, administrative efficiency, ease of implementation, equity, acceptability, and economic efficiency.

This experience is helpful in initial scoping and providing an indication as to which instruments appear suitable to meet different objectives, however little post-evaluation has been undertaken to date.

What current research has suggested is the potential that taxes could have on disposal operations to encourage the development of alternative forms of waste management other than landfill, and this has been implemented in the UK through the introduction of the landfill tax.

3. THE LANDFILL TAX

The landfill tax had its genesis in a recommendation to the Government made by the Advisory Committee on Business and the Environment in its first report to Ministers in October 1991 [8], stating that the price of landfill should be increased significantly to levels attained elsewhere in the EU, (Figure 4). The following year in *'This Common Inheritance- The Second Year Report'*, the Government gave a general commitment in favour of economic instruments as a means of achieving environmental goals. Following a period of internal Whitehall debate, the Chancellor in his Budget Statement on 29 November 1994 announced the Government's intention to introduce a levy in 1996. A consultation paper emerged in March 1995, which proposed a single rate *ad valorem* tax on the charges levied by landfill site operators, with a tax rebate for environmental trusts for the restoration of orphan landfill sites and for research into and development of more sustainable waste management practices. The consultation paper received over 700 responses, with most criticisms surrounding the ad valorem charge, and the Government responded to this by announcing on 2 August 1995 that the landfill tax would be weight-based. The rates of the tax were announced by the Chancellor on 28 November 1995, and the Finance Bill was published in January 1996 [9].

Figure 4: Landfill prices per tonne in Europe, excluding tax [10]

Country	*Landfill cost per tonne (£)*
Norway	40
Germany	32
Sweden	28
Denmark	28
Netherlands	24
Italy	20
UK	13
France	11
Spain	7
Finland	6

The Landfill Tax is placed on every tonne of waste which goes to landfill for disposal, and is set at £7 per tonne for non-inert wastes (most household and municipal wastes), and at £2 per tonne for inert wastes, since its inception in October 1996. This will raise the cost of landfilling considerably and should encourage the adoption of alternative strategies as they become more economically competitive against an ever more expensive landfill route. The current emphasis of UK waste management policy is to enable, encourage and push the industry and its practices further up the waste hierarchy towards its aims of sustainable development. However, the Government must ensure that the tax actively moves operations up the hierarchy, and the Environmental Bodies may prove to be an important tool in achieving these aims. This can be achieved through the revenue raised from the tax which need not all be paid to the Inland Revenue, but upto 20% can be reclaimed to form an environmental body (trust) to carry-out positive local environmental activities. This could allow more positive and beneficial use to be made of the funds made available from the landfill tax, whether it be through land restoration and remediation, pollution abatement, education, research and building maintenance.

In his budget on Tuesday 28 November 1995, the Chancellor of the Exchequer said,

> *"Last year I proposed a new landfill tax, a charge on the disposal of waste, in for example, tips and old quarries. This will come into effect on October 1, 1996. It will be charged at a standard rate of £7 per tonne and a lower rate of £2 per tonne for inactive waste. This is a tax on waste in order to reduce the tax on jobs. The money raised by the landfill tax will allow for a matching cut in the main rate of employers' National Insurance contributions by a further 0.2% to 10% from April 1997. This will cut the costs of employment by £500 million and make it cheaper for businesses to create new jobs."*

However, this tax will be of maximum benefit to both the environment and industry if it encourages more businesses to move toward recycling, re-use and waste minimisation, whilst encouraging greater pollution prevention through the discouragement of landfilling. Current estimates show that approximately 1,400 businesses, operating 2,700 sites will need to register with HM Customs and Excise for the tax [11]. The Chancellor predicts that the new tax will raise around £450 million in a full year, plus VAT [12]. For both private organisations and local authorities, the landfill tax could be the catalyst that creates significant funds to invest in the local environment, minimisation trials and research projects on recycling. As an example, in 1994, the UK consumed approximately 11.6 million tonnes of paper and board, of which almost 31% was recycled. The remaining 8 million tonnes were disposed of in landfill, accounting for about 8% of all waste which is landfilled. Recovery and recycling more of this waste stream would potentially save up to £150 million on disposal and tax costs alone [13].

Many of the complaints that have been made about the tax have suggested that council tax bills will rise, or that local government services will be cut because the tax will be passed onto the councils (collection and disposal authorities) as they are amongst the biggest depositors in the UK. It has been predicted that in Ireland, waste will start to flow from Ulster to the Republic where the tax does not apply [14].

However, the optimists see the tax as a significant step towards an ecologically sustainable society. It could generate hundreds of new, labour-intensive, recycling schemes to blossom and allow numerous research projects of practical use to be initiated. Few can doubt that Government fiscal policy and instruments are increasingly being applied to influence behaviour in resource management. The landfill tax is an immediate and obvious manifestation of an end of pipe resource tax designed to shift behaviour [10]. The aggregates industry faces the threat of tonnage levies at the point of production on the front of the pipe, whilst the producer responsibility initiative is an attempt to deliver sector-based solutions encouraging the further use of resources in the production cycle in ways that will improve sustainability.

Jones [10] has warned that if continental practice is followed, the level of the tax will rise fourfold in the next few years. In Denmark it came in at 40 kroner in 1987, whilst next year it will be at 285 kroner (£31), which is a 600% increase, whilst the Belgian equivalent has risen by more than 700% in the four years since its inception and now stands at £50 per tonne, (Figure 5). This evidence suggests that within a 4 year period of the introduction of a landfill tax in the aforementioned nations the tax was artificially raised by on average 600-700%, which would result in the landfill tax be setting at perhaps £25-30 by the year 2000 and reaching £50-60 by the year 2002.

Figure 5: Current Landfill Taxes in Europe [10]

Country	Waste Type	Cost per Tonne (£)
UK	Inert	2
	Remaining waste	7
Denmark	All	31
France	MSW	2.50
	Industrial / Hazardous	5-8
Germany	Industrial / Hazardous	10-41
Netherlands	All	10.5

On the surface, a rise in tax must seem like yet another burden for industry to bear, but in this case, the Government intends to mitigate the burden by reducing employer National Insurance contributions [15]. Planning regulations in the UK have made consents for more landfill sites unlikely and it is the Government's intention to make resource abuse (putting waste into landfill) more expensive [10].

An opportunity now exists for producers of waste to re-examine their modus operandi in order to meet the Government objectives without undue financial burden. The most obvious solution is to minimise the amount of waste that is being created and thus minimise the cost of disposal, but this requires long term strategic panning and large scale reorganisation with associated financial costs. Another obvious alternative is the re-use of materials before they enter the waste stream, however it is not always possible to find readily available ways of re-using existing materials. Even if companies have implemented waste minimisation and re-use schemes, there will always be waste materials which must be dealt with, and this is where recycling and other forms of recovery come into operation as viable waste management strategies. The landfill tax is a powerful incentive to change our, and the industry's, perception of waste handling, with the main issue for society being where will the waste go if it does not go for landfill disposal. From the waste management industry's viewpoint the obvious place for the material to go, and the initial raison d'être of the tax, was to divert more to recycling and other waste management methods further up the hierarchy, particularly the fundamental option of waste reduction and minimisation [16]. However, these options will only succeed in diverting waste if the necessary infrastructures can be implemented at minimal costs and if markets are available for the materials. What the landfill tax will do is to create a core price for legal disposal which if properly enforced and policed, will enforce producers and carriers to examine where their cheapest disposal outlet actually is. Much will then depend upon how the industry reacts and how it decides to set and pass on these costs. The problem at the moment is that the alternatives to landfill are simply not available and that start up and lead in times are generally very long, and markets are showing no signs of even beginning to develop [10].

3.1 Tax liability

For landfill tax, material is disposed of as waste if, when disposing of it, or having it disposed on his behalf, the producer intends to discard or throw it away. It is the original producer's intention that determines if the material is waste. If waste is processed before its disposal to landfill and the process fundamentally changes its properties, the original producer's intention is no longer relevant, including composting, anaerobic digestion and recycling processes. However, crushing, baling, sorting or screening waste does not fundamentally change its properties and so the material remains waste. Thus, waste that goes for recycling and incineration is not liable to tax, however the waste passed to a landfill site operator and the waste landfilled is liable to tax. If waste is bought by a site to be used for engineering purposes within the landfill it will be liable to tax, whereas soil and clay are not defined as waste materials and are thus not liable to the tax, although they will be used for the same purpose [17]. To qualify for the lower tax rate (£2 per tonne), the waste transfer note must accurately describe the waste so that it can be related to the terms used in the Landfill Tax (Qualifying material) Order 1996. Where disposal involves a mixed load containing both active and inactive waste, tax will be due on the whole load at the standard rate (£7 per tonne.) However, as long as the amount of active waste is incidental, and it does not lead to any pollution potential, the entire load may be treated as taxable at the lower rate. Those wastes to be taxed at the lower rate include: Rocks & Soils (if naturally occurring), Glass, Ceramics & Concrete (if un-used), Furnace slag, Ash, Low activity inorganic compounds, Calcium Sulphate, Calcium Hydroxide, Brine and Water containing qualifying materials in suspension.

3.2 Penalties and interest

As with any new tax there will be an initial period of transition, where difficulties arise and misunderstandings occur in relation to the landfill tax. HM Customs and Excise [17] have stated that they will take a sympathetic view of 'genuine errors' or mistakes made during the first year of tax when considering whether to impose penalties and interest, providing companies with a period within which to review their accounting systems.

Failure to register, following a change in behaviour so that the company is now liable to tax, will render the company liable to a penalty equal to £250 of 5% of the relevant tax, whichever is the greater, and pay the tax which is due. There will be a penalty of £250 for failure to keep the required records, whilst a penalty of £250 will be liable if records are not provided when requested, and if failure to comply with the request continues then there will be an additional £20 fine for every day after the date of the initial penalty. Any other breach of regulations will result in a £250 fine. HM Customs and Excise will come down heavily on all companies that break the rules, whether they be premeditated or accidental, after the first year of operation, and typical of the Government's approach to tax regulations they will be particularly strict in monitoring and enforcement.

3.3 Environmental Bodies

ENTRUST, the regulatory body for Environmental Bodies, was created in October 1996, and Dr Sills, acting chief executive, stated at the ESA annual conference in October 1996 that,

> *'the waste management industry is being given the opportunity to spend money on environmental improvements that would not otherwise be affordable. Both the waste industry and the environment will benefit from this innovative initiative.'*

Landfill operators, who must not benefit from the supported activities, can claim a landfill tax rebate of 90% from Customs and Excise on funds contributed to environmental bodies, upto 20% of their tax payments. The landfill tax is expected to raise around £450 million each year, of which as much as £90 million could be diverted to the environmental bodies. Qualifying bodies must be non-profit making, from the private sector, independently audited, accountable to a regulatory body, created at a national, regional or local basis, managed by a board of trustees and may be newly established or existing organisations. A unique feature of the tax is the provision that landfill site operators may claim tax credits in respect of financial contributions made voluntarily to approved environmental bodies.

However, operators (contributors) must not themselves benefit from the supported services. John Gummer, Secretary of State for the Environment, speaking in November 1995 said,

> *"Environmental trusts represent a significant opportunity for the private sector to build upon their involvement in improving the environment. The establishment of environmental trusts will complement and reinforce our policies for sustainable waste management, by promoting recycling, and will strengthen the environmental credentials of the landfill tax."*

The landfill tax presents new challenges to the waste management industry. The Government's aims in introducing the tax were to reflect the environmental impact of landfill and to promote more sustainable waste management practices by providing a financial incentive to deal with waste at higher levels of the waste hierarchy. In the short term many companies will take a cautious approach to investing in environmental trusts, although more likely will be the growth of partnerships with existing environmental organisations and partnerships, particularly Groundwork who have been highly successful in land reclamation projects. Setting up an environmental trust should not be undertaken lightly and without fully thinking through all of the implications [18]. On the face of it the environmental trust concept is a golden opportunity for the industry, in some ways it is a balancing contribution from government to offset the fiscal risks associated with the imposition of the tax [10].

Perhaps only the leading twenty companies in the UK will get involved in the trust scheme focusing on localised schemes (school initiatives and community provisions), national environmental projects (contributions to existing corporate bodies and the growth of new umbrella bodies) and industry focused research projects focusing on new technologies and innovative applications. Landfill operators face the classic prospect, beloved of management gurus, of turning a problem into an opportunity.

Companies can now plough back landfill tax credits into good works to improve the environment rather than see all the £450 million which HM Customs and Excise expects to collect in this financial year disappearing into the depths of the Treasury [19]. The field is wide open for imaginative companies who wish to help to improve the environment, and incidentally do themselves and the waste industry no harm by enhancing the image of often maligned landfill operations in the eyes of local communities. The opportunities are many and the available funding, to a large extent, will be as great or as little as the landfill operators wish, but hopefully sufficient to allow a wide range of projects to be initiated.

The landfill tax is to be welcomed as a genuine initiative to move fiscal policies away from end of pipe solution to front of pipe resource use. The impact on gate fees paid for landfill for some local authorities will be as much as a 200% increase whilst business throughout the UK will on average expect to pay around double for their disposal. In May 1995 Biffa Waste Systems commissioned a MORI poll to find out awareness of the landfill tax amongst environmental managers (private companies) and chief environmental officers (local authorities). The results showed that Britain's larger companies had a weak knowledge of the tax and its implications for them, which is in marked contrast to local authorities which showed much greater awareness of the possibilities. The potential benefit of environmental bodies remains obscure to many key individuals working in the public and private sectors [10].

The majority of companies (86%) knew nothing, whilst 41% of local authorities acknowledged the role that bodies could play in clearing up old landfill sites, although after explanation 70% of private companies thought that the trusts would be fairly or very beneficial. Some feedback from companies in Surrey and Northampton as highlighted a common theme whereby local authorities mistakenly view the trusts as a means of generating income to enable them to plough into education, social services and other local government services, which is frightening the landfill companies. These results are rather worrying considering the recent launch of the tax and the accompanying environmental body regulations, and their potential positive benefits for UK waste management practice.

3.4 Regulation

ENTRUST has been formally approved by HM Customs and Excise as the regulator of the environmental bodies which are being set up to spend landfill operators' contributions, under the landfill tax credits system. ENTRUST is a private sector regulator and is independent of Government, of the waste industry landfill operators and of the environmental bodies. Although independent of Government, ENTRUST will be responsible for enrolling environmental bodies intending to attract funding from landfill operators under the scheme and for monitoring the operation of environmental bodies and ensuring that all expenditure complies with the landfill tax regulations. It has set itself a target of enrolling 450 bodies within its first year. ENTRUST may withdraw the enrolment of any body that fails to meet the conditions of the scheme and will report such cases to HM Customs and Excise, which has the power to seek repayment of tax credits from contributing landfill operators. An important task of the board will be to ensure that landfill operators' contributions, qualifying for landfill tax credits, are spent on projects that comply with the objectives stated in section 33 of the regulations, as listed below [12]:

- *Reclamation, remediation, restoration or any other operation that facilitates the economic, social or environmental use of land where its use has been prevented or restricted because of previous use. This may include the creation of new wildlife habitats or public parks or form redevelopment.*
- *Any operation intended to prevent or reduce any potential for pollution or to remedy or mitigate the effects of any pollution on land polluted by a previous activity. This will include the treatment of contaminated land.*
- *Research and development, education or collection and dissemination of information about waste management practices, the purpose of which is to encourage the use of more sustainable waste management practices. This will include research, pilot schemes, demonstration projects or training schemes aimed at waste minimisation, reuse, recycling, composting and energy recovery.*
- *For the protection of the environment, the provision, maintenance or improvement of a public park or other public amenity in the vicinity of a landfill site. This will include the creation of wildlife habitats, conservation areas, urban forestry and positive land management.*
- *For the protection of the environment, maintenance, repair or restoration of a building or other structure of religious significance or historical and architectural importance.*
- *The provision of financial, administration and other related services, necessary to the functioning of the environmental body.*

4. RESEARCH METHODS

The initial research method employed was a telephone survey of all landfill site operators with active landfill sites in the two counties under investigation, Northampton and Surrey. This involved the identification of sites and their licensees and their contact telephone numbers through Regional Environment Agencies. The companies were then telephoned and a short questionnaire was administered over the phone, preferably with the landfill manager or the company's development manager. If the company or officer required confirmation of the questions then the questions could be faxed to the company on request, on the proviso that the response was returned within the day. The questionnaire used in this survey is shown in Figure 6.

4.1 The two case studies

These two counties were selected because of the location of the two research centres most involved with the research, namely Northampton and Kingston. It was also presumed that their proximity to London would allow both counties to suffer from similar problems relating to wastes generated in the capital, whilst providing an opportunity for a comparative analysis to be made of the two counties. The two case studies have many similarities based on their location and physical characteristics, but are far from identical allowing the opportunity for an assessment of differences.

Northamptonshire lies at the very centre of England, with a population of 578,807 according to the 1991 census. In the past the relationship between mineral extraction and waste disposal has been an obvious one, with the majority of waste disposal in the county occurring in voids created by past mineral extraction. Infilling of mineral voids with wastes has been viewed in a positive light as a means of achieving suitable standards of restoration. From the Waste Management License returns, some 1.8 million tonnes of waste was disposed of in Northamptonshire in the year 1993/94, of which 658,000 tonnes was inert, 772,000 trade and 375,000 putrescible. In 1993/94 Northamptonshire produced approximately 250,500 tonnes of household waste, and about 40% of this was exported for disposal in Bedfordshire, Buckinghamshire and Oxfordshire, however, approximately 19,000 tonnes of waste was imported to Northamptonshire for disposal from Leicestershire.

Thus on average 182,000 tonnes of household waste is disposed of in Northamptonshire annually. There are 9 major landfill sites in Northamptonshire, taking wastes from a variety of sources.

These sites currently provide 14,000,000 m^3 of void, and with current rates of annual infilling at 1,2000,000m^3 per annum, providing capacity until the year 2006. As landfill space decreases in neighbouring counties, Northamptonshire's available void may become attractive to waste disposal contractors, particularly for wastes originating in London, thereby increasing the quantity of waste imported and decreasing their available landfill lifetime.

Surrey is a densely populated suburban county with over 1 million inhabitants, and 444,000 households. The county has significant reserves of minerals, notable sand and gravel, and clay, and land reclamation and restoration of these workings by landfilling plays an important role in maintaining the character of these areas. In December 1994 there were 136 sites permitted for the treatment, keeping or disposal of waste in Surrey, with a total throughput of 2.7 million tonnes in 1994/94, which is substantially greater than the total quantity produced in the County, due to the high proportion of wastes delivered from London. Currently, Surrey County Council must dispose of 500,000 tonnes of household waste each year, and commercial and industrial waste production is estimated at an additional 300,000 tonnes every year. Allowing for the growth of the County's population and the impact of recycling initiatives, it is expected that the disposal of 600,000 tonnes of household and commercial waste will be required by the year 2000. Surrey's current disposal facilities are coming under increasing pressure and there is an emerging policy that does not favour further landfilling of untreated waste due to mounting environmental concerns.

Figure 6: Questionnaire used in the Telephone Survey

Q1 Annual Tonnage for the site?

Exact Figure	
Under 10,000 tonnes	
10,000 to 50,000 tonnes	
50,000 to 100,000 tonnes	
over 100,000 tonnes	

Q2 Estimated money raised because of the landfill tax? (annually)

Exact Figure	
Under £200,000	
£200,000 to £400,000	
£400,000 to £600,000	
£600,000 to £1 million	
Over £1 million	

Q3 Are there any plans to set up an Environmental body?

Yes		Undecided	
No		Under Review	

Q4 What is the timescale for this?

Within 2 months	
2 to 6 months	
6 months to 1 year	
Over 1 year	

Q5 What activities are earmarked for spending the funds?

Recycling facilities	
Education programmes	
Research	
Land Reclamation	
Other- please specify	

Q6 Has there been sufficient advise available to you on setting up and getting involved with an Environmental body?

Yes	
No	
Not an Issue	

5. RESULTS

It seems that the majority of landfill companies are not currently pursuing the financing of environmental bodies. However, existing regional and local trusts are setting up their own environmental bodies in the hope of attracting the necessary finances from disposal companies. County Councils, Higher Education Institutions and Local Consultancy companies are also looking to initiate trusts and get involved in their operation, but at present they are simply being turned down by landfill operators who are on the whole spending time formulating their policies for dealing with the landfill tax and the environmental bodies. Few companies are willing to talk specifically about developments or sites at the moment, as they are waiting to see what happens in the few trusts that are operational, indicating a very cautious approach to this new Government initiative

In Northampton, it appears as though the County Council is in favour of a county wide environmental body into which all landfill operators would pay, from which all local councils would receive funds for local environmental improvement schemes that they propose, but this seems to have received relatively negative feedback, and would be particularly problematic to initiate given current regulations, and thus does not look as though it will be set up or registered in the near future. Whilst in Surrey, there are a number of conversations and discussions going on between the County Council and some of the landfill operators, about the potential development of environment bodies and proposed improvement schemes, but at present nobody is willing to comment, or commit themselves at this early stage of development.

The confusion surrounding environmental bodies is generally too great at the moment for any significant developments to be reported, with over 30% of all landfill disposal companies in the survey wishing to wait and see what happens in a case study of success, and another 35% not willing to comment specifically on their plans and developments. The question remains who will go first? If no company is willing to make the effort, then the system and environmental bodies in general will stall and fail to take off as was predicted and expected.

However, this remains a potentially huge market to be developed and exploited for the improvement of a variety of local environmental proposals, using money raised from a tax on waste disposal. The results obtained from the telephone survey are listed in Figure 7.

Figure 7: Telephone Survey Results of Landfill Companies operating in Surrey and Northampton

	Surrey	*Northampton*
Q1 Annual Tonnage for the site?		
Under 10,000 tonnes	3 (22%)	1 (7%)
10,000 to 50,000 tonnes	2 (14%)	4 (29%)
50,000 to 100,000 tonnes	2 (14%)	7 (50%)
over 100,000 tonnes	7 (50%)	2 (14%)
Q2 Estimated money raised because of the landfill tax? (annually)		
Under £200,000	5 (36%)	3 (21%)
£200,000 to £400,000	4 (29%)	4 (29%)
£400,000 to £600,000		2 (14%)
£600,000 to £1 million	4 (29%)	4 (29%)
Over £1 million	1 (6%)	1 (5%)
Q3 Are there any plans to set up an Environmental body?		
Yes	2 (12%)	3 (18%)
No	4 (24%)	5 (28%)
Undecided	3 (16%)	3 (18%)
Under Review	8 (48%)	6 (36%)
Q4 What is the timescale for this?		
2 to 6 months		
6 months to 1 year	2 (100%)	4 (57%)
Over 1 year		3 (43%)
Q5 What activities are earmarked for spending the funds?		
Recycling facilities		
Education programmes	1 (13%)	1 (14%)
Research	2 (29%)	1 (14%)
Land Reclamation	2 (29%)	2 (28%)
Other- Building Restoration	2 (29%)	3 (44%)
Q6 Has there been sufficient advise available to you on setting up and getting involved with an Environmental body?		
Yes	2 (14%)	2 (13%)
No	9 (64%)	12 (80%)
Not an Issue	3 (22%)	1 (7%)

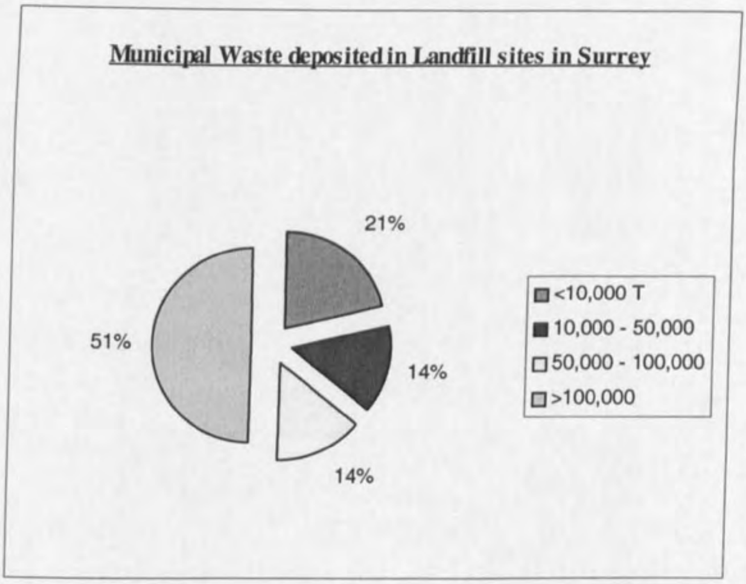
5.1 Surrey

In summary, 50% of companies deposit over 100,000 tonnes of waste in their landfill sites each year, and are thus large companies with potentially large landfill tax costs (Figure 8), whilst 36% of companies predicting additional costs of in excess of £600,000 per annum. Only 12% of companies responded positively that they were currently investigating trusts or were considering proposals for funding, yet 24% of companies were definitely not interested in funding environmental bodies. Sixteen percent remain undecided over the issue wishing to investigate it further and to assess trusts that have already been set up and are receiving funding, whilst the majority of companies (48%) currently have the issue under review either at Head Office level or at a regional scale. Three of the sites were not yet operational but were looking at the whole issue of environmental bodies.

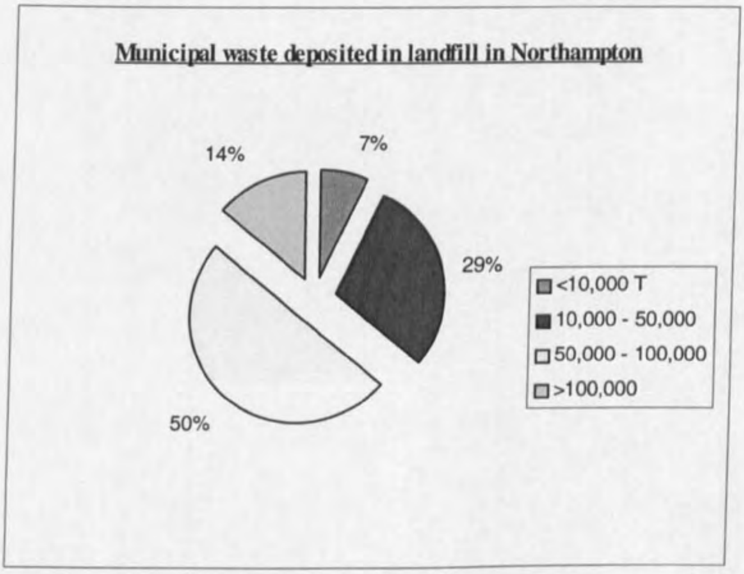
The larger companies appear to have centralised policies which are then implemented at their local sites. In general there is too much confusion, and companies need more time to get to grips with the tax before they look at ways and means of reducing tax payments. Of those companies that expressed a definite interest in funding environmental bodies all of them expected to be actively involved with a trust within 6 months to a year. Most of the larger companies have received approaches from numerous environmental bodies and trusts, but are wary of these advances as they are inappropriate to local sites and will not benefit the company, so why should they get involved. The proposed activities that the companies had earmarked for their financial contributions included education programmes (13%) and research, land reclamation and building restoration, all receiving 29% of the response. 64% of companies thought that the advise and material available on environmental bodies had been insufficient, and a further 22% claimed that it was not an issue for their company, leaving only 14% of companies in Surrey satisfied with the materials provided.

Figure 8. Municipal waste landfilled in the case study counties

[1] Surrey



[2] Northamptonshire



5.2 Northampton

In Northampton 64% of companies deposit in excess of 50,000 tonnes of waste each year (Figure 10), with predicted additional landfill costs of in excess of £600,000 for 34% of the companies, whilst 50% would experience an additional landfill costs of under £400,000.

18% of companies expressed a definite interest in providing funding for environmental bodies, yet 28% of companies were dead set against the idea and would not be considering it. Eighteen percent of companies were undecided on whether to investigate environmental bodies, and the majority of companies (36%) were reviewing the issue in light of environmental body proposals and head office policy. Both Biffa and two other of the landfill operating companies stated that decisions relating to the landfill tax rebate system and the funding of environmental bodies were currently being discussed at central offices where a universal policy and statement will be made.

One company stated serious reservations about the system remarking that the risks and costs involved would be too great for his company, because if a trust was to fold or if the planned project was rejected then the company would need to reimburse Her Majesty's Customs and Excise, whilst to ensure that the environmental body was being responsible with the companies money they would need to appoint an officer to work closely with the body, thus incurring time and management costs. Of those companies that expressed some interest in the scheme 57% hoped to have initiated a trust or have set their funding in progress within a year and the other 43% expected it take longer. Those companies that were interested in the scheme suggested that building restoration would be their most favoured option (44%) with land reclamation receiving 28% of the response and education and research each receiving 14%. Of greater significance are the 80% of companies who cited that the advise and material available on environmental bodies was insufficient, whilst only 13% thought the advise was of the required level for their interest.

5.3 Comparison

From the results obtained from this research the landfill situation in Northampton and Surrey is rather similar with 64% of companies in both counties disposing of over 50,000 tonnes per annum, with an additional landfill cost of in excess of £600,000 for 35% of companies in Surrey and 34% of companies in Northampton.

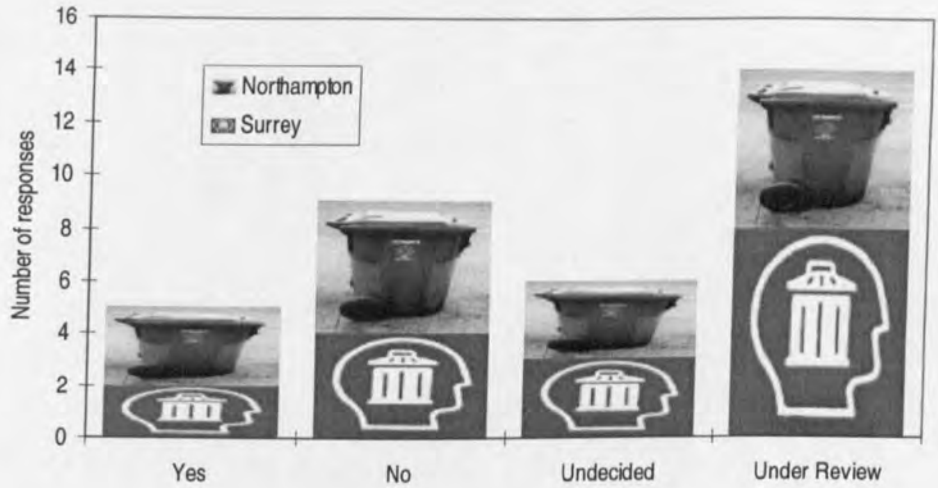
However, there is a significant difference in the two counties as 50% of companies operating in Surrey dispose of over 100,000 tonnes at their sites each year, whilst 50% of sites in Northampton deal with between 50,000 and 100,000 tonnes per annum, making sites in Surrey larger on average. The average weight of waste disposed of in Surrey per annum, in the surveyed sites, is 90,000 tonnes, which when compared to Northampton is much greater, where the average is 68,000 tonnes per annum.

Similar responses were received on the issue of getting involved with environmental bodies, with 12% in Surrey expressing a keen interest and 18% of companies in Northampton agreeing, and 24% of companies in Surrey and 28% of companies in Northampton showing no interest in the scheme, whilst 64% of companies in Surrey and 54% of companies in Northampton are currently considering the issue or are undecided (Figure 9). Thus in both cases under one fifth of companies were definitely interested in providing money for environmental bodies, whilst over one quarter of companies are not interested. This is a rather worrying scenario as both counties, and the landfill operators, appear lethargic in their approach to environmental bodies, and the success of the scheme depends a great deal upon the undecided groups who dominate the survey samples. As a single sample of landfill operators only 15% were interested in the scheme, whilst 26% were definitely not interested in providing funds from their landfill tax payments to support environmental trusts. It is the remaining 59% of companies that need to be encouraged to get actively involved in this Government initiative is to remain its present form as a means of recycling landfill tax funds into local environmental schemes.

One the whole, none of the companies expected anything relating to environmental bodies to be initiated within the next 6 months, with all 100% of interested companies in Surrey and 57% of companies in Northampton expecting some headway to be made between the next 6 and 12 months. The remaining 43% of interested companies in Northampton expected nothing to happen within the next year.

Thus the scheme with all its potential benefits will have little or no benefit for environmental bodies or landfill companies during the coming year, but it is hoped that in subsequent years initiation and funding will increase, but if the current trend in funding continues then upto £100 million per annum will be lost in available environmental body funding.

Figure 9: Comparative response of landfill operators with relation to their proposed involvement with environmental bodies



Those companies that did express an interest in the environmental body scheme, provided a broad range of favourable uses for their funding which they hoped would be carried out by the bodies that they became associated with. In Surrey the favoured options were; research, land reclamation and building restoration all of which received 29% of the response, whilst in Northampton a slightly different pattern was observed with building restoration being the dominant option (44%) and land reclamation coming second with 28% of responses, (Figure 10). One similarity between the two counties was the lack of inclination in providing recycling facilities, and the 14% of companies who expressed an interest in education programmes, making it the second least popular option for landfill tax rebate funds. On the whole 36% of the entire companies surveyed favoured building restoration, and a further 29% indicated land remediation as their preferred use for the funds.

Most important were the figures relating to adequate information on the environmental bodies and the landfill tax to allow companies to make informed choices. The results were rather similar for both counties with 14% of companies in Surrey and 13% in Northampton stating that sufficient advise and material was available to them, whilst 64% in Surrey and 80% in Northampton thought the advise was wholly inadequate leading to confusion and dissatisfaction. Of the whole sample 72% of companies thought the advise and information was unsatisfactory, and this may be a prime reason behind the poor involvement of companies with the currently registered environmental bodies (Figure 11). This issue will need immediate addressing if the scheme is not to collapse before it has really has a chance to develop and evolve into what is a potentially hugely beneficial scheme for recycling taxes from polluters to improve local environments.

6. DISCUSSION

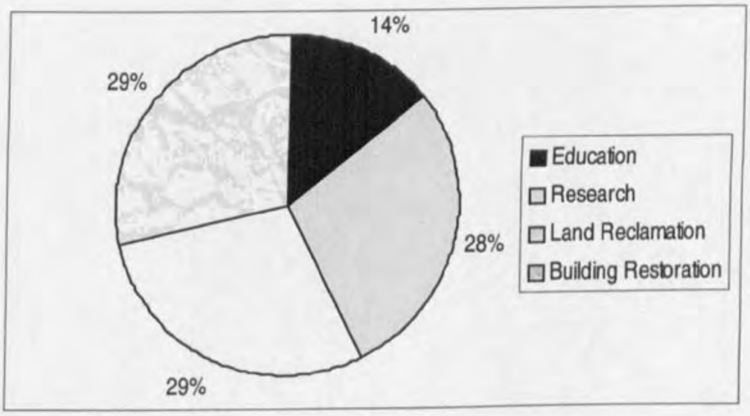
Despite the registration of 71 environmental bodies in the first three months following the initiation of the Landfill Tax, and the tax credit system, virtually no money has been donated by landfill operators thus far, with only a tiny trickle of money appearing in January 1997, as companies have been cautious whilst the system tries to find its feet. Derby based Business Environment Association (BEAM) is the first body to secure funding (£1000), from BIFFA, which is to go towards an £85,000 pilot 18-month assessment of the environmental impacts of an industrial estate in Heanor Gate, Derby. BEAM has proposed six separate projects to ENTRUST, all of which have been approved, requiring a total funding of £500,000.

Once a project has been approved by ENTRUST, the environmental body must go into the marketplace and rattle the begging bowl. In addition to the 71 bodies already enrolled, a further 44 bodies were considered, with applications coming from a wide range of interests. 10 of the enrolled bodies are wildlife trusts and a further 14 are groundwork trusts.

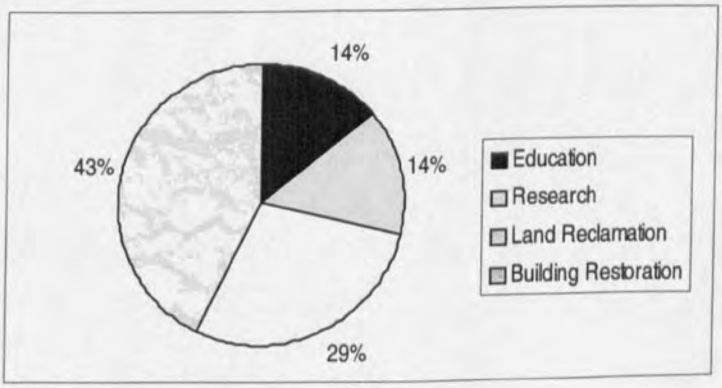
Other popular organisations are research units, recycling promoters, as well as Waste Watch, The Environment Council and The World Resource Foundation. According to Dr Sills, acting Chief Executive of ENTRUST, 700 forms have been sent out since October 1996 to potential applicants and interested bodies, with 160 official applications being received by 5 February, and 135 of these having been enrolled. There are generally two sorts of environmental body [i] those that are an existing trust or charity with organisational structures and programmes in place which are enrolled and approved in one go, whilst there are [ii] those new bodies which are little more than concepts are thus enrolled but must have their projects approved at a later date [20].

Figure 10: Potential programmes identified by the landfill operators for their landfill tax funds

[1] Surrey



[2] Northamptonshire



[3] Aggregate Response

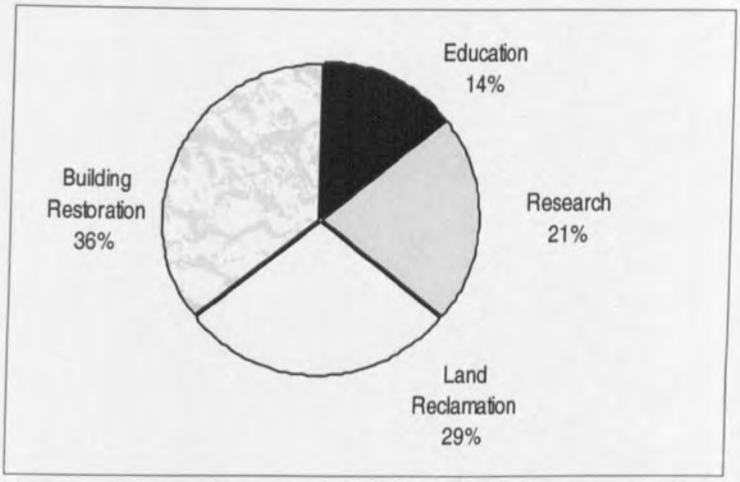
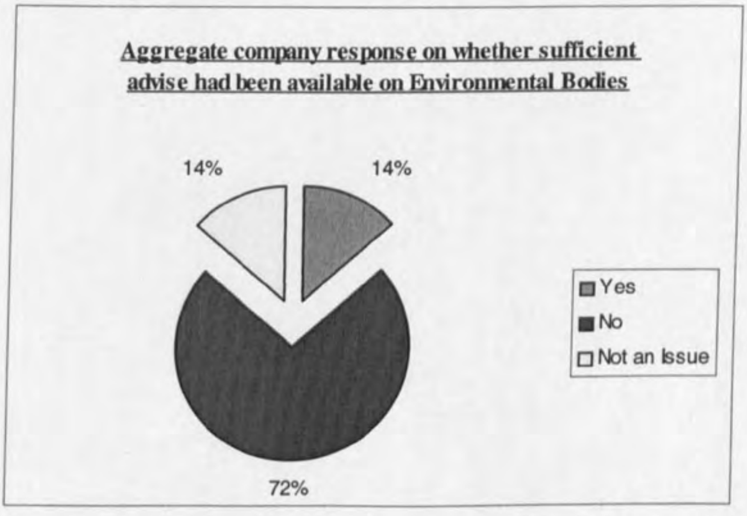


Figure 11: An assessment of whether sufficient advise had been provided on issues relating to Environment Bodies



An example of a newly formed organisation to take advantage of the landfill tax credit system is Waste Management Research, which is a wholly-owned subsidiary of Robert Long Consultancy. Mr Long, company spokesperson, believes that after the initial rush the system will level out so that two types of environmental bodies are formed: [i] those concerned with specific projects at certain sites and [ii] a smaller number of general purpose bodies that do anything that the market calls for.

There has been criticism over the lack of basic knowledge among landfill contractors about how the scheme operates and what opportunities exist. Roger Hammond, commercial development manager of BEAM, has spoken to the majority of landfill operators in the East Midlands, and the general consensus is that 'people don't know what is going on, and alot of the smaller companies don't understand the full implications of the landfill tax' [21].

An example of a recently initiated Environmental Body is the Landscape Trust, which is a non-profit making organisation dedicated to identifying and carrying out projects which involve the use and treatment of waste materials, in an environmentally sustainable way. It has been set up in direct response to the opportunity created by the Landfill Tax legislation of 1996. The trust has recently been accepted by ENTRUST, and is an independent body, formed with the benefit of over 25 years experience dealing with a wide range of waste materials in environmentally sustainable ways. It takes a 'hands-on' role in identifying and carrying out projects on the ground which demand a high level of creative and technical skills, supported by appropriate project management and research expertise. A key objective of the Trust is to produce projects which are sustainable, which means sound, and long term management.

At present the trust is looking for projects to become involved in and landfill site operators to help in fund these projects through their landfill tax payments. For many years members of the Trust have been developing positive ways of using waste materials to bring about environmental improvement and return derelict land to productive use. There are two basic requirements for the trust to become involved in a project [i] a waste disposal operation which generates a potential landfill tax liability and [ii] land in the vicinity (within 10 miles) which is suitable for a qualifying environmental project to be carried out on it.

Once these requirements have been identified, the Trust prepares terms of reference for the project and agrees them with the landfill operator and the landowner. Although the main source of funding is normally from the landfill tax credit, other sources of finance can be explored in appropriate circumstances.

Once the scope of the work is agreed, more detailed proposals are worked out by the Trust, and the Trust will be responsible for the detailed management of the project. The landscape trust is one of the first environmental bodies to be approved by ENTRUST, the Government appointed regulator administering the new landfill tax credit scheme. The trust based in Yorkshire and Merseyside, will operate on a non-profit making basis throughout the UK to restore problematic derelict sites into productive use. This body is currently searching for landfill companies who wish to actively become involved in environmental improvement schemes and who are willing to pay into their body.

More recently UK Waste have announced details of two environmental projects which it is backing to the total of £365,000 under the auspices of the ENTRUST scheme. The waste management company is financing a £200,000 environmental education programme run by the Groundwork organisation, and is also providing the London based charity Waste Watch with funds to enable it to develop its own educational project nation-wide. It is able to finance these schemes through the landfill tax rebate system. Ian Wakelin, managing director of UK Waste, stated that 'we have well established links with these organisations and are greatly impressed by the quality of their work in raising awareness of recycling. These are areas which UK Waste has sponsored for several years and is an excellent way of using the money available to us through the rebates system' [22].

7. CONCLUSIONS

The landfill tax and its associated environmental bodies, which are to be funded from landfill tax credits, are a very new and untested form of environmental regulation which are currently being applied to the UK waste disposal industry. Their intention has been to artificially raise the cost of landfill to a level which accounts, in part, for the environmental externalities of this disposal method, which had previously been ignored. It is hoped that this rise in disposal costs will force companies and local authorities to re-assess their strategies for dealing with municipal waste, by making recycling, waste to energy, composting and minimisation more costs effective in light of increasing landfill costs.

In addition the environmental bodies will allow disposal companies to recover upto 20% of their landfill tax payments if they are used to fund local environmental initiatives, thus allowing a tax on environmental pollution to generate some funds for environmental rehabilitation.

The recent introduction of these two initiatives has left the disposal industry somewhat in state of shock, with a limited amount of response being acknowledged by the survey results. Perhaps it is too soon to make any critical analysis of the development of environmental bodies and their associated funding from landfill tax credits, but the findings are a little disappointing, considering the obvious potential benefits for all involved from this system. On the whole, under 30% of companies are actively looking to develop links with environmental bodies in the case study counties, with the remaining 70% unwilling to comment whilst they assess their options, or are simply disinterested in the system.

Although there are a large number of environmental bodies now registered, if there is no funding from disposal companies these trusts will not be able to function, and environmental improvement strategies will not be initiated. If this trend continues then the landfill tax will have only achieved one of its aims, that of increasing landfill costs to take account of environmental costs, but will have failed in its attempt to encourage the money generated to be funnelled into waste related environmental improvement programmes, and may not have achieved the overall aim of shifting waste management activities to higher rungs on the waste management hierarchy. The response from the survey suggests that none of the companies expected anything relating to environmental bodies to be initiated within the next 6 months, with all 100% of interested companies in Surrey and 57% of companies in Northampton expecting some headway to be made within the year.

This leads one to believe that their will be little effective funding of environmental bodies before 1998, with perhaps it taking as long as 5 years for the real benefits of this scheme to be evident.

The experiences gained from this survey suggest that the industry at present does not have enough confidence to fully commit themselves to environmental body funding, and that this situation will not radically alter within the next year until reports of success stories are provided.

The uses of environmental body funds most favoured by the funding bodies (landfill companies) were building restoration (36% of company responses), research and education (35%) and land remediation (29%). This suggests that there is a new market for educational institutions to operate within because over one-third of all funds are predicted to be made available for research and education. Perhaps it would be appropriate for University departments to register as environmental bodies so that they can have a significant impact on the uses of the funds, Luton University are currently in the process of filling in the forms, whilst the topic is also being discussed at Kingston University. Judging from comments made by the company representatives it would appear as though companies will eventually support environmental bodies, but are being scarred away at present by continual communications from Bodies requesting funds for their projects.

At present these projects appear to have little local benefit and no benefit (direct or indirect) for the companies in question, and thus they are unwilling to commit themselves. In the long term it would seem appropriate that companies will favour environmental bodies that are carrying out local education or land remediation, and more significantly research themes, rather than funding building restoration which is of little interest to the waste industry.

In the view of Dr Sills, Acting Chief Executive of ENTRUST, the environmental body scheme has been a coup by John Gummer, Secretary of State for the Environment, in an aid to recycle money raised through environmental taxation into local environmental initiatives. ENTRUST is a novel and imaginative innovation in the regulatory field, as it is private sector, nominally independent of Government, and certainly independent of the waste industry that it regulates. However, the waste industry must take advantage of this 'gift' from the treasury or avoid losing many of the potential benefits that may arise from it.

Money if not recycled will be lost into the treasury black hole, and the scheme will fall into disrepute, as the treasury argues that the environmental sector is not interested in the money available and will push for the scheme to be altered. Many of the benefits may be lost, and there is a real chance that the voluntary aspects of the scheme will bee removed, with companies being forced to pay 20% of their tax payments into a central fund from which the treasury will distribute funds nationally, removing the local emphasis, benefits and nature of the scheme.

Few donations appear to have been made, which calls into question the Government's estimate last November that £10 million would be paid in landfill tax credits by the end of March 1997, and the Government's expectation that this figure will increase to £50 million in 1997/8.

There will be a need to continue to monitor the progress of the environmental bodies and the impact of the landfill tax over the coming years, as it seems inevitable that positive developments will occur, particularly in light of diminishing landfill availability.

Soon disposal companies will see the obvious benefits of the environmental bodies for their company and the local environment and will begin to respond to requests from existing trusts to provide funding from their tax credits. This would appear to be a particularly fruitful area of future research, with the Government taking a positive step to alter the balance of the waste management market place, and to enable the initiation of local environmental improvements, and perhaps University departments can get more actively involved in the running of these trusts, and benefit from the associated funds generated.

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APPENDIX 10

INTEGRATED SOLID WASTE MANAGEMENT

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INTEGRATED SOLID WASTE MANAGEMENT
'THE WHOLISTIC APPROACH'

1. INTRODUCTION

Waste is undoubtedly a significant environmental problem, and finding environmentally acceptable and cost effective solutions for its management can often prove difficult [1]. For householders it is quite easy for waste to be *'out of sight and out of mind'* with many people not knowing what happens to their waste once it has been collected from their home. The most common problem for the waste management industry (both private and public sectors) is that *'everybody wants rubbish picked-up but nobody wants it put-down again.'* People are happy for their waste to be collected swiftly and effortlessly from their doorsteps but are not so happy for a landfill or waste treatment plant to be sited near their home. However, waste is everybody's problem and we all have a responsibility for its safe and effective management [2].

The post-war period has seen a dramatic increase in the production of waste (both locally in the UK and more globally) reflecting unprecedented global levels of economic activity. The increase in the waste steam can be attributed to a number of factors; rising levels of affluence; cheaper consumer products; the advent of built-in obsolescence and shorter product cycles; the proliferation of packaging; changing patterns of taste and consumption; and the demand for convenience products. Many of these issues are outside the control of waste management authorities and companies and are thus not the focus for the work, however it should be noted that decoupling economic development from consumerism and wastefulness is perhaps the greatest challenge facing developed nations today. There has also been a steady increase in the cost and logistical difficulties associated with municipal solid waste management, representing the continual improvement in standards that are now so widely evident across the UK. This has put increasing pressures on existing infrastructure and the authorities responsible for waste management, particularly local authorities in the UK [3].

But things are changing. Damage to the environment (groundwater pollution from leachates, global warming from methane emissions and noxious odours) due to poor waste management can be avoided by implementing environmentally sensitive waste management techniques, involving options from the so-called waste hierarchy (from waste avoidance through materials and energy recovery to ultimate disposal).

Figure 1. The Waste Management Hierarchy (a list of preferred approaches to the management of society's waste) [4]

Increasingly, communities (and authorities) are beginning to utilise what has been commonly called *integrated waste management* (IWM) approaches, and this booklet will explain in some detail what this means and how it can be effectively achieved. Pressures to divert waste from landfill (including the landfill tax and recycling targets from the Government, and the NIMBY attitude of residents) have led many authorities to consider alternative treatment options to the more traditional landfill disposal route, which has dominated the management and disposal of municipal solid waste (MSW) throughout the last century. These alternatives include anaerobic digestion, composting, recycling and energy from waste [5].

Modern waste management practices have evolved rapidly in the last 30 years in light of these increasing pressures. The 1970's was characterised by a focus on reducing the environmental impact of existing disposal practices and the creation of controlled landfill sites.

The 1980's and 1990's were dominated by the raising of technical standards for treatment and disposal and by looking at new technological solutions for waste management. From the mid 1990's the focus has shifted to the integration of policy measures to move management away from disposal towards resource recovery and integrated solutions and services (contracts). In the coming decade this emphasis will be superseded by a new focus on how to effectively prevent waste, with attention shifting towards patterns of consumption and de-coupling waste generation from economic development (ultimately becoming resource management).

Any waste management system must be operated within an environmentally, economically and socially sustainable framework in order for it to be effective at both a national and local level – in accordance with sustainable development. It must operate under the guiding framework of Agenda 21 (established at the UNCED World Summit in Rio in 1992) and within its local manifestation 'Local Agenda 21' (LA21), and this is where sustainable waste management practices must start and be focussed.

Waste and its management has been historically characterised by ready-made formulaic solutions, with single-issue activists and associations promoting a single management solution, at the expense of all others. It is often argued for example that all waste should be recycled, and that there is no need for landfill or incineration. However, no one solution can effectively manage society's waste however much one is willing to pay [6].

Integrated waste management (IWM) is a waste management system (collection, treatment, supply for re-use, reprocessing and final disposal) for a defined area that delivers the optimum economic and environmental result both now and with sufficient flexibility to adapt to future circumstances whilst maintaining effectiveness and utilising the most appropriate methodologies and techniques. The system must be inclusive of all relevant waste streams (commercial, domestic, and hazardous), of appropriate combinations of methodologies and technologies, and sufficiently flexible to maintain its ability to deliver results over a specified time period. So what does this mean for the UK?

Table 1. Common Approaches to Waste Management;

Option	*Advantages*	*Disadvantages*
Waste Reduction	tackles the problem at source reduces collection & disposal costs socially acceptable	requires co-operation & education can have a limited effect household action is restricted
Waste Re-use	extends product lifetime reduces raw material & energy use promotes household sustainability	can involve increased costs refillables may be initially expensive limited number of times it can occur
'Bring' Recycling	can encourage high participation cheaper than separate collections socially attractive	reliant on available markets siting problems & contamination lower volumes of material recovery
MRF	improved quality of materials proven technology reduces volume going to disposal	siting can be difficult reliant on manual sorting limited markets for materials
Central Composting	reduces the organic fraction in landfill provides a beneficial product (compost) can manage large throughputs	sensitive to contamination uncertain market for end product potential odour & leachate problems
Anaerobic Digestion	generates useful methane and soil conditioner achieves volume reduction reduces pollution potential	how suitable for household waste? contamination problems only treats the organic fraction limited development at present
Energy from Waste	deals with a large portion of the waste stream (70%) proven and viable technology generates heat and electricity	public concerns over emissions and health effects capital intensive ash residue need disposal
Landfill	manage the bulk of the waste stream well proven technology low investment required relatively cheap	amenity issues increasing costs declining void capacity not popular (socially / environmentally)

2. WASTE MANAGEMENT PRACTICE AND POLICY IN THE UK

The operations within any waste management system are clearly inter-connected. The collection and sorting method will affect the ability to recover materials or produce marketable compost, whilst the segregation of materials for recycling could affect the calorific value of the waste residue going to an incinerator. It is therefore necessary to consider the whole waste management system in an holistic manner. Waste management policy and strategy throughout Europe has developed in both a costly and complicated manner in recent years, with focus on specific sectors, products or packaging. This rather fragmented approach is not economically efficient or environmentally effective in managing society's waste.

In the Audit Commission's 'Waste Matters' [3] they state that *'responsibilities and the costs and benefits associated with waste management involve different tiers of local government and a number of other players and agencies. An integrated approach, where waste disposal and collection authorities work together to formulate joint policies and proposals would help to avoid contradictory actions and missed opportunities, and help to overcome institutional barriers.'*

They go on to suggest that 'similarly, incineration, composting and landfill operations may all be under the control of different operating companies. Each company or authority only has control of the waste handling within its operation, so what is the feasibility of taking an overall systems approach when no-one has control over the whole system?'

A simplified look at a waste management system with all 'available' management approaches included would look something like the box below, but this is not integrated it is simply using a range of approaches to manage the available waste stream [7].

Figure 2. The Waste Management System [8]

One of the stumbling blocks for improved waste management practices has been this lack of co-operation between collection and disposal authorities, and worse, the fiercely competitive nature of neighbouring local authorities. Many wheels have been reinvented, and mistakes repeated, because of a failure to share information. With responsibility for collection and disposal of waste often vested in two different bodies, a lack of co-operation has undoubtedly slowed progress towards sustainable waste management. Where partnerships have been formed, more has always been achieved; refer to the Isle of Wight, and Hampshire. These partnerships might be between collection authority and disposal authority, such as those in Hampshire. Alternatively they might involve the disposal agency and one or more community groups; community and voluntary groups have played a large part in innovative waste reduction and recycling in the UK in recent years, Bath being just one example of where the community sector has been contracted to manage recycling for the local authority. Another partnership might involve a three-way collaboration between the disposal authority, a community organisation and an industry partner, such as that in Bristol [9].

The successful management of household waste has to involve a partnership between those responsible for this task (local authority), those who provide the waste collection, recovery and disposal services (private contractor or local authority labour), and those who generate the waste (the public).

Over the last few years local authorities (who are charged with managing household waste) have implemented a diverse range of collection and treatment systems in an attempt to diversify the waste management services they offer. The primary aim of the waste management practitioners is the delivery of an efficient, affordable service, which protects public health and the environment. There may also be a number of secondary aims including the achievement of targets, maximising recovery of value, reducing long distance transportation and minimising the ultimate disposal of waste in landfill, and with this in mind IWM is achievable, but it may not be as easy or as simple to develop or implement as we would like!

However, with so many waste treatment and processing options and available combinations of techniques the task of identifying the optimum integration of options is difficult. Work has begun on this problem through consideration of the relative costs and environmental impacts associated with alternative scenarios. The most common approach is Life Cycle Assessment, currently being developed and employed by the Environment Agency through WISARD. South Gloucester Council has recently secured PFI (public finance initiative) funding for their integrated waste management contract (service) with United Waste, and their strategic thinking was informed by the WISARD lifecycle tool [10]. This requires consideration of;

- *different waste management scenarios which may be appropriate to the area*
- *key performance measures of these scenarios (environmental impact, cost and recovery rates)*
- *appropriate assumptions in relation to the volume of waste arisings and how they will change with time, the stability of the markets for the recovered materials, transport distance to facilities and recovery outlets.*

Another failing in UK waste management has been the emphasis on single materials, either because of their ready recyclability (e.g. aluminium) or their public profile (e.g. plastics), which is likely to be less effective on the whole, in both environmental and economic terms, than taking a multi-material approach which can be more robust under current market conditions and can deal with a greater proportion of the municipal waste stream. Dealing with all sources of solid waste (including domestic, commercial, industrial, institutional, construction and agricultural) means that all the materials within the system are available rather than only some within a specific waste stream (household schemes have historically focussed on paper recycling for example). Focusing on the source of a material (on packaging or domestic waste or industrial waste) is also likely to be less productive than focusing on the nature of the material, regardless of its source, because a process technique (or technology) will generally benefit from a greater throughput (secured feedstock), whilst piecemeal approaches to individual waste streams will not allow these 'scales of economy' to be achieved.

2.1 Sustainable Waste Management?

At a time of increasing concern over global sustainability, the development of adequate municipal waste management systems is of paramount concern. By sustainable waste management we mean managing waste in a manner today that does not leave any undue management or environmental legacies for future generations, or that would hinder their ability to manage their own environmental problems. An IWM can deliver both environmental and economic sustainability, by recognising that no single method of waste treatment or disposal can deal with all the materials in the waste stream in an environmentally sustainable way. Ideally a range of management options is required. Instead of focusing on and comparing individual options as has been the case historically in the UK (the competitive and blinkered stance of recycling versus incineration, or incineration versus landfill), there is a need to focus on waste management systems that can deal with the whole waste stream and asses their performance in both environmental and economic terms. However, for solid waste management to be sustainable it needs to be environmentally effective, economically affordable and socially acceptable.

Sustainability is about balancing the needs of 3 elements [11];

Life Cycle Analysis is an effective tool for planning for more sustainable solid waste management systems, supporting the ideal of IWM. LCA can help assess the environmental sustainability of a system, and will allow any potential combination of treatment methods to be considered to determine the 'theoretical' BPEO. LCI has been invaluable in setting regional waste strategies in London (Ontario, Canada), Barcelona (Spain) and Gloucestershire in the UK. LCI is a decision support tool, as opposed to a decision-making tool, helping to inform and influence waste management decision-making using sound science. In this way not only material flows are considered but also emissions to all media and energy flows through the system can be accounted for [7].

The application of Life Cycle Analysis (LCA) tools to IWM systems is enabling waste managers to plan for and then reduce the overall burdens associated with waste collection, treatment and disposal practices at a range of scales. Economic affordability requires that the costs of waste management systems are acceptable to all sectors of the community served, including householders, commerce, industry, institutions and government.

These costs have always been closely and carefully monitored (historically) as non-financially viable systems will quickly become expensive failures! Social acceptability requires that a waste management system meets the needs of the relevant local community, and reflects the values and priorities of that society (and this requires consultation).

2.2 Integration in the Policy Arena

IWM is not a new concept in the UK. It was identified clearly in the Government's Waste Strategy 'Making Waste Work' (1995), that there is a need to use a range of complementary waste management techniques to effectively manage the waste stream (a key feature of IWM). Another key element noted was the proximity principle, which suggests that waste should be managed and disposed of as near to its place of production as possible thus limiting the need for transportation. Although this concept only really applies to disposal alternatives, it is equally valid for all treatment options because in a sustainable system transportation elements would be kept to a minimum.

The document stated that 'an integrated approach, whereby each adoption of the waste hierarchy contributes to the overall recovery of the waste, will usually be the preferred practice.' This is the Government's interpretation of IWM, and is how they foresaw its application by local government across the UK.

Government policy towards IWM changed little with the shift in Government in 1997 and in the draft waste strategy 'A Way With Waste' (1999) the newly elected Government stated that 'there is an absolute need to develop an integrated approach to waste management' which will deliver a reduction in the quantity and hazard of waste arisings; higher levels of re-use; increased recycling and composting; increased energy recovery; further development of alternative recovery technologies including; pyrolysis, gasification and anaerobic digestion; and greater public participation in the decision-making process.

These messages have been supported by the recent National Waste Strategy for England and Wales 'Waste Strategy 2000,' and the previously published strategy for Scotland, which signal the most significant changes to UK waste management practice. In order to meet the stringent requirements of the EU Directives on Packaging and Landfill a switch to 'front-of-pipe' (at the source of the waste generation) solutions is deemed essential as opposed to 'end of pipe' solutions (when the materials have entered the waste stream). In this strategy new combined recycling and composting targets for England and Wales have been set; requiring authorities to recycle or compost at least 25% of household waste by 2005, at least 30% of household waste by 2010, and at least 33% of household waste by 2015.

A variety of approaches can be used to fulfil these targets for household waste due to the sheer diversity of materials within the household waste stream. This would require a mix of treatment options to manage the household waste stream, whereby individual waste fractions can be sub-divided and treated accordingly (e.g. paper, metal, glass, plastic can be recycled; putrescibles / organics are compostable; combustibles are suitable for incineration with energy recovery and the residue for landfill disposal).

3. DEFINITIONS OF IWM

So, we have heard from the Government about integration, and the failings of waste management practice in the UK because of a lack of integration, but just what does IWM mean for a local authority in terms of its waste management contracts, services and strategy?

IWM is an holistic concept for the collection, treatment and disposal of waste. There are two fundamental requirements; [1] less waste and [2] an effective system for its management. The concept of IWM is essentially being led by the public sector (local authorities) as the client, but it is the waste industry that will provide whatever services are required as the contractor. IWM will mean different things to different people, depending on their particular perception or their waste management function.

It could be the use of complimentary disposal techniques alongside landfill for a WDA or the linking of recycling and refuse collection with ultimate disposal for a WCA. IWM is a term that has been frequently applied but rarely defined, although it is being increasingly accepted as an industrial buzzword in light of sustainable development and best practice [7].

Clearly there are many interpretations of IWM, and associations and organisations promoting their own messages will often use their own definition. In order to take IWM forward we need to have a more clear and precise definition that means something for local government officers, politicians and residents [10]. Thus, Integrated Waste Management (IWM) means – *a strategy for the management of waste utilising a range of environmentally sound systems and processes. Typically it would include the promotion of waste minimisation, materials recycling, resource recovery with landfill considered only as a last resource – the intention being to 'optimise' minimisation, recycling and recovery whilst minimising landfill.*

Under these circumstances 'optimising' means developing alternatives to the historic approach of landfilling all of the waste stream (an obvious waste of resources) through a range of different techniques to their 'most suitable level' given local conditions and regional factors.

There is no single solution, and nor is there a simple diagram explaining IWM, it is simply a concept that will have many local interpretations and applications, depending on a range of factors including availability of markets for recyclable materials, land availability for facilities, the public, budgets, and policy objectives.

What is certain is that IWM takes an overall approach to the management of solid waste, managing waste in an environmentally and economically optimum way, and involving the best use of all available assets and treatment options at local / regional levels to meet given objectives. IWM should offer a range of different waste management techniques and processes used to achieve a sustainable and / or effective waste management policy.

It is often associated with the waste hierarchy, although the approach will vary with geographic location and the nature of the waste. In an IWM approach materials recycling, composting, anaerobic digestion, and Energy from Waste (EfW) and / or landfill may be used together. Clearly IWM is all about the ability to select the 'best' management option for a particular type(s) of waste(s). One must make 'informed' decisions based on the local waste stream composition, the availability of markets, and the strategic aims of relevant regional and localised bodies.

The emphasis must be on evaluating all available strategies for dealing with society's residues, and in most cases implementing a mix of waste management techniques in a complimentary fashion, as determined by environmental, economic and social criteria. IWM must involve the use of best practise to attain the most sustainable solution to dealing with disposal and treatment at any given scale, and it must be in accordance with BPEO, the proximity principle and best value, whilst using LCA to inform the decision-making process. IWM ought to indicate that all available tools have been used to assess the Best Practicable Environmental Option (BPEO) for the whole waste stream under investigation and that the most appropriate means have been gathered together to form a waste management scheme. However, an IWM system in one authority or location may not resemble another IWM system elsewhere – it is a concept representing the best available mix of waste management options being used together as part of a single solution.

3.1 Types of integration

The key work to date on IWM comes from Peter White (of Proctor and Gamble) who suggests that waste management can be 'integrated' in a number of different ways; it may integrate [1] the management of different materials or [2] wastes from different sources or [3] wastes from different product areas [11].

There are perhaps three levels at which integration can effectively occur. The first is where upstream waste and materials collection and handling is integrated with downstream treatment, processing and disposal activities, so that the two distinct systems operate in tandem.

The second option is to integrate municipal waste management with the management of industrial or commercial waste streams (of similar nature) providing a greater throughput of material to feed processing facilities and scales of operation which should in turn lead to improved efficiency.

The final form of integration involves linking the collection of materials for recycling and composting with available markets (outlets and end-user requirements) for these materials. Thus, material value is recovered where there is a demand, and there is no recycling for recycling's sake! There is perhaps one final level at which integration has a part to play in waste management, and this involves the need for siting new facilities which brings the waste industry in close co-operation with the land-use planning authorities and the local residents; a clear need for stakeholder dialogue and partnership approaches [12].

3.2 What are the advantages of IWM?

IWM allows flexibility in the choice and operation of waste options giving freedom to operate within a context, which combines best available recovery and disposal methods in line with local market conditions, and the option of changing systems to suit changes in local or regional markets or conditions. There is a clear need to link the collection of materials with available local (or regional) processing capacity for the collected materials – if there is no market then we should not be collected the materials if they cannot be processed! IWM also leaves room for continuous improvement, allowing the pursuit of best technology and the customisation of solutions to suit local conditions when appropriate.

IWM should also complement single market solutions unlike fragmented waste management policies, which create intra-community trade barriers, and thus fulfil our national obligations within Europe. Perhaps more important for the future development of the waste industry, IWM encourages cost transparency and best practice which in turn lead to greater trust (public and private) and improved decision-making.

These in turn act as a powerful incentive for society to reduce the waste they generate as they can see the real costs of the waste. And finally IWM should result in long-term lower costs through improved economies of scale (a benefit for all).

3.3 A working definition of IWM

According to the Oxford English Dictionary;
Integrate (verb) – *to blend into a whole; to make part of a whole or group; to open (a society or school) to all races; to mix socially and participate in the social life of a group or community.*

Following from this definition of 'integrate' and the previous discussion of IWM we feel that the most accessible and accurate definition of IWM for use in the UK is '*a system for waste management that deals with: all types of solid waste materials and all sources of solid waste' through a range of complementary treatment options which represent the BPEO for the wastes in question, whilst taking account of social, economic and environmental considerations at the local and regional scales.*'

3.4 Implementing IWM

An integrated system would include waste collection and sorting, followed by one or more of the following options, as determined by the stakeholders involved and the local environmental, social and economic conditions:

- *recovery of secondary materials (recycling) and its subsequent processing*
- *biological treatment of organic materials and the selling of the compost.*
- *anaerobic digestion of the organic waste to produce methane and release energy*
- *thermal treatment which can recover energy and render residues as inert materials*
- *and landfill where this increases amenity via land reclamation*

However, integration will only be complete when the complementary facilities are operating within a unified service contract so that flexibility is enabled within the service. This will enable the operators to alter waste flows from one treatment plant to another in response to changing market prices, transportation problems or shifts in the waste composition.

This integration of options to manage a single waste stream will ensure that minimal environmental impact is achieved by ensuring maximum materials recovery thus resulting in a minimum of materials disposal to landfill. It is important for local authorities to ensure that the waste materials they are disposing to landfill cannot be treated otherwise within the waste management framework as discussed previously [7].

More importantly, leading this integrated process must be producers and consumers, who should have regard at all times for waste minimisation in all their activities (including home composting, re-use of packaging and applying green consumer choices), thus reducing the amount of waste going into the stream at source.

An IWM strategy and system has the overall objective of ensuring that waste management practices develop in accordance with the principles of sustainable development. IWM is an essential part of a sustainable future and it is time to start talking, planning and developing the strategies, and contracts required to make this concept a reality in the UK. Thus, an integrated (or sustainable) solution would normally involve;

- *operating across all 3 waste sectors – industrial, commercial and domestic*
- *operating throughout the supply chain – collecting, treating and disposing of waste*
- *operating in national or regional partnerships with the major reprocessing companies*
- *recognising the importance of innovative technologies for waste separation, sorting and treatment processes*
- *operating across regions large enough to provide reasonable economies of scale whilst still being responsive to local needs*

4. BRIEF HISTORY OF INTEGRATION

The development of IWM strategies and systems has evolved over the past 20 years in parallel with the establishment of Environmental Departments, Waste Management Authorities and environmental policies across local government. The common theme of IWM is holistic, meaning that industrial development, waste disposal and environmental strategies are inextricably linked.

The idea of 'integration' in Europe began initially with the concept of a multi-purpose facility able to manage a mixed waste stream, and has been developed through contracts between the public and private sectors to the level of integration that we have throughout Europe today, with integrated contracts, facilities and close co-operation between a whole range of waste related stakeholders.

4.1 European Examples

Since there is no single waste treatment or disposal method, apart from landfill, which can deal with all wastes, it is now generally agreed that an integrated mix of options is needed to manage waste in the best possible way. Today there are many IWM systems in operation, highlighting the environmental benefits and economic optimisation, making the systems integrated, market-oriented, flexible and operational. These systems strive for the incorporation and optimisation of the three concepts of sustainable development; the environmental, the economical and the sustainable. In some instances the integration has focussed on separate treatment operations linked by a unified contract, whilst on other occasions the integration has focussed on a multi-process facility offering a range of treatment options at a single plant or site.

In Europe the concept of a discrete IWM facility was pioneered in France as *'Aurore'* by the waste management company Onyx, meaning new dawn and symbolising the awakening of the community to a new environmental concept. The scheme was devised as a network involving all stages of collection, sorting, treatment and the disposal of waste [13].

An example of where the theory of IWM has been practically implemented is Cergy-Pontoise (a new town in the Paris suburbs) where there was a need for an infrastructure with the ability to; dispose of its waste against a back-drop of locally full incineration capacity and legislation preventing landfill disposal of untreated waste; dispose of trade, commercial and household wastes; provide a flexible solution that could handle rising quantities of waste; provide recycling capacity; obtain maximum value from the waste stream whilst keeping costs down; and provide a scheme that was acceptable to the entire community.

The integrated network was implemented between 1992 and 1994 through the introduction of a selective door-to-door collection of recyclables, which was gradually expanded to cover the whole town. To operate alongside this collection, 11 material recovery 'drive-in' facilities for household waste were built to enable residents to off-load bulky materials (and large quantities if they wished), and a material recovery 'drive-in' facility for trade and commercial waste was also constructed. A total of 200 container sites for 'recycling banks' for paper were planned and implemented, and a central processing facility including a sorting and conditioning unit, a green waste compost plant and an EfW plant were also built. Clearly, this first experience of 'integration' provides an overview of the use of many processes, different waste streams, and the holistic planning, which are all trademark features of IWM today [13].

One of the best examples of an operating integrated facility is the GAVI plant at Wijster in The Netherlands. It is not only the largest integrated waste processing plant in Europe, but also stands out thanks to the unique combination of techniques used. In Wijster, 400,000 tons/year of source-separated bio-waste is composted, whilst 400,000 tons of waste is landfilled. GAVI combines a mechanical waste separation plant with an Energy-from-Waste plant, a flue gas scrubbing unit and a bioreactor located at a landfill site. Operational since April 1996, GAVI treats in total 840,000 tonnes of Municipal Solid Waste every year. Of this, 430,000 tonnes/year are incinerated, generating 48 megawatts gross, which are sufficient to supply a hundred thousand households with electricity. The remainder is sorted and recovered via other waste management options, for it would be pointless feeding partly non-combustible material into an incineration furnace. Rather, efforts are focused on mechanical separation into two streams of non-combustible and combustible waste to make the maximum amount of waste suitable for recycling [7].

Across Europe there are many examples of cities that are utilising a range of waste management approaches to effectively recover value, materials and energy from their waste streams.

The figures from Zurich and Vienna (for example) are indicative of what can be achieved through complementary management approaches within a holistic contract and service [9].

Table 2. Municipal waste management practices in some of the leading European authorities [12];

	Recycling	*Composting*	*Energy from Waste*	*Landfill*	*District Heating*
Copenhagen	52%	7%	37%	4%	Yes
Helsinki	52%	6%		42%	No
Malmo	39%	5%	28%	27%	Yes
Vienna	18%	11%	0%	30%	Yes
Zurich	20%	6%	55%	19%	Yes
Saarbrucken	27%	8%	20%	44%	Yes

One classic example of city-wide integration is the Danish city of Copenhagen, where responsibility for the entire waste arisings from all sources has been placed with the municipality (unlike in the UK). This provides a vital overview (and necessary control) and ensures that a narrow focus on one waste stream does not have negative knock-on effects on others. It also allows wastes to be directed to certain facilities, enabling the optimisation of waste transport, and perhaps most important of all, maximises the recovery of value from all wastes reducing landfill to a minimum. All of Copenhagen's waste which is not recycled or segregated for special treatment (eg. hazardous waste) is separated into combustible and non-combustible streams.

The landfilling of combustible waste has virtually stopped, and the waste going to landfill decreased from 48% in 1988 to only 4% in 1994. However, the proportion of waste being incinerated has remained steady at around 37% because while combustible waste has been transferred from landfill to incineration, this has been counter-balanced by a similar transfer of waste from incineration to recycling. The city's incinerators are combined heat and power plants, producing around 10% of the city's district heating and generating 6% of the electricity consumed in the city.

Table 3. Copenhagen's Waste Management in 1998 (tonnes) [12]

	Household Waste	*Commercial Waste*	*Construction and Demolition waste*	*Total*
Recycling	41,491 (20%)	94,800	405,000	541,291 (59%)
Incineration	162,814 (77%)	141,600	43,000	347,414 (38%)
Landfill	6,066 (3%)	14,400	2,800	23,266 (3%)
Total	***210,371***	***250,800***	***450,800***	***921,971***

4.2 North American Example

Perhaps the best available example of IWM from North America is Edmonton (Alberta – Canada) which has implemented an integrated solid waste management system (ISWM) that achieves a very high level of urban sustainability; combining several approaches to waste management to best address the particular environmental, social and political, climatological and demographic factors of the city. Integrated Solid Waste Management (ISWM) is broadly accepted (in Canada) as being the application of two or more waste management practices to a range of different waste material types. The system has been user-friendly and has achieved exceptionally high levels of participation in voluntary waste reduction and recycling programmes, with 70% of collected residential materials being diverted from landfill in 1999!

Not only is it successful but also all processing occurs at only one site, limiting transportation requirements (an integrated approach at an integrated site). The key components of the system include;

- *a composting plant processing 200,000 tpa of residential waste and 100,000 tpa of wet sewage sludge*
- *aggressive recycling programs with a 40,000 tpa MRF processing materials (kerbside & banks)*
- *upgrading of the landfill operation to include gas recovery, revegetation and leachate treatment*

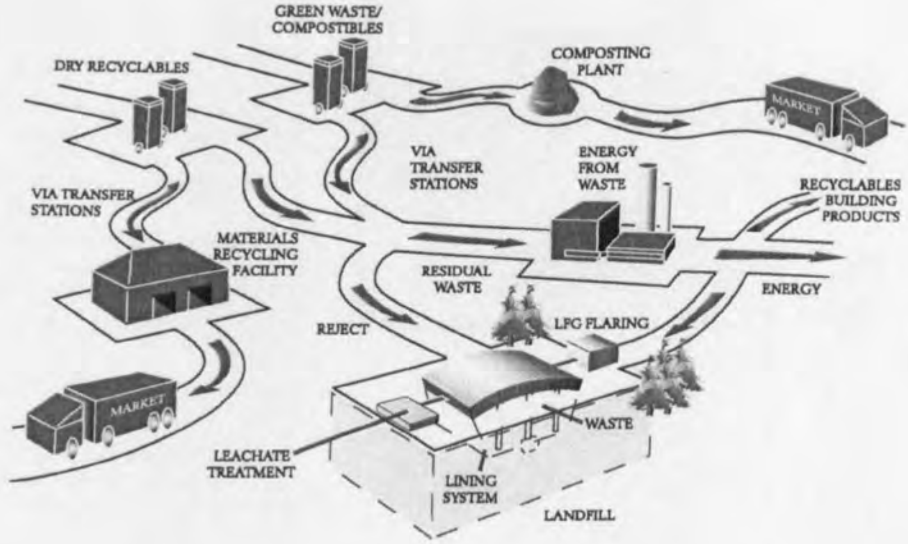
- *2 eco-stations (drop-off centres) for residents to leave household hazardous waste and bulky waste items*
- *a two-stream collection system designed to complement the recycling and composting focus of the system*
- *a waste management centre of excellence in conjunction with Alberta institutions (training, education and research)*
- *a network of 18 recycling drop-off depots around the city*

In the 2-stream residential waste collection system, co-mingled bagged recyclables are collected and delivered to the Materials Reclamation Facility (MRF) for sorting into market commodities; all other waste is collected for processing at the compost facility. This achieves a voluntary participation rate of 77%, and 70% diversion from landfill is now a reality. The system is efficient, environmentally sound and well integrated with both the area's culture and society. It is fully sustainable, treating waste as a resource, and creating products rather than long-term liabilities.

Tabl 4. Waste management routes in Edmonton (Canada) (source: author)

Year	*Landfill*	*Recycle*	*Compost*
1988	220,000 (100%)	0	0
1992	170,000 (79%)	30,000 (14%)	15,000 (7%)
1996	180,000 (88%)	25,000 (12%)	0
2000	100,000 (43%)	40,000 (17%)	90,000 (40%)
2002	65,000 (29%)	40,000 (18%)	120,000 (53%)

Figure 3. The integrated waste management system in Edmonton



5. UK DEVELOPMENTS IN IWM

In the UK I think it would be fair to see that we have lagged behind some of our European counterparts in developing integrated approaches to the management of society's waste. We do not have either the fully integrated plant, or a city-wide integrated waste management service in operation, but there are some good examples of progress and some interesting developments in integration. At a strategy level one of the new breed of integrated and partnership approaches to solid waste management planning is in Northern Ireland where 10 authorities have agreed common principles and objectives on the way t a unified waste management strategy.

IWM solutions are at the forefront of environmental and sustainable development policy. Authorities are being required to think about their long-term arrangements for managing the wastes produced in their areas and to maximise the recovery potential Many authorities are now preparing IWM strategies in response to national and European policy initiatives; these will set out the authority's proposals for future waste management within their areas over a 20 year horizon.

In Waste Strategy 2000, the Government promotes the preparation of joint Municipal Waste Management strategies involving WDAs and WCAs, and proposes to make them statutory. Contractual arrangements with the private sector are changing, partly in response to the requirements of integrated waste strategies, but also due to other initiatives including the Private Finance Initiative (PFI) and Best Value framework; the Isle of Wight and Biffa Waste Services is the best example currently in operation in the UK (fully integrated).

5.1 Project Integra

Project Integra is the UK equivalent of the French 'Aurora' concept (also implemented by Onyx), and represents the disposal contract awarded by Hampshire County, which effectively implements an IWM philosophy across the whole county. Project Integra is as close to IWM in the UK as we are at present (although it does not completely fulfil the criteria for integration), and is leading the way as an example of what can be achieved through integrated services, contracts and partnerships [9].

The waste authorities have tried to overcome their parochial tendencies to employ and implement a strategy embracing a number of techniques within their contractual ability – however overall cost-effectiveness is not yet proven and only time will tell on this issue. In 1992 Hampshire County Council began an extensive process to devise a long-term strategy for managing its waste. One strand of the policy was to increase the recycling rate to 25% by the year 2000, and to 40% in the long term, through the kerbside collection of recyclables and their processing at 3 MRFs. The purpose of 'Project Integra' is to; keep dustbin waste at 1995 levels; achieve 25% recycling by 2000; increase recycling to 40% in the long term; use energy recovery for residual waste; and dispose of the remaining waste and residues to landfill. Specific elements of the integrated philosophy and contract include; the sorting of mixed kerbside dry recyclables; the bulking of bring bank dry recyclables; the aerobic composting of green waste form CA sites and kerbside collection; the anaerobic digestion of bio-waste; energy from waste processing for combustible waste components; and ultimate disposal by landfill of the residues.

According to Hampshire County Council, *'Onyx Aurora Integrated waste management is an intelligent, holistic approach which balances local needs, cost effectiveness and environmental consideration.'* The partners involved include the Waste Disposal Authority (Hampshire County Council), Unitary Authorities (Portsmouth City Council, Southampton City Council) and the County's Waste Collection Authorities (Basingstoke and Deane BC, East Hampshire DC, Eastleigh BC, Fareham BC, Gosport BC, Hart DC, Havant BC, New Forest DC, Rushmoor BC, Test Valley BC, Winchester CC) in partnership with the private sector (Hampshire Waste Services Ltd and Hopkins Recycling Ltd) [9].

Project Integra has had 5 key objectives from the outset; [1] optimising collection arrangements, [2] limiting waste growth, [3] expanding recycling, [4] recovering energy and [5] avoiding landfill; all of which are essential elements of integrated waste management, as noted throughout this document.

Figure 4. Onyx Aurora 'The Integrated Approach' as applied in Hampshire

The County's *'Integrated Waste Management Strategy'* includes; a Joint Waste Minimisation Strategy, and plans for 3 EfW plants, 5 Landfill sites, 3 Regional MRF's, 1 anaerobic digestor, and an assortment of kerbside recycling collections. The strategy (and contract) has a budget of £750 million for its 20-year lifetime, and total capital investment of approximately £140 million. To date Project Integra has achieved a collective recycling rate of 21%, with over 75% of Hampshire's households having access to a kerbside collection of recyclables.

Developments have been made in terms of infrastructure with the current provision of: 3 Material Recovery Facilities, 2 Centralised Composting Facilities, a network of transfer stations, and 3 Energy Recovery Incinerators which are on schedule to be completed within the next couple of years. Slowly the integrated concept is becoming an operational reality, but it does take time to get the required infrastructure in place and all of the interested parties to agree on a common strategy. The effective delivery of the strategy requires joint working between all of the partner authorities and stakeholders. The mechanics and principles for the joint working arrangements were established in the following ways:

- *a joint memorandum of understanding setting out the principles of the respective authorities and obligations supported by all partners.*
- *a tri-partite contract management agreement between Hampshire County Council and the two unitary authorities of Portsmouth and Southampton.*
- *a formal meeting structure to include representation by all Project Integra partners at officer and elected member level.*
- *a proposal for a formal agreement to share income and risks from the sale of recyclables.*
- *a 'Project Integra' joint service plan agreement setting out detailed objectives and responsibilities for the next year.*
- *a joint waste volume planning process establishing service needs and aspirations for the next five years.*
- *a joint promotional campaign focusing on waste minimisation and recycling.*

Clearly joint working and co-operation is essential for the development and delivery of IWM. Onyx Aurora represents an integrated solution offering a complete package covering all aspects of solid waste management from collection, through transportation and sorting, recycling, composting, and energy recovery through to final disposal. It is a completely flexible concept which can be adapted and developed with time and can be tailored to suit different community needs. The prime advantage of this approach is that it breaks down the barrier between collection and disposal to offer an integrated solution, which is flexible and can offer appropriate solutions for different communities. Through *'Aurora'* bulking and sorting of waste will allow marketable products to be recovered. Where appropriate, all suitable material that cannot be re-used or recycled can be incinerated to produce energy. Thus, the Aurora Concept can significantly reduce volumes of waste going to landfill and has to date a county-wide recycling rate in excess of 20%, and an expected diversion of waste from landfill through minimisation, recycling and recovery of 60-70% within the next 5 years. Here is a lesson for us all to take on-board [5].

5.2 Other examples?

Other examples of partial IWM in the UK include; Biffa on the Isle of Wight (integrated contract); Grundon's at Colnbrook (integrated facility);United Waste in Kirklees (an integrated service) and Sita in Surrey (an integrated contract). However, it is fair to say that the whole of the waste management industry has taken up the challenge laid down by the Government in their recent policy documents and begun to develop a portfolio of IWM techniques, approaches and philosophies. Hansons have proposals for a series of 'waste parks' (integrated locations and facilities); United Waste already have 2 county-wide integrated waste management and disposal contracts, SITA and Onyx are bringing their French experiences of integration to the UK, and more and more private and public sector organisations are reviewing their practices in light of what could be achieved through an integrated approach.

Grundons Waste Services Ltd

Grundons (the waste management company) are perhaps best known as one of the leading waste management companies offering a 'complete integrated waste management service.' They can collect, handle, treat and manage dry, liquid, special and clinical wastes, and offer the 'total package' of options for its management from collection, transfer, recycling, recovery to ultimate disposal. At their Colnbrook site (near Slough) they offer; transfer station capabilities; an MRF (which can sort either mixed waste or mixed recyclables); and a clinical incinerator. They also offer collection services and clinical waste treatment to their clients. The company also has permission to build a 440,000 tpa WtE plant that will be operational from 2005. They also have similar facilities around the country, including Swindon and Gloucester. This is integration of a different type from those lead by local authority / waste industry partnerships as in Project Integra); in this case it is an integrated facility offering a range of waste management services to clients at the one site – perhaps similar in style to the GAVI plant.

Isle of Wight – an integrated model

The Isle of Wight became a Unitary Authority in April 1997 and awarded a contract to Biffa Waste Services to operate their waste collection and disposal services, which began in September 1998. This is an initial 12-year contract, with replacing the Waste Derived Fuel (WDF) plant with a hi-tech composting facility for segregated organic waste as its first priority. Other facets of the contract specification include; separate collections of recyclables from households; reconstruction of the MRF; upgrading of existing household recycling centres; and development of the existing landfill site. This contract required a £15 million investment over the contract period and expects to achieve 30% recycling from the waste stream.

Island Waste (a Biffa subsidiary) operates (perhaps) the UK's first integrated household collection, recycling and disposal service, where 40% of municipal rubbish is currently recovered by recycling glass, paper and aluminium and, through a small WtE plant with a capacity of 43,500 tonnes per annum (tpa), electricity is produced which powers 500 homes.

The garden and food waste is also source separated and composted at a special facility. Clearly a range of waste management approaches are in use each focusing on the elements of the waste stream to which they are most suited. All processing occurs on the island, and very little material is shipped on or off the island, thereby complying with the principles of self-sufficiency and proximity.

Kirklees Metropolitan Council

United Waste Services Ltd was appointed provider of an IWM scheme for Kirklees in 1997 where the focus was on a 25-year time frame for environmental sustainability and social affordability. Having control over all aspects of the waste management service enables the unitary authority (and their service provider) a source segregation system to be tailored to suit the forms of treatment, recycling and disposal that are chosen by the stakeholders (separation of recyclables by the households for example). The contract involved the formation of Kirklees Waste Services Ltd (a joint venture company in conjunction with Kirklees MBC and United Waste Services Ltd) with responsibility for 4 CA sites, 2 transfer stations and the future provision of a new EfW plant, a new MRF, a new transfer loading station, 2 new green waste composting facilities, and the conversion of 3 CA sites to household waste recycling centres, all at a cost of £40 million (partially funded through PFI) with the intention of achieving an expected diversion rate of 60% by 2002.

Table 5. Comparison of 2 integrated contracts in the UK [9]

Kirklees Waste Services Ltd	Island Waste Services Ltd
25 year contract	12 year contract
2 new green waste composting facilities	Replace WDF with a hi-tech in-vessel composting plant (1st in the country) for segregated organic waste
New MRF	Reconstruction of existing MRF
New EfW plant	New transfer loading station
Conversion of 3 of 4 CA sites to household waste recycling centres	Upgrading of existing household recycling centres / separate collections of recyclabless
£40 million investment	£15 million investment
Target: 60% diversion rate by 2002	Target: 30% recycling rate by 2000

Both of these examples secured funding through the Private Finance Initiative with the Government providing capital investment for the provision of new infrastructure, which can be paid back over the duration of the contract. This has also proved successful in the development of IWM contracts and systems in Hereford and Worcester, and in Surrey.

Surrey County's Integrated Plan and Contract;

This is the most recent example of an integrated solution applied in the UK. The County are not relying on any one technology, method or site, giving the people of Surrey maximum flexibility and value for money with regards their waste management services. Sita (who won the 25 year integrated contract) intend to release Surrey from its current principal approach to waste management (which is landfill) and provide a modern solution, which will be the envy of county councils across the country.

At the heart of the 'plan' is the firm belief that no single method will provide the solution. Recycling is a key component, with a target level of 25% by 2005 being set, whilst reducing landfill reliance by 70% over a similar timeframe; also the integrated contract and plan includes proposals for two energy-from-waste plants. Other contractual requirements include; improvement of the 15 civic amenity sites and 4 transfer stations throughout the county (to make them more user-friendly and efficient in recycling); the introduction of three Material Recycling Facilities (MRFs); the development of composting schemes in the to divert garden waste away from landfill towards production of compost (for use by local people). Again, the nature of this integrated contract is the use of a range of complementary management techniques to increase diversion of waste from landfill.

This county-wide approach (Surrey and Hampshire) is not as integrated as the Copenhagen example where waste collection, treatment and disposal are the function of a single authority that have let a single unified contract fro all their waste management facilities. Perhaps the Biffa system on the Isle of Wight is the closest we have got to true integration in the UK at present.

6. THE WAY FORWARD

We have moved from a waste management system which was centred on collection and out of site disposal to one where recycling has now been integrated through joint collections and integrated contracts to be part of the total system, but we need to go further. There is a need for structural integration where recycling is but one part of an integrated service suited to the local waste streams and conditions, and then for the ultimate in integration when we no longer focus on waste and its management but think in terms of resource management and the optimisation of waste steams as a potential resource, only then will we become sustainable. To conclude, IWM will (and must) consist of an overall approach to the waste problem, managing waste in an environmentally and economically sustainable fashion, and involving the use of an 'optimum' combination of treatment methods (best determined through LCA).

6.1 How integrated can it get?

If IWM involves taking an overall approach, what can we include in the term overall? Clearly we could have 'integrated municipal solid waste management' to optimise the handling of this waste stream, but there may be advantages in also handling materials from other sources (eg. industrial, building and demolition etc.) in the same system. Optimising the overall handling of all solid wastes would lead to 'integrated solid waste management'. But again, there are good reasons for widening the boundaries further to include water-borne wastes. Some solid wastes, such as paper products like tissues, can enter either the solid or water borne waste streams.

To prevent 'problem-shifting' between the two systems, an overall approach, optimising the treatment of all wastes would be preferable. This would lead us to a full-scale example of IWM, and develop ultimately into an Integrated Resource Management (IRM) system, where waste is part of a broader management system with all resources considered during planning, strategy and service decision-making.

The onus is on local authorities to achieve sustainable waste management (or as best as they can under their local economic, social and environmental conditions), and simply 'bolting-on' waste management options such as composting is unlikely to achieve this goal, as different components of an integrated system are strategically interconnected and must work unison. Simply adding a piece of technology to it will not strengthen it and could act on the contrary. An integrated system is only as strong as its weakest component and to avoid a compromise of achievement the system may need to be recalibrated to incorporate any changes.

However, we must accept that we cannot fully achieve IWM as we cannot completely achieve sustainability, but we can move towards it – the faster the better! However, as local authority decision-makers with tight budgets and a multitude of requirements, there is a need to balance the needs of the community (health, welfare and education) with those of waste management and resource recovery, and so the ideal integrated contract and service may not be an immediate priority and far from an operational reality. We must aim for continuous improvement (as with best practice), and achieve in the long term our final goal of sustainable resource use or Integrated Resource Management (part of the bigger picture – where waste is but one element of the system). The emphasis is now about 'management' and not disposal, and ISWM – integrated solid waste management – implies an optimisation of the system (both materials and energy), and one of the principles of integrated waste management is to recognise waste as a resource rather than a problem!

To conclude, integrated waste management will;

- *take an overall approach*
- *manage waste in an environmentally and economically sustainable fashion*
- *involve the use of an optimum combination of treatment options at the local scale*
- *deal with the entire solid waste stream*

We must all consider the role of integrated contracts, facilities and strategies in our waste management thinking. There is little doubt that integrated solutions, contracts and services are alien to the UK waste management culture which has been characterised by; cheap landfill and a public want for recycling; municipal waste streams managed by local government and other waste streams with their own controls and regulations; authorities with the task of collection or disposal; and by small scale and short time frame approaches. The tide of change is with us, and the pioneering work in Hampshire, South Gloucestershire, Kirklees and others points the way to go. However, IWM will cost more money from the outset because it is dealing with all of the waste stream, it will require political support for the greater budgets required and in securing land for the new facilities, and it will require greater dialogue and partnership between authorities and the waste management sector. If we get all of these (and that may take some time) we will start to see the befits of integration in the years to come, with systems that are flexible and adaptable, which manage all of the waste in the best practicable option, which are environmentally acceptable, economically affordable (in the long term) and socially supported.

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APPENDIX 11

IMPLICATIONS OF EU LANDFILL DIRECTIVE

APPENDIX 11
IMPLICATIONS OF THE LANDFILL DIRECTIVE: COMPOSTING AND WASTE DIVERSION IN THE UK

1. STRATEGIES FOR MANAGING WASTE IN THE UNITED KINGDOM

The year 1999-2000 saw the publication of waste strategies for England and Wales [1], Scotland [2] and Northern Ireland [3]. All three strategies call for a reduction of the amount of MSW sent for landfill disposal and increases in waste recycling and recovery. These strategies are also intended to meet the requirements of the European Landfill Directive [4]. Many of the Directive's requirements are already covered through existing UK legislation, but the principal article as far as these strategies is concerned is Article 5. This article calls for a phased reduction in the amount of biodegradable MSW (BMSW) disposed of to landfill:

to 75% of the amount produced in 1995 by the year 2010;

to 50% of the amount produced in 1995 by the year 2013;

to 35% of the amount produced in 1995 by the year 2020.

These dates take account of a four-year delay for member states (such as the UK) that currently landfill over 80% of their MSW and it is understood that the UK intends to make use of the delay.

2. MEETING THE LANDFILL DIRECTIVE TARGETS

2.1 The Directive

A European Union Directive to control the landfilling of waste has been under discussion for many years and was finally agreed in April 1999 [4]. The overall aim of the directive is to prevent, or reduce as far as possible, any negative impacts on human health or the environment due to the landfilling of waste. In particular, it is concerned with preventing pollution of surface and ground waters, pollution of soils and air pollution. The objective of the directive will be met by several measures designed that will improve the design, operation and management of landfills and also restrict the types of waste that are allowed to be landfilled.

As well as the reduction in BMSW landfilling the following wastes will be banned from landfill:

- *liquid waste;*
- *explosive materials, highly-flammable wastes, corrosive or oxidising wastes;*
- *infectious wastes from hospitals and other medical and veterinary premises;*
- *whole tyres by 2001 and shredded tyres by 2004.*

The co-disposal of hazardous wastes with MSW in the same site will be banned as will the landfilling of any waste that has not been subjected to "pre-treatment".

2.2 Implementing the Directive in the UK

In a paper on the Landfill Directive published before the national waste strategies were finalised, Burnley, Coleman and Gronow [5] carried out a modelling exercise on meeting the requirements of Article 5. These targets mean that the UK will have to take action at two levels. Not only must it limit the amount of biodegradable waste going to landfill by the target dates but it must also build up the alternatives to landfill to deal with the waste diverted from landfill, encourage the diversion of waste away from landfill towards these alternatives, and encourage initiatives which minimise the amount of biodegradable municipal waste produced. Even with the derogation of up to four years for Member States who landfill in excess of 80% of their MSW, the UK will still have to divert additional amounts of biodegradable MSW from landfill.

The results suggested that the UK would have to divert some 15 million tonnes per year of waste from landfill which would involve introducing intensive household waste recycling schemes throughout the UK and constructing up to 46 new MSW incinerators (see Figure 1). These figures assume that there will be no growth in MSW production over the next 20 years. If MSW production grows at an annual growth rate of 3%, the number of new incineration plants required would increase to around 130 (as noted in Figure 2).

Figure 1. Total plant requirements (with 0% growth in MSW) [5]

The following plant sizes that will be required have been suggested to be:

- *Compost plant: 20,000 tonnes per year*
- *Anaerobic digestion plant: 40,000 tonnes per year*
- *Material Recovery Facilities: 50,000 tonnes per year*
- *Incinerators (EfW) facilities: 250,000 tonnes per year*
- *Landfills: 150,000 tonnes per year*

The model used has now been modified to take account of the recycling and recovery targets specified in the strategy for England and Wales. If these targets are applied to the whole UK, required diversion rates and number of new waste management facilities are shown in Table 2. The ranges of values represent annual growth rates in MSW production of zero and 3%.

Table 1. Meeting the Landfill Directive and Waste Strategy Targets [5]

		UK Diversion required by 2020
	Total mass (Mt per year)	Number of new plants required
Recycling	6.9 - 12.5	100 – 210
Organic waste composting	3.0 - 5.6	130 – 260
Incineration with energy recovery	10.9 - 30.1	35 – 110
Total diversion	20.8 - 48.2	

Note: The lower figures represent no growth in MSW generation and the higher figures represent an annual growth rate of 3%.

3. UNCERTAINTIES IN THE DIRECTIVE

The landfill directive must be incorporated into the national law of each EU member state by July 2001 and the first tranche of BMSW targets must be met within 5-9 years of this date. However, there are still a number of issues to be resolved including the definitions of "MSW" and "biodegradable". The final definitions adopted will have a significant effect on the way in which the directive is implemented. In addition, as Table 2 shows, changes in the amount of MSW produced will also have a profound impact on the amount of BMSW to be diverted and the number of facilities required.

3.1 The Definition of MSW

In the UK, MSW is currently defined in terms of the waste collection operation rather than in terms of source or composition. MSW is generally defined as "household waste plus other waste of a similar composition collected by (or on behalf of) the local authority" [4].

In practice, this means that if the waste generated by a particular commercial business is collected along with household waste the material is classed as MSW. On the other hand, if this same commercial waste is collected in a separate commercial waste collection round it becomes "commercial waste" and is not subject to the Directive.

Some European countries recognise this ambiguity and include at least some of their commercial and office waste in their definition of MSW. If the UK was to adopt this definition the amount of MSW generated would rise from 32 to about 57 Mt per year. This assumes that MSW would comprise the current waste classified as MSW plus the 23 Mt of "general commercial waste" identified by the Environment Agency of England and Wales in its survey of commercial and industrial waste and 2 million tonnes of "commercial waste" identified by Scottish Environment Protection Agency. It is understood that the Environment Agency will be publishing the results of its survey [6], but a summary table is including in the waste strategy for England and Wales.

If this additional non-household waste is included in the definition of MSW, the amount of material to be diverted from landfill is increased. Table 3 shows the increased recycling and incineration assuming no growth in MSW.

Table 2. Adopting a wider definition of MSW [5]

ASSUMPTION			***Required capacity 2020***
	Recycling and Composting (Mt/year)	Incineration Mt/year	Incineration (new plants)
No increase in non-household MSW recycling	14.2	24.4	97
Non-household MSW recycling reaches household waste recycling targets	18.9	19.3	64
Maximum recycling of non-household MSW	21.7	16.2	65

Making the most optimistic assumptions about commercial waste recycling (diverting 12 million tonnes per year) the number of new incineration plants required would be 65 (compared to 35 under the current definition of MSW).

However, if we assume that future recycling is concentrated on the household waste stream (in order to meet the national targets) and there is no further increase in non-household MSW recycling there will be a need to construct 97 new incineration plants. Alternatively, we can assume that non-household MSW recycling increases to the rates specified in the waste strategy. In this case, the number of new incinerators is reduced to 64.

All these figures should be treated with caution. In particular, further surveys are required to confirm the quantities and composition of general commercial waste. Due to this uncertainly, it is not considered realistic to make any assumptions about future growth rates in commercial waste production. However, combining this analysis with the results shown in Table 1 would suggest that up to 170 new plants could be required in the most extreme circumstances.

3.2 Biodegradability

In their calculations Burnley, Coleman and Gronow [5] made a number of assumptions about the composition and biodegradability of MSW that are summarised in Table 4. The compositional data were based on surveys undertaken in the 1980s and early 1990s [7,8] and the biodegradability figures are estimates and not based on any experimental studies. However, identical values were subsequently used in the national strategy for England and Wales. It is certainly possible to determine the degradability of MSW and the separate components under aerobic and anaerobic conditions [9] and it is understood that the Department of the Environment, Transport and the Regions (DETR) is carrying out research in this area.

The National Household Waste Analysis Project (NHWAP) [7,8] has provided much useful information on the composition of part of the MSW stream. However, further information is required to update the existing data and also to provide compositional information on wastes delivered to public waste disposal sites and the non-household parts of the MSW stream.

Table 4. Municipal Waste Composition and Biodegradability [5]

Category	*Composition (% by mass)*	*Biodegradability (%)*
Paper and card	32	100
Putrescible material (kitchen and garden waste)	21	100
Textiles	2	50
Fines (particles smaller than 5mm)	7	60
Miscellaneous combustible material	8	50
Miscellaneous non-combustible material	2	0
Ferrous metal	6	0
Non-ferrous metal	2	0
Glass	9	0
Dense plastics	6	0
Film plastics	5	0
Total	***100***	***62.2***

In practice, differences in the degradabilities of each component will not have a large effect on the amounts of waste needed to be diverted because the required diversions are all relative to the 1995 baseline figures and are dominated by the two major biodegradable components paper and putrescible material. However, one very important factor is the assumed degradability of composted MSW.

Waste composters in the UK generally aim to produce a high-grade product to be used in soil conditioners and growing media aimed at the domestic and professional horticultural markets. This involves using separately-collected wastes from households, public waste disposal sites, municipal parks and food-processing plants. An alternative, lower cost approach is to screen mixed MSW and compost the fine organic-rich material. This has been done in large-scale experiments reported by Wheeler [10]. The final product is contaminated with glass, plastics and metals and also contains high levels of potentially toxic elements. However, the compost could be used on landfill sites as cover material. If this practice is to be adopted on a large scale (as some English local authorities are considering) it could be argued that the composted cover material would not be classed as sending BMSW to landfill.

This concept is being taken even further in the process known as mechanical and biological treatment (MBT). In this process, raw waste is composted with minimal pre-processing (screening or size reduction) and the resulting compost is landfilled. This would result in some reduction in the potential for landfill gas production, but the important questions are 'how big would the reduction in uncontrolled landfill gas releases be?' and 'would this composted waste be classed as "biodegradable" under the terms of the Directive?'. Some countries, such as Austria, are considering MBT as a precursor to landfill. For example, Austria has strict limits on the landfilling of organic wastes and normally no waste with an organic carbon content in excess of 5% maybe landfilled. However, waste that has been subjected to MBT may be landfilled if its calorific value is less than 6,000 kJ kg^{-1} (typical values for raw MSW are in the region of 10,000 kJ kg^{-1}) [11].

If the Landfill Directive requirements could be met by subjecting mixed MSW to BMP followed by landfilling treating 14 million tonnes of waste a year would achieve the 2020 target. Such a measure would not contribute to the recycling and recovery targets set in the national strategies, but would allow the UK to meet its obligations to the EU and probably at a lower cost than the massive increase in recycling, composting and incineration outlined above.

3.4. Waste growth rates

The figures in Table 2 show the importance of the growth in household waste on the amounts of BMSW that the UK will have to divert from landfill. Reliable data on MSW production have only been available in the recent past so it is difficult to predict long term changes in MSW. However, one study by Hands *et al.* has suggested that the national growth rate is in the region of 3% per year [12]. However, this overall figure hides the wide range with some local authorities reporting current annual growth rates as high as 7% per year. Much can be done to reduce the amount of waste produced and planning for a growth in MSW may appear to be contrary to the principles of the waste management hierarchy that places waste reduction at its head. However, it is prudent to allow for such a growth because the UK is seeing a trend towards more households (albeit with fewer residents per household).

Waste production increases with increasing numbers of households because many components in household waste are largely independent of the number of people living in the household - for example, newspapers, advertising mail, garden waste and some types of food packaging. The growth in single person households means that the number of households is rising above the rate expected due to rises in population [13]. Therefore, it is prudent to base future waste management needs on at least a small growth in MSW.

4. IMPLEMENTATION OF THE DIRECTIVE

Although waste policies in the UK are determined by central government, their implementation is the responsibility of the local authorities. In England, for example waste collection is administered at the District level and waste disposal at the County level where a County typically comprises up to six Districts. In a number of "Unitary Authorities" both collection and disposal responsibilities reside with the single authority. It is expected that this system will continue to apply and it would be logical for responsibility for the implementation of the Directive would be at County level (for non-unitary authorities).

The Waste Strategy for England and Wales [1] suggests that the Directive will be implemented by means of a system of *"tradable permits"*. Under such a system each authority will be allowed to send a specific quantity of BMSW to landfill. The permitted quantity will vary from authority to authority and may be based on a number factors such as population, number of households, authority type (urban/rural), predicted population growth and affluence. The authorities would be given the appropriate number of electronic or paper permits each one valid for (say) 10,000 of BMSW. The total number of permits issued would be reduced in line with the amounts specified under the directive.

Authorities would then let contracts to public or private waste management companies to dispose of its waste and all consignments sent to landfill would have to be accompanied by the correct quantity of permits. The waste management companies would then return the permits to the waste regulators for auditing purposes.

An authority that invested heavily in recycling/recovery capacity or that let long-term contracts to a private company that would make the necessary investment would not use up its entire quota of permits. These excess permits could then be sold to an authority that needed to landfill more than its permitted amount - for example a rural area where the cost and environmental impacts of an intensive recovery scheme would rule out such an option. This sale would help to offset the cost of the investment or contract. Only the permits would change hands with the waste being deposited close to the point of generation so trading could take place between neighbouring authorities or between authorities several hundred kilometres apart.

The price of these permits could either be left to market forces or determined by the Government. The latter would mean that the price paid for a permit would closely reflect the additional costs of the recycling/recovery operations. This would prevent authorities from profiteering by developing recovery operations far in excess of the amount that would be environmentally beneficial.

5. COMPOSTING AS A SOLUTION

The European Landfill Directive [1] will have a profound effect on how the UK collects and processes biodegradable waste. Composting will clearly have an important role in processing much of the biodegradable waste, which in future will have to be diverted from landfill. This paper will focus largely on the kitchen and garden fraction of biodegradable waste, for which composting is likely to be the most appropriate processing option.

5.1 History of composting in Europe

The concept of large-scale municipal composting appears to have originated in Holland in 1929 with the setting up of N. V. Vuilafvoer Maatschappij (VAM) by the Dutch Government [14]. The facility was used to dispose of the refuse from several cities and to produce compost for which there was a great demand for in land reclamation projects. However, the first serious attempts to use large-scale composting to treat unsorted municipal solid waste in Europe began in the 1970's and extended into the 1980's, at which time it was hoped that these types of plants could treat approx. 35% of the total municipal solid waste (MSW) [15].

These plants would typically attempt to process the entire MSW stream and facilities such as these are now known as mechanical and biological treatment plants (MBT). The key element of the MBT process would involve mechanically separating the organic matter fraction from the MSW prior to composting. The plants would also undertake limited recycling of some materials from the MSW such as ferrous metals and plastics and some would produce a refuse derived fuel (RDF) from the remaining light fraction.

However, the quality of the recycled materials, including compost, from these old type plants was often very poor. Because these plants tended to use hammer mills, shredders or Dano drums to initially reduce the particle size of the incoming MSW, the resulting composted fraction was often heavily contaminated by inorganic debris such as glass and plastics which were found to be impossible to completely screen out. Equally problematic was the presence in the compost of high concentrations of heavy metals (potentially toxic elements), such as mercury and lead, arising from household products. The contaminated nature of the composted materials meant that the composts became increasingly difficult to sell to the public or to use in agriculture [16].

Because of these difficulties and growing environmental awareness, the number of MSW processing plants began to decline in Europe during the 1980s. For example, Gruneklee [16] reported that there were 18 MSW plants operating in Germany up until 1983 with a total plant capacity of around 0.5 million tonnes per year. However, by 1985, most of these old plants had closed down and a new type of composting plant began to emerge. This new approach to composting in Europe involved separating and processing much 'cleaner' biodegradable wastes than mixed MSW in order to produce more acceptable and more marketable products. However, in some southern European countries, where there is a huge need to replenish soil organic matter, MSW composting is still a dominant force. Italy, although now developing extensive source segregation schemes, processed and composted 9.4% of total municipal waste in 1997 using MBT [17].

The composting industry in the UK has tended to reflect the history and changes taking place in Germany and other northern European countries. Gray and Biddlestone [14] reported that a study of unsegregated MSW composting plants in 1971 had shown that there were 13 operating plants. A subsequent survey in 1977 identified only 10 operational plants and noted that only one new plant had been commissioned since 1971 while a number had closed down. None of the MSW composting plants identified in the 1977 survey are currently in operation. Although a number of centralised plants for sorting and recycling unsegregated MSW have been subsequently built in the UK, none are currently producing marketable composts. This point is discussed further in later sections.

5.2 Development of the modern composting industry Europe

Increasing legislation and higher environmental standards appear to have been responsible for encouraging the development of a new generation of composting facilities throughout Europe. A cornerstone of the new approach to composting has been the realisation that only good quality compost derived from uncontaminated wastes has the potential to be sold to the public, used in agriculture or in large-scale reclamation projects [16,18]. Hence, Barth and Kroeger [19] have noted that *"European policy exhibits a trend towards rapid development of source segregated organic waste composting"*.

It is estimated that around 60 million tonnes of potentially recoverable organic waste is produced in the EU each year. Of this 60 million tonnes; France produces 24%; Germany, Italy and the UK 15% each; Spain 11%; Austria 4%; Belgium, Greece and the Netherlands 3% each; Sweden and Portugal 2% each, and Denmark, Finland and Ireland each contribute 1% [20]. Approximately 15% (9 million tonnes) of the recoverable organic fraction is currently recovered through home composting or source separation and centralised composting throughout the EU. However, this European average masks large differences in the amount of organic waste currently recovered for individual Member States (see Table 5).

Table 5. Separately collected and composted household organic waste (including home composted) plus amounts of compost produced in various EU Member States [20].

EU Member State	*Household Organic Waste*		*Compost produced*
	Quantity of organic waste recovered ('000 tonnes)	% of total recoverable in each country	Quantity ('000 tonnes)
The Netherlands	1,800	90%	650
Denmark	500	55%	250
Austria	1,100	50%	500
Germany	4,000	45%	2,000
Belgium	320	34%	160
Sweden	250	16%	100
Luxembourg	7	14%	3
Finland	70	10%	30
UK	317	6%	159
France	400	3%	150
Italy	200	2%	100
Portugal	0	0	0
Spain	0	0	0
Greece	0	0	0
Ireland	0	0	0
Total	***8,964***	***(total 15% recovered)***	***4,102***

The UK in 1997 recovered relatively little of its municipal organic waste (6%) compared with some other European countries. In contrast, the five countries with source segregation polices and infrastructure in place, Austria, Belgium, Denmark, Germany and the Netherlands, collect and compost around 85% of all the organic waste collected and composted in the EU.

The organic material collected from source segregation schemes tends to comprise mainly the vegetable, fruit and garden (VFG) waste fraction. Although the trend is towards increasing levels of source segregation, those countries with poorly developed source segregation schemes tend to compost unsegregated MSW, producing large quantities of low quality compost [15].

In 1996, between 50-60% of German households were serviced with a collection scheme for source segregated organics, with a target to reach 90% [20]. In the Netherlands, organic source segregation is virtually nation-wide, with 94% of all municipalities separately collecting VFG from more than 95% of households. In Finland, source segregation is progressing rapidly in response to organic waste recycling targets [19].

Germany is typical of advanced composting countries in terms of having installed a very diverse range of composting plants from simple windrow systems to more technically advanced processes. Gruneklee [16] noted that in 1995, around 28% of the composting plants in Germany were technically advanced and these composted around 50% of the 4 million tonnes of source separated household waste collected. Plants composting exclusively garden waste amounted to only 30% of the total number of plants in Germany while the remaining 70% composted either kitchen waste on its own or a mixture of kitchen and garden waste. Source segregation and composting is developing very rapidly in Germany.

Compared with the figures given in Table 5, which were collected in the early to mid 1990s, Gruneklee [16] estimated that at the beginning of 1997, Germany composted 77% of its 8 million tonnes of household organic material which is potentially recoverable. This significant increase in the amount of waste collected and composted was also reflected in a steep increase in the number of composting plants, rising from 378 in 1995 to 520 in 1997.

In anticipation of the European Union Directive on the Landfill of Waste, Germany has had strict regulations in place for some time prohibiting landfilling of waste without prior treatment [21].

This is to minimise environmental problems caused by landfilling biodegradable waste. Consequently, in addition to composting the separately collected VFG fraction of municipal waste, Germany has also been investigating the use of MBT processes to pre-treat prior to landfill, the organic material still remaining in the waste stream after source segregation. This waste is sometimes referred to as "restwaste" or "residual waste".

5.3 The current state of the UK composting industry

Compared with many other European countries, the UK recovers and composts only a small fraction of its potentially recoverable municipal organic waste. European countries that are currently achieving high levels of organic waste recovery and composting are doing so through the adoption of source segregation legislation or mandatory targets and the widespread use of kerbside collection schemes. Typically these countries collect both garden and kitchen waste. In contrast, the UK relies almost exclusively on composting the garden waste fraction of municipal waste, this being largely derived from civic amenity sites.

To date, this focus on garden waste, which is also known as green waste, does not appear to have constrained industry growth. The overall picture for composting in the UK is one of continued expansion as reflected in the growth of centralised sites over the last decade, illustrated in Figure 3. In 1999 in excess of 800,000 tonnes of material was composted in 1999, of which centralised sites composted 92%, the other 8% being composted at on-farm sites or community run sites. The 1999 throughput showed an increase of around 20% on the previous year, and an even greater increase (around 30%) is predicted for 2000 according to The Composting Association, who survey authorities annually [22].

Figure 3. The increase in the number of centralised composting sites in the UK

Of the 80 centralised sites, 45 sites processed less than 7,000 tonnes in 1999, with the most common size being 5,000-6,000 tonnes (Table 6). Of the 65 on-farm sites identified, 90% composted less than 1,500 tonnes per site, and of the 52 community sites identified, 98% composted less than 100 tonnes per site. Based on this current performance, centralised sites will have a more dominant future role than other site types in terms of diverting large quantities of organic waste from landfill [22].

Table 6. The throughput of centralised composting sites. [6]

Throughput of individual sites (Tonnes per year)	Number of sites	Percentage of centralised site throughput (%)
<7,000	45	21
7,000 – <14,000	14	19
14,000 – <21,000	11	23
More than 21,000	10	37
	80	***100***

Of total waste composted, almost 619,000 tonnes, around 74% was municipal waste. As mentioned earlier, UK composting is dominated by garden or green waste. Around 93% of municipal waste composted was green waste.

Of all municipal waste collected for composting, 72% of this was green waste from civic amenity sites, 17% was from Local Authority parks and gardens and only 4% was garden waste collected from the kerbside [22]. Although the proportion of organic waste collected from the kerbside has remained relatively constant since 1997, the survey indicated that this is likely to increase in the future; 42 Local Authorities said they currently operate a scheme, 61 said they are planning to introduce a kerbside collection scheme and 12 said they are considering implementation. The survey also revealed a renewed interest in mixed MSW composting (or MBT) with 10 composting operators planning to open an MBT plant or conduct trials.

Respondents to the survey reported that around 57% of 460,000 tonnes of composted material produced was sold to the public or trade, mainly as soil conditioners or mulch. A further 29% was used on-site for purposes such as landfill restoration or landfill cover, and only 14% of the material produced was distributed without charge.

5.4 Likely Impact of the Landfill Directive

Limiting the amount of biodegradable waste going to landfill implies the diversion of this waste towards appropriate treatment options such as composting. A large proportion of BMSW will be made up of paper and cardboard and within an integrated waste management framework the best practicable environmental option (BPEO) may be recycling or incineration with energy recovery rather than composting. However, a substantial fraction will be the organic fraction comprising garden and kitchen waste, where the BPEO is more likely to be composting. Hence, it has been assumed here that future composting effort in the UK will be devoted to diverting VFG wastes rather than other biodegradable wastes, derived largely from paper and card.

UK Government estimates of the proportions of biodegradable waste (53%) and kitchen and garden waste (20%) normally found in municipal waste are now very dated and widely disputed.

In particular they appear to greatly underestimate the large amount of garden waste produced in the UK [23,24] and it is likely that the amounts of biodegradable waste as well as organic waste in MSW are currently much greater than Government estimates suggest. Other published figures for the average biodegradable fraction of the MSW stream range from 53% to 59% [25, 26, 27]. Equally, the proportion of organic waste has been estimated as 29.1% [16], 25.7% and 29% [28] and 28% [26]. Another study in the West Midlands of England found the biodegradable fraction to be 61% of MSW while the organic fraction was around 32% [29]. This report also estimated that garden waste in refuse amounted to around 7.2% of the total with as much again being deposited directly to civic amenity sites.

Hence, in practice it is likely that the overall proportions of biodegradable waste and organic waste in MSW in the UK could now be as high as 60% and 30% respectively. Garden waste could account for as much as 15% of MSW and these estimates are similar to other European countries [4,7]. Table 7 contains estimates for waste to be diverted from landfill and these estimates reflect the uncertainty over the composition of household waste.

Table 7. Estimates of the quantities of biodegradable municipal solid waste and organic waste to be diverted from landfill to meet the Landfill Directive Targets [5]

Year	Total BMSW to be diverted from landfill (million tonnes per annum)	Organic fraction to be diverted from landfill (million tonnes per annum)
2010	12.4 – 15.5	4.9 – 7.7
2013	18.5 – 21.9	7.3 – 10.9
2020	26.8 – 31.0	10.6 – 15.5

Assumptions made in calculations for Table 4:

- *Municipal waste arisings in 1995 in the UK were 29 million tonnes*
- *Waste arisings increase by 3% per annum from 1995 [19]*
- *The composition of the biodegradable fraction remains constant and is assumed to be between 53% and 60%*

- *The organic fraction (garden and kitchen) ranges from 20% to 30%*
- *The Landfill Directive targets will apply equally to each BMSW type*
- *The UK opts for the four year derogation period*

5.5 The growth of composting

Preliminary analysis of the survey data for 1999 shows the UK composting industry continuing to expand strongly, providing a sustainable alternative to landfill for municipal organic waste [22]. The average rate of growth in the number of centralised composting facilities over the last five years was approximately 25% each year and this growth in sites was also reflected in the increase in throughput.

The amount of municipal waste composted in 1999 (619,000 tonnes) was 21% greater than in the previous year (512,000 tonnes) and the results of the 1999 survey forecasts that the amount is likely to grow by a similar amount (maximum 29%) in the year 2000. The composting sector appears to be an industry showing rapid growth in capacity matched by an ability to find markets and uses for the resulting composted products. This raises the question whether the rapid growth observed in UK composting is sustainable? Is the industry focussing on the most appropriate material and utilising the most suitable processes to meet the very onerous targets laid out in the Landfill Directive, and to deliver an option for sustainable waste management in the longer term?

A more detailed analysis of the centralised composting industry, which handles around 92% of all waste composted in the UK, suggests that the industry differs significantly in certain respects from other European countries more advanced in the use of composting. In theory, an estimated 10 million tonnes of municipal organic waste is currently available for composting in the UK. In 1999, around 619,000 tonnes of municipal organic waste was recovered, equating to a 6% recovery rate, and 93% of this was garden waste. In contrast, Germany recorded a 77% recovery rate in 1997, and only around 30% of plants handled exclusively garden waste [16].

Despite rapid growth in the UK composting industry, results of the 1999 survey raise serious concerns about its ability to deliver sustainable waste management in the longer term and pressing structural changes may be necessary. Concerns centre on three main features of the current industry profile;

1) *the sector is dominated by small sites, with typical throughputs of around 5,000 to 6,000 tonnes per year, and forecasts for 2000 confirm this dependence on small sites is set to continue. At present these small sites comprise more than 50% of all sites but account for only 20% of waste composted.*
2) *2) in terms of processing municipal waste, the industry is totally dependent on composting garden wastes (93%), rather than processing kitchen wastes, which are potentially the more environmentally polluting fraction of household waste. Furthermore, much of the garden waste (72% of municipal waste) is collected from civic amenity sites.*
3) *3) because of the continued emphasis on composting relatively benign garden wastes, the industry is based on relatively unsophisticated composting technology and management systems with 90% of sites employing open air windrow systems.*

6. DISCUSSION

The objective of the EU Landfill Directive is to *"prevent or reduce as far as possible negative effects on the environment"* [4]. Member states have a statutory duty to implement the directive, but in such a way that its implementation does not create different, but equally environmentally-damaging stream of pollutants. The introduction of the proposed tradable permits system should prevent areas of the country from adopting waste management systems that do not represent the Best Practicable Environmental Option (BPEO) simply to meet the Article 5 requirements at a local level. All the UK environmental regulatory bodies are encouraging local authorities to use life-cycle assessment tools in developing their waste management strategies and this will also help to ensure compliance with the Directive and the application of BPEO.

There are however several unanswered questions that must be clarified before the UK as a whole, the constituent countries or the local authorities can begin to develop and implement strategies to meet the Directive's requirements.

In particular it is essential to know:

- *what is meant by MSW;*
- *the degradability of each component of the MSW stream;*
- *whether composted waste is classed as "biodegradable";*
- *likely growth rates in MSW.*

The definition of MSW requires a policy decision. There is no doubt that the pollution caused by the landfilling of a tonne of waste is the same whether the waste is classed as "commercial" or as "municipal". This argument would support adopting a wider definition of MSW, but the cost and environmental impacts of diverting the additional quantities of waste from landfill may not be justifiable. Whilst the final decision is a policy one, it must be guided by sound science, engineering and economics.

Determining the degradability of MSW and composted MSW by establishing standard test regimes should be a relatively easy task, but the results of such a test will have far-reaching implications. If composted MSW is defined as non-biodegradable, the UK (and other member states) will be able to continue with a landfill-based waste management strategy. On the other hand, if composted MSW is still classed as biodegradable, the UK (and other member states) will have to invest billions of Euros in expanding its recycling and incineration infrastructure.

Similarly, the growth rate of MSW must be established if national and local government is to provide the correct number of waste management facilities. Recent improvements in waste arisings and disposal statistics is helping in this area, but there are still a number of uncertainties that need to be resolved.

6.1 Implications for composting

The Landfill Directive seeks to reduce the amount of biodegradable municipal waste going to landfill. Of particular relevance to the composting industry is the kitchen and garden waste fraction of municipal waste because that is the fraction where BPEO is most likely to be composting.

The first Landfill Directive target in 2010 requires the UK to have diverted between 4.9 – 7.7 million tonnes per annum of organic material in MSW from landfill. In 1999, the UK composting industry processed around 619,000 tonnes of municipal waste and the composting capacity was estimated to be growing at around 22% per year. If this growth and current sector profile is maintained, it is possible that around 5 million tonnes of waste could be processed and this would require approximately 600 composting facilities, many of which would be relatively small. An eight-fold expansion of the present composting capacity would be required and this would only reach the lower end of the target. Meeting subsequent targets would require at least a twelve to sixteen fold expansion in the current composting capacity. Can this growth be achieved in practice and can it be sustained in the longer term without major structural changes in the way the UK collects and composts waste?

A major factor in determining growth and shaping the form of the industry relates to future waste production, composition and collection. If the emphasis on green waste composting is maintained then around 93% of the waste composted in 2010 would be garden waste. If it is assumed that garden waste comprises 15% of municipal waste and that the amount of waste increases by 3% per year then sufficient green waste could be available for collection and composting in 2010 to meet the first Landfill Directive target, at around 7 million tonnes. However, it is highly likely that only a fraction of this garden waste would actually be available for composting. For example, at present most garden waste (72%) is collected via civic amenity (CA) sites, which serve only a relatively small number of the UK population.

For England and Wales, in 1997/98, only 480 CA sites existed and these collected on average 80 kg of garden waste per household served per year [30]. On the basis of these figures, even if similar CA sites were to be extended to cover the whole of the UK, it is likely that less than two million tonnes of garden waste would be collected every year by this route. Although important to the current profile of the composting industry, garden waste from CA sites, coupled with additional parks and garden waste, is unlikely to be a sufficient source of material to sustain future growth if the industry is to meet the obligations ahead.

In considering how the industry may develop to complement the current small scale garden waste sites, two interesting, and potentially conflicting features emerge. The most obvious of these is that source segregation and kerbside collection of household organics are set to rise considerably, with more schemes planned than are currently in operation, and secondly the renewed interest in MBT to treat unsorted municipal waste.

Source Segregation

As mentioned earlier, source segregation and kerbside collection of organics is requisite in countries advanced in composting. In Italy, it has been estimated that between 30-70 kg of garden waste may be collected per person per year using kerbside collections.

When garden waste has been combined with the collection of kitchen waste recovery rates can be as high as 150 kg per person per year [17]. In UK terms, with approximately 2.5 persons per household, this suggests that kerbside collections could at present recover up to 375 kg of organic waste per household per year. This compares with the current, very limited capacity of collecting only 80 kg of garden waste per household per year from civic amenity sites. Estimates suggest that there will be over 13 million tonnes of kitchen and garden waste available for composting in the UK in 2010. Kerbside collection schemes similar to those already common in other European countries could deliver over 8 million tonnes of household waste for composting. These figures suggest that kerbside collection of both kitchen and garden waste is a realistic method of recovering the large amounts of organic waste that will be required if the UK is to achieve the first and subsequent Landfill Directive targets.

Adopting a model involving kerbside collection of kitchen waste as well as garden waste would also have a profound effect on how the industry composts waste due to the putrescible nature of the kitchen waste fraction, and the associated potential for increased environmental impact. This would mean a change from largely outdoor systems of composting to more sophisticated enclosed processes.

At present there are a number of other factors impinging on the growth of the composting sector which are also shaping its form now and, unless addressed, will continue to do so in the future. Composting operations, especially outdoor facilities, are known to have a high environmental impact resulting from odour and bioaerosol emissions and noise problems [31]. Consequently, licensing and planning issues have often been cited as the main reasons for constraining growth in the composting sector [32]. Is it realistic to assume that suitable sites will be found for hundreds of small outdoor facilities, with the likelihood of many being situated near to highly populated areas, or would it be more practical to consider a number of much larger enclosed facilities with high levels of environmental control, such as those found in Germany? Finding markets for the large amount of compost expected to be produced in the future has always been an issue. However, at present finding outlets for compost appears not to be a major problem and agriculture has been identified as the most likely end user in the longer-term [33].

Mixed processing

'Mixed MSW composting' is the term usually used in the UK to refer to those processes that other European countries term 'mechanical and biological treatment' or 'bio-stabilisation'. This issue of semantics is important, since the 'composting' process implies the production of a 'compost' rather than simply treatment of the waste. The experience from the UK and advanced composting countries in Europe suggests that mechanical and biological treatment of mixed MSW is unlikely to produce a composted material that would meet the exacting standards required for marketing to the public or for use in agriculture [16].

The European Commission's working document on the *'Biological Treatment of Biodegradable Waste'* [34] suggests quality standards for, and makes a clear distinction between, a quality compost produced from a composting process, and stabilised biodegradable waste produced from MBT. The assumption in this document is that composts are derived from relatively uncontaminated source segregated wastes while MBT of unsegregated MSW produces stabilised biodegradable waste which, if conforming to strict standards, may be used in land restoration projects.

At present there are many uncertainties surrounding mixed MSW processing/composting in the UK. A clearer 'composting' definition is required, that distinguishes between 'composting' to produce a quality product and 'composting' as a treatment to stabilise the organic fraction in municipal waste. Guidelines and standards in the European Commission's working document should help address some of the current uncertainties surrounding possible uses, including landfill cover, for the processed/composted material.

Despite these uncertainties, mixed MSW composting (or MBT) is likely to have a valuable role to play as a pre-treatment stabilisation method prior to landfill, thereby helping to meet the Landfill Directive pre-treatment and diversion targets.

However, UK policymakers need to provide a framework so that as MBT develops it is able to emerge as a treatment process that integrates with, rather than competes against, source segregation and kerbside collection.

7. CONCLUSIONS

In order to implement the Landfill Directive all parts of the UK will need to develop intensive national recycling schemes and expand their incineration capacity. Depending on the definition of MSW used, the recycling rates achieved and the growth rate in MSW between 35 and 170 new energy from waste incinerators will be required in the UK. Large scale composting of MSW followed by landfill could provide one relatively cheap way of complying with the Landfill Directive.

The experience of other more advanced composting countries in Europe suggests that a sustainable approach to recovering significant amounts of municipal organic waste depends on establishing extensive source segregation and composting networks. An evaluation of the current profile and the long-term needs of the composting industry in the UK confirms that widespread adoption of source segregation is a technically feasible option for the UK. Many local authorities are actively investigating or commissioning source segregation schemes, and there is also a renewed interest in using mechanical and biological treatment to process MSW directly.

In many European countries, these two technologies will increasingly complement each other. In general, organic waste, separately collected, will be composted to produce quality products whilst mechanical and biological treatment will be used to stabilise residual or 'restwaste' after source segregation has removed most of the organic fraction. It is not clear to what extent the UK will reflect best practice as demonstrated in the more advanced composting countries, but the lessons from the past suggest that adopting widespread mechanical and biological treatment of unsegregated MSW will not be sustainable in the longer term.

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APPENDIX 12

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APPENDIX 12.1

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APPENDIX 12.2

AUTHOR'S PUBLISHED PAPERS & CONFERENCE PRESENTATIONS

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3. PRESENTATIONS AT CONFERENCE

1. The Waste Hierarchy, at the Human Geography Postgraduate Research Forum, Egham, April 1997
2. The Waste Hierarchy: the local government role in driving national policy, at the School of Geography Research Seminar, Kingston University, May 1997
3. Environmental Bodies: early developments from two English Counties, at the 6th Annual East Midlands Conference on the Environment, Nottingham, July 1997

4. English County Council Waste Minimisation Initiatives, at the 6th Annual East Midlands Conference on the Environment, Nottingham, July 1997
5. Landfill Policy and Availability in England: a future waste management option, at the 13th International Solid Waste Management and Technology Conference, Philadelphia, November 1997
6. English County Councils and Waste Minimisation Strategies, at the 13th International Solid Waste Management and Technology Conference, Philadelphia, November 1997
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9. The Waste Hierarchy: a local authority perspective, preliminary survey findings, at the IBG-RGS 1998 Conference, Surrey University, January 1998
10. The Recycling Roadshow: effective public communication, at the IBG-RGS 1998 Conference, Surrey University, January 1998
11. Waste Minimisation in the UK: future trends and research areas, at the University College Northampton - School of Environmental Science Research Seminar Series, February 1998
12. Is anybody there? Promoting recycling services to the public, at the IWM Young Persons Research Conference, Loughborough, April 1998
13. The Environmental History of Waste Management in the UK, at the European Association of Environmental History Annual Conference, Northampton, May 1998
14. Waste Minimisation Programmes: funding and future?, at the School of Geography Lunch-time Research Seminar series, Kingston University, May 1998
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22. Publishing; hurdling for beginners? at the IBG-RGS 1999 Conference, Leicester University, January 1999
23. Excuse me, do you recycle? Public participation in Kerbside recycling a case study from the UK, R'99-Recovery, Recycling, Re-integration, February 1999, Geneva
24. The Message is Sustainable Waste Management; the Focus is using characters from Children's literature and television to promote this message, 1st International Conference on Solid Waste Management, Rome, April 1999
25. How to Fund Sustainable Waste Management Research and Practice? The Example of Landfill Tax Credits, 1st International Conference on Solid Waste Management, Rome, April 1999
26. A New Role for Recycling Officers in the UK? Social marketing, awareness raising and overcoming barriers to public participation? 1st International Conference on Solid Waste Management, Rome, April 1999
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29. Is the landfill tax credit system driving sustainable waste management? WEMRU 'Waste Matters' Seminar, Kingston University, Kingston, July 1999
30. Partnership opportunities in the solid waste management sector; how we can help each other? WEMRU 'Waste Matters' Seminar, Kingston University, Kingston, July 1999
31. The Landfill Tax and its contribution to the polluter-pays principle, lunch-time research seminar at the Process-Engineering Laboratory, Oulu University, Oulu, Finland, July 1999
32. Municipal Solid Waste Management policy implementation in the UK, lessons from local authority experience, lunch-time research seminar at the Process-Engineering Laboratory, Oulu University, Oulu, Finland, July 1999
33. Waste management in the UK and the START Group concept, RVF Young Generation Event, Sweden, August 1999
34. Funding Waste Management Research and Development? Landfill Tax Credits, Higher Education and the Private Sector, Sardinia '99 7th International Waste Management and Landfill Symposium, October 1999
35. Overcoming barriers to public Involvement in Recycling Programmes? An Innovative Marketing Approach used in the UK, Sardinia '99 7th International Waste Management and Landfill Symposium, October 1999
36. Waste management around Europe, the IWM Young Members meeting, Kingston upon Thames, November 1999
37. Swedish Waste Management Practices; lessons from site visits? The IWM London Centre Open Meeting, Barking, November 1999
38. An overview of waste disposal and treatment in Sweden; thoughts on the RVF Young Persons Conference, the IWM London Centres Seminar on Sewage Sludge and Anaerobic Digestion, London, November 1999
39. Achieving Sustainability in Waste Management? Institute of Wastes Management Mission to the Lebanon, Beirut, November 1999
40. Waste Management Policy Implementation; thoughts, data and anecdotal evidence from English local authorities, the 15th International Conference on Solid Waste Technology and Management, Philadelphia, December 1999
41. The UK Landfill Tax Credit System; progress, research funding and partnership opportunities? the 15th International Conference on Solid Waste Technology and Management, Philadelphia, December 1999
42. 'Making good use of the things that we find'; the Womble agenda for sustainable waste management in the UK, the 15th International Conference on Solid Waste Technology and Management, Philadelphia, December 1999
43. Waste Minimisation Project Clubs in the UK; putting the environment on the business agenda? the 15th International Conference on Solid Waste Technology and Management, Philadelphia, December 1999
44. The Recycling Roadshow; an example of public communications in the UK, the 15th International Conference on Solid Waste Technology and Management, Philadelphia, December 1999
45. The UK Landfill Tax - an evaluation of the first three years, the 15th International Conference on Solid Waste Technology and Management, Philadelphia, December 1999 (with John Morris and Paul Phillips of University College Northampton)
46. County-wide waste minimisation: are they successful? A case-study from the East Midlands of England, the 15th International Conference on Solid Waste Technology and Management, Philadelphia, December 1999 (with Beth Gronow, Paul Phillips and Karen Pike of University College Northampton)
47. Public education and social marketing; lessons from studies of Recycling behaviour in London, the RGS-IBG Annual Conference, Brighton, January 2000
48. Putting academic research in the public domain - satisfying the needs of the RAE?, , the RGS-IBG Annual Conference, Brighton, January 2000
49. Why does policy implementation fail - lessons from local government waste management professionals, the RGS-IBG Annual Conference, Brighton, January 2000
50. Career paths, research agendas and academia - life beyond the PhD?, the RGS-IBG Annual Conference, Brighton, January 2000
51. Publishing – an art or a science? How to turn consultancy and research into RAE bonus points, DfEE Waste Minimisation Discipline Seminar Series, Northampton, April 2000

52. An overview of waste management in the Lebanon – opportunities for UK plc? IWM-DTI Feedback Seminar on the UK Waste Trade Mission to the Lebanon, London, April 2000
53. Landfill Tax Credits for the promotion of Recycling and Education – some examples of successful partnerships, Robert Long Consultancy 'Landfill Tax Credits for Recycling & Contaminated Land' Conference, Cambridge, May 2000
54. Sustainable waste management research and development; the successful use of the landfill tax credit? R'2000 the 5th World Congress on Integrated Resources Management, Toronto, June 2000
55. The Future of the Institute of Wastes Management - The Next Generation or Warp Factor 8? IWM Annual Conference and Exhibition, Torbay, June 2000
56. MSW Policy Implementation and Barriers to change at the local scale, CEESR Annual Postgraduate Research Seminar, Kingston University, Kingston, June 2000
57. Where there's muck there's brass – the cost of London's waste management, British Association SPARKS Event 'London Audit; a Sustainable City?' London, September 2000
58. Public education and recycling performance – how to convince the public to participate in recycling? WASTE 2000 – Research, Policy and Practice, Stratford upon Avon, October 2000
59. What can we achieve? The Recycling Roadshow Launch (with Michael Portillo MP), Royal Borough of Kensington & Chelsea, October 2000
60. Waste segregation, recycling and diversion in London – lessons in public participation from Kensington & Chelsea, ACR – AVR International Waste Management Conference, Dublin, October 2000
61. Encouraging participation in residential recycling and composting programmes, HDRA Consultants Organic Waste; from the kerbside to compost one-day conference, Coventry, October 2000
62. Effective Communication Programmes and their role in improving Public Participation in Recycling – lessons from London,, 16th International Solid Waste Technology and Management Conference, Philadelphia, December 2000
63. Initiating Environmental Management Systems in Small to Medium Enterprises (SMEs) – Successful Waste Minimisation lessons from Surrey County (England), 16th International Solid Waste Technology and Management Conference, Philadelphia, December 2000
64. The Landfill Tax Credit System; an interpretation of the 'polluter pays principle' in the UK? - Opportunities for Funding Local Authority Recycling Projects, 16th International Solid Waste Technology and Management Conference, Philadelphia, December 2000
65. Sustainable Strategic Waste Planning and the 'cost' of London's Waste - the new Mayor's agenda for the capital?, 16th International Solid Waste Technology and Management Conference, Philadelphia, December 2000
66. Increasing Public participation in Sustainable Municipal Solid Waste management, 16th International Solid Waste Technology and Management Conference, Philadelphia, December 2000 (with Malgorzata Grodzinska-Jurczak)
67. The Landfill Tax and the Landfill Tax Credit Scheme - a possible misuse of public funds, 16th International Solid Waste Technology and Management Conference, Philadelphia, December 2000 (with John Morris)
68. Public Education Campaigns and the Recycling Message - what do the public think of recycling and do they want to do it? Towards the Future; Waste in the 21st Century, University College Northampton, January 2001
69. Green fingered? - Organic Waste Management in London, Towards the Future; Waste in the 21st Century, University College Northampton, January 2001 (with Steve Jones)
70. Waste Minimisation in the Royal Borough of Kensington & Chelsea, MEL's Waste Reduction Conference, Aston Science Park, Birmingham, January 2001
71. The role of waste minimisation project clubs in driving sustainable waste management, IWM Workshop Rapporteur, IWM Annual Conference, Torbay, June 2001
72. IPPC as a driver for business sustainability; a role for waste prevention? IWM Workshop Rapporteur, IWM Annual Conference, Torbay, June 2001
73. Public communication campaigns and effective participation in kerbside recycling; lessons from London, ISWA 2001, Stavanger, Norway, September 2001

4. POSTER PRESENTATIONS

1. Channelling landfill tax monies into local environmental improvements: the role of environmental bodies and landfill site operators, at the SCI Environment and Water Group Young Scientists Research Symposium, December 1997, London
2. An innovative and effective approach to the promotion of kerbside recycling in the Royal Borough of Kensington and Chelsea, at the SCI Environment and Water Group Young Scientists Research Symposium, December 1997, London
3. Promoting kerbside recycling in London; social marketing by a local authority, at the launch of The Centre for Earth and Environmental Research (CHEERS), Kingston University, October 1998, London
4. Crossing the divide, national strategy and local practice? MSW policy implementation by local government in the UK, R'99-Recovery, Recycling, Re-integration, Geneva, February 1999
5. Do you Recycle – social marketing of the recycling message, WEMRU 'Waste Matters' Research Seminar, Kingston University, Kingston, July 1999
6. Freshkills Landfill site – closure and implications for waste exports from New York City, WEMRU 'Waste Matters' Research Seminar, Kingston University, Kingston, July 1999
7. Waste Minimisation Project Clubs – saving money through improved environmental performance, WEMRU 'Waste Matters' Research Seminar, Kingston University, Kingston, July 1999
8. Sustainable waste management- how to drive research, education and training through landfill tax credits, WEMRU 'Waste Matters' Research Seminar, Kingston University, Kingston, July 1999
9. Getting in the press- the art of writing, publishing and dissemination, WEMRU 'Waste Matters' Research Seminar, Kingston University, Kingston, July 1999
10. Sustainable Waste Management; How to use characters from Children's literature and television to promote this message; a Role for the Wombles? Sardinia '99 7th International Waste Management and Landfill Symposium, October 1999
11. Placing waste minimisation on the business agenda in the UK; the club approach? R'2000 the 5th World Congress on Integrated Resources Management, Toronto, June 2000
12. A new marketing role for Recycling Officers in the UK; overcoming barriers to public participation through the 'Roadshow' concept, R'2000 the 5th World Congress on Integrated Resources Management, Toronto, June 2000
13. Public waste awareness and green consumerism - a comparison of Finnish and British practices? R'2000 the 5th World Congress on Integrated Resources Management, Toronto, June 2000 (with Eva Pongracz, Oulu University, Finland)
14. Public waste awareness and green consumerism - a comparison of Finnish and British practices? 16th International Solid Waste Technology and Management Congress, Philadelphia, December 2000 (with Eva Pongracz, Oulu University, Finland)
15. The Wombles – promoting sustainable waste management to the general public, 16th International Solid Waste Technology and Management Congress, Philadelphia, December 2000
16. Public waste awareness and green consumerism - a comparison of Finnish and British practices? 16th International Solid Waste Technology and Management Congress, Philadelphia, December 2000
17. How to Exceed 50% Waste Diversion Through Composting and Recycling from the Kerbside Daventry District Council's Green Waste Diversion Scheme, Towards the Future; Waste in the 21st Century, University College Northampton, January 2001 (with Sue Reed, Daventry District Council)
18. Using the landfill tax to drive sustainable waste management in the UK – how to fund recycling programmes, ISWA 2001, Stavanger, Norway, September 2001
19. Waste minimisation practices and strategies in small-medium enterprises; lessons from Surrey County and projects across the UK, ISWA 2001, Stavanger, Norway, September