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SID 5 Research Project Final Report

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Project identification

1. Defra Project code: WR0107
2. Project title: Modelling the Impact of Lifestyle Changes on Household Waste Arisings
3. Contractor organisation(s): AEA
   The Future Foundation
   The Social Marketing Practice
4. Total Defra project costs (agreed fixed price): £ 148,875
5. Project: start date ..... 24 June 2005
   end date ..... 31 July 2006

6. It is Defra's intention to publish this form.
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Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

This research was commissioned and funded by Defra. The views expressed reflect the research findings and the author's interpretation. The inclusion of or reference to any particular policy in this report should not be taken to imply that it has, or will be, endorsed by Defra.

<u>Important Research Update (September 2009)</u>

The innovative input-output model (forecasting tool) that was constructed as a part of this research, was developed using the most up-to-date data on waste arisings available in 2005, at the project start, i.e. up to and including data for 2003/04. Following completion of the initial research and model development in July 2006, new data on waste arisings became available, which highlighted a divergence between the model predictions and reported data from 2002-2006.

Additional research indicated that it would be necessary to include a range of as-yet-not-understood factors within the model in order to develop more accurate predictions. Defra have commissioned further research to try to understand other factors that may have influenced changes in waste growth patterns. The Information Note published with this report gives more detail on this research and the background.

The divergence observed between the model forecasts and recent waste growth currently limits the application of the model for policy purposes, and means that caution should be used with respect to interpreting the figures contained in this report and the associated research documents (e.g. quantification of future waste tonnages). However, this project still allows exploration of future trends in waste composition, if not total quantity.

SUMMARY

Considerable work has been done over many years to try and gain a better understanding of the composition of household waste and also how those arisings might grow in the future. However, the impact of economic, social and consumer trends on the composition and magnitude of household waste arisings has, to date, not been fully analysed. This research project, funded by the Defra Waste Resources Evidence Programme, has considered these inter-relationships and constructed a forecasting tool that provides a range of alternative projections on the impact of different lifestyle trends on the future of household waste composition in England through to 2020. The model enables policy-makers to see the effect of probable trends in the main economic and social drivers on household waste arisings, such as increasing affluence and decreasing household occupancy levels. It also enables policy-makers to identify which sources of the waste stream are most sensitive to potential policy interventions and therefore provides evidence on which to prioritise and target policies.

Research Methods in Outline

An initial scoping study was conducted to explore the historic development and market dynamics relevant to waste generation. The data was used to calibrate the model against existing trends and trajectories to provide a more robust picture when making future forecasts based on future assumptions. The tool is based around the fact that most household waste is generated by consumers' expenditure (important exceptions being garden waste, direct mail and free newspapers) and using a series of data assumptions the model was constructed and calibrated to provide excellent agreement with historical trends. A detailed phase of stakeholder consultation and validation workshops was conducted throughout the subsequent development and refinement stages of the research, prior to delivery of the final model and reporting.

Key Questions Addressed in the Research

1. What are the key drivers affecting future waste arisings?
2. What is the anticipated quantity and composition of household waste arisings in England over the next 15 years?
3. In what areas might waste policy interventions have the greatest impact in terms of arresting waste growth?
4. What is the origin of the waste generated by households?

Key Outcomes

The research has led to the development of an innovative and flexible model allowing Defra to explore the economic, social, and consumer attitudinal and behavioural factors that will have the greatest impact on future waste composition. The research has provided:

- A better tool for forecasting and planning sustainable waste management policy incorporating an integrated view on socio-economic impacts;
- Inputs to help Defra prioritise policy strategies for waste reduction and behaviour change, thus mitigating future waste growth;
- An interactive model that can be used to explore the possible policy options available at national level and their likely impacts on the household waste stream.

There are two main ways in which the model was designed to be used:

The model can be applied in a ***future forecasting mode*** and is capable of predicting future waste arisings and composition under different scenarios. From this holistic approach, policy options on the impact of consumer lifestyles on household waste volume and composition, and the implications for future infrastructure and service requirements can be derived.

The model can also be used in a ***backcasting*** mode. If the user begins from the baseline model predictions, one can then investigate how far the assumptions used in the model would need to be changed in order for the model to come up with an alternative prediction. A 'desired future outcome' can be investigated by applying an iterative process of incrementally varying the percentage change in selected base case assumptions, in order to find one possible scenario that will yield the desired outcome. The assumptions and data varied may include those that are likely to be susceptible to waste policy interventions (e.g. local waste collection service arrangements) and also underpinning socio-economic factors beyond the realm of waste policy (e.g. disposable income; number of single person households). By assessing the degree of change needed to align the model to the desired outcome, the user can make a judgement both about the sensitivity of the model to the input data and assumptions, and about the likely degree of difficulty in reaching the particular desired outcome being investigated. The process can then be repeated as required, either to find alternative scenarios to reach the same outcome, and/or to assess model sensitivity by investigating a different 'desired' outcome.

Key Recommendations

The primary recommendation and output from this study is for the use and application of a unique modelling tool that can be used by Defra to assess forecasts of future household waste arisings in England.

The modelling tool enables policy makers to determine the probable impacts of possible waste prevention interventions and to therefore determine quantifiable impacts of a broad range of waste management policy options. This will in itself lead to the identification of a series of recommended actions for implementation.

Finally, a number of opportunities for the further validation and development of the model have also been identified and the research team will discuss the potential benefits of these with Defra.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
   - the scientific objectives as set out in the contract;
   - the extent to which the objectives set out in the contract have been met;
   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Transfer).

1. INTRODUCTION

Considerable work has been undertaken to understand the nature and arisings of household waste with annual statistics being gathered for more than two decades. In parallel, there have been sophisticated developments in understanding social and consumer trends by product manufacturers and retailers. Although it is widely recognised that the two are interdependent, our knowledge indicates that the relationship between the household waste stream and societal trends has not been previously explored. Nor has there been predictive analysis of the impact of these trends on the future volume and composition of household waste. This research, commissioned by the Defra Waste Resources Evidence Programme, has sought to identify these inter-relationships and provide a range of alternative projections on the impact of different lifestyle trends on the future of household waste composition over the next 15 years. The work has been carried out by a multi-disciplinary consortium, comprising waste management expertise (AEA) working in partnership with organisations with an understanding and ability to forecast social and consumer behaviour (The Future Foundation) and how those attitudes and behaviours can be influenced (The Social Marketing Practice).

The research aimed to develop an innovative and flexible model that would provide Defra with a clear idea of the economic, social, and consumer attitudinal and behavioural factors that are likely to have the greatest impact on future waste composition. The model was designed to assist Defra by providing:

- Better tools for forecasting and planning in sustainable waste management policy to include an integrated view on socio-economic impacts;
- Inputs to help Defra prioritise policy strategies for waste reduction and behaviour change, thus mitigating future waste growth;
- An interactive model that can be used to explore the possible policy options available at national level and their likely impacts on the household waste stream.

There are two main ways in which the model was designed to be used:

The model can be applied in a ***future forecasting mode*** and is capable of predicting future waste arisings and composition under different scenarios. From this holistic approach, policy options on the impact of consumer lifestyles on household waste volume and composition, and the implications for future infrastructure and service requirements can be derived. This is discussed in Section 6 of this report.

The model can also be used in a ***backcasting*** mode. If the user begins from the baseline model predictions, one can then investigate how far the assumptions used in the model would need to be changed in order for the model to come up with an alternative prediction. The assumptions and data varied may include those that are likely to be susceptible to waste policy interventions (e.g. local waste collection service arrangements) and also underpinning socio-economic factors beyond the realm of waste policy (e.g. disposable income; number of single person households). By assessing the degree of change needed to align the model to the desired outcome, the user can make a judgement both about the sensitivity of the model to the input data and assumptions, and about the likely degree of difficulty in reaching the particular desired outcome being investigated. An example of this approach is considered in Section 7 of this report.

The original research has been conducted over a 12 month period between July 2005 and 2006 and involved four key stages of development:

- Scoping Study and Data Gathering (Section 2);
- Analysis and Consultation (Section 3);
- Model Development (Section 4);
- Consultation and Validation (Section 5);

This report provides: a review of the model design process; highlights some of the outputs and functionality of the model; and identifies future opportunities for the further development of the model to assist policy makers (Section 8). A detailed, main report is also provided: *WR0107 Annex 1 – Main Report, August 2006.*

2. SCOPING STUDY AND DATA GATHERING

The construction of a model capable of forecasting future waste patterns necessitates a full understanding of the historical developments and market dynamics in household waste generation. This data enables the model to be calibrated against existing trends and trajectories to provide a more robust picture when making forecasts based on future assumptions. Relevant data sources have included:

- Historical and current waste data sources available in the UK, including compositional waste data (see Parfitt 2002);
- Relevant consumer spending economic data, market and industry trend forecasts (such as that from the Office for National Statistics, ONS);
- Stakeholders and experts for specific data consultation.

The initial scoping research identified a lack of availability and quality with respect to household waste data appropriate for the proposed modelling tool. The other main observations at this stage showed that:

- Most household waste is generated by consumers' expenditure (key exceptions being garden waste, direct mail and free newspapers);
- Household size is a key factor in waste arisings (smaller households generate higher waste levels per capita);
- Around 50 ONS consumer-spending categories contribute directly to household waste arisings.

The conclusion of the initial research was to develop the forecasting tool as an 'Input-Output' model based around the fact that most household waste is generated by consumers' expenditure. We are therefore able to use historical data on consumers' expenditure to construct a model of household waste and use detailed consumers' expenditure forecasts to generate forecasts of waste. To do this we have used consumer expenditure data back to the mid 1980s to track spending in constant price terms – which can be used to generate a 'physical' measure of purchases – and mapped this on to waste production.

Primary data assumptions that have been used to convert consumer expenditure data into waste data are, the:

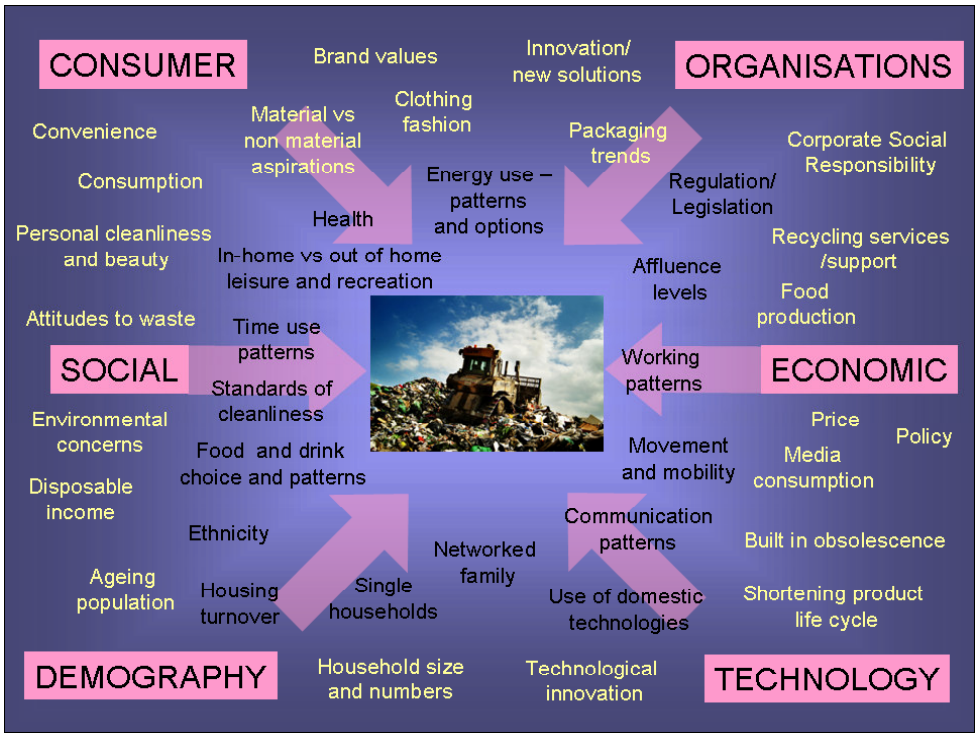
- Average price charged for goods (by weight);
- Proportion of product that ends up as waste;
- Proportion of the waste that gets diverted outside of the household collected waste stream (e.g. home composting);
- Proportion of packaging associated with products;
- Composition of product waste;
- Composition of packaging waste;

- Average length that goods are kept after purchase before disposal into the waste stream.

Following construction of the prototype model, a very good agreement with historical trends was achieved when comparing the model outputs with the published waste data. This provided an excellent basis for the next stage of generating future forecasts. Full details of this initial work can be found in *WR0107 Annex 2 – Inception Report, August 2005.*

3. ANALYSIS AND CONSULTATION

A critical task in the development of the future waste arisings model was to identify the key political, societal, economic and technological trends that are affecting consumer behaviour and are also affecting waste generation. This included an assessment of both the future direction (positive or negative) and the magnitude of impact of those trends, and subsequent consultation on the findings.



An extensive process of analysing around 100 different lifestyle trends and drivers was conducted drawing significantly on the expertise of the Future Foundation. The process, known as 'futureproofing' (see Nelson and Garvey, 2005) involves an assessment of each driver considered in terms of both the certainty of occurrence and the degree of impact on future household waste arisings.

The quantitative impact of each driver was examined through a combination of two approaches; a 'statistical analysis' of historical trends (dependent on quantity and quality of data), and a 'structured assessment' (involving for example, discussions with industry experts, qualitative analysis of developments in the UK and overseas markets). The latter option was used in cases where the available data was insufficient to allow a statistical assessment, and expert judgment and knowledge was required.

For each driver, the historical and potential waste impacts were assessed. As far as possible, the impacts of each driver were assessed 'in isolation' as many of the factors influence the production of waste simultaneously. The interaction between the factors and their compounding effect on waste composition were considered.

This futureproofing exercise led to the identification of twelve key drivers and trends that are likely to have the greatest impact (either positively or negatively) on household waste volume and composition over the next 15 years. These are:

- Increase in consumer affluence;
- Increase in single society living;
- Culture of lifestyle change (e.g. house moves, divorce, retirement, etc.);
- Growth of the 'experience' economy (e.g. spending on experiences rather than goods);

- Shortening product life cycle;
- Growth of tele-working and the knowledge economy;
- Increasing longevity (life expectancy);
- Lifestyle choices of the 'baby boom' generation;
- Growth of online, convenience shopping;
- New regulations and legislation;
- Perceived effect of climate change;
- Increase in ethical consumption.

These findings and results were presented at a project research consultation workshop held in October 2005, involving a broad spectrum of stakeholders from Government policy teams, local authorities, the Waste Resources Evidence Programme, the Environment Agency, environmental experts and waste specialists, trade and industry representatives, and academia (see *WR0107 Annex 3 – Interim Report, December 2005* for further details). The feedback demonstrated broad support for the modelling approach proposed and specific contributions were used to inform the development of the predictive model.

4. MODEL DEVELOPMENT

A Microsoft Excel spreadsheet provided the platform for the forecasting tool, which is capable of providing a range of forecasts, including the overall level of household waste generated and a breakdown of this total into the key 'product' waste streams. A series of future assumption variables were fed into the various drivers, for example, forecast rates of economic growth based upon changes in Real Household Disposable Income levels. Forecasts of arisings are then calculated at the individual product group level (based on 54 selected ONS consumer spending categories).

Waste arisings that do not occur as a result of direct consumer expenditure, principally garden waste, direct mail and free newspapers, need to be forecast separately and combined with other data. Of these three, garden waste arisings poses the greatest difficulty due to the myriad of factors affecting the degree of arisings, such as seasonal weather, local authority waste collection service infrastructure and the number and size of gardens. Combining a variety of data sources the model currently uses a forecast of around 8 kg per household (with a garden) per week.

Once all the data forecasts are combined, a final step involves probabilistic "Monte Carlo" modelling to gauge possible ranges of forecast outcome. This technique provides a range of possible outcomes, each outcome having an associated probability. The model was run many times using a range of different assumptions on the key drivers, to identify the full range of possible outcomes in the future. The output is therefore not just a single forecast but a range of forecasts with different probabilities. Further details of the approach adopted can be found in Section 10 of Annex 1 to this report.

There are two main ways in which the model was designed to be used:

The model can be applied in a ***future forecasting mode*** based on targets for generic product waste minimisation interventions applied to distinct product categories. It assumes that these targets can be rationalised in terms of specific intervention outcomes based on evidence that supports the target setting. This is discussed in Section 6 of this report.

The model can also be used in a ***backcasting*** mode. If the user begins from the baseline model predictions, one can then investigate how far the assumptions used in the model would need to be changed in order for the model to come up with an alternative prediction. The assumptions and data varied may include those that are likely to be susceptible to waste policy interventions (e.g. local waste collection service arrangements) and also underpinning socio-economic factors beyond the realm of waste policy (e.g. disposable income; number of single person households). By assessing the degree of change needed to align the model to the desired outcome, the user can make a judgement both about the sensitivity of the model to the input data and assumptions, and about the likely degree of difficulty in reaching the particular desired outcome being investigated. An example of this approach is considered in Section 7 of this report.

5. CONSULTATION AND VALIDATION

Throughout the development of the future waste arisings model an ongoing process of consultation and validation was conducted involving bodies that could provide specific expertise and knowledge. These included: the Industry Council for Packaging and the Environment (INCPEN), the Waste and Resources Action Programme (WRAP) and the Local Authority Waste Recycling, Recovery and Disposal (LAWRRD) Model Advisory Group.

A summary of some of these specific consultation workshops and meetings and the key issues discussed are presented in the Table 1.

Table 1: Principal consultation events held during the course of the research project

Date	Consultees	Key Issues Discussed	Outcome
13th October 2005	First stakeholder consultation event	Key drivers identified Modelling approach	Support for proposed modelling approach
7th February 2006	INCPEN and industry representatives	Packaging data assumptions	Validation of packaging forecasts and assumptions
22nd February 2006	WRAP and Imperial College	Green waste data arisings assumptions	Model adopts a simplified approach to a complex issue
6th April 2006	Second stakeholder consultation event	Provisional model outputs	Validation of finalised model approach
8th May 2006	Defra Waste Strategy Consultation Team	Policy intervention modelling	Quantitative model outputs of possible policy interventions
22nd May 2006	LAWRRD Model Advisory Group	Future waste arising data forecasts	Arisings model outputs can be used as an input to other Defra forecasting tools

6. INSIGHTS INTO THE FUTURE

The model provides value to policy-makers in the following ways:

- It provides forecasts of overall waste growth and future trends for over 50 categories of product. This identifies which product waste streams are rising fastest or slowest if no further policy interventions are made;
- It enables policy-makers to see the effect of variations in the main economic and social drivers, e.g. affluence and household occupancy levels;
- It enables policy-makers to identify which types of policy intervention have the greatest impact, and which product waste streams are the most sensitive to such interventions. That is, the model provides better evidence on which to prioritise and target policy interventions.

The mechanism for interrogating the model is through its 'assumptions', which are based on best available evidence and stakeholder consultation. Assumptions include a range of factors such as consumer affluence, household size, weight of garden waste per household, proportion of product weight that ends up as waste or constitutes packaging and lifetime for which goods are kept before disposal.

For example, from the point at which goods are purchased, they stay 'in use' for varying periods of time, dependent on the nature of the goods (e.g. for food, this period is weeks, for electrical appliances, it is years), emotional attachment or passing on for use by another person. The model then combines the standard assumptions of the 'lifetime' of the different goods categories. e.g. clothes and textiles 5.7 years average; electrical goods 6.4 years average; food < 1year.

The model is based on purchase levels. The consequence of changing the assumptions is that waste volumes will grow or diminish in future years, at a point dependent on the time delay as goods move from purchase to disposal in their life-cycle.

By varying these assumptions, graphical scenarios can be presented of waste growth and relative proportions of waste stream product categories. This provides the evidence base for policy-makers to then target policy interventions and measure impact in future years.

The following examples illustrate how the model can be interrogated.

6.1 Forecasts of overall waste growth and future trends with no further policy intervention

Figure 1 illustrates the forecast changes in relative proportions of waste stream composition for household waste arisings from 2005 to 2020.

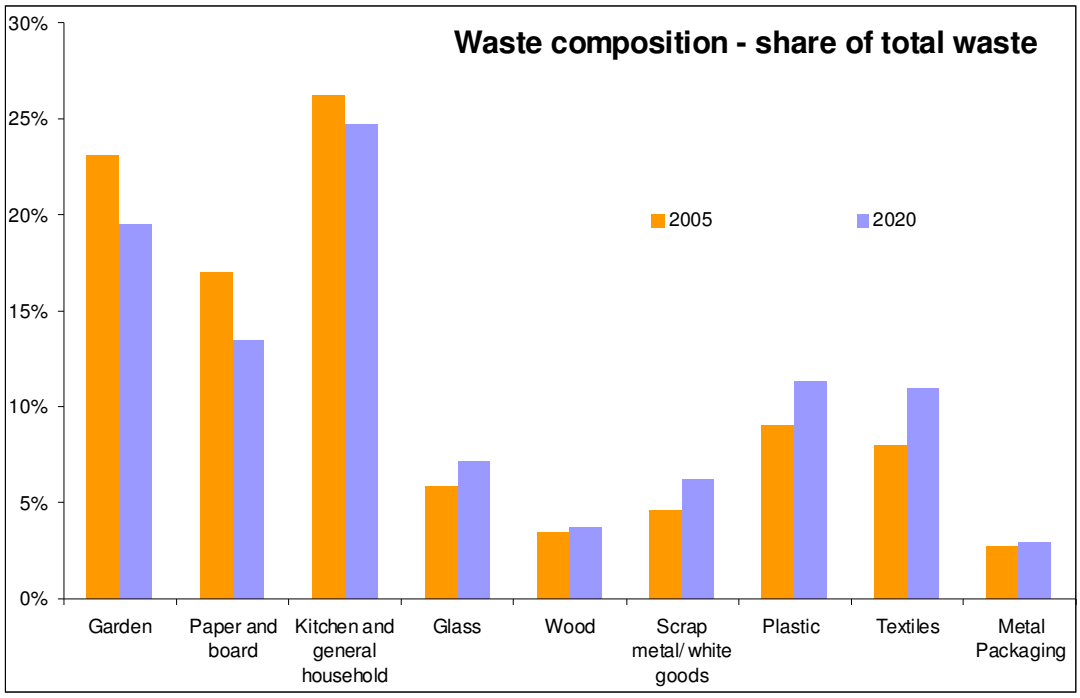


Figure 1: Household waste composition in 2005 and 2020 split by waste category

This shows, for example, that if the trends that have been forecast in the model's base case hold true, then textiles would be expected to be the fastest growing product sector in terms of household waste. The reasons for this might be explained by the recent availability of low cost garments arising from Far East production centres, coupled with steadily increasing affluence of consumers. Clothes become less valued and permanent as personal possessions, changes in fashion become more affordable. There may be consequences, too, in terms of garment quality and wash durability. Both aspects will lead to diminishing lifetime for textile goods and higher discard rates.

This provides a signal for policy-makers to consider addressing this area. The re-use market for clothing has been impacted by this trend (e.g. Salvation Army recycling schemes). Policy may, for example, need to consider support for export of used clothing to developing countries, or technology development to overcome barriers to transforming of textile waste into other products.

6.2 Effect of changes in economic and social drivers

Figure 2 illustrates the impact on household waste arisings of the market trend in reducing household size. It shows the effect of changing the assumption for average household size in 2020 from 2.18 persons per household to 2.00.

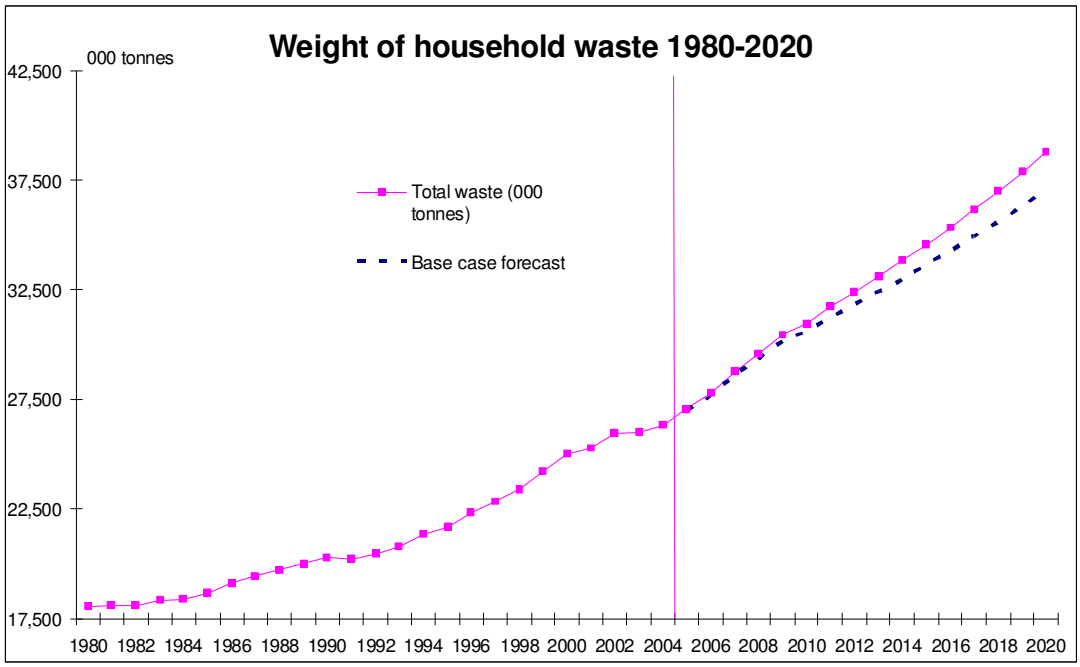


Figure 2: Effect of reducing household size on total household waste arisings

This demonstrates an increase in waste arisings as a consequence of reducing household occupancy levels. The underlying issue is that homes with fewer people generate more waste per person than larger families.

For policy, this could imply that targeting behaviour change at low occupancy dwellings has greater potential than larger units. Other than this, the main policy interventions lie outside the sustainability arena, being more related to the drivers for low occupancy (people getting married and having children later in life, aging population, increasing divorce rates, affordability of homes etc) and require social policies to address them.

6.3 Identify which types of policy intervention have greatest impact, and which product waste streams are the most sensitive to such interventions

By interrogating the model through changing the values of the base assumptions, it is possible to compare and contrast waste outcomes, identify the product sectors and product waste characteristics to which the model is most sensitive, and hence suggest where policy priorities might lie. For example, consider the durability of products.

Figure 3 illustrates the effect of doubling the lifetime of all product sectors by 2020. This is an extreme view for the purposes of illustration only (there would be other significant implications, such as lower economic growth, higher unemployment, etc) but it shows a significant reduction in waste arisings by 2020.

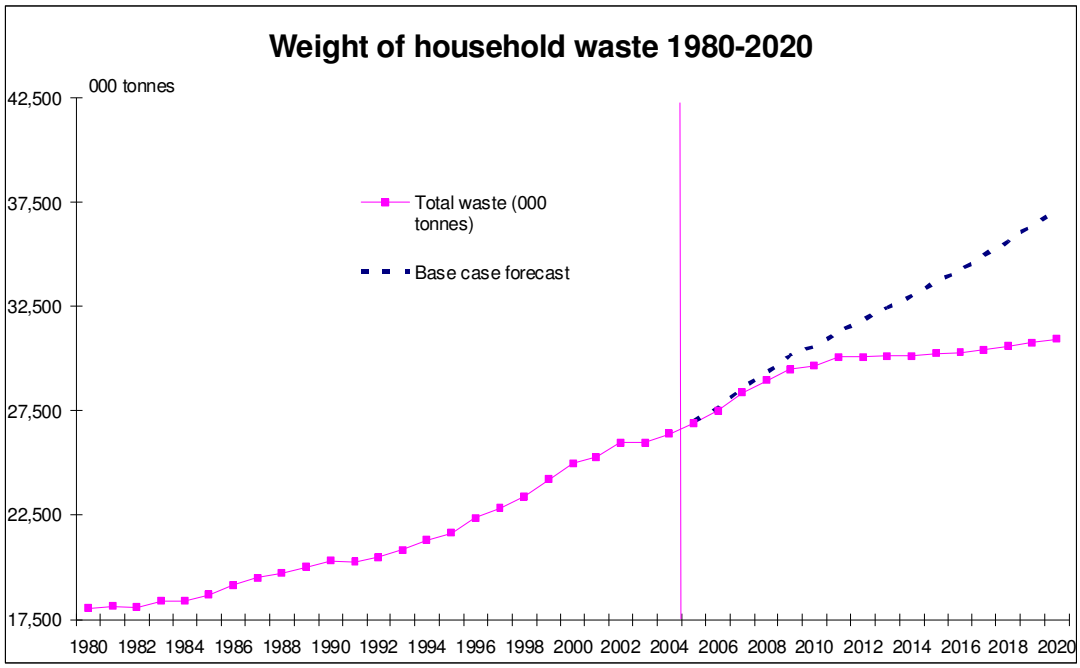


Figure 3: Effect of doubling the lifetime of all product sectors on total household waste arisings

By comparison, product groups can be varied individually, without changing others. Figure 4 shows the effect of doubling non-electrical household goods lifetime alone. This reveals that non-electrical household goods are far more dominant than food, electrical items and paper.

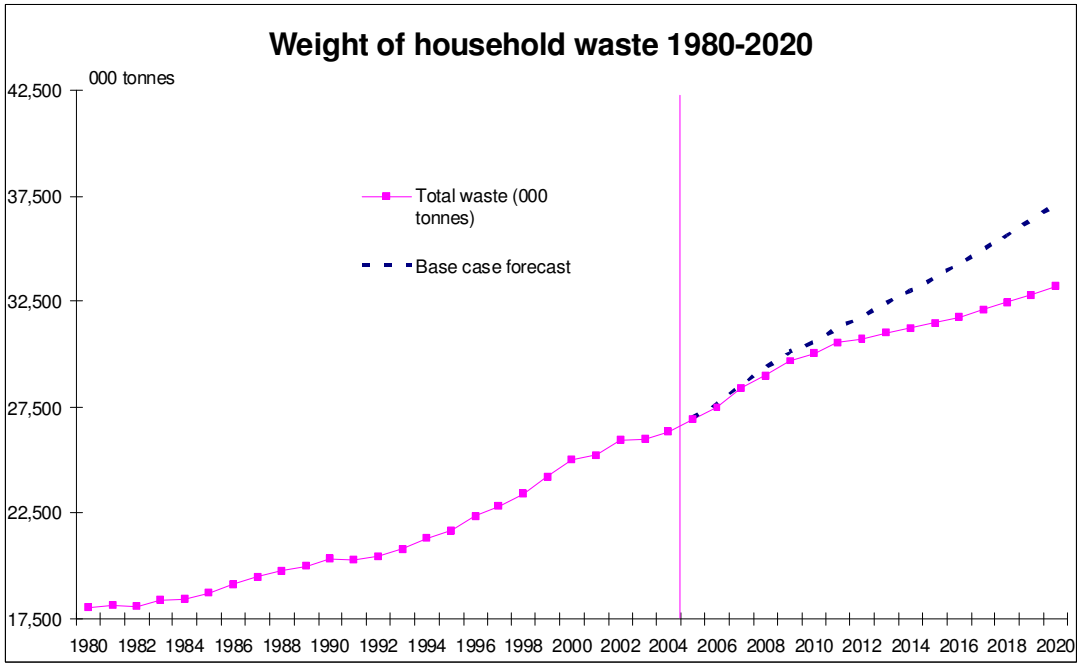


Figure 4: Effect of doubling the lifetime of non-electrical household goods only on total household waste arisings

This implies that policy interventions might best be directed at this group in particular in regard to product durability, if the main aim is to reduce overall waste tonnages. The policy-maker would need to consider, for example, what interventions could facilitate greater durability, what evidence is needed to build a prognosis of future impact on waste and then build this into the model to gain a picture of overall impact. This can be done at individual product level or product group level. Future trends that might affect future product durability forecasts include:

- The development of social enterprises and infrastructure, and the fashionability for purchasing re-used products that extend product life through multiple-ownership;
- Changes in skills capacity for product renovation and maintenance;
- Availability of emotionally-designed products (i.e. ones which the consumer has played part in the design e.g. bespoke modular-design footware), which encourage lengthier ownership and use;
- Uptake of the service ownership model, rather than product ownership (product service systems) and upgradeability of goods through modular design.

Assessing the impact of these potential trends, in terms of potential product lifetime change by a certain date, would enable a new assumption to be incorporated in the model and the effect on the waste arisings for this scenario to be assessed.

Taking another example, targeting householder behaviour in food waste is an area of policy interest. The model enables priorities to be explored in food groups or individual food types. The food groups (meat & fish, solid edibles excluding meat and fish, and liquids) have embedded assumptions about the proportion of each that ends up as waste.

For illustration, Figure 5 shows the impact of halving the level of food waste for all three categories by 2020.

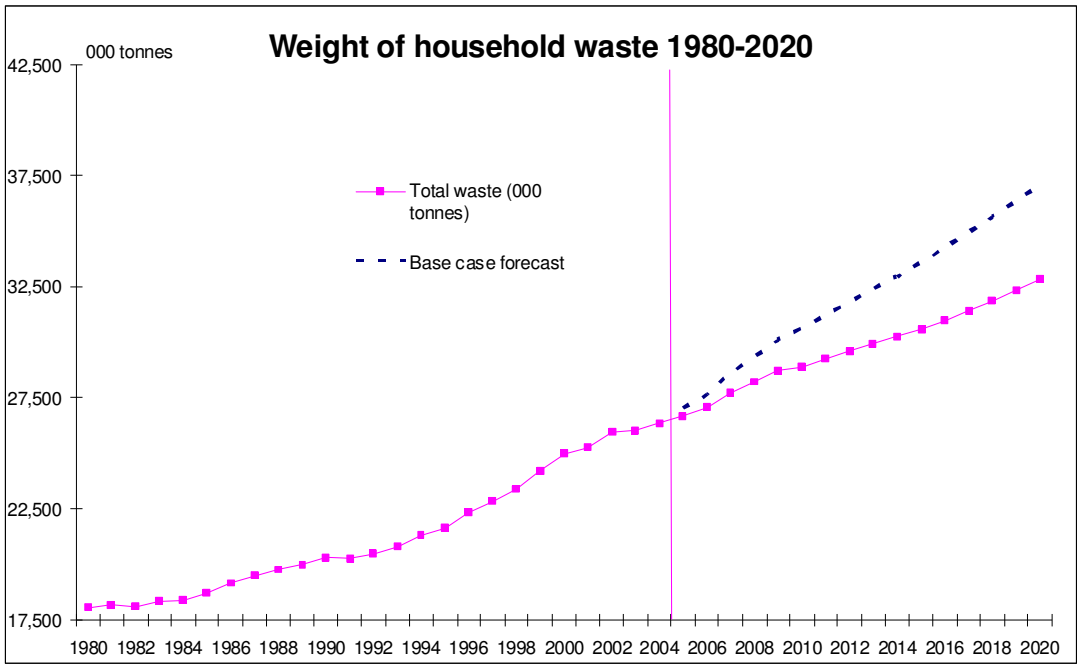


Figure 5: Effect of halving the level of food wastage on total household waste arisings

By comparison, if only solid food (excluding meat and fish) waste is halved from 13.9% to 6.9% by 2020, then the following scenario arises.

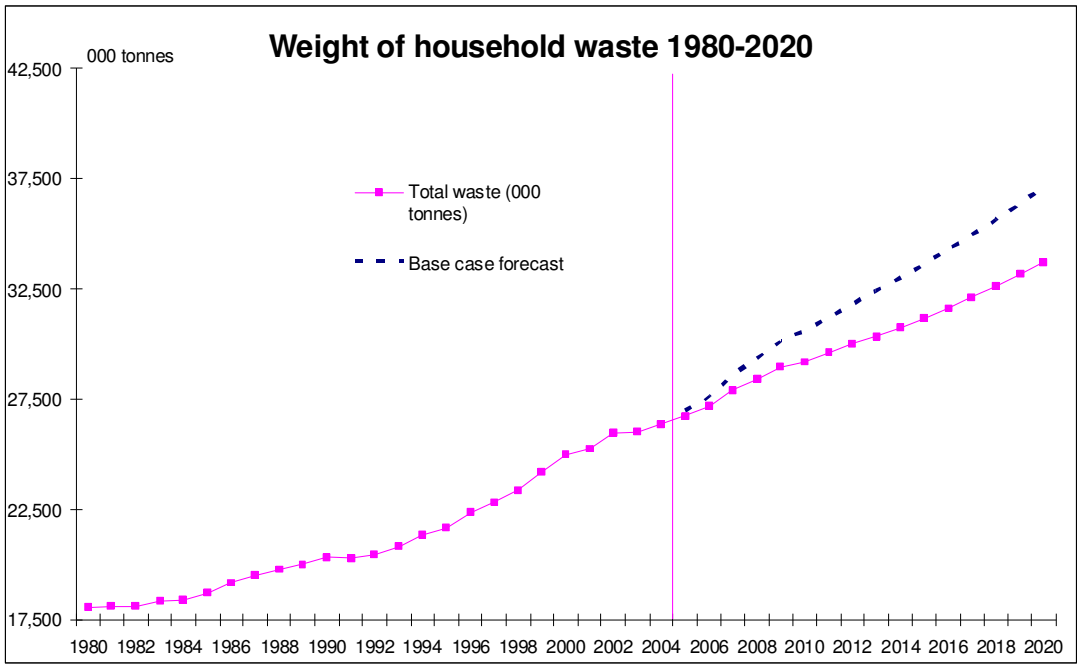


Figure 6: Effect of halving the level of solid food wastage only on total household waste arisings

This demonstrates that these (non-meat and fish solid waste) food products might be a priority area for targeting policy intervention, if again the primary target is to reduce overall waste tonnages. For example;

- Encouraging and enabling consumers with gardens to compost non-putrifying solid food;
- Understanding the relationship between behaviours for non-meat & fish food and lifestyle choices (e.g. dieting, growing your own vegetables, experimenting with different foods, entertaining) and then targeting waste policy at the areas which can most easily be influenced and generate most waste.

The above analysis shows how the model can be applied in a 'future forecasting mode' based on targets for generic product waste minimisation interventions applied to distinct product categories. It assumes that these targets can be rationalised in terms of specific intervention outcomes based on evidence that supports the target setting.

7. WASTE GROWTH SENSITIVITY ANALYSIS

Please note the content of the 'Important Research Update (September 2009)' cited earlier in this document prior to consideration of the quantitative data discussed in this section.

The model can also be used in a 'backcasting' mode. If the user begins from the baseline model predictions, one can then investigate how far the assumptions (data) used in the model would need to be changed in order for the model to come up with an alternative prediction. So for example, in the case study illustrated below, the baseline model is predicting an annual increase in waste arisings equivalent to 1.6% per annum, and the user asks the question, what assumptions and/or data would need to be changed in the model in order to stablilise waste arisings (i.e. achieve 0% growth) within the next 5 years? This 'desired future outcome' is then investigated by applying an iterative process of incrementally varying the percentage change in selected base case assumptions, in order to find one possible scenario that will yield the desired outcome. The assumptions and data varied may include those that are likely to be susceptible to waste policy interventions (e.g. local waste collection service arrangements) and also underpinning socio-economic factors beyond the realm of waste policy (e.g. disposable income; number of single person households). By assessing the degree of change needed to align the model to the desired outcome, the user can make a judgement both about the sensitivity of the model to the input data and assumptions, and about the likely degree of difficulty in reaching the particular desired outcome being investigated. The process can then be repeated as required, either to find alternative scenarios to reach the same outcome, and/or to assess model sensitivity by investigating a different 'desired' outcome.

To illustrate the approach, the example question posed (in the context of the baseline model predictions as reported earlier in this report) is: what assumptions and/or data would need to be changed in order to stablilise waste arisings (i.e. achieve 0% growth) within the next 5 years? In the scenario illustrated here, this has been tackled by making relatively small changes to a large number of variables.

The key changes made in this scenario to the 'Top level factors' (i.e. underpinning socio-economic data) contained in the model are:

- Slightly lower growth in disposable incomes (1.9% versus 2.2% in the base case).
- The price of goods is assumed to rise in line with services. Over the past 10-20 years the price of goods have risen more slowly than the price of services (this has been due to a range of reasons, e.g. globalisation, productivity gains, etc, and has most dramatically been seen in clothing and electronic goods). Consequently the 'real' price of goods has fallen. Under this scenario we assume that increasing wage rates in places like China and India, higher commodity prices and a levelling off of productivity gains means that real prices only fall marginally (-0.1% versus -0.6% in the base case).
- Household size does continue to fall, but at a much slower rate than in recent years (e.g. due to the increased cost of housing). Average household size in 2020 set at 2.25 against 2.18 in the base case assumption.
- Proportion of dwellings with gardens falls (e.g. due to more flats being built). Reduced to 85% by 2020 compared to 90% in the base case.
- Amount of garden waste falls to an average of 7.25kg/week per household (e.g. global warming impacts).

Top level factors	2004 level	2020 level	Average annual growth 2004-2020
Consumer affluence			1.9%
The average real price charged for goods			-0.1%
Average household size	2.32	2.25	-0.2%
Number (millions) of English households	21.6	23.9	0.6%
% of households with gardens	91%	85%	-0.4%
Weight of garden waste per household (kg/week)	8.29	7.25	-0.8%
Number (millions) of direct mail items received by households	4415	6204	2.1%
Number (millions) of free newspapers received by households	1077	910	-1.0%

With respect to the product level factors (where waste policy can have more direct influence on the magnitude of waste arisings) the following changes have been made:

- For each of the relevant categories the amount of product being wasted is assumed to by between 15% and 17.5% compared to the base case (e.g. due to greater waste awareness, government persuasion, better information on such things as optimum refrigerator temperatures, etc.)
- The amount of the waste that is produced and gets diverted from the household waste stream increases by between 5 and 10% compared to the base case (e.g. due to greater awareness, promotion and support for home composting)
- The proportion of product and packaging weight that is made up of packaging falls by 15% (e.g. due to legislative/economic pressure on manufacturers/retailers; technological improvements; etc.)
- The time goods are kept before disposal increases by between 5 and 7.5% (which is consistent with the top level factor assumption of lower growth in consumer affluence).

Product level factors		Average of all waste	Meat and Fish	Solid edibles (exc. meat and fish)	Liquids	Clothing and textiles	Electrical goods	Household items (non-electrical)	Paper items	Garden products	Green waste
Proportion of product weight that ends up as waste	2004 level	48%	15.8%	13.8%	5.5%	100%	100%	68%	100%	5.5%	
	% change from 2020 base case	-12.7%	-17.5%	-17.5%	-17.5%	0.0%	0.0%	-15.0%	0.0%	-15.0%	
Proportion of waste that gets diverted outside the household waste stream	2004 level	8.9%	5.5%	15.6%	3.6%	8.9%	3.3%	3.7%	4.7%	96%	27%
	% change from 2020 base case	7.5%	10.0%	10.0%	10.0%	5.0%	5.0%	5.0%	5.0%	5.0%	10.0%
Proportion of total weight (of product plus packaging) that is made up of packaging	2004 level	4.8%	4.8%	4.3%	8.8%	2.4%	7.9%	6.6%	0.3%	2.9%	
	% change from 2020 base case	-15.0%	-15.0%	-15.0%	-15.0%	-15.0%	-15.0%	-15.0%	-15.0%	-15.0%	
Average number of years that goods are kept before disposal into the waste stream	2004 level	3.9	1.0	1.0	1.0	5.7	6.4	6.5	8.1	1.0	
	% change from 2020 base case	3.5%	0.0%	0.0%	0.0%	7.5%	7.5%	7.5%	5.0%	0.0%	

The results for this 'scenario' are shown in Figure 7. Due to 'time lags' inherent in the model, the results show continuing growth in waste arisings over the next three or four years, regardless of any policy interventions or changes in the socio-economic assumptions, due to the volume of product that is 'out there' waiting to enter the waste stream (a consequence of growing consumption over the last five years or so). However, after this transition period, the cumulative affect of the modified assumptions listed above is to stabilise waste arisings. The next step could be for the user to compare the baseline and alternative assumptions/ data, in order to come to a judgement as to the relative likelihood of the two scenarios, and then to test alternative sets of assumptions/ data to construct a scenario that seems more likely, and still produces the desired outcome.

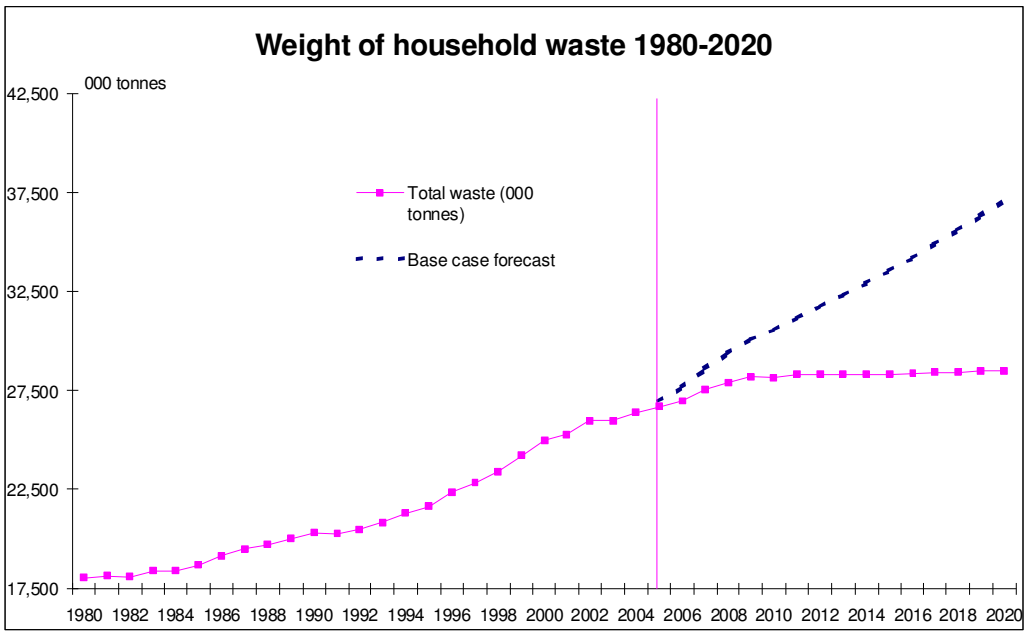


Figure 7: A possible scenario resulting in the stabilisation of future household waste arisings

8. OPPORTUNITIES FOR FURTHER DEVELOPMENT

The modelling tool will be explored by Defra policy-makers and economists to establish whether it can be used to assist in the decision making process for strategic development. Future opportunities exist to improve the robustness of modelling assumptions and extend its potential areas of application, for example:

- Inspection and validation of the baseline waste data used to calibrate the model, e.g. assessment of the (2005-2007) Defra Local Authority Support Unit (LASU) funded waste compositional analysis studies and the new Waste Dataflow datasets;
- Review of the evidence base for key data assumptions, such as the prediction of garden waste arisings (there is a need to link to recent WRAP research into impacts of home composting and also to the increase in local authority green waste kerbside collections);
- Investigate a development of the model to forecast the wider carbon implications (i.e. climate change impacts) of future waste arisings. e.g. a tonne of waste electrical goods has a much larger overall carbon footprint compared to a tonne of garden waste.
- Adaptation of modelling parameters to allow the forecasting of future 'lifestyle scenarios' as documented in parallel research (WR0104) being funded by the Defra Waste Resources Evidence Programme.
- To review the need to update modelling assumptions in line with the findings from more recent research into possible explanations of observed waste growth trends - WR0121 'The Influence of Local Waste Policies'.

Details of subsequent research and development work undertaken between August 2006 and October 2007 can be found in:

- *WR0107 – Supplementary Report SID5 (October 2007)*
- *Annex 4: Supplementary Model Validation Report (December 2006)*
- *Annex 5: Supplementary Divergent Trend Analysis Report (May 2007)*

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

Project Reports and Presentations available from the Defra Research website:
http://www2.defra.gov.uk/research/project_data/

Maunder, A; White, P; Howard, M; Farmelo, C; Yates, T:

WR0107 – Summary Report SID5 (August 2006)

WR0107 – Supplementary Report SID5 (October 2007)

Annex 1: Main Report (August 2006)

Annex 2: Inception Report (August 2005)

Annex 3: Interim Report (December 2005)

Annex 4: Supplementary Model Validation Report (December 2006)

Annex 5: Supplementary Divergent Trend Analysis Report (May 2007)

Brook Lyndhurst
WR0104: Lifestyle Scenarios: The Futures for Waste Composition

Resource Futures and AEA
WR0121: Municipal Waste Growth - The Influence of Local Waste Policies

Nelson, W & Garvey, B (Market Research Society, Annual Conference, 2005); *Using research to 'futureproof' strategies*

Office for National Statistics; *Household consumption expenditure data* www.statistics.gov.uk

Parfitt, J (Strategy Unit, 2002); *Analysis of household waste composition and factors driving waste increases,* http://www.cabinetoffice.gov.uk/strategy/downloads/su/waste/downloads/composition.pdf