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Landfill as a future waste management option in England: the view of landfill operators

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Abstract

Municipal solid waste (MSW) management issues have moved to the fore of the public agenda, with levels of concern and activity by citizens and governments world-wide reaching unprecedented levels. New waste management techniques are being developed in response to this situation, but many are in their infancy and are not proving to be economic in England. Landfill remains the dominant waste management method employed by waste disposal authorities in England, whilst recycling and waste to energy schemes have struggled due to the historically cheap nature of landfill. The opinions and views of both waste disposal authorities and private disposal contractors were obtained using a postal survey, allowing an assessment to be made of the potential role of landfill as a waste management option for municipal waste in England. This survey provides an insight into the broader issues of current interest to the waste industry, focusing upon the take-up rates of alternative treatment routes to landfill by the private and public sectors, and their attitudes towards the various 'carrots and sticks' that are currently being used by the Government to shape the management of municipal solid waste in England. By the year 2010 many regions of England will be suffering from a shortage of landfill void and it is in (part) response to this scenario that the Government has begun to actively promote the development and use of alternative strategies, through the initiation of the recycling credit scheme and the imposition of the

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landfill tax, to preserve landfill void for the future disposal of untreatable residues. © 1997 Elsevier Science B.V.

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1. Introduction

1.1. Framework

According to the Environmental Protection Act (1990) [1],

> ''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.''

There are numerous definitions available for what constitutes waste, and many classifications exist which attempt to segregate and 'box' waste materials, the most common of which focus upon the source of the waste materials. Thus, there are Agricultural, Industrial, Civic Amenity, Household, Commercial, and Sewage wastes, but for the purposes of this work only 'municipal solid waste' (MSW) will be discussed, where household and commercial wastes are grouped together. They are the responsibility of the local waste collection authority, and are the wastes that are most noticeable on the streets each week. Of the 35 million tonnes (approx.) of municipal solid waste generated on average each year in England and Wales about 88% is landfilled, some 6% is incinerated and the remaining 6% is recycled [2]. This reliance on landfill has been of great concern of late due to the need for continuous void availability which is now proving difficult to meet [3], and this is the fundamental theme investigated within this paper.

Municipal solid waste management has evolved from primitive origins through the development of open dumps in ancient Rome to the sophisticated collection and disposal systems that are in use today. In 1875 The Public Health Act made it law that all domestic refuse should be kept within a dustbin which would be emptied by the relevant Local Authority at least once per week. The foundations of the present controls relating to municipal waste collection and disposal were laid down in the 1936 Public Health Act, and in the 1947 Town and Country Planning Act, whereby Local Authorities were given power of control over the development of new disposal sites which had to meet certain environmental standards [4]. The fundamental piece of waste management legislation was the 1974 Control of Pollution Act, which really took hold of the industry and provided it with new and greater direction, guidance and regulation. Much of

this legislation has been maintained and developed within the 1990 Environmental Protection Act, which tightened the structure of the waste industry and provided greater guidance and regulatory controls [5].

There have been several important contributions to the development of waste management theory and practice during the recent past. Particularly notable are the work of Powell and Brisson [6] and Cooper [7] on 'green economics', Pearce and Turner [8] on 'economic instruments', Coggins [10] and Gandy [11] on minimisation and recycling strategies, and Petts [12] on environmental perception and risk. However, there has been little active research focusing upon Government control over choice of municipal solid waste management strategy by waste disposal authorities or national landfill availability, which are intrinsically linked and are the central concerns of this paper.

The main theme of this work is to assess what municipal waste management decision makers think the future role of landfill will be in England, whilst investigating whether Government policy has been actively encouraging the growth of alternative waste management options at the expense of landfill. A number of preliminary objectives were established to guide the research.

- To establish the extent of the landfill problem facing the future disposal of municipal solid waste in England.
- To determine whether alternative waste management practices have been adopted in response to the predicted landfill shortage, and to assess the impact of these options on landfill disposal of municipal solid waste.
- To investigate the role of UK Government policy and legislation in shaping the behaviour of municipal waste managers, through their adoption of alternative management strategies other than landfill.

1.2. Environmental concerns

Damage to the environment due to poor waste management can be avoided by implementing environmentally sensitive waste management techniques, involving minimisation, composting, recycling, reuse and waste to energy programmes [13]. The problem of disposing of waste is international in its scope with many nations suffering from a similar fates, with serious local implications particularly groundwater pollution from leachates, methane gas production from landfill and atmospheric pollution from incinerators. For decades, the response of the majority of governments and waste practitioners or operators world-wide has been to burn or bury it, but such poor, and often polluting, waste management techniques are no longer necessary or acceptable. Numerous waste management techniques are currently available which, when used together, can create a truly integrated waste management system, that constitutes a viable, environmentally friendly, alternative to landfill disposal [14].

The 1992 Earth Summit in Rio set a series of Agenda 21 (action today to preserve the environment for the 21st Century) objectives for environmental management. The main theme of this conference was to assess the nature of

sustainable development, how it could be achieved and what it would cost, both socially and economically [15]. Sustainability, acting in a manner that will not leave poor environmental consequences for future generations, is now a key theme for UK waste management. A number of objectives were set for increasing the sustainability of waste management [16], and these included:

- minimising waste
- stabilising waste production
- quantifying waste flows
- maximising environmentally sound waste re-use and recycling
- developing national programmes for waste management research and practice
- raising public awareness
- and promoting environmentally sound waste disposal.

These goals require translation through national policy and legislation to targets which can stimulate local authorities and private waste companies to promote minimisation, recycling, reuse and energy recovery. The onus is presently on local authorities to implement strategies to deal effectively with their waste in a sustainable, self-sufficient and environmentally acceptable manner [17].

The availability of suitable void for municipal waste disposal is closely tied to changes in the role of the aggregates mining industry, which until recently has been a relatively successful industrial sector and has thus, provided a continuous flow of new sites requiring infilling with waste, thus keeping the costs of landfill disposal to a minimum [18]. Landfill will usually only fill void created by mineral extraction, and the rate of mineral extraction has slowed recently to below the rate required by annual waste generation, leaving a surplus of waste requiring treatment and disposal. In some parts of England there may be available void, but permission to use it for landfill is becoming increasingly difficult to obtain, with more rejections of planning applications, due on the whole to the greenbelt policy of local authorities and the NIMBY (Not In My Back Yard) attitude of residents [19].

This trend has been noted by Adams [20], who concludes that of the plethora of new legislation introduced to the waste industry since 1990, only a tiny fraction has addressed land use planning, as opposed to waste regulation. However the vast majority has indirectly made it more difficult to obtain planning permission for landfill sites. With both the NIMBY and NIMTO (Not In My Term of Office) syndromes on the increase the waste planning system is approaching gridlock. An absence of accurate Government statistics means that there is no way of quantifying the extent to which landfill capacity has shrunk during the decade, but most would agree that Landfill is a wasting asset. In 1994, 90% of landfill appeals were rejected, amounting to 50 million m^3, or half of the annual landfill consumption rate in England and Wales. Thus, there appears to be a need for planning guidance on landfill and waste disposal to ease this problem as the availability of landfill continues to wane during the coming decade [21].

2. Policy review

2.1. The waste hierarchy

Currently, the Government's first priority is to reduce waste at source, through the imposition of rigorous standards and increased disposal costs, which it is hoped will filter down through the waste sector to producers and 'brokers'. In line with this, the UK Government has a policy of promoting recycling initiatives, and developing the potential of energy from waste. Landfill is to be considered as the last option for those wastes which cannot be treated by alternative measures and for the residues of incineration [22]. The Government's municipal solid waste policy is based on a hierarchy which has adopted the ideals and principles of the European Union's waste hierarchy, refer to Table 1.

This hierarchy embodies sound waste management practice and mirrors the requirements of sustainable development. However, Government research has identified two main failures in the operation of the solid waste market, first there is no direct incentive through the pricing system to reduce or recycle waste, and second the prices of the different waste management options do not accurately reflect their environmental impacts [23]. The Government has actively attempted to partially correct these failures through the introduction of the Recycling Credit Scheme, whereby local authorities are paid subsidies on the basis of verified weight of recycled material which is removed from the disposal chain. A more recent attempt to alter the economic balance of the municipal solid waste market has been through the introduction of the landfill tax to raise the cost of landfill to a level which accounts more fully for its environmental impacts [24]. However, experience from the USA and Europe suggests that direct household waste charges or mandatory recycling schemes could be successful alternatives for correcting the failures of the municipal waste sector, and encouraging waste management practices to move up the hierarchy of preferred options. At present there seems little chance of either of these measures being introduced through legislation in England as this tightening of control, regulation and enforcement does not fit with the general themes of the current Government of free markets and privatisation [25].

Table 1
The waste hierarchy [26]

Reduction	Use less material in product, produce less waste in manufacturing, and longer lasting products
Reuse	Returnable bottles, reusable packaging and Oxfam style charities
Recovery	Finding beneficial uses for waste, including recycling, composting and energy recovery from incineration and landfill gas
Disposal	Through incineration and landfill without energy recovery

2.2. The Environmental Protection Act (EPA)

The principal pieces of waste legislation in England are the Environmental Protection Act [1] and the Environment Act [27] which created a framework within which local authorities, contractors and individuals within the industry would be stimulated to recycle more waste, by providing a system of recycling credits to be paid for each tonne of material removed from the disposal path. The UK Government White paper 'This Common Inheritance' [28] set a recycling target of 25% for household waste by the year 2000, which was a goal that local authorities were to aim for, whilst funding was made available to these authorities to aid the establishment of new recycling facilities, indicating the Government's commitment to reducing the nation's dependence on landfill.

In conjunction with this changing emphasis came the Environment Agency which has been operational since April 1996, and was set up through the Environment Act [27]. This Agency has responsibility for the regulation and monitoring of the municipal solid waste industry, ensuring standards are met, encouraging the initiation of regional waste facilities, and providing long-term policies for sustainable waste management. This body has inherited the regulatory powers of the former waste regulation authorities which were part of County Councils, and is thus a key development in the continuing shifting balance of the municipal sector, taking practical discretionary power away from local government who remain only responsible for waste collection and disposal through contracts with the private sector [18].

2.3. The national waste strategy

In view of the potential landfill crisis and rising public opinion, the UK Government in December 1995 published their National Waste Strategy 'Making Waste Work', in which they outlined a number of policies and action points for the UK waste industry; listed below.

Aims of Making Waste Work

- to reduce the amount of waste that society produces
- to make the best use of the waste that society produces
- to minimise the risks of immediate and future environmental pollution and harm to human health
- to increase the proportion of waste managed by the options towards the top of the waste hierarchy

Targets of Making Waste Work:

- to reduce the proportion of controlled waste going to landfill from 70 to 60% by 2005
- to recover 40% of municipal waste by 2005
- to recycle or compost 25% of household waste by the year 2000
- 40% of domestic properties with a garden to carry out composting by the year 2000

- all waste disposal authorities to cost and consider the potential for establishing central composting schemes by the end of 1997
- easily accessible recycling facilities for 80% of households by the year 2000

2.4. 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, stating that the price of landfill should be increased significantly to levels obtained elsewhere in the EU [29]. The following year in 'This Common Inheritance-The Second Year Report' [30], the Government gave a general commitment in favour of economic instruments as a means of achieving environmental goals. Shortly afterwards Coopers and Lybrand [9] were commissioned to write a study on a possible levy on controlled waste which was landfilled, as part of a series of studies on economic instruments. It came to the preliminary conclusion that a levy based on weight would be simplest and most practical to administer. It also concluded that in the short term there would be little change in the quantity of waste being landfilled, though in the long term there would be an increased incentive to incinerate waste. The study expected recycling to be relatively unattractive even at a levy of £20 per tonne, whilst the levy posed the threat of encouraging fly tipping and other forms of illegal disposal. 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.

The landfill tax is placed on every tonne of waste which goes to landfill for disposal, and the tax is set at £7 for active wastes and at £2 for inert. 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. Predictions from Coopers and Lybrand (1993) suggested that a £10 levy per tonne would stimulate an increase in recycling from 2 to 4%, whilst incineration levels would rise by 5% from 7 to 12%. However, more significantly a £20 levy would raise the recycling rate to 12% and produce an increase of 12% in incineration to 20%, thus leaving only 68% of the waste to be disposed of by landfill, a major improvement on the present situation. However, this tax will only be of benefit to both the environment and to UK industry if more businesses and local authorities move toward recycling, re-use and waste minimisation. Current estimates show that approximately 1400 waste management busi-

nesses, operating 2700 landfill sites will need to register with HM Customs and Excise for the tax. To help prevent additional fly-tipping, the Environment Agencies will give the problem a higher profile, although it will not become a revenue offence in tax law. The Chancellor predicts that the new tax will raise around £450 million in a full year, plus VAT. The landfill tax is likely to assist the current trend away from landfill disposal, with more waste being directed toward recycling and recovery, with some increase in the amount of incineration. Thus, the new landfill tax may have the desired effect on reducing municipal waste requiring landfill.

For both private organisations and local authorities, the landfill tax could be the catalyst that creates significant cost savings. For 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. Thus 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 [29].

The main issue for society is where will the waste go if it does not go for landfill disposal. From the waste management industry 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. However, these options will only succeed in diverting waste if their necessary infrastructures can be implemented at minimal costs and if markets are available for the materials.

3. Research methods

3.1. The survey

A postal survey was selected as this is the accepted standard practice for conducting social surveys. However, postal surveys are often hindered by having low response rates, thus in order to achieve acceptable levels the questionnaires were sent to the officer responsible for waste disposal or policy at each of the organisations. It was assumed that those people most in-tune with the research would be more willing to return a completed questionnaire and thus they were targeted by this survey. Large scale postal surveys have been used extensively in previous waste management research, and the value of this style of research has been shown time and time again. It was decided that the population for the landfill policy survey would include all the County Councils and Metropolitan Authorities in England, representing the waste disposal authorities, along with all the major

waste disposal contractors that dealt with landfilling. The contact names and addresses for the public sector bodies were obtained from the Croner Directory of Waste [31], whilst the contractor sample was selected by using the National Association of Waste Disposal Contractors Handbook [32]. This enabled all the national waste management companies to be selected, whilst regional and local companies were not chosen as it was deemed that a sample of only the larger companies would provide the necessary data for the intended analysis. It was also concluded from literature searching that these companies would be potentially more responsive to changing policy and economic circumstances, and thus would provide an ideal sample of the private sector from which a comparative analysis could be made. The handbook provides a detailed breakdown of all the registered companies, their regional offices and their local authority contracts, enabling a private sector sample to be selected which was both adequate in size and areal coverage, but which was consistent in definition allowing only national operators to be selected. The survey was implemented during July 1994, and the questionnaire used is shown in Table 2, along with the responses from the public and private sectors surveys.

3.2. The response

The response rate was respectable with an average return rate of 72%, well in excess of the 30% predicted for most postal surveys, the breakdown for the survey responses is shown in Table 3. The success of the questionnaires is attributed to the initial research and planning carried out during the draft stages of the survey design. The surveys were subsequently sent to the correct people, usually the waste manager or disposal officer, and the questions were structured to make it as simple as possible to fill in the form and send it back in the pre-stamped envelope. The areal coverage of County Council response is depicted in Fig. 1.

4. Results

4.1. National landfill life expectancy

There has been much publicity regarding the future of landfill as a municipal waste management option, and SERPLAN have made a series of studies of available landfill void throughout the south-east region [33–36] concluding that landfill capacity at present rates of use will last for no more than 10 years. Data have been obtained from both county councils and private contractors on the life expectancy of current landfill operations within their jurisdiction. The data obtained are summarised in Table 4.

Table 2
Summary of national survey responses

		Local authority (%)	Contractor (%)
1. How does you authority/company dispose of its waste? (specify the % for each route)			
Landfill	[ ]	90	78
Incineration	[ ]	6	21
Recycle	[ ]	4	21
Other	[ ]		
2. How long has Landfill been a method of disposal?			
1–3 years	[ ]		3
3–5 years	[ ]		5
5–10 years	[ ]		8
10–15 years	[ ]	10	16
over 15 years	[ ]	90	68
3. What is the predicted operation life of these Landfill sites?			
1–5 years	[ ]	25	21
5–10 years	[ ]	27	21
10–15 years	[ ]	30	26
15–20 years	[ ]	10	11
Over 20 years	[ ]	8	21
4. Has your involvement with Landfill increased or decreased over the last 5 years?			
Increased	[ ]	6	55
Decreased	[ ]	31	16
No change	[ ]	63	29
5. If it has decreased, it has done so as a response to … (rank in order, 1 = lowest)			
Environmental issues	[ ]	23	18
Pressure from National Government	[ ]	20	24
Pressure from Council members	[ ]	20	21
Public relations	[ ]	13	15
Cost of present methods	[ ]	19	22
Lack of space	[ ]	5	1
6. Have you decreased the amount of waste being Landfilled over the last 5 years? (give a %)			
Yes	[ ]	44	26
No	[ ]	56	74
Average decrease	[ ]	12	16
7. Do you intend to decrease the amount of waste going to Landfill over the next 5 years? (give a %)			
Yes	[ ]	73	37
No	[ ]	27	63
Average intended decrease	[ ]	16	12

Table 2 (contd.)

		Local authority (%)	Contractor (%)
8. Do you feel that Government policy is forcing the waste industry away from Landfill? (and how?)			
Yes	[ ]	50	58
No	[ ]	50	42
Landfill tax	[ ]	49	21
Recycling policy	[ ]	38	58
EC policy	[ ]	7	5
Planning restrictions	[ ]	6	6
9. Are you encouraging other waste management options? (please rank, 1 = lowest)			
Incineration	[ ]	15	21
Recycling	[ ]	46	48
Minimisation	[ ]	36	27
Composting	[ ]	3	4
10. How are you encouraging these options?			
Policy	[ ]	50	54
Incentives	[ ]	15	28
Subsidies	[ ]	20	8
Publicity	[ ]	7	3
Facility provision	[ ]	8	7
11. Do you feel that Landfill prices will change over the next couple of years			
Increase	[ ]	96	100
Decrease	[ ]	4	
No change	[ ]		
12. Are you in favour of Landfill as a disposal option?			
Favourable	[ ]	52	76
Unfavourable	[ ]	27	8
No preference	[ ]	21	16
13. Is there a future for Landfill? (and for how long?)			
Yes	[ ]	Not asked	95
No	[ ]	Not asked	5

4.2. Discussion

There is a distinct difference between the results of the contractor and authority surveys, which may be attributed to their positions within the waste management sector, whereby the public sector setting policy and strategy and the private sector responding to these requirements. Over 50% of authorities tend to agree with the life-expectancies quoted by SERPLAN with under 10 years of active landfill life available at current disposal rates, with 81% of authorities suggesting that landfill availability in their regions will be exhausted by the year 2010. In contrast to the depressing picture painted by the public sector, the private contractors seem to view

Table 3
Response rates for the surveys

Survey group	Sent (population)	Returned	Response (%)
Public sector (waste disposal authorities)	59	48	81
Private sector (landfill operators)	60	38	63
Total	119	86	72

the present situation with less concern, with only 16% believing that void would be utilised within the next 10 years, and only 32% stating that all landfill would be exhausted by the year 2010.

In general, it appears as though the private sector perceives a longer life-expectancy for landfill than the public sector. It is difficult to explain this difference, although there are a number of influential factors. The County Councils may be responding more rapidly to Government policy and legislation and are more aware of the impending landfill crisis, as they are preparing long term waste management policies for their respective regions. Thus, they are already looking towards the increased development of recycling, incineration and composting for the coming decade. The contractors may be over confident in their expectations, as some companies may have included sites which have yet to be granted planning permission or sites which are presently undergoing mineral extraction within their estimate. These differences do suggest that shifting patterns are occurring within the waste sector with greater control being exerted by the private sector since the introduction of Compulsory Competitive Tendering and the contracting out of local government services under the Thatcher administration.

In summary 51% of the total sample expect landfill void in their respective regions to be used-up by the year 2010. The county councils predict an average of 12 years of life remaining, in comparison to the average of 19 years suggested by the contractors. This provides a national landfill life-expectancy for England of 14 years taking the nation to the year 2010 before landfill availability reaches crisis point. This scenario is a little less critical and imminent than the figures being cited by SERPLAN [33–36] for the south-east, but the relative similarity of these figures and those of previous SERPLAN reports adds to the credibility of this study.

4.3. Regional summary of landfill availability

From the landfill policy survey data, those areas with the shortest duration until exhaustion are generally located in the vicinity of major conurbations, including Liverpool and Birmingham, with the most acute shortage around London, where landfill will cease to operate in a number of counties by the year 2000. In contrast, the periphery of England has more available void with capacity for another 15 years throughout much of the North, East Anglia and the South-West. In particular the county of Cornwall, in the South-West, has a landfill life-expectancy in excess of 20 years due to its legacy of mining and extraction works (available void), its low population density (low domestic waste production) and its distance from

Table 4
Summary of national landfill life predictions

Landfill life predicted	Number of authorities	Percentage of authorities	Number of contractors	Percentage of contractors	Total responses	Overall percentage
0–5	12	25	3	8	15	17
5–10	13	27	3	8	16	19
10–15	14	29	6	16	20	23
Over 15	9	19	26	68	35	41

major conurbations (sources of waste). Similarly the counties of Oxfordshire, Leicestershire and Essex have relatively lengthy capacities (15–20 years) due to their historic role as aggregate producing counties. In contrast the North-West and Shire counties in the south have a life-expectancy of under 10 years due to heavy population densities, and limited free land for the development of landfill sites, refer to Fig. 2. At the extreme are Dorset and Hampshire which have almost no void available and are presently incinerating much of their waste, when these plants close in the coming year they have plans for a number of large-scale waste to energy, recycling and composting plants, to further reduce their need for landfill.

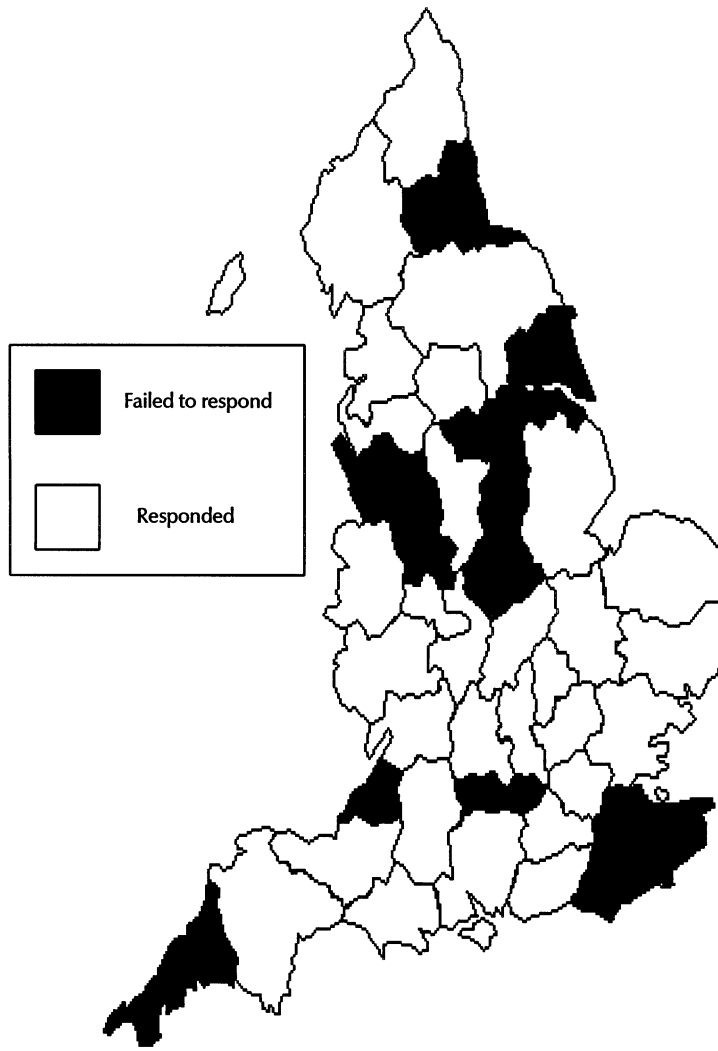

Fig. 1. English counties who failed to respond to the survey.

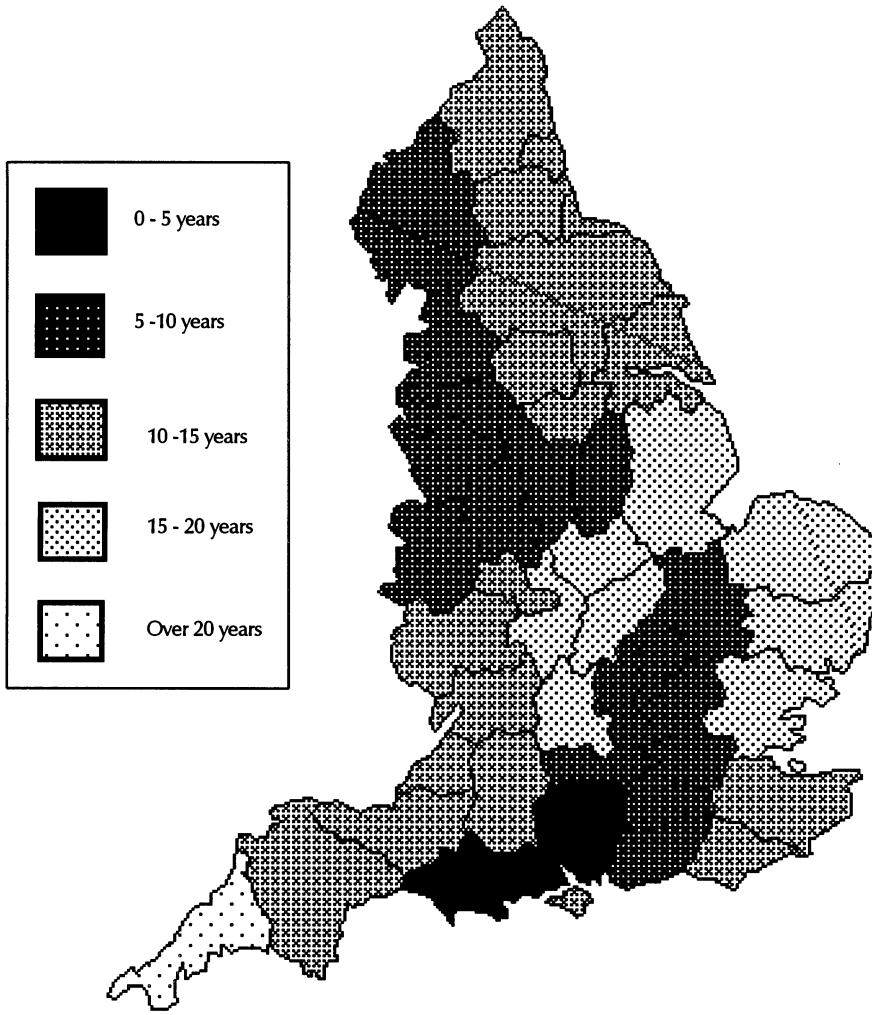

Fig. 2. Average county landfill life predictions based on the landfill policy survey.

In summary, England faces a difficult future regarding the landfilling of waste. The South-East is already beginning to experience the problems associated with limited landfill capacity, particularly rising disposal costs, greater transportation requirements and the inability to initiate long term disposal contracts for their waste materials, and within 5 years these problems will spread to the North-West and the Shire counties, whilst by 2010 almost all of England will be suffering from a landfill shortage. These findings do bear some similarity to the figures published by SERPLAN [34], and it is in the light of this impending problem that the Government has begun to attempt to influence the waste industry away from landfill, where alternative methods higher up the waste hierarchy are given priority.

4.4. National survey comparison and analysis

Of the authorities, had decreased their volumes of waste going to landfill, whilst only 26% of contractors had done so over the last 5 years. More important though were the 69% of authorities and 37% of companies who were intending to decrease their volumes of waste going to landfill over the next 5 years, which is 55% of the total number sampled. Thus, authorities appear more aware of the impending crisis facing landfill and are actively seeking alternative waste management options.

There is general agreement between both authorities and contractors over the main reasons behind their decision to reduce the use of landfill, with rising costs, environmental concern, and Government influence all receiving about 20% of the response. Most interesting of all were the 58% of contractors and 50% of authorities who recognised the important role played by the Government in attempting to shift the focus of municipal waste management by reducing the industry's dependence on landfill through the promotion of alternative practices. Some 37% of the total sample who acknowledged the role of the Government, accredited their influence to the landfill tax, and another 48% stated the growing influence of recent recycling and incineration policy, particularly the National Waste Strategy. Thus, it would appear that the Government, through legislation and policy measures, is one of the major influences acting upon the private and public sectors to reduce their use of landfill.

For those questionnaires from the landfill policy survey which were fully completed, about 10% were not, a more detailed analysis was carried out and the results have been placed in a series of cross-reference tables, whereby the response to one question can be directly linked to another to allow an assessment of relationships to be made. Of those authorities who have previously decreased waste going to landfill (during the last 5 years), 93% will further decrease the waste they send to landfill (in the coming 5 years), compared with 56% of contractors, showing the greater commitment of the public sector to removing the burden on landfill through changing waste management strategies and systems. However, 88% of those authorities intending to decrease their landfill use recognised the role of the Government, whilst 100% of the contractors intending to decrease landfill use concurred. All 100% of the contractors who had decreased their use of landfill acknowledged the role of the Government as an influential factor in their decision, as did 73% of the authorities who had decreased their use of landfill. These figures clearly show that there are some striking correlations relating to Government influence and landfill practices operating in England. These figures are summarised in Table 5 and Table 6.

From the summary cross-reference table (Table 7) two important themes can be drawn. Of all those surveyed 79% of those who have so far reduced landfill use will continue to do so in the future, whilst 43% of those who have yet to reduce waste to landfill will start doing so in the next 5 years. Of those who have decreased their use of landfill, 83%, and 92% of those who intend to reduce their use cited the role of the Government as being an important factor. This clearly highlights the significant role which the Government has for reshaping the state of the municipal

Table 5
Authority cross-reference table

	Have decreased landfill	Have not	Will decrease landfill	Will not	Government role	No Government role
Decreased Landfill			14	1	11	4
			95%	7%	73%	27%
Have not			10	10	13	7
			50%	50%	65%	35%
Will decrease	14	10			21	3
	58%	42%			88%	12%
Will not	1	10			21	3
	9%	91%			27%	73%
Government role	11	13	21	3		
	46%	54%	88%	12%		
No Gov. role	4	7	3	8		
	36%	64%	27%	73%		

Table 6
Contractor cross-reference table

	Have decreased landfill	Have not	Will decrease landfill	Will not	Government role	No Government role
Decreased Landfill use			5	4	9	0
			56%	44%	100%	0%
Have not			8	14	12	10
			36%	64%	55%	45%
Will decrease use	5	8			12	1
	38%	62%			92%	8%
Will not	4	14			9	9
	22%	78%			50%	50%
Government Role	9	12	12	9		
	43%	57%	57%	43%		
No Government role	0	10	1	9		
	0%	100%	10%	90%		

Table 7
Summary cross-reference table

	Have decreased landfill	Have not	Will decrease landfill	Will not	Government role	No Government role
Decreased Landfill use			79%	21	83	17
Have not			43%	57%	60%	40%
Will decrease use	51%	49%			92%	8%
Will not	17%	83%			41%	59%
Government role	43%	57%	74%	26%		
No Gov. role	11%	89%	15%	85%		

solid waste management industry. These are very striking results, as they clearly show that awareness of the Government's role is a key theme in shifting the balance of municipal waste treatment.

4.5. Summary of national survey responses

From the landfill policy survey there are a number of points that need to be noted, and the major findings from the landfill survey are listed below.

- Landfill dominates the municipal waste industry in the UK, and the majority of active landfill sites will be infilled and returned to agricultural or recreational use within the next 15 years.
- Landfill use has decreased during the last 5 years, in response to a range of Government initiatives, and the growth in awareness of the environmental issues surrounding landfill disposal.
- There is widespread support for a reduction in the use of landfill during the coming decade from landfill policy makers and practitioners, and this will be achieved primarily through the adoption of recycling systems, waste to energy facilities, and minimisation programmes.
- The industry 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 of Government activity.
- Those authorities who have already decreased their use of landfill will continue to decrease their use during the next 5 years. A similar response was found from the contractors although the correlation was not as strong.
- Both the private and public sectors are beginning to adopt and develop alternative waste management strategies to landfill, in response to growing public opinion, declining void availability and Government influence.

5. Conclusions

5.1. Assessment of the objectives

There is a serious problem facing the future of landfill as a management and disposal option for municipal solid waste in England. 81% of authorities will have filled their available void within 15 years and 32% of companies have only 15 years of void remaining according to their figures. There is however the embryonic technique of landfill mining whereby covered and closed landfill sites are being dug-up to recover items which can be recycled, thus leaving the site with available volume for additional waste. This technique, currently a common practice in the USA, and under way in Buckinghamshire, could provide a valuable source of new landfill void, through the recycling of used void. The Government has introduced the Environmental Protection Act [1] with the recycling credit scheme and also initiated the non-fossil fuel subsidy, both of which were recognised within the survey as being influential factors from the Government on the encouragement of

alternative treatment options. More importantly the recent introduction of the landfill tax supported by the national waste strategy, suggests that the Government is responding to the decreasing landfill availability situation. However, the pace of change remains slow. Landfill use has decreased over the last 5 years, with 31% of authorities and 15% of contractors obliging. The main reasons stated were increasing costs, County Council policy, National Government legislation and growing concern for the environment. There is little doubt that landfill use will continue to decrease, with 69% of authorities and 37% of companies intending to decrease the volumes of waste that they send for landfill during the next 5 years. This is in response to Central Government legislation and policy, declining landfill void and increasing landfill costs. All alternative waste management options are presently being used and encouraged but at differing rates by the private and public sectors. Recycling is the most important, being encouraged (and subsidised) by 79% of authorities and 88% of companies, whilst 66% of authorities and 69% of companies are actively supporting minimisation programmes and trials. This is very encouraging for the future reduction in landfill use and the conservation of existing void, which will be an essential part of any future integrated waste management strategy dealing with untreatable waste materials and residues.

The Government has taken a more active role in the planning and management of the waste industry, since the inception of the EPA [1] and its influence has continued to grow through the national waste strategy and the landfill tax. The authorities, 50%, acknowledged that the Government was an active factor in shaping the use of landfill and alternative treatments, whilst 58% of the companies agreed with this sentiment, and it is this awareness of Government involvement that is in part influencing the decrease in use of landfill in English counties. Over 22% of the companies and 20% of the authorities recognised the influence of the government as a major reason for their decreased use of landfill, whilst another 17% of companies and 20% of authorities recognised the role of County Council policy, which is often in direct response to Government policy and targets. The most important methods used by the Government have been the non-fossil fuel subsidy, recycling credits and the landfill tax.

5.2. Summary

The use of both primary and secondary data has provided the basis for an increased understanding of the waste disposal industry in the UK, and has allowed an assessment of the role and influence of National Government in shaping the industry's future, particularly the role which landfill will fulfil. Research into current waste management issues is an essential part of the evolving waste management sector, with the intention of identifying important trends which could prove useful for future waste policy decision-making. This research charts the general confusion that has existed during the last few years and shows that even after Government attempts to focus the industry, there still remains some disorder and a general lack of direction, which will need to be further addressed in the coming decade.

The recent growth in Government legislation has appeared in response to an increasing awareness of the distorted waste disposal market, whereby disposal and treatment costs have previously not taken account of the environmental costs of particular treatment options. The Government is presently acting to correct this distortion through the non-fossil fuel obligation, recycling credits, the waste hierarchy principles and most significantly the landfill tax. The Government has recently taken a more active role, than in the past, in encouraging the recent changes within the waste industry and will continue to provide incentives for the adoption of alternative strategies to landfill. It is hoped that the landfill tax will have an immediate positive effect upon the use of recycling and waste to energy options in order that precious void can be preserved for the future disposal of untreatable residues and ash.

There is little doubt that the industry is changing in response to diminishing void, public opinion and Government action, and this paper has discussed a number of the avenues of change presently in use, and indicated the potential routes which the industry could follow. It would appear that the landfill tax is a necessary development given the inadequacies of the recycling targets, recycling credits and non-fossil fuel subsidies, which were tried previously, but proved unsuccessful. Perhaps now the waste industry will be given the high political and media profile that it requires, which will enable more positive pro-active, rather than reactive, steps to be taken towards the goal of sustainable waste management practice in the UK.

To conclude, there is an overall growth in awareness from those involved in the management of municipal waste for the need and benefits of adopting alternatives to landfill, but this growth must continue and be nurtured by Government support through new waste legislation. The attractiveness of recycling and waste to energy schemes must be enhanced, by a more ethical government stance where the environmental is assigned a realistic value, and environmentally acceptable and preferable waste treatment strategies are funded and legislated for. These changes must occur soon if the limited landfill void available is to be conserved for the disposal of residues.

Current trends and renewed Government commitment must continue if the nation is to be prepared to cope with the landfill crisis which will arise over the next 15 years, through the increasing use of environmentally friendly alternatives to landfill. Landfill will no longer be the cheapest or simplest waste disposal option, and the new targets will encourage local authorities and waste management companies to embrace the ideals of minimisation, recycling, re-use, composting and waste to energy, in an attempt to minimise their costs, achieve their targets and maximise their environmental performance.

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