ENVIRONMENT AND HERITAGE SERVICE

Department of the Environment
Environment & Heritage Service

BPEO - Decision Makers' Guide

Prepared by Environmental Resources Management Ltd
in conjunction with the Environment & Heritage Service

Department of the Environment

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Foreword

The management of wastes entails a range of activities, from collection, through transport, treatment and recovery to the ultimate disposal of residues. There are likely to be a number of alternative means of conducting any one of these activities. In practice, an integrated approach to waste management is likely to be adopted, in order to provide flexibility and to ensure that all waste streams can be managed reliably. Nevertheless, there will be a great many potential integrated 'options' that will allow wastes to be managed effectively. These will differ in, inter alia, the type of collection employed, the specific materials recovered, the recycling rate targeted, the dominant disposal route and the broad location of waste management sites.

Each integrated waste management option will have a range of impacts on the economic, environmental and social objectives that comprise the concept of sustainable development. The preferred option is that which provides the most benefit, and/or least damage, overall, a concept which is captured as the Best Practicable Environmental Option (BPEO). In practice, the options available are likely to have different advantages and disadvantages, and the preferred option will not be readily apparent. Identification and justification of BPEO will therefore require a transparent analysis of option performance, as well as articulation of the relative significance of the criteria employed to assess the options.

The BPEO approach implicitly recognises that the preferred option may differ from location to location because of variation in local needs, resources, impacts and in the relative significance of criteria. Nevertheless, because of the nature of the analysis required, the concept is not sufficiently precise to be used to justify the selection of specific sites, but is appropriate to use in conjunction with broad areas of search. Local impacts should be addressed through Environmental Impact Assessment (EIA) once the BPEO has been identified and specific sites are being sought, with alternative sites addressed through the comparison of alternatives in EIA.

There has been much discussion regarding the relation of BPEO and Best Value. BPEO is used, within a Waste Management Plan (WMP), to select to the best 'potential' option. This then needs to be tested at the local level, through the planning, EIA and competitive tendering processes, to determine the best 'practicable' option which delivers best value.

Two examples serve to illustrate how the Department sees this working in practice:

- Example 1: for a 'built' facility, where different developers could compete to build their facility on a given site, the following sequence might be appropriate: (i) indicate one or more facilities/sites as representing BPEO in the plan; (ii) select a specific site (and acquire it if appropriate); (iii) go to tender for provision of a facility meeting a defined set of performance criteria on this site; and (iv) support the successful contractor in applying for planning permission.

- Example 2: for a facility that is integral to the specific site (e.g. a landfill), where the WMP might identify within the BPEO the need (inter alia) for landfill in a particular geographical area, using site X as one option or site Y via a transfer station as another. In the subsequent Best Value competition, other landfill sites could also compete, provided that they can demonstrate that they also fulfil the BPEO criteria.

As indicated in the *Waste Management Strategy*, the Department of the Environment collaborated with Scottish Environment Protection Agency (SEPA), under the auspices of Scottish and Northern Ireland Forum for Environmental Research (SNIFFER), to develop BPEO decision making guidance for use in waste management planning (September 2000).

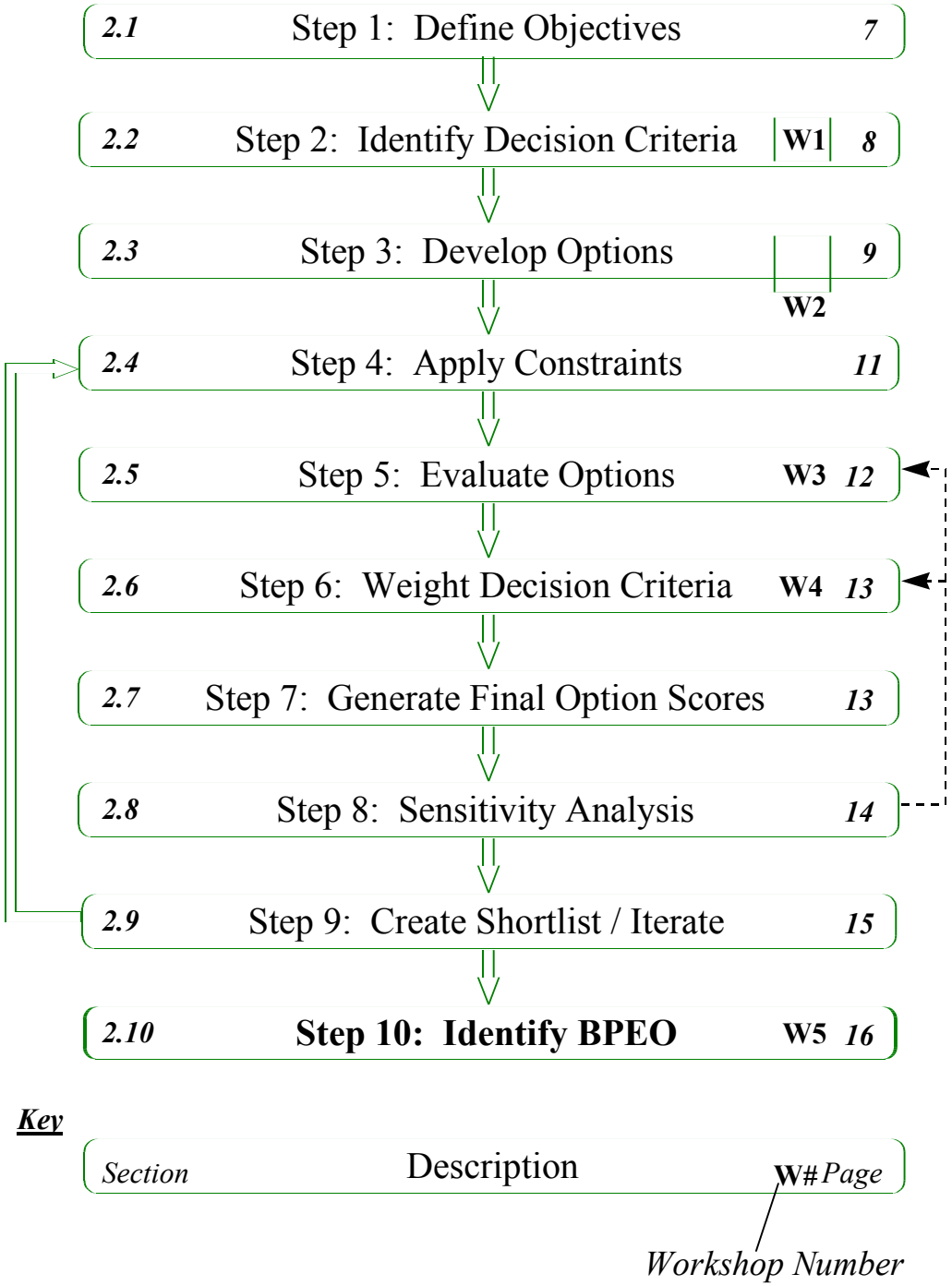
This guidance has been completed following an evaluation of the provisional Waste Management Plans, submitted in June 2001. It complements the previous guidance but can also be used independently.

The main body of the document is a decision makers' guide, designed to explain the process to those who might attend the workshops and others with a general interest in the process.

Annexes A and *B* present support data for the stakeholders involved in selecting Decision Criteria, developing integrated waste management options and evaluating those options. The main text refers to these two annexes as appropriate.

Annex C provides the additional information required by the BPEO practitioners, focussing on how to run the recommended workshops and the mathematics of the calculations.

STRUCTURE OF BPEO PROCESS/CONTENTS



Plus:

Annex A	Decision Criteria
Annex B	Waste Management Methods
Annex C	BPEO - Practitioners' Guide

1.1 EXECUTIVE SUMMARY

District Councils are facing ever-increasing pressure to change the arrangements they make for managing waste arisings. There is a need to respond to targets for recycling and composting waste, to address the demands of the Landfill Directive - in particular, the diversion requirements of Article 5 - and to pursue the economic, environmental and social objectives of which sustainable development is comprised. This context was set out in the Northern Ireland Waste Management Strategy (2000).

The Strategy embraces Best Practicable Environmental Option - BPEO - as one of the key principles to guide progress towards more sustainable waste management practice. BPEO as a concept was the basis of the Integrated Pollution Control regime during the 1990s, and originates from the fifth (1976) and twelfth (1988) reports of the Royal Commission on Environmental Pollution. It entails a systematic and balanced assessment of options, in order to identify which one provides the maximum environmental, economic and social benefits, as well as meeting legislative and practicability constraints. The BPEO concept is thus clearly consistent with the objectives of sustainable development.

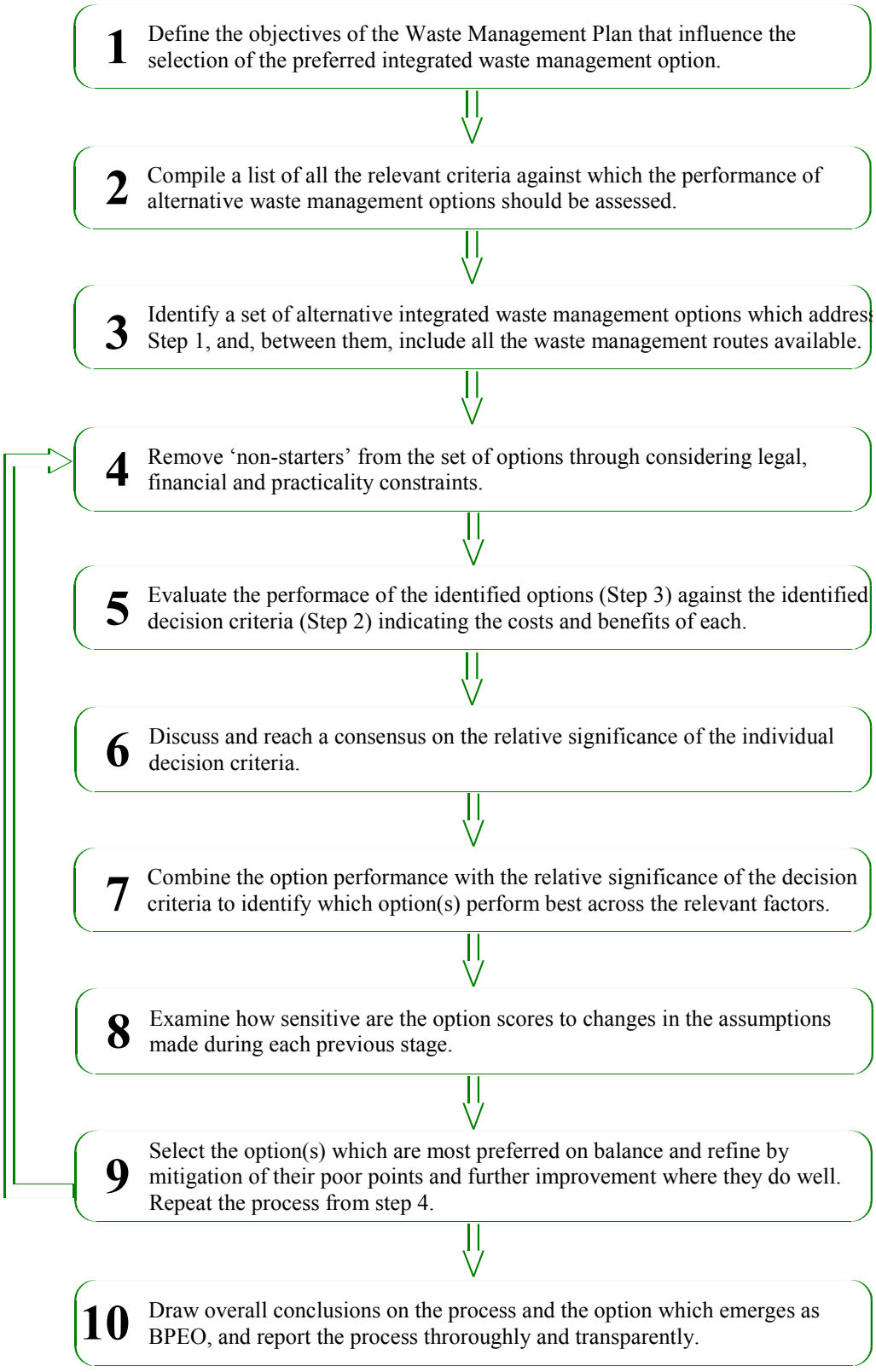
This document provides guidance to the Northern Ireland district councils on the use of BPEO as a means of assessing integrated waste management options for their Waste Management Plans. The BPEO process is broken down into ten simple steps, which start by defining the objectives of the work. The basic tasks of each step are summarised in Figure 1.1, overleaf. Each step is explained in the main body of the document, and further guidance for practitioners is provided in the Annexes.

The criteria that are used to rate the possible waste management options include aspects of cost, natural heritage and social implications. The BPEO process thereby ensures that the right choices are made concerning (among other things) Best Value, protection for the environment and equal opportunities across the community.

The process requires that a great deal of data is collected and analysed by technical officers in the course of determining BPEO. There is also an important role for stakeholders, in contributing to the assessment of waste management options against qualitative criteria and the evaluation of the relative significance of criteria. The guidance recommends the use of a series of workshops to fully engage the stakeholders in the process, and ensure accountability to them.

BPEO is a transparent methodology, showing how conclusions were reached. Using sensitivity analysis, BPEO demonstrates the robustness of the option to changes in the assumptions and to other inputs upon which it is based. This openness will secure public confidence, and should facilitate the procurement of new waste management facilities in due course.

Figure 1.1 Ten-Step BPEO Process



1.2 PURPOSE

A guidance document on decision making for Best Practicable Environmental Option (BPEO) was published by SNIFFER in September 2000. (1) This guidance document provides a stand-alone methodology to district councils in Northern Ireland for determining BPEO, but may also be used as a complement to the SNIFFER guidance. Furthermore, there may be other approaches to identifying BPEO that the councils might choose to adopt. However, these approaches must clearly demonstrate that they adhere to the basic tenets of the concept - namely that:

- a full set of options is compared;
- performances are assessed against all relevant criteria;
- the relative significance of criteria is addressed explicitly;
- sensitivity analysis is conducted to demonstrate the robustness of the methodology; and
- the process of determining BPEO is transparent.

1.3 INTRODUCTION TO THE BEST PRACTICABLE ENVIRONMENTAL OPTION

The BPEO concept was first outlined in the Fifth Report of the Royal Commission on Environmental Pollution (RCEP), in 1976, where, for a given waste stream, the concept was defined as:

'...the optimum combination of available methods of disposal so as to limit damage to the environment to the greatest extent achievable for a reasonable and acceptable total combined cost to industry and the public purse.'

The RCEP's Twelfth Report (1988), elaborated on the concept, and defined it as:

'...the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits or the least damage to the environment as a whole, at acceptable cost, in the long-term as well as the short-term.'

This highlights the need for BPEO to involve the analysis of alternatives. A preferred option is chosen which, for a given objective, provides the optimum balance in terms of emissions and discharges to land, air and water, so as to minimise harm and ensure the protection of the environment, taking account of what is affordable and practicable.

(1) *National Waste Strategy: Scotland - Best Practicable Environmental Option Decision Making Guidance, from SNIFFER and SEPA, available on the internet at http://www.sepa.org.uk/publications/environmental_reports/nws/nws_best_practicable_environmental_option.pdf [19Jul 01 at 10:00]*

The concept was introduced into UK legislation through Part I of the Environmental Protection Act 1990, specifically for prescribed processes regulated under Integrated Pollution Control (IPC). BPEO, as used in IPC, was applied to pollutant emissions from **sites**, and was closely related to the concept of Best Available Techniques Not Entailing Excessive Cost (BATNEEC). Although not applied to waste management **strategies** under IPC, BPEO in this context was a practical demonstration of the need to articulate a trade-off between one consequence of an activity and another in order to arrive at a compromise that maximises benefits. IPC has subsequently (1999) been superseded by Integrated Pollution Prevention and Control (IPPC), which does not employ the term BPEO.

With regard to the application of BPEO to strategies for the management of wastes, the concept is explicitly a key policy imperative in the draft *PPS11 Planning and Waste Management document (2001).*

BPEO has been a fundamental part of UK government policy towards the strategic management of waste streams since this point. It is identified in the *Northern Ireland Waste Management Strategy* (henceforth the 'Strategy') as one of six key concepts of particular importance to the implementation of the Order (1). The Strategy states that:

'The Department will encourage waste reduction and integrated waste management systems in Northern Ireland founded on the principle of the hierarchy of options emphasising reduction, reuse, recycling and recovery. The choice of waste management technique in particular circumstances will be informed by assessment of the BPEO.'

Identifying the BPEO is a complex task in the context of integrated waste management systems. It requires assessing the performance of options against a number of objectives, and resolving the conflicts between these objectives by making appropriate trade-offs. The Strategy states that:

'In evaluating BPEO presented in sub-regional Waste Management Plans, the Department will seek to ensure that:

1. *objectives are clearly stated;*
2. *data and information used has a sound basis;*
3. *all available options have been identified;*
4. *analysis of options is systematic;*
5. *economic, social and environmental considerations (including transport) have been taken into account;*
6. *the process of determining BPEO is transparent; and*
7. *concerns and preferences of the community have been taken into account.'*

The above principles have been embodied in the guidance presented in this document.

(1) *The Waste and Contaminated Land (Northern Ireland) Order 1997, available on the internet at http://www.hmso.gov.uk/si/si1997/1972778.htm [24Jul01 at 09:27]*

1.4 THIS GUIDANCE DOCUMENT

In the absence of this guidance, the advice from the Environment and Heritage Service was to follow the BPEO guidance document developed by SNIFFER. This document follows the approach of the SNIFFER work extensively, and large parts of the process are borrowed directly from it.

However, as the draft plans did not adequately carry out the BPEO process as outlined by SNIFFER, the guidance has been reviewed, and some changes made, in the hope of improving the understanding of all involved. The process itself is broken down into ten basic steps, depicted in the flowchart contents list on *page 1*.

1.4.1 Terminology

The use of the phrases 'methods' and 'options' can become confusing in discussing BPEO work. This guidance adopts the following convention:

A **method** is a particular technique of waste management, such as windrow composting, separate kerbside collection of dry recyclables, or gasification.

A WMP will not simply adopt one method for the management of all its waste arisings. Rather, a particular combination of methods will be chosen, that together present an *integrated* **option** for managing the waste. It is the options that will be compared to seek the BPEO.

1.4.2 Workshops

Mention is made during this text of the use of workshops. **Although this is not compulsory, it is felt that workshops provide an excellent forum for the open discussion and review of plans, and transparency is a key requirement of the BPEO process**. It is therefore strongly recommended that the workshop structure be adopted.

During the course of completing a first pass through the process (and the areas will almost certainly need to run at least one iteration), a total of four workshop sessions are recommended. These sessions open up the decision making process to the relevant stakeholders, and thereby increase the accountability of the plans developed.

A fifth workshop is suggested at the end of the process, to share the principles behind the final BPEO selection and to seek stakeholder commitment to the option chosen.

2 THE BPEO PROCESS

2.1 STEP 1: DEFINE STUDY OBJECTIVES

The final result of applying the BPEO process will be a set of sub-regional Waste Management Plans (WMPs) covering all the district councils within Northern Ireland, that represent the best practicable options for each region, taking into account environmental, social and economic considerations.

This perspective leads to two fundamental objectives that the studies must encompass. Firstly, in order to identify the BPEO for waste management, it is necessary to consider **all waste streams**. The Order makes clear that this means addressing all of the following:

- household waste;
- commercial and industrial waste;
- construction and demolition waste;
- hazardous and special waste; and
- specific requirements for priority waste streams, such as tyres, packaging, Waste Electrical and Electronic Equipment (WEEE) Directive and End of Life Vehicles (ELVs) Directive. (1)

Secondly, the plans must look to **long-term targets**, while nevertheless accounting for intermediate objectives. Planning, construction and operating times for installations run into tens of years. To account for this, it seems inevitable that the WMPs should be based on timelines of 20 years or more. However, the plans must also meet targets from, for example, the Landfill Directive, in 2010, 2013 and 2020.

The sub-regional BPEOs that are developed at this stage will be compared by the Department, to confirm consistency. For example, a capital investment in one area may be used by another area as part of their BPEO. To facilitate this, the regions should make provisions to ensure some **compatibility** between the plans, and incorporate neighbouring facilities in the consideration of their own BPEOs.

2.2 STEP 2: IDENTIFY DECISION CRITERIA

The objectives developed in Step 1 are likely to be generic and qualitative. After this section, Step 3 will address the question of how to develop integrated waste management options to meet those objectives. Those options will inevitably have advantages and disadvantages over each other, making it complex to assess which is the most preferred. The BPEO process uses **Decision Criteria** (DC) as a means to perform that assessment.

(1) *NB Agricultural waste is omitted from this list, as it is not included in the definition of 'controlled waste'. Nevertheless, councils would do well to consider possible synergies with this waste stream as well, because it is expected that the definition of controlled waste will alter to include agricultural waste in the near future.*

The DC are the set of factors that have to be taken into account when assessing the options. The criteria presented in this guidance as a starting point are those developed by SNIFFER (1), following extensive stakeholder consultation, and are grouped into sections such as 'Environmental' and 'Economic'. **Because the DC will have such a strong bearing on the choice of the final BPEO, they should be identified before the options, so that the temptation to fit criteria to options is diminished**.

However, the process does not stop at identification. It is also necessary to agree a suitable means of scoring the performance of the options against those criteria, that embraces the stakeholders' perceptions of what each criterion represents. In *Step 6*, the criteria will be assessed against one another, so that their relative importances are quantified.

2.2.1 Identifying Relevant Decision Criteria

Annex A presents the recommended list of DC from the SNIFFER guidance document. The first step in this part of the process is to review the DC for local relevance. While none of the criteria should be removed, it might be that there are other local factors that have not been suitably covered. In this instance, it is acceptable for criteria to be added to the list. **Particular consideration should be given to the fact that the SNIFFER DC do not take into account non-municipal waste arisings**.

At the same time as agreeing *what* DC should be used to rate the options, it is worthwhile considering *how* to assess the options against those DC. Could a life cycle assessment tool such as *WISARD* (2) be used, or is a qualitative score from one to a hundred based on expert judgement appropriate? Again, *Annex A* provides some ideas on various ways to score the options against the DC.

This work is analogous to *Stage 2* of the SNIFFER process, and, as in SNIFFER's guidance, it is recommended that it is completed by means of a workshop session.

2.3 STEP 3: DEVELOP OPTIONS

This step develops a set of integrated options, which will be assessed for their suitability in delivering the objectives identified in *Step 1*. This process follows that outlined by *Stage 3* and *Workshop 2* of the SNIFFER guidance.

At one end of the spectrum is the 'Do Nothing' option. This represents a projection of what will happen with no intervention, continuing with business as usual. This option is a very useful baseline against which to compare the others, although it will almost certainly not meet the basis targets set out in the objectives.

At the other extreme is the 'Do Everything' option. It is a combination of all of the possible interventions, at their maximum levels (eg don't just commission a gasification plant, but commission the biggest that might possibly be required). Developing the plausible set of options that fall between the two extremes can be done by Option Mapping, as recommended by the SNIFFER Guidance.

(1) See Annex A of the SNIFFER Guidance

(2) Waste Integrated Systems Assessment for Recycle and Disposal

2.3.1 Option Mapping

Option Mapping is a visual methodology that can be used to facilitate the selection of sets of methods, to develop integrated waste management options.

The first task is to define a suitable list of waste management methods. *Annex B* presents a number of methods under each of seven headings, and lists some points to consider against each. At least two methods should be selected under each heading, with consideration given to all controlled wastes.

The next step is to select compatible combinations of methods, to develop complete and integrated waste management options. These must include methods of waste collection/transfer and final disposal as a minimum, but may also include various combinations of the other techniques.

To use Option Mapping to help with this process, draw up seven well spaced and large circles - to represent the seven categories. Next to the large circles, draw smaller circles to represent each of the methods in that category. Where methods are compatible, indicate that **resonance** by drawing a solid line between the small circles. Where methods clash, mark that **incompatibility** with dotted lines.

Figure 2.1 Option Mapping Diagram

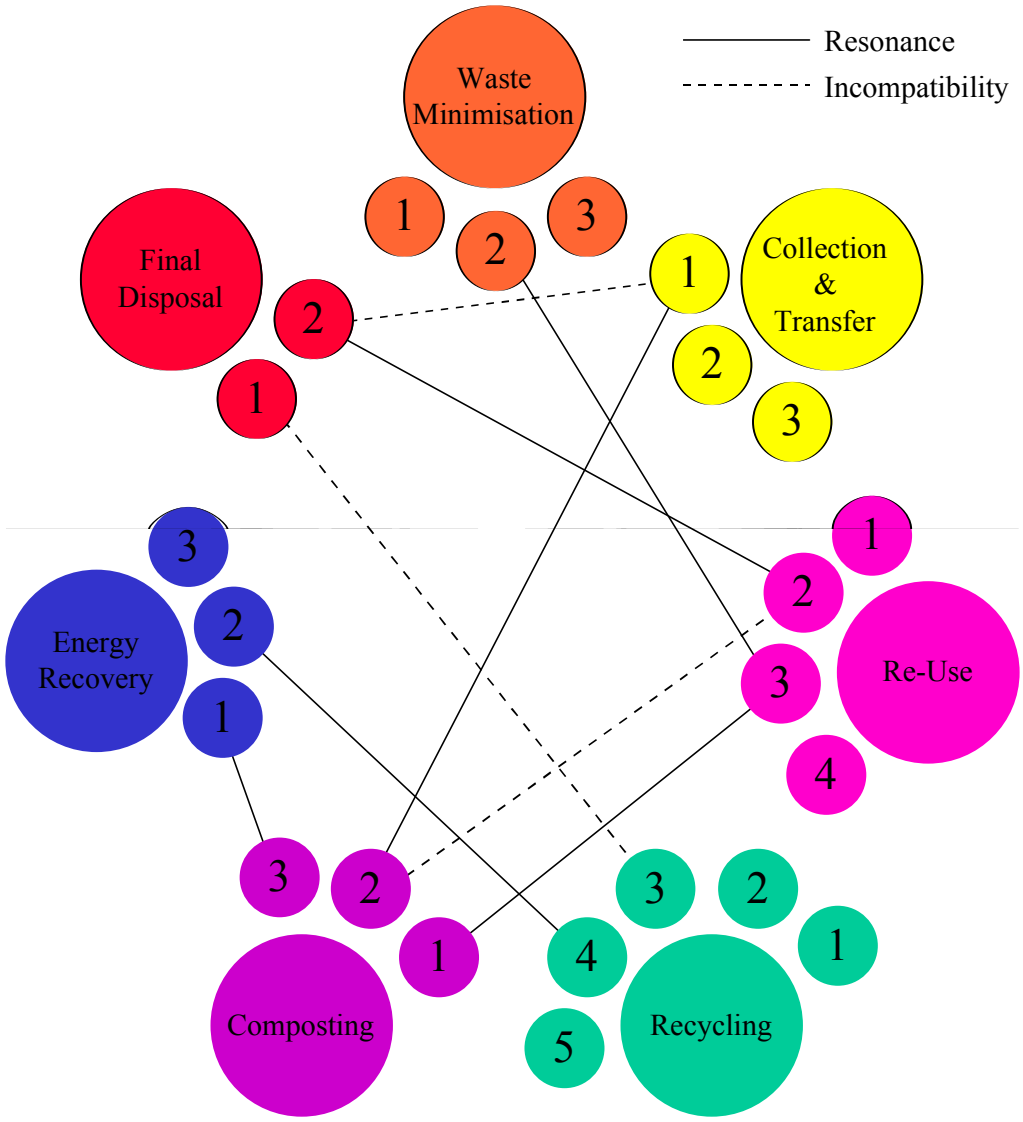


Figure 2.1 indicates schematically such a process. *Method 1* in the Collection & Transfer category might be 'Kerbside collection of green waste', with *Method 2* of 'Composting' being 'Open cell composting'. Clearly there is a synergy between these methods, so a solid line is drawn between them. Conversely, if *Method 2* of Final Disposal is 'Landfill', this is less compatible with 'Kerbside collection of green waste' (why separately collect green waste and then landfill it?), so a dotted line is drawn between them. Representing such relationships diagramatically is obviously not compulsory, but it does make it simpler to picture the methods and understand how they might be combined to generated integrated options.

The complete process of option development, together with the application of constraints, lends itself well to a workshop session.

2.4 STEP 4: APPLY CONSTRAINTS

2.4.1 Constraints

The consideration of constraints is covered implicitly in *Stage 3* of the SNIFFER guide. This revised process treats constraints in a more formalised fashion, so that their role is clearer.

Step 3 develops a set of integrated options to be assessed against each other and against the objectives of the study. Before proceeding to this assessment, it is worth considering whether there are any constraints that must be applied, which the options cannot meet.

Are there any absolute cost limits that cannot be exceeded? Does any option break national or EC law? Are relevant targets met? If an option does not satisfy one of the identified constraints, it may well be appropriate to drop the option at this stage, before a complete evaluation is undertaken. **It is likely that 'Do Nothing' will fall foul of the Landfill Directive, while 'Do Everything' may well exceed cost limits, but these options are usually worth pursuing, in order to present boundaries for the other options**.

For other options that do not meet one or more of the constraints, there is likely to be less value in assessing them further. The decision may therefore be taken at this juncture to drop the option entirely, or perform a first round of iteration, to refine the option so that it does not breach the constraints. This process should be included as part of the procedure for Workshop 2.

2.4.2 Summarise Options

With the completion of the work on the constraints, the options are ready for evaluation. Before this takes place, it is worthwhile (though not obligatory) to summarise them in their current format. This can be done by drawing up a flow diagram for each option, showing how the waste moves from sources to treatment and disposal, with information on the number and size of new installations.

2.5 STEP 5: EVALUATE OPTIONS

The remaining options must now be evaluated against each DC (this is covered in the SNIFFER guide in *Stage 4*). Workshop 1 identified which DC would be used, and also how the options should be evaluated against those criteria. For some DC, a software tool such as WISARD might be required, while for others, a qualitative assessment will be the only possibility. **It is crucial that, whichever method is used, the process is transparent, so that, when it comes to performing the sensitivity analysis, it is clear where the adjustments might be most usefully made**.

The district council should go through each DC, assessing whether the agreed assessment methodology is quantitative or qualitative. The former can be evaluated outside a discussion forum, but the latter should be assessed during a third workshop.

2.5.1 Quantitative Decision Criteria

For some DC, absolute scores may be assigned, such as tonnes of CO_2 generated, average waste collection distance or expected cost to build a new installation. These figures can be generated outside a workshop session, since there should be no necessity to discuss the figures, other than to consider their accuracy, and this is done during the sensitivity analysis (*Step 8*).

2.5.2 Qualitative Decision Criteria

For other DC, such as 'Cultural Heritage', no such absolute scoring is possible. For these cases, it is really the *difference* in performance that should be ranked rather than the absolute impacts. By using a workshop forum of appropriate stakeholders, the whole spectrum of opinions can be heard, and decisions taken that are significantly more transparent and defensible.

The preferred technique is to give the stakeholders a set total number of points for each DC. These points must be distributed between the options, with the most important options getting more points than the others, depending on how much more important they are perceived to be. The number of points awarded to each option is open to debate among the stakeholders, and consensus decisions must be reached.

This approach forces the stakeholders to talk about their opinions on the relative performance of each option as judged against the DC. This open technique should facilitate the sharing of thoughts and further the group understanding of how various stakeholders perceive both the options and the DC.

2.6 STEP 6: WEIGHT DECISION CRITERIA

With scores assigned to all the options against all the DC, it is time to weight the relative importance of the DC against each other. This is done now because the assessors have information regarding the nature of each DC, how the options were rated against each one, and the range of scores. In order to fully assess the importance of each DC, it is necessary to consider not only the absolute importance of the DC, but also the significance of the difference between the highest and lowest rated options.

The judgement of the relative importance of the DC is only considered implicitly in the SNIFFER guidance, being incorporated into the discussed assessment of the relative merits of options under the 'Pairwise Comparison' technique (1). The technique recommended below is designed to make the process more transparent, by encouraging the participants to explicitly 'value' the criteria against one another.

2.6.1 Dividing Points Between the Decision Criteria

The favoured method of weighting the DC is exactly analogous to the scoring of the options against qualitative DC, presented above. The stakeholders are given a set total number of points to distribute between the DC, and agree by consensus. Again, this approach forces the stakeholders to talk about the DC, and should clarify any misunderstandings on the meanings of the DC.

(1) See page 27 of the SNIFFER guidance.

2.7 STEP 7: GENERATE FINAL OPTION SCORES

In order to compare the performance of the options on an even basis, the range of scores assigned must now be normalised (1), and then scaled by their importance, as dictated by the weighting of the Decision Criteria.

This process generates Final Option Scores, rating the options between zero (worst on all counts) and one (best on all counts). This step is also covered under Stage 4 of the SNIFFER guidance. By generating numbers to quantify the rating of the options, the technique presented here again makes the process more transparent.

Because this step is simply a mathematical manipulation of the previously assigned figures, further discussion is reserved for the Practitioners' BPEO guidance, in *Annex C*.

2.8 STEP 8: SENSITIVITY ANALYSIS

Step 7 will most likely identify one or a few options as 'lead options', and others as less desirable. This should allow the selection of two or three options for the shortlist, at the expense of the others.

However, before the shortlist is finalised, it is crucial to check that the basis on which those options were chosen is robust. This is done through **sensitivity analysis**.

Sensitivity analysis is an absolutely critical part of the BPEO process, and one which is too frequently treated with insufficient rigour. Its essence is to investigate how susceptible the Final Option Scores are to the ratings assigned along the way - in particular, those ratings that are least robust.

Sensitivity analysis is done by examining, where options score are least certain, or DC weightings least concordant, whether changes in those ratings have a large effect on the Final Option Scores. If they do, it is important to flag in the overall record of the process that the decisions made are sensitive to changes in those variables.

During the first round of option assessment, sensitivity analysis should focus on the clear winners and losers, to confirm that their Final Option Scores are robust.

The details of how to perform sensitivity analysis are again reserved for the Practitioners' BPEO guidance, in *Annex C*.

2.9 STEP 9: CREATE SHORTLIST/ITERATE

2.9.1 Initial Shortlisting of Options

The above work will have generated a list of integrated waste management options, each with a Final Option Score and some idea of how robust that score is to changes in the underlying data and assumptions, from the sensitivity analysis. Any options that are clear losers (ie which score poorly yet have a robust score) can now be dropped from consideration. It is quite likely that the 'Do Nothing' and 'Do Everything' options might both fall at this stage.

(1) Normalisation is a simple mathematical process, whereby a set of numbers are scaled, so that the lowest becomes zero, the highest one, and the rest fall proportionately between these two extremes.

2.9.2 Refine Shortlist

The initial shortlisting will have generated a list of options that includes the lead options and a few others 'in the middle', which are rated similarly and/or which are susceptible to changes in the data. The purpose of this stage is (if necessary) to combine the best parts of the options available, to generate one or more lead options for an iterative evaluation.

It therefore makes sense to start with the current lead option, and look at how it is rated against each DC. Where it performs poorly, are there other options that fare better? If there are, can relevant aspects from any of those options be beneficially incorporated into the lead option? Conversely, if the lead option performs well for a DC, could that performance be magnified by doing 'more of the same'? For example, if windrowing proves to be expedient, how about considering in-vessel systems?

Without knowing specific circumstances, it is impossible to recommend how these hybridisations may take place. However, the users should seek to identify two or three lead options for iterative evaluation. If the sensitivity analysis revealed a particular sensitivity to one or more of the DC Weightings, or the data used to generate the option scores, it may also be worthwhile to revisit these matters, and consider alternative methodologies.

Having iterated the new lead options, a clear winner may emerge, or the systems may perform comparably well, within the accuracy of the method as shown by the sensitivity analysis. If the latter is the case, a further iteration of a new hybrid may be necessary, in order to determine the final best combination.

2.10 STEP 10: IDENTIFY THE BPEO

The outcome of all the work above, which will probably involve at least one iteration of the evaluation process, is a plan for the management of waste in the local area that can be demonstrated to be the overall Best Practicable Environmental Option.

At the end of *Step 9*, the few remaining lead options will have been evaluated. Either there will be an apparent BPEO, or there will be two or more options that could be adopted. To endorse the apparent BPEO, or to select from the lead options, a final workshop should be held with a large range of stakeholders, to discuss the final BPEO.

Following this, the district councils have three more tasks to perform. The first is to report the entire process in their WMP, in particular making transparent the assumptions and value judgements that are inherent in BPEO evaluations. This may leave the report open to criticism, but this is exactly the sort of debate that should be encouraged, to further understand how to rate the Decision Criteria and the performance of the options against those criteria. If the final workshop is run well, there should be few surprises in the responses to the report.

The second task is to commit to (and, in time, perform) repeat analyses in future years, to confirm that the option chosen is still BPEO. Opinions, data and technologies change and evolve with time, and the option chosen now may not reflect BPEO in years to come. Therefore check-steps must be built in, to keep the process on track and in the right direction.

The third task, to implement the WMPs, almost goes without saying, but is, of course, the most important of all.

Annex A

Northern Ireland BPEO - Decision Criteria

A1 NORTHERN IRELAND BPEO - DECISION CRITERIA

This Annex presents the Decision Criteria (DC) identified by the SEPA BPEO Guidance, and suggests means of allocating scores to the developed options for the criteria.

A1.1 BACKGROUND TO THE DEVELOPMENT OF THE CRITERIA

SEPA developed its national DC via a five stage process, which is described in their BPEO Guidance thus:

1. Four specific stakeholder groups (the waste industry, regulators and public agencies, NGOs and experts) were identified and facilitated workshops were held, attended by between 12-16 representatives of each group. The workshops were designed to identify all the issues which the group considered were important in planning waste management in Scotland. Participants in the stakeholder process are listed at the end of this Annex.

2. The results from the four specific groups were brought together into a "long list" of potential DC grouped under five main headings. These headings were:

   economic, environmental, social, practicability and fit with policy.

3. The "long list" was presented to a further multi-stakeholder workshop and a "short list" of twenty proposed DC was agreed.

4. The "short list" was presented to three further stakeholder groups in the form of a questionnaire seeking their views on:

   - whether all the relevant issues were covered;
   - how important each criterion was to decision making on waste management.

   The three further groups whose views were obtained by this route were community councils (representing the general public), industry associations (representing industrial waste producers) and Members of the Scottish Parliament (MSPs). The responses from the questionnaire are presented in *Box AA1.1.*

5. In the final stage the results of the surveys were integrated with the earlier work to create the final set of National Decision Criteria.

Box AA1.1 SEPA Survey Results Rating the National Decision Criteria

Having identified 20 national Decision Criteria (DC), SEPA conducted a postal survey to assess the relative importance of the DC. 292 Community Councils, 61 Industry Associations and 129 Members of the Scottish Parliament, together with all the previous stakeholders, were asked to rate the importance of each DC on a scale of zero to five. 96 responses were received and averaged, resulting in the following scores:

96 responses	Average Score
Air, land and aquatic environment	4.7
Global climage change	4.3
Making producers responsible	4.3
Local amenity	4.2
Accidental Risks	4.1
Flexibility	4.1
Natural heritage	4.0
Practical deliverability	4.0
Non-renewable resource use	3.9
Public acceptability	3.7
Technical feasibility	3.6
Making best use of existing facilities and expertise	3.6
Compliance with other policies	3.5
Impact on local economy	3.4
Cultural heritage	3.4
Employment	3.3
Social implications (poverty, exclusion and access)	3.3
Cost	3.3
Financeability/affordability	3.1
Skills base	3.0

Considered separately, all four groups rated *'air, land and aquatic environment'* as the most important DC, apart from the MSPs, who ranked *'making producers responsible'* the highest.

The following sections provides detailed guidance, based upon that in the SEPA Guide, on each Decision Criterion, in terms of:

- a brief introduction to the issue and its relationship with waste management;
- examples of the sorts of questions users should or could ask in appraising an option against the criterion;
- information on some of the tools available for appraisal of each criterion and sources of information that may be useful when undertaking the appraisal.

A2 ENVIRONMENT

A2.1 AIR, LAND AND AQUATIC ENVIRONMENT

A2.1.1 Air

When assessing waste management system options in terms of air quality the following questions can be asked:

- will the management system option result in increased or decreased emissions of pollutants to air (ie will there be a change from the current situation) from waste combustion, fuel combustion in stationary plant or vehicles, or other sources (eg waste storage or processing)?
- what pollutants will be emitted and in what quantities?
- how hazardous are these pollutants?
- how will these emissions affect air quality, increasing concentrations of pollutants in the atmosphere?
- what are the current levels of emissions and air pollution in the area?
- what are the expected impacts of predicted changes in air quality on human health and natural systems?
- will there be other effects, such as increased dust or odour, which might cause local nuisances?
- are there any particular air quality problems in the local environment which could be exacerbated by the option?
- are there any particularly vulnerable receptors in the local area which could be affected by changes in emissions (eg vulnerable populations or habitats sensitive to air pollution)?

The following information sources may be useful in determining current and future levels of air quality, areas with pollution problems or particular sensitivities, and the types of pollutant which are of most concern to the planning and environmental authorities.

- The UK National Air Quality Strategy for England, Scotland, Wales and Northern Ireland, published in 2000, by DETR provides a framework on air quality issues in the UK and identifies those pollutants of particular concern for air quality now and in the future.
- The document can be downloaded from the DETR website (http://www.environment.detr.government.uk/consult/ air quality). SEPA has also recently published a review of air quality in Scotland called 'State of the Environment -Air Quality' (http://www.sepa.orguk/publications/air-report/index.htm).
- Research reports and information on local air quality, and the air quality monitoring network across the UK can also be obtained from the DETR's National Air Quality Archive (http://www.aeat.co.uk/netcen/airqual/).

- The DETR's Nationl Atmospheric Emissions Inventory (http://www.aeat.co.uk/netcen/airqual/) provides estimates of the amount of many atmospheric pollutants emitted from a range of sources including waste management.

- Information on the health effects of air pollution can be found in the publications of the DETR's Expert Panel on Air Quality Standards (EPAQS) (http://www.environment.detr.gov.uk/ airq/aqs/index), the Department of Health's air pollution pages on http://www.doh.gov.uk/hef/airpol/airpolh.htm) and the Department of Health Committee on the Medical Effects of Air Pollution (http://www.doh.gov.uk/comeap/ index.htm). Information on air quality standards for each pollutant is also provided by EPAQS.

The WISARD model can be applied to the appraisal of air quality impacts for municipal waste options or systems. WISARD will allow the following outputs to be modelled:

- acidification;
- stratospheric ozone depletion;
- photochemical smog formation; and
- human toxicity for selected emissions.

For other waste streams an assumed waste composition could be used to allow WISARD to calculate impacts. However, WISARD requires the inputting of a data about waste types, logistics and proposed recycling/recovery systems. Such data may not always be complete for other waste streams therefore the model should be used with care (and consistency across options), particularly if the default parameters in the data input stages are selected by the user. For a fuller description of WISARD please refer to the SEPA Guidance on Area Waste Plans.

A2.1.2 Land and Aquatic Environment

Water is essential for life and plays an important part in the economy. Rivers, estuaries, coastal waters and groundwater are all integral parts of the natural environment. Water also provides important habitats for wild plants and animals. We use water in agriculture and industry, for leisure activities, for transport - and of course for drinking.

Soil is an important resource which supports a variety of ecological, agricultural, economic and cultural functions. Development can have an adverse effect on both the biological and physical properties of soil and can limit its future use.

When assessing a waste management system option in terms of its impact on land and water the following question can be asked:

- will the management system option result in an increase or decrease in releases to or contamination of, surface water, groundwater or soil from deposits or processing of waste?
- if so, which elements of the option are predicted to cause the pollution?
- what pollutants will be released to which media and in what quantities?

- how hazardous are the pollutants?
- what impact will they have on soil or water quality?
- what is the current quality of surface water, groundwater and soil in the area?
- what are the expected impacts of changes in soil or water quality on environmental resources, human health and the economic value of the resource?
- will there be any other effects, for example on quantities or flows of water or erosion of soils, as a result of the option?

A variety of information and data on existing water and soil quality, key pressures on these resources and their vulnerability to pollution/development is available, to assist in assessing the likely effects of waste options on land and the aquatic environment. Key sources are listed below.

- Information on the quality of surface water under the Scottish River Classification Scheme is available from SEPA (http://www.sepa.org.uk/). This updates the previous Scottish Office Water Quality Survey of Scotland, published in 1992.
- Improving Scotland's Water Environment. SEPA Report, September 1999.
- Annual reports from the three SEPA Regions and the annual report on 'Scottish Environment Statistics' published by the Scottish Executive.
- A classification of aquifers, provided in published hydrogeological maps. Drift and solid geology can be determined from British Geological Survey maps eg the 1990 BGS map 'Hydrogeology of Scotland'.
- Critical load maps for Scottish soils have been produced by the Macaulay Land Research Institute and Aberdeen University. These maps show the sensitivity of soils to acid deposition and the areas where critical levels have been exceeded. The Institute has also produced a digitised 1:250,000 soil map for Scotland and a national soil database.
- The 1994 Scottish Vacant and Derelict Land Survey identifies around 14,100 hectares of vacant and derelict land across 6,000 sites, many of which are contaminated. Local authorities across Scotland have new duties under Part IIA of the Environmental Protection Act 1990 to identify contaminated land in their areas.
- Current trigger levels for contamination in soil are provided in a publication by the Interdepartmental Committee on the Redevelopment of Contaminated Land (1987) available from the DETR (Guidance on the Assessment and Redevelopment of Contaminated Land: ICRCL 59/83). The Dutch guidelines are often used in conjunction with the ICRCL trigger levels as they provide guidelines for additional contaminants and for contaminants in groundwater. The latest guidelines can be found on http://www.contaminatedland.co.uk/std-guid/dutch-l.htm.

For municipal solid waste, the WISARD model can predict releases to land and water. For other waste streams an assumed waste composition could be used to allow WISARD to calculate impacts.

A2.2 GLOBAL CLIMATE CHANGE

Climate change is predicted to occur as a result of emissions of various gases to the atmosphere. The principal sources of so-called greenhouse gases from waste management include CO_2 from fossil fuel combustion and CH_4 and CO_2 from waste decomposition. Climate changes could include temperature increases, sea level rise, an increase in extreme weather conditions, drought and flooding. Climate change also poses significant risks to public health, property, society and biodiversity. Due to the greenhouse gases that have already accumulated in the atmosphere from burning of fossil fuels and agricultural activities some human-induced climate change is now expected to be inevitable. But the worst effects of climate change may be avoided if action is taken now to reduce emissions and stabilise levels of greenhouse gases in the atmosphere.

Any option employed for waste management will lead directly or indirectly to emissions of greenhouse gases contributing to climate change. The main sources of these gases will include:

- CO_2 emissions from vehicles used to collect and transport waste;
- CO_2 emissions from energy used to power waste facilities;
- CH_4 emissions from waste decomposition;
- CO_2 emissions from composting operations;
- CO_2 emissions from burning waste; and
- CO_2 emissions from burning landfill gas.

For each management option the production of global warming gases should be considered by asking the following questions:

- will the waste management option require an increase or decrease in fossil fuels used for transport and processing?
- will the management option result in an increase or decrease in emissions of greenhouse gases?
- what greenhouse gases will be emitted and in what quantities?
- what will be the impact of these gases in terms of CO_2 equivalents?
- how will this change the level of greenhouse gas emissions in the area and from the waste industry?
- will landfill gas recovery and combustion convert CH_4 to less potent CO_2 and reduce greenhouse gas emissions?
- will increased re-use or recycling reduce greenhouse gas emissions from use of primary raw materials?
- will energy recovery from waste substitute for fossil fuel use?

Information on greenhouse gas emissions and climate change can be obtained from the recently published draft UK Climate Change Programme (http://www.environment.detr.government.uk/climatechange/ index.htm). This document sets out the policy framework for reducing greenhouse gas emissions in the UK in line with international and domestic targets, together with appropriate actions in key sectors of the economy. In March 2000 a Draft Scottish Climate Change Programme was published by the Scottish Executive for consultation.

A scoping study of the implications of climate change in Scotland, prepared by the Centre for the Study of Environmental Change and Sustainability at the University of Edinburgh, was published in 1999 by the Scottish Executive (http://www.scotland.government.uk/news/1999/12/se1559.asp).

Work has recently been undertaken for the DETR on disaggregation of national greenhouse gas emission inventories, including an inventory and emissions projections for Scotland. Further details can be obtained from the DETR's Global Atmospheric Division (020 7890 3000).

The life-cycle assessment (LCA) software WISARD can be used to estimate the quantities of greenhouse gases that will be generated by municipal waste options. Waste streams other than municipal solid waste can be dealt with by WISARD by creating an assumed waste stream composition, paying particular regard to the composition of organic materials.

A2.3 LOCAL AMENITY

Low noise levels, as well as low levels of traffic, dust and odour, attractive buildings, streets and green spaces are important aspects of local amenity. Waste management options will have differing potential to impact on these and other aspects of local amenity.

When considering a waste management system option in terms of its likely effect on local amenity the following questions should be asked:

- will the waste management option impact on levels of odour and noise?
- what is the expected impact of the option on vehicle kilometres travelled, traffic levels, congestion, risk of accidents etc?
- are there opportunities to transport waste by rail or sea?
- will new infrastructure have the potential for adverse visual impacts and are there areas of landscape or visual sensitivity in the area which should be avoided?
- will it be difficult to find locations for new infrastructure which are not sensitive in landscape and visual terms?

Amenity issues such as existing noise climate, traffic flows and congestion and quality of open space and the general landscape are largely within the remit of local authorities who will be represented on the Waste Strategy Area (WSA) Groups. The Scottish Executive maintains a database of traffic in Scotland, the Scottish Road Traffic Database. The significance of visual impacts will vary depending on the existing visual character of the surrounding landscape. In this appraisal, the generic impact on amenity of any new facility will need to be qualitatively assessed since its precise location may not be known. This might be presented as the potential for significant landscape or visual impacts within

different parts of the planning area (eg lowlands and coastal areas may result in greater visibility; upland areas may have landscape designations which increase the significance of the impact of the development in these areas).

A number of sources of guidance which may be consulted when considering amenity issues are identified below.

- Guidance on the environmental effects of changes in road traffic has been published by the Institute of Environmental Assessment (Guidelines for the Environmental Assessment of Road Traffic).
- Various National Planning Policy Guidance Notes (NPPGs) and Planning Advice Notes from the Scottish Executive including:
  - NPPG10: Planning and Waste Management
  - NPPG11: Sport, Physical Recreation and Open Space
  - NPPG15: Rural Development
  - NPPG17: Transport and Planning
  - PAN51: Planning and Environmental Protection
  - PAN56: Planning and Noise
- Guidance on Landscape and Visual Impact Assessment has been published by the Institute of Environmental Assessment and the Landscape Institute.

A2.4 NATURAL HERITAGE

Potential impacts on natural heritage which could arise from the development of waste management options include impacts on habitats and species, predominantly from the development and operation of new waste management infrastructure and transport operations.

Specifically, these impacts may include loss of habitats or species of flora and fauna, disturbance to or displacement of species, fragmentation of habitats or severance of ecological corridors. Features which may be of nature conservation interest could include natural water bodies, woodlands, hedges, wetlands, moor and heath, unimproved grassland and scrub. There may also be opportunities for creation of new habitat and introduction of species as a result of restoration works and landscaping.

Questions to ask when appraising management system options for impacts on natural heritage are presented below.

- Is the management system option likely to involve new infrastructure development?
- If so, are sites likely to be available on previously developed land so that disturbance of nature conservation interests is minimised?
- If building on undeveloped land is likely to be necessary, are there particular areas of nature conservation and biodiversity importance which could be affected?

- How likely is it that a site or sites can be found in the area which will avoid areas or features of nature conservation interest?
- What are the expected impacts on ecological resources if development in such areas is likely to be unavoidable?
- Is the option likely to offer opportunities for habitat creation e.g. from restoration of landfill sites in the short or long term?
- Are there any other aspects of the management option which could provide benefit or have an adverse effect on nature conservation interests?

If development is necessary as part of an option (eg a large new materials reclamation facility, landfill or energy-from-waste plant) the impact will be greatest if a greenfield site, on or near sites of ecological importance, is developed. Although site-specific information for such facilities is unlikely to be available at the strategic appraisal stage, the likelihood of development in areas of national ecological significance (eg Sites of Special Scientific Interest (SSSIs)) or local importance for conservation should be considered. For example certain facilities will be very constrained in location due to factors such as road, rail or water access, size of site, geotechnical conditions etc making the likelihood of significant ecological impacts easier to assess. Nevertheless, a qualitative approach to appraisal of each option is envisaged.

Initial information on the ecological significance of the area can be gathered from information sources including Development Plans, local biodiversity action plans and state of the environment reports. Local Authority biodiversity officers and Scottish Natural Heritage (SNH) as well as non-statutory agencies such as the Scottish Wildlife Trust and local conservation groups can also provide information on baseline conditions, important areas, habitats and species under threat or of conservation importance and key sources of impact in the local area.

A2.5 CULTURAL HERITAGE

Cultural heritage may be defined as the resource encompassed by the stock of archaeological remains (both known and potential) and historic sites and buildings including monuments, listed buildings, Conservation Areas, and historic gardens and landscapes. Cultural resources provide an educational, recreational, historic and cultural resource which is non-renewable. Impacts on cultural heritage could arise from waste management options which involve developments directly or indirectly affecting cultural features or their setting.

Questions to ask when appraising the effects of waste management options on cultural heritage include:

- is the management system option likely to involve new infrastructure involving new development or earth works?
- if so, are sites likely to be available in previously developed (brownfield) land so that disturbance to cultural heritage features can be minimised?
- if building on undeveloped land is likely to be necessary, approximately how much land is likely to be required (compared with other management options)?
- how likely is it that a site or sites may be found in an area which will avoid areas or features of cultural heritage?

- does the area generally have a high known or potential importance for cultural heritage and are there locations where new development should be specifically avoided?

- are there any aspects of the option that are likely to offer opportunities to enhance preservation and/or public access to areas of cultural heritage?

An option requiring new build on a greenfield site is more likely to impact on cultural heritage than one that uses existing and brownfield sites. At the strategic appraisal stage, however, it is unlikely that specific development locations for waste facilities will be known. Instead, the appraisal should focus in a qualitative manner on the historic significance of the area and seek to assess whether the option is likely to result in unavoidable impacts to the cultural heritage, taking account of sensitive areas (such as broad designations like Conservation Areas) and the likelihood of new waste facilities being required.

Baseline information on key archaeological and built heritage features can usually be identified from the proposals maps of Development Plans prepared by local planning authorities. These documents will also contain policies relating to the protection of such features and typically provide an outline of the cultural heritage resource in the area. Consultation with statutory and non-statutory consultees will give a more detailed indication of areas of known and potential cultural heritage significance. Key contacts include:

- Archaeologists, who can advise on cultural heritage issues and who may be able to provide further documentation of the resource in each area;

- Historic Scotland, the national agency responsible for protection and preservation of historical and cultural resources;

- the Royal Commission of Ancient and Historic Monuments of Scotland (RCAHMS) which maintains a register of archaeological sites and features.

Key sources of policy and guidance on cultural heritage and development affecting it in Scotland are listed below.

- National Policy and Planning Guidance (NPPG) 5, Archaeology and Planning; and

- Planning Advice Note (PAN) 18, Planning and the Historic Environment.

A2.6 NON-RENEWABLE RESOURCE USE

The prudent use of finite natural resources is a key objective of sustainable development. Non-renewable resources such as fossil fuels or mineral ores should be used efficiently. The choice of waste management system option can have a significant influence on the consumption of finite resources. For instance, an option involving reuse and recovery of materials should result in a reduction in the consumption of primary raw materials. A management system option involving recovery of energy from waste should result in a reduction in the use of fossil fuels.

When considering the performance of a management system option in terms of use of non-renewable resources the questions set out below should be asked.

- Will the option require use of non-renewable resources for construction and operation of waste infrastructure?

- Will the option result in a change in the quantity of non-renewable resources used through reuse, recycling or recovery?
- Which non-renewable resources will be affected and how much more or less will be used?
- What is the current accessibility to second-hand goods in the area eg refurbished white goods?
- Will the option encourage reduction and re-use of materials in the area?
- Will the option increase or reduce the percentages of materials recycled?
- Will the waste option increase the recovery of unwanted but re-usable goods and materials?
- will the option lead to recycling of particularly scarce resources?

For municipal waste, the appraisal may be carried out using WISARD. For waste streams other than municipal solid waste an assumed waste stream composition may be used to allow WISARD to calculate the impacts. WISARD can estimate consumption of all resources individually and provide two indexes of non-renewable resource use based on resource depletion (% of resource remaining) and consumption rate (% of current consumption rate).

A2.7 RISK OF ACCIDENTS

A safe and healthy environment for employees and the public in the waste management industry is required by health and safety law and employers are required to take necessary measures to comply with the legal requirements. However, some risk may be associated with certain tasks, for example, for workers using heavy and mechanical plant, handling of hazardous wastes and waste transportation.

Probably the greatest risk involved in a waste management system option will be the risk of road traffic accidents. A waste management system option concentrating on local solutions to waste arisings will involve less transport and thus reduce the risk of accident from this source. A hand picked materials reclamation facility or kerbside waste collection system could involve a risk to employees as a result of working in close proximity to machinery with moving parts. Data on operator risks from these activities should be identified and compared with the risks from alternative waste management systems and with the current arrangements.

When considering the safety performance of a waste management system option the following should therefore be addressed.

- What are the risks of accidents to people (workers and public) from this management option e.g. on the roads, accidental releases of pollutants, risk of explosions or fire etc?
- Have the safest possible technologies and systems been adopted or specified for the option?
- Are any particularly risky technologies necessary for the option?

- How safe has been the waste management industry in the area to date? Are there any sectors where risks have been assessed as being unacceptably high or where accident frequencies are high?

Detailed and quantitative risk assessment will be difficult to undertake at the strategic appraisal stage. Some information on relative risks of the different measures and technologies should be available however. Sources of information on risks include the Health and Safety Executive, and waste management industry bodies and institutes.

Relative risks of road traffic accidents may be appraised for each option by referring to road traffic accident data for the routes used by waste management vehicles and assessing the effect on future accidents from information on the traffic generation of the new option (ie an increase in vehicle kilometres compared with the present situation suggests that accidents would increase, all other things being equal). Data on road traffic accidents are maintained by local authority transport/road safety units which can be used to reveal routes with the highest frequency of accidents involving fatal, severe and slight injuries. Data on road accident casualty rates may also be available from the Scottish Executive Development Department which is responsible for national road safety issues.

DETR have also produced guidance on the economic value of accident reductions which could be useful (http://www.roads.detr.gov.uk/roadsafety/rvs/appendix.htm)

A3 ECONOMY

A3.1 COST

Waste management options will include a combination of measures, including avoidance, minimisation, reuse, recycling, recovery and disposal. Developing the best package of measures to reduce waste going for final disposal will depend on both technical and economic factors. From an economic perspective, the objective is to satisfy waste management objectives at the least overall cost to society. This does not necessarily mean least cost to the waste management authority, as there may be activities that it could undertake more efficiently than other parties, or which only it is able to implement. Least economic cost also does not mean least short-term financial cost as some actions, such as recycling, might appear more expensive but might yield big savings in raw materials or even the future cost of landfill provision. Management system options can therefore be compared using a number of different measures of cost such as:

- capital costs of infrastructure and equipment;
- operating costs per year for waste collection, handling, processing and disposal;
- annualised capital and operating costs over the longer term (say 20-30 years);
- costs per tonne of waste handled;
- decommissioning costs;
- revenues from recycled materials and energy recovery;
- degree of uncertainty about future costs (certainty about costs can be important for planning).

The cost and revenue streams for each option should be analysed, and if possible a net present value (NPV) calculated. The most attractive options in economic terms, are those that have the lowest NPVs. At the first stage of appraisal, many of the cost and revenue items will not be available, and so estimates will be necessary based on generic industry costs.

Sources of information on waste costs include:

- Wastewatch (2000). Beyond the Bin - The Economics of Waste Management Options (http://www.wastewatch.org.uk/publicat/beyondbin.htm)
- Accounts Commission (2000) Benchmarking Refuse Collection, A Review of Councils' Refuse Collection Services. Published by Audit Scotland, April 2000. (http://www.audit-scotland.gov.uk/publications/ pdf/00l01ac.pdf).
- Coopers & Lybrand (1996) Cost-benefit analysis of the different municipal solid waste management systems: objectives and instruments for the year 2000.
- Sofres (1996) Elements for a cost-effective plastic waste management in the European Union: objectives and instruments for the year 2000.
- PIRA/IVM (1999) Development of a combined methodology to evaluate recycling processes based on life cycle assessment (LCA) and economic valuation analysis (EVA), European Commission DG Research Project No. ENV4-CT95-0091

- ETSU (1996) Economic evaluation of the Draft Incineration Directive.
- Excoser (1996) Techno-economic study on measures to reduce or remove waste water from incineration of dangerous and municipal wastes.

A3.2 FINANCEABILITY/AFFORDABILITY

In order for a waste management system option to be implemented successfully it is essential that there is sufficient funding available to put the system in place, and that once in place the costs entailed in operating and maintaining the system are affordable to all involved. In looking at funding, issues about the potential for private sector involvement are relevant.

Another issue to consider is whether an option will leave the authorities with long-term contracts for waste disposal services which could become inappropriate in the future and whether these contracts could be renegotiated so that they fit with the proposed new arrangements.

The following will help to assess the viability of a waste management system option in terms of financeability and affordability:

- what sources of funding are available to help introduce the new waste management system?
- does the option include new works which could be funded through public-private partnerships?
- could any elements of the option be eligible for support funding (grants, subsidies, etc)?
- what revenues might the project generate?
- what savings might arise because of the project (eg savings in landfill space/cost)?
- will the ongoing debt repayment and operating costs (net of any additional revenues) be higher than existing expenditures?
- what level of charges would be required, and would it be possible to charge customers the full cost?
- are there competing private services which could undertake the activity at a lower charge?
- will these combined sources of funding be sufficient to implement the system?
- does the option complement existing long-term contracts for waste disposal or are these long-term contracts negotiable?
- are the costs involved in operating and maintaining the system affordable to public authorities, to the private sector and to the public?
- The WSA Group will need to use its own judgement in appraising against this criterion. Advice can be sought from local authorities and financial experts involved in financing infrastructure projects.

A3.3 IMPACT ON LOCAL ECONOMY

Waste management systems can have positive or negative effects on the local economy by various means including providing business opportunities or adversely affecting existing businesses; creating new sources of supply or markets for goods and services; and increasing or reducing costs to local businesses.

When appraising a management system option against this criterion the following questions can be asked:

- if the waste management system option requires additional infrastructure or services (transport, processing etc), could the local economy benefit from construction, operation and maintenance contracts?
- what employment and therefore local income generating opportunities will be created by the system?
- what markets (for example, recycling markets) will be generated/stimulated by the management system and could the local economy benefit from these markets?
- what ancillary/secondary requirements will the management system option create eg knock-on requirements for the service sector?
- will the option reduce or increase the costs of waste management for local businesses?

A qualitative assessment is likely to be all that is possible taking account of the scale and nature of new facilities, quantities of materials recycled and additional transport and processing requirements. Information on revenues from recycled material sales can be found in the Wastewatch report 'Beyond the Bin - The Economics of Waste Management Options' (http://www.wastewatch.organisation.uk/publicat/beyondbin.htm). Local enterprise companies can provide guidance on likely business opportunities and the capacity of local businesses and entrepreneurs to respond to these opportunities.

A4 SOCIAL

A4.1 EMPLOYMENT

Waste management systems have the potential to impact positively or negatively on employment in terms of the number of jobs, their quality and distribution. Employment enables people to meet their needs and improve their living standards and is the single most effective and sustainable way of tackling poverty and social exclusion for those who can work.

Development of new waste management facilities will create temporary construction employment which may be available to local people and their long term operation will create jobs, the nature and number of which will depend on the type of facility. Options involving labour intensive technologies will offer employment for additional personnel (who might otherwise be unemployed). This will result in reducing unemployment and contribute to wider benefits for social inclusion. If these jobs are located in a rural area with high unemployment and high levels of out-migration caused by lack of jobs their social benefit may be even greater.

The following questions may be a useful prompt when appraising waste management system options in terms of their effect on local employment:

- will opportunities for temporary construction employment be created by development of new facilities?
- will the option result in an increase or decrease in the number of waste management jobs compared with the current situation?
- approximately how many jobs will be created or lost?
- in which sectors of the waste management process will these changes be experienced?
- what is the significance of this change with regard to the current level of employment in waste management and with respect to current levels of unemployment and underemployment in the area?
- what type and quality of jobs will be lost or gained (eg skilled/unskilled part time/full time, temporary/permanent) - for example would a loss of a large number of poorly paid part time jobs be offset by a smaller increase in full time places offering opportunity for skills upgrading?

In undertaking the appraisal, it should be borne in mind that changes in employment do not just affect the individuals and families of employees directly concerned, but also the wider local economy as a result of changes in their spending levels and patterns. This will generate further employment in the local economy (induced by multiplier employment). In addition, changes in the structure of waste management brought about by the option may cause knock-on effects for businesses supporting and supplying the waste industry in the area either during construction of new facilities or long term operation. These changes may generate further indirect multiplier employment in these businesses.

The following sources of information may be useful in defining current levels of employment in waste management and regulation:

- Scottish Executive Development Department;
- Local Authority economic development functions which may have baseline surveys characterising employment within their areas;
- the Enterprise Network - Scottish Enterprise and Highlands and Islands Enterprise, together with the local enterprise companies in each area;
- results of the 1991 census (and forthcoming 2001 census) which includes data on employment by standard industrial classification;
- waste industry/trade associations (eg Environmental Services Association) and professional institutes (eg the Institute of Wastes Management) who may have undertaken surveys of employment in the industry.

In addition, a report for the European Commission by the consultancy RPA into the employment effects of waste management policies is expected in early 2001.

A4.2 PRODUCER RESPONSIBILITY

Due to the distribution of goods, environmental considerations downstream in the life cycle of products have become a problem for organisations far removed from their manufacture and packaging. For example, products manufactured in Germany and consumed and disposed of in Scotland are likely to become a disposal responsibility for Local Authorities. The principle of producer responsibility is that producers are responsible for the environmental impacts of their products. Viewed from a life-cycle perspective, this would include responsibility for upstream impacts arising from the materials, energy and manufacturing processes involved in manufacturing the product, and downstream impacts arising from the use and disposal of the product.

In the context of appraising waste management options the issue of concern is whether the people and businesses generating waste take responsibility for what happens to that waste, or do they adopt an out of sight out of mind approach. An option which encourages this type of producer responsibility would be one that made households and businesses conscious of what happens to their waste and why it matters to minimise waste arisings, to keep hazardous wastes out of the municipal waste stream and to participate effectively in schemes for materials separation.

Each management system option should be assessed for its encouragement of Producer Responsibility for each waste stream by asking the questions below.

- Are households encouraged to reduce and recover waste where possible, eg buy products with minimal packaging, segregate waste, compost putrescibles, recycle glass and cardboard?
- Are businesses encouraged to reduce and recover waste where possible, eg buy recyclable products with minimal packaging, segregate waste at the 'back door', recycle and reuse where possible?
- Is industry encouraged to reduce its production of waste and recover it where possible (eg process waste)?
- Is industry encouraged to consider the life-cycle impacts of its products downstream and recover them (eg electronics products)?

- Will construction and demolition (C&D) producers be encouraged to minimise and recycle materials where possible (eg bituminous material, by-products such as pulverised fuel ash (PFA) and cement kiln dusts and construction and demolition waste)?

- Do the waste management options support recovery and recycling mechanisms for packaging wastes and other wastes likely to require future producer responsibility (eg clinical, electrical, batteries, end-of-life etc)?

- Do options encourage separation of hazardous from non-hazardous wastes?

Strategic waste options should include drivers and incentives for participation in segregation and recycling. These may be driven by legislation (eg Packaging Waste Regulations), fiscal measures (eg Landfill Tax), or encouraged at a local level eg through local recycling groups. Further information on producer responsibility may be obtained from the sources below.

- Information on international and national legislation is available from the DETR, website www.detr.gov.uk.

- Information on fiscal measures is available from the DETR and UK Treasury.

- Existing incentives at the local level in Scotland for recovery and recycling are driven by Local Authorities, the REMADE (REcycling MArkets DEvelopment) programme and community groups. The first point of contact to assess these local incentives is Local Authority waste teams.

- More thorough research of public participation is possible through surveys of attitudes of waste producers for each waste stream eg survey of households and their waste disposal practices. Year on year surveys will highlight any changes in attitudes that result from, for example, public education.

A4.3 PUBLIC ACCEPTABILITY

Public acceptability is an important issue to consider on two levels. Firstly, for a waste management system option that requires the public to do things differently (eg involving increased participation on their part) it is important that the public find this acceptable and are prepared to play the role required of them in order for the system to work. Because the degree of resistance to a proposed management system option will vary from one community to another, the appropriateness of a management system may vary geographically. Public resistance could possibly be overcome by education or the introduction of incentives. The appraisal should therefore attempt to quantify the proportion of the community (ie % of householders) who would participate in such schemes, the level of intensity of education/awareness programmes needed to bring about this co-operation (ie resources implication) and the likelihood of success of the participation scheme given the appraiser's local knowledge of the community.

Secondly, waste management system options requiring development of new facilities may also encounter resistance from the public due to perceived impact on local amenity, environmental quality and health risks. As a result planning permission for the development may be more difficult to obtain, and goodwill between the community and waste developers/planners is lost. Where an option includes the development of significant new infrastructure, the probability of opposition to the location of new waste

facilities within the area should be assessed. This will inevitably be a qualitative appraisal since the specific location of facilities will not be known, but again knowledge of the community and case history from previous contentious land use developments in the area may assist with the appraisal.

When appraising a management system option against this criteria the following questions may be useful:

- does the management system option require increased public participation and is this likely to be acceptable?
- have the means of engendering participation been considered and are they likely to be effective?
- is there a history of opposition to siting of waste management facilities in the area, or of other reported problems associated with waste collection and disposal?
- does the management system option involve development which may encounter public resistance?
- if the management system option is unacceptable to the public, can this be overcome through education, incentives or good planning?

Ideally, public acceptability issues should be considered at an early stage of Strategic Waste Management Baseline Assessment (SWMBA) and option development. However, if further information on public acceptability is required at the appraisal stage, the appraiser(s) may consider undertaking a specific survey within the community (or using focus groups) to test likely reactions to changes in waste management (including education programmes as well as siting of new facilities). Surveys are resource intensive, however, and care must be taken to design them correctly so that a representative picture of public opinion is obtained. Expert advice may well be needed. Consultation with other members of the WSAG, in particular the local authorities, is also recommended as a complementary course of action to appraise public acceptability issues.

A4.4 IMPACT ON SKILLS BASE

In order to achieve stable and sustainable growth a well educated, trained and adaptable workforce is required. Learning has a wider social contribution to make in that it promotes active citizenship and helps to combat social exclusion. It also opens opportunities for people, provides personal fulfilment and gives them the chance to make a contribution to the community. The appraisal should seek to evaluate the extent to which the existing skills base can match the skills requirements for the option, and whether any identified shortfalls will be made up through specific training programmes or met through import of expertise.

Assessing the effect a waste management system option will have on the skills base of the local area will require a significant degree of professional judgement on the part of the WSA Group. The following questions, however, may be useful when considering the issues.

- Does the management system option require a more skilled workforce than is currently available in the area?
- Are there particular technical or managerial areas where skills gaps have been identified?

- Will there be training opportunities for current or future employees?
- What level of training and education might be necessary to equip the workforce with the skills necessary to resource the option?

Information on existing skills levels and potential gaps in skills may be available from local enterprise companies or representatives of the existing waste management industries in the area. Alternatively, surveys might be necessary to obtain accurate primary data.

A4.5 SOCIAL IMPLICATIONS

The waste management methods used for each management system option may have the potential to impact positively or negatively on society at a local and national level. A key sustainable development objective is to tackle poverty and social exclusion and the vicious circle that it creates, for example unemployment, low educational achievements, poor quality housing and poor health. Another key issue is equity. Different waste management systems can result in different winners and losers and equitable distribution of costs and benefits is therefore a factor to be considered.

Different waste management options will have varying social implications and if any of the competing management options shows signs of performing better in one or more areas then this should be reflected in the appraisal. The following questions could be used:

- Would the waste management system option result in different groups within local society experiencing costs and benefits?
- What is the nature of the effects predicted and can they be quantified?
- Are there any particular social issues of concern currently in the planning area (eg areas of deprivation or social exclusion)?
- Will the option exacerbate or improve these conditions?
- Does the waste management option provide an opportunity for creating jobs in deprived areas or areas of high unemployment?
- Background on the social dimension and some of the relevant issues are discussed in Social Inclusion - Opening the Door to a Better Scotland, 1999. Further policy and background on social inclusion is included in:
- 'Quality of Life Counts' , Department of the Environment, Transport and the Regions, 1999;
- Bringing Britain Together: A National Strategy for Neighbourhood Renewal, 1998, Report by the Social Exclusion Unit of the Cabinet Office; and
- Social Exclusion in Scotland, A Consultation Paper, 1998, The Scottish Office.

Local authorities will have information on social conditions and socio-economic characteristics of the planning area. Appraisal of the social implications of waste management options will typically be qualitative at this stage.

A5 PRACTICABILITY

A5.1 FLEXIBILITY

In order to meet variation in the demands on waste management arrangements in the future or to accommodate newer and more effective techniques or respond to changes in regulation, it is important that the waste management system option should be able to incorporate or allow for response to future changes. A waste management system option based on a fixed scale capital intensive waste management option with a long lifetime and contract lengths is less flexible than an evolving option based on shorter lifetime infrastructure emphasising waste minimisation and reuse. Options placing waste separation at their heart are more adaptable to the possible demands of new legislation such as the Batteries Directive and Waste Electrical and Electronic Equipment Directive.

When assessing a management system option's performance in this regard the following should therefore be considered:

- Can the system cope with uncertainty about future population and demographic change and changes in the structure and vibrancy of the economy?
- Is the total capacity of the option's waste management infrastructure sufficient to accommodate changes in the amount of waste arisings eg from population or economic growth or decline?
- Is the option's waste management infrastructure designed to take account of possible changes in the nature of waste arisings and changes in the relative quantities of waste streams eg from economic restructuring and technological changes?
- How readily could the management system option incorporate new waste technologies or standards as and when they emerged and what effect, for example on cost and operational capacity/efficiency, might incorporating such changes have?

This criterion will be assessed qualitatively by considering plant scales, flexibility (for example from modular facilities) and contract lengths and the likely requirements of forthcoming Directives and legislation affecting waste management and planning. Fixed plant scales can be compared with potential variability in forecast waste arisings and the implications of successful waste minimisation or accelerated growth on the provision of services assessed.

A5.2 MAKING BEST USE OF EXISTING RESOURCES

The development of new infrastructure to deal with waste can be costly and involve impact on the environment. It will be important therefore to make good use of existing resources such as current infrastructure, waste management facilities, disposal capacity and expertise/skills as discarding these will be a waste of resources already committed and available.

When assessing a waste management system option in this respect the following questions should be considered:

- Does the management system option make effective use of existing waste management sites, facilities and plant?

- Does the option make best use of the skills available in the local workforce?
- Where there is a skills resource in a particular sector or location is this exploited by seeking to develop local markets for recovered materials in that industry?

The appraisal should also consider the effects of closure and decommissioning of facilities which will not form part of the new option.

This criterion will be assessed qualitatively by comparing current infrastructure and resources with those required in implementing the waste management system option.

A5.3 PRACTICAL DELIVERABILITY

Although a waste management system option may perform very well against a range of criteria, it may not be possible to implement the management system due to simple practical constraints. Considering the possibility of such constraints before deciding on a management system option is particularly important since there are potentially huge economic, planning and legal risks associated with developing waste management options which encounter practical difficulties in implementation.

The following questions may help identify possible problems with delivering the option:

- Is there a risk that the actions required to make the management system option work will not actually happen in practice and on the required timescale eg through difficulties in obtaining planning consent?
- Will waste producers do what is necessary to make it work eg separating materials effectively?
- Are there likely to be sufficient financial resources to implement it?
- Are there sufficient skills and personnel available or can they be recruited/trained?
- Will legislation be required to enforce aspects of the waste management system option and is this legislation in place (or expected)?

The likelihood of obtaining planning consent for new facilities can be assessed qualitatively and by referring to the success or failure of similar initiatives elsewhere (albeit that local circumstances must be taken into consideration when reviewing cases elsewhere). Planing case history can be obtained from several sources including planning encyclopaedias and the Waste Planning periodical issued by the Mineral Planning Group.

The practicality of options can also be discussed with the waste industry, service providers, developers, community representatives, waste planners and financers. Where there are changes to legislation or behaviour required for an option to deliver the required performance this can also be assessed.

A5.4 TECHNICAL FEASIBILITY

If a waste management system option is incorporated into an area waste plan that is technically unfeasible there could be serious repercussions on the obligation to provide a reliable waste management service, particularly for household and commercial waste. For instance, a large amount of capital could be invested in facilities that fail or perform below expectations or new requirements placed on existing facilities may be beyond their capability.

In appraising a waste management system option for technical feasibility, the following questions should be reviewed:

- Is there a risk associated with the performance of the technologies involved, for example because they are untried at the required scale or for the proposed waste streams?

- Are the processes sufficiently proven that permitting requirements such as IPPC will not constrain their development?

- If existing facilities are to be used or adapted, are they likely to be adequate and appropriate eg do they have sufficient remaining lifetime and do they provide sufficient space, protection and access?

Assessment will be qualitative and based on information about existing facilities elsewhere for a specific technology, including applications overseas as many technologies have not been proven in the UK, and identifying how successful they have been and what factors have influenced their performance.

A6 FIT WITH POLICY

A6.1 COMPLIANCE WITH OTHER POLICIES

It is important that the waste management system option does not conflict with areas of local, national or EU policy either on waste management or on other related areas, such as development planning, energy and economic development.

There are several levels and types of policy to consider.

The Scottish Executive produces National Policy Planning Guidelines and Planning Advice Notes which set out national policy and practical guidance on a range of issues including, Renewable Energy (NPPG6), Business and Industry (NPPG2), Planning and Waste Management (NPPG10) and Transport and Planning (NPPG17). The statutory development plan in each local authority area sets out policy at an area level and consists of a Structure Plan and a Local Plan. Structure Plans look forward at least 10 years with areas covering several local authorities. Local Plans are developed by each local authority (and there may be several local plans within one authority area) and set out more detailed polices which are responsive to local needs and promote change in the wider community interest, within the context established by the Structure Plan and NPPGs. Local plans are reviewed on no more than a five year cycle and include policies for housing, leisure and recreation, cultural heritage and environment.

Other Scottish policy of potential relevance to waste management planning includes Making it Work Together, A Programme for Government (Scottish Executive, 1999); The Way Forward: Framework for Economic Development in Scotland (June 2000); Rural Scotland: A New Approach (May 2000); Scottish Climate Change Programme (April 2000); the National Cultural Strategy (August 2000); The Manufacturing Strategy (in development); Social Inclusion - Opening the door to a better Scotland: Strategy (1999); Actions for Scotland's Biodiversity (Aug 2000) and of course the National Waste Strategy: Scotland (SEPA 1999).

There are also UK wide polices relevant to Scotland on topics which are not devolved, for example The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DETR Jan 2000).

Relevant EU policy and legislation includes:

- the Framework Directive on Waste (75/442/EEC as amended by 91/156/EEC);
- the Landfill Directive (which is anticipated to become law in the UK by 2001);
- the Packaging and Packaging Waste Directive (94/62/EC);
- Fifth European Community Environment Programme: Towards Sustainability (in which waste is one of six priority areas);
- **EU Focus on Waste Management (CEC DG Environment 1999).**

Wider international obligations on sustainable development such a Local Agenda 21, and the international conventions and protocols on climate change and biodiversity are also relevant although most of their direct implications will be addressed in the national policies noted above.

Annex B

Waste Management Methods

B1 WASTE MANAGEMENT METHODS

This Annex provides some guidance on the possible methods for managing waste. In keeping with the option mapping methodology presented in Section 2.3.1 of the main report, the methods are presented under seven category headings:

- waste minimisation;
- collection and transfer;
- reuse;
- recycling;
- composting;
- energy recovery; and
- final disposal.

A complete system option will include methods from at least the collection and final disposal stages, and should also include methods selected from other stages to achieve targets for diversion of waste from landfill and, where appropriate, for delivering enhanced levels of minimisation, recycling and recovery.

The lists of methods are a starting point only and are not intended to be comprehensive. There will be other methods which have not been included, and variations upon those identified which are not described, which may be suited to application in particular areas. The groups should draw upon their own knowledge and experience and that of the waste industry and waste experts to identify other possibilities as well as using the tables below.

Table BB1.1 Methods for Waste Minimisation

Method	Things to Consider
Variable charging by volume of waste collected	Needs bagged or standard sized bin collection. Charges calculated on basis of number of bags collected or size of wheelie bin used. Need to consider how per bag charges are collected - council tax? Alternatively customers can buy marked bags in advance.
Variable charging by weight of waste collected	Weight based charging requires collection vehicle weighing and billing system.
Incentive schemes	Cash back schemes for return of recyclable materials to collection points.
Business clubs, community	Advice provided by public agencies, the waste industry, clubs business networks and partnerships.
School and college initiatives	One-off or ongoing collection scheme.

Table BB1.2 Methods for Waste Collection and Transfer

Method	Things to Consider
Conventional refuse collection with direct delivery to final destination	Continuing use of existing vehicle fleet and collection regime. Consider need for vehicle replacement over period. Consider frequency and household storage options (bins, bags, wheelie bins).
Conventional refuse collection with intermediate transfer and bulk haulage - by road - by rail - by sea/canal	Will new transfer station be required? Options for mode of transport.
Provision of intermediate treatment at transfer station: - compaction - baling - pulverisation - materials reclamation	Consider transport distances to transfer station.
Separate kerbside collection of mixed dry recyclables	Bags or boxes of recyclables can be collected at same time as normal waste in two compartment vehicles but more usual to have separate collection round. Can be done alternate weeks which encourages waste reduction but raises public health concerns about waste storage in homes. Mixed recyclables are sent to clean MRF (see recycling below). Consider transport requirements, participation and recovery rates (max usually 70% x 70%), and markets for reclaimed materials.
Separate kerbside collection of sorted dry recyclables	More complex arrangements for householders than mixed collection, requiring separate containers for each material. Different materials can be collected on different days. Material can be sent directly for recycling without further processing. Consider location of materials reprocessing facilities, participation and recovery rates (max usually 70% x 70%) and markets for reclaimed materials.
Separate kerbside collection of green waste	Kitchen and garden waste collected separately and delivered to centralised composting plant/s (see Table BB1.5 below). Consider transport requirements, participation and recovery rates (max usually 70% x 70%) and markets for end product.
"Survival" bag systems	High value recyclables placed in heavy duty bags which survive in compactor collection vehicles, collected at same time as normal waste and delivered to transfer station where they are abstracted for recycling. Reclaimed at clean materials reclamation facility (MRF) (see Table BB1.4 below).
Bring centres for dry recyclables	Consider density of provision and locations - at supermarkets, and end of every street, no. per population. Who operates them? Usually for sorted recyclables sent directly for recycling.
Reclamation by private collection or return systems for commercial wastes	Paper, toner and ink cartridge, etc return schemes operated by merchants and suppliers.

Table BB1.3 Methods for Reuse

Method	Things to Consider
Unwanted goods sent to charity and second hand shops and sales	Furniture, clothes, books, antiques etc. Generally low impact and small scale but income generation for charities and local economy. Impact on primary raw material use and social benefits from availability of second hand goods.
Bring centres at supermarkets etc for re-usable goods	Books, clothes, etc. Usually supplied to charities.
Refurbishment centres for white goods and furniture	Who runs them - Local Authority, charity or commercial? Wastes could be collected commercially (scrap merchants, second hand/junk shops) or from local authority civic amenity sites and bulky uplift operations.

Table BB1.4 Methods for Recycling

Method	Things to Consider
Clean MRF (Materials Reclamation Facility)	Mixed or part sorted dry recyclables are sorted for onward transport to reprocessing facilities. Consider location of reprocessing and consequent transport requirements. Choice of technology and size of MRF will be very dependent upon the collection and segregation systems employed for the waste management option. Technology choice will vary according to numbers of material types being handled and levels of prior sorting and separation. Plant can vary in size and technical sophistication from hand sorting to full mechanical separation. Examples include the use of several small facilities (eg Hampshire) handling only a few materials to large plants (eg Milton Keynes) where over 30 materials may be accepted and sorted. High levels of separation can be achieved using latest plant/technologies.
Dirty MRF	Takes mixed waste delivered for reclamation of recyclables by sorting. Residues can be landfilled or composted if high putrescible content. Consider markets for (availability and reliability) and revenues from recyclates. Plants usually involve magnetic separation and mechanical sorting and tend to be less efficient and produce lower quality recyclate than clean MRFs because feedstock is contaminated. Technologies likely to be more complex than Clean MRFs due to need for cleaning and greater sorting of mixed waste materials. Type of plant influences quality of recyclate. May be hard to find markets for contaminated recyclate.

Table BB1.5 Methods for Composting

Method	Things to Consider
Simple open windrow composting	Can be open or under simple roof. Consider scale and number of facilities, availability of suitable sites not constrained by neighbours and markets for relatively low quality product. Often used as pre-treatment prior to landfill or as landfill cover.
Open cell composting	Similar to windrowing but in partially enclosed area eg three sided cell with hard floor.
In-vessel aerobic composting	Various technology options. Can be single large unit or modular, batch or continuous. Can be combined with sewage sludge.
In-vessel anaerobic composting	Widely used for sewage sludge and agricultural waste. Municipal waste experience in Europe but little in UK.
Worms	Temperature sensitive. Not suitable for sensitive locations. Need to consider scale, requirement for pre-treatment and macerator.
Home composting	Consider the level of participation, bin provision, publicity and education and recover rates.
Community composting	Consider Scale.

General considerations: Quality and marketability of product will depend on input material - mixed household waste will produce lower grade compost than green waste - and nature of plant and degree of composting achieved. Could be combined with agricultural, sewage sludge or industrial organic wastes (eg food processing)

Table BB1.6 Methods for Energy Recovery

Method	Things to Consider
Mass burn incineration with energy recovery	Options include: - fluidised bed; - moving grate; - cement kiln; - co-combustion at coal fired power station; - co-combustion with sewage sludge or other organic wastes - electricity only or combined heat and power (CHP).
Batch incineration with energy recovery	Need to consider recovery/recycling at front end; pre-treatment and capital costs.
Gasification	Can be developed on a modular basis. Produces liquid fuel for combustion on site or elsewhere. Produces gaseous fuel for use on site or elsewhere. Can provide flexible alternative to high volume mass burn as smaller units (suited to lower population density areas) with relatively short payback periods can be developed, including flexibility for expansion through use of modular units.
LFG recovery	
Anaerobic digestion	Anaerobic digestion can be used to produce methane for fuel use as well as compost (see Table BB1.5 above). Will require nearby user.

General considerations: All options require disposal of residues - usually to landfill. Reclamation of non-combustible materials can be carried out prior to or post combustion. Plants can be used to generate energy and waste heat or for more efficiency combined heat and power plants. Both require access to the grid (or a large single electricity user). CHP requires a user of waste heat/steam.

Table BB1.7 Methods for Final Disposal

Method	Things to Consider
Landfill	Need to consider scale, type, location and operator. Also requirements for adoption of good landfill practices - leachate recovery, gas collection. Possibility of LFG recovery from suitable sites but need to consider end use of gas. Quantities disposed of to landfill must not breach the Landfill Directive targets for biodegradable municipal waste (BMW).
Landfill engineering, cover or restoration	Suitable materials may be used for engineering, cover or restoration and may be necessary to ensure long term safe management of existing landfill sites.
Export	Waste may be exported from the area for recycling, recovery or landfill. Landfill permit trading will enable sale of surplus or purchase of extra capacity for landfilling of BMW.

Annex C

BPEO - Practitioners' Guide

C1 BPEO - PRACTITIONERS' GUIDE

C1.1 PURPOSE AND USAGE INSTRUCTIONS

This guidance is intended for use by the BPEO practitioners. It contains the more technical and procedural details of the process that were considered unnecessary information for the main body of the report.

The practitioners should start by consulting the main text. Where appropriate, this *Annex* will provide additional information on how to complete each step of the process. The bulk of this information involves the recommended procedures for running workshops and guidance on how to perform the calculations.

C1.2 WORKSHOPS

Before looking at the individual steps, mention should be made about the workshops in the guidance. We recommend that five workshops be run during the course of a full pass through the ten steps, in order to maximise the transparency and accountability of the WMP.

If it is felt that there is not sufficient time to run the five workshops, it is possible to reduce the number, while accepting that the transparency and accountability will also be reduced. The two critical workshops are the third and fourth ones, which evaluate the integrated options against qualitative Decision Criteria and then weight the Decision Criteria against one another. Further time may be saved by running these two workshops as part of a single event, but this is likely to require a couple of days, in order to address adequately the issues involved.

C1.3 STEP 1: DEFINE STUDY OBJECTIVES

The main report stresses the need, in defining objectives, to consider all controlled wastes, to look to long-term targets, and to ensure that there is compatibility between the areas' plans.

The England and Wales *Waste Strategy 2000* cites four qualities of a good BPEO process, which the practitioners would do well to consider in designing their work process:

- **comprehensiveness**: all concerns regarding waste management alternatives should be seen to have been identified and addressed;
- **flexibility**: the robustness of potential decisions should be thoroughly explored;
- **iterativeness**: the options should be developed and refined by repeating the assessment process; and
- **transparency**: so that the reasons behind a particular choice are made clear.

C1.4 STEP 2: IDENTIFY DECISION CRITERIA

It is recommended that the identification of the Decision Criteria be completed by means of a workshop session. In addition to the main report, the stakeholders will need access to *Annex A*, which presents the SNIFFER 'national' Decision Criteria as a starting point for the discussions. The workshop may be run as outlined in *Box CC1.1*.

Box CC1.1 Workshop 1 - Identifying Decision Criteria

The identification of the Decision Criteria (DC) represents a good topic to be covered in a Workshop. As an introduction, present the participants with an overview of the BPEO process, and how the DC will be used to score the options. Present the starting list of DC, and provide some background on their source. Emphasise that these DC are based upon municipal waste arisings, so additions may need to be made for other waste streams. Then proceed with the main session:

1. If the group is above 12 in size and includes representatives from different stakeholder groups, divide the group into syndicates (with three or four people in each). Divide up the 20 criteria approximately evenly between the syndicates. Try to give criteria to syndicates whose members have some knowledge of the issues (eg practicality to waste managers).

2. Ask each group to review the criteria they have been asked to consider and agree amongst themselves any particular issues which ought to be considered in their local area. The additional information on appraisal questions in Annex A may be helpful in prompting them to consider relevant issues. These may be either specific sub-issues under the existing criteria or additional issues which are not addressed by the criteria, such as those pertaining to non-municipal waste. They can be recorded on flipcharts and the results photographed as a record.

   If the group is smaller than 12 it may be easier to review the criteria in a single group.

3. Also ask the groups to consider the most appropriate way of scoring the options against each criterion. Again, Annex A provides some suggestions, and the groups may adopt one or more of these or develop their own ideas. Record the results in the same fashion.

4. Ask each syndicate to make a brief presentation of their proposals to the workshop in a plenary session and then hold an open discussion. The aim is to agree additions or refinements to the questions under each criterion, add new criteria to the list if relevant, and agree the scoring methodology.

   If there is disagreement about whether an issue should be included in the DC or not, reassure the doubters that including an issue does not mean it has to be given the same weight as other factors. The weighting will be decided in a later workshop session.

5. Record the results on the whiteboard or flipcharts for each criterion. Note where no change is suggested and what revisions or additions are agreed. Photograph the whiteboard or flipcharts to provide a record.

C1.5 STEP 3: DEVELOP OPTIONS

The main text details how to develop options, starting with the two extremes - 'Do Nothing' and 'Do Everything' and then using option mapping to generate intermediate options. As in the SNIFFER procedure, it is recommended that a workshop be used to develop the options, as outlined in Box CC1.2. This workshop will need to make use of the information on methods presented in Annex B.

Box CC1.2 Workshop 2 - Developing Options

In Workshop 2, participants develop a set of integrated waste management options, for assessment using the Decision Criteria identified in Workshop 1. As in Workshop 1, photographed whiteboards and/or flipcharts should be used to record decisions.

1. Depending on the overlap between the participants in the first and second workshops, you may need to begin with an introduction to BPEO.

2. Explain to the participants that the options developed will be used as the starting point for defining the best waste management solution for the area. Emphasise that the intention is to develop a diverse range of options, from the simple to the innovative and advanced.

3. Start by using a plenary session to define all the waste management methods that may be adopted. The methods in Annex B may be used as a starting point, both as a list and for the discussion itself. Make sure that two or more methods are available for each of the seven categories, and that methods are not limited to those suitable for dealing with municipal waste.

4. With the pick-list of methods in place, hold a round table discussion of the 'Do Nothing' and 'Do Everything' options, to define the boundaries of the options. Do not allow consideration of cost limitations, diversion targets or suchlike to affect the option selection at this stage. With the 'Do Everything' option in particular, encourage lateral and innovative thinking.

5. The final preparatory step is to agree any constraints that must be applied to the intermediate options. If there is (for example) an absolute cost ceiling, a legal requirement or a target that must be met, this should be identified as a constraint. Constraints should be limited to those that can be easily assessed as part of the methodology that follows.

6. Depending on the numbers present, it may be worthwhile at this juncture to break into syndicates, to consider the intermediate options.

7. Use the Option Mapping methodology (see main text 2.3.1) to group compatible methods into integrated waste management options. Keep an eye on the question of constraints, so that the developed options are feasible. It may be worthwhile trying to identify integrated solutions that fulfil different needs, such as a 'Maximum Recycling' or 'High Energy Recovery'. In this case, such options could be identified before breaking into syndicates, or each syndicate could be given different options to try to define.

8. Back in a plenary session, the identified options should be presented and discussed, with the aim of identifying perhaps three or four, in addition to the 'Do Nothing' and 'Do Everything' options, to be considered against the BPEO Decision Criteria. Ensure that the intermediate options do not breach any constraints. If they do, consider modifying the options so that the constraint is met, or dropping them altogether.

9. In finalising the list, try to make the options as specific as possible, including some reference to the likely site of any new installations. This will maximise the accuracy of the evaluation procedure.

C1.6 STEP 4: APPLY CONSTRAINTS

The concept of constraints is fully explained in the main text. The process is combined with the previous step in Workshop 2, outlined in Box CC1.2, above.

C1.7 STEP 5: EVALUATE OPTIONS

The evaluation of quantitative DC can be performed using such tools as WISARD, away from workshops. For qualitative DC, where no absolute score is possible, the most transparent means of evaluating the options is through another workshop session. The recommended procedure for this is given in Box CC1.3.

Box CC1.3 Workshop 3 - Evaluating Options against Qualitative Decision Criteria

This third workshop should be convened to evaluate the integrated waste management options against the Decision Criteria (DC) identified in Workshop 1 that require a qualitative rather than quantitative assessment. A wide stakeholder base is worthwhile for this session.

1. The workshop should open with an overview of BPEO, detailing the various steps and how the session will fit into the overall process.

2. Afterwards, each integrated waste management option should be introduced, with details on how it should work and what (if any) its particular aim is.

3. This should be followed by a presentation of all the Decision Criteria, so that the complete picture can be understood.

4. At this point, if numbers are large, it may be appropriate to break once more into syndicates. For this exercise, syndicates should all have as diverse a group of members as possible. If syndicates are being used, each should be assigned a subset of the qualitative DC to evaluate.

5. The participants should be presented with the DC to be evaluated, and the issues identified in Workshop 1 that need to be considered in assessing the option against the DC. The options should be discussed in open sessions, using a whiteboard or flipchart to record ideas, and photographed to document the decisions.

6. As with the weighting of the Decision Criteria (see *Step 6*), participants may either use a system of assigning a rating between one and a hundred, or dividing a total number of points between the options. For the same reasons given there, the latter is the preferred technique. Emphasis should be given to rating the *difference* in performance of the various options, as well as their absolute impacts.

7. If this work is done in syndicates, the participants must reconvene for plenary discussion of each syndicate's conclusions. Open debate in this forum should precede the final assignment of ratings of each option against each DC.

C1.8 STEP 6: WEIGHT DECISION CRITERIA

Assigning weights to Decision Criteria is a difficult and sensitive step in the BPEO process, and is the single step in which a transparent approach, through a workshop, is most needed. It is essential that adequate preparations are made before conducting this workshop, and that sufficient and experienced facilitation is provided on the day.

Information should be provided in advance of the workshop, to allow delegates time to familiarise themselves with the concepts. Expert facilitation will enable the delegates to better articulate and capture their preferences, and it may help for the facilitator to have no or limited waste management experience, in order to avoid any bias. Such facilitators may also have their own favoured techniques, and the format suggested in *Box CC1.4* can be amended as appropriate to accommodate their preferences, as long as the overall goal is still fulfilled.

The main text presents the preferred means for weighting the Decision Criteria. As an alternative, the practitioners might consider the following procedure:

A representative group of stakeholders is asked to assign a score to each of the criteria. In order to differentiate between important and relatively trivial criteria, it is recommended that a scale of one to a hundred (a hundred indicating the most significant criteria) be

used. The results from all the stakeholders should then be averaged, to arrive at final scores between one and a hundred. SNIFFER used this method as a guide to assess their DC (see *Box AA1.1* of *Annex A* for details), but used a more restrictive scale of zero to five.

The chief benefit of this approach is that it can be done without the stakeholders being present. However, this also hints at the chief weakness, which is that the scores are assigned individually. Even if the scores are developed in group discussions, there is not the same degree of interaction as is available with the second method. **Therefore, we recommend that the users adopt the alternative DC rating technique, of dividing points between the Decision Criteria, which is presented in the main text**.

Box CC1.4 suggests how a fourth workshop might be used to rate the Decision Criteria.

Box CC1.4 Workshop 4 - Weighting the Decision Criteria

In order to weight the Decision Criteria (DC), the participants should be presented with a matrix of the results: a list of the DC, the units in which they have been scored, and the option scores (arranged in ascending order and therefore not sorted by option, to avoid risk of biasing the scoring).

1. Depending on the size of the group, it may be appropriate to split up into two or more syndicates. For this session it is important to spread representatives of similar functions among syndicates, rather than grouping them together, so that a broad opinion base is available to each syndicate.

2. Give each syndicate (or the whole group if numbers are low) a number of points to divide between all the Decision Criteria. Bear in mind that a higher total number of points will make compromises easier, but may promote unnecessary arguments over minor points allocations. Instruct the syndicates that they must come to a consensus agreement on the allocation of the points between the DC, assigning more points to more important DC, depending on their relative worth.

3. Emphasise that the weightings of the DC should be done both on the absolute significance of the criteria and the range of scores assigned. Global warming potential may be regarded as important, but if all the options were to score the same, its significance as a judge of BPEO is zero - it provides no distinction between options. This can be a difficult concept to convey to decision makers, and warrants careful explanation (graphics may be useful).

4. Contextual information can provide a useful benchmark against which to assess how important is the range of scores for a criterion. For example, rather than stating that greenhouse emissions from the options range from 'a' to 'b' tonnes of CO_2, the information could be presented in terms of 'x' to 'y' percent of the region's emissions. As well as local or national emission inventories, comparisons might be made to other familiar units, such as household or car equivalents.

5. Syndicates should debate the assignment of points, using a whiteboard or flipcharts to record comments (photograph to provide a record). One option is to start by agreeing a rough ranking into, say, three groupings, and then assessing each group in turn. If there are major disagreements about the points allocations, confirm that the relevant parties fully understand the basis of the DC. Ask the syndicates to double-check that their final points scores do add up to the allocated total.

6. Each syndicate should present its results to a plenary session, before an open debate is conducted to arrive at final points assignments. Do not simply average the points, since this avoids discussing the underlying issues that resulted in the allocations. Again, use a whiteboard or flipcharts to record the discussion, and photograph for permanent records.

C1.9 STEP 7: GENERATE FINAL OPTION SCORES

The main text provides an overview of the two tasks in this step - the normalisation of the data and the application of the DC weighting to the scores. This section presents more information on how to perform these tasks.

C1.9.1 Normalise the Evaluation Score

In *Step 5* the options were assigned a combination of quantitative and qualitative scores against each DC. Some of these scores will be absolute figures, whilst others will be ratings - perhaps a score between one or a hundred or a share of (say) one thousand points. In order to compare these evaluations on an equal basis, they must first be normalised.

Normalisation is a relatively simple mathematical process, whereby a set of numbers are scaled, so that the lowest becomes zero, the highest one, and the rest fall proportionately between these two extremes. Rather than go into the details in the main text, this process is explained in *Box* C*C1.5*. The output of this stage is a set of Normalised Option Scores, rating each option on a scale of zero to one against each DC.

Box CC1.5 Normalising Data

During *Step 5*, scores are assigned for such aspects as tonnes of acidifying gases released to the atmosphere, miles travelled to the nearest civic amenity site, or relative cultural heritage value. In order to compare different sets of scores, it is necessary to reduce them to a common basis. This is done by normalising the data.
For a set of 'n' figures x_1 to x_n, the normalised value y_i of x_i is given by:

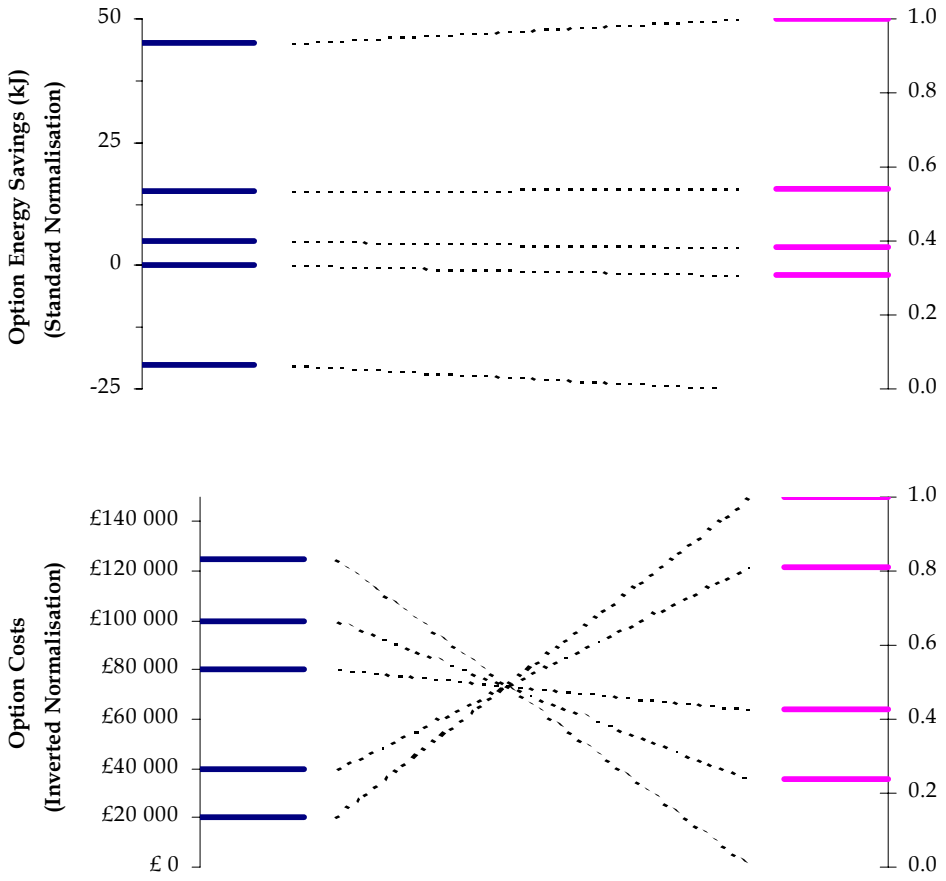
$$y_i = \frac{x_i - \text{Min}[x_1, x_2, \ldots x_n]}{\text{Max}[x_1, x_2, \ldots x_n] - \text{Min}[x_1, x_2, \ldots x_n]}$$

This formula sets the highest value at one, the lowest at zero, and the rest in a relative position between one and zero. If the highest value actually represents the worst option, the numbers must be inverted, as follows:

$$y_i = 1 - \frac{x_i - \text{Min}[x_1, x_2, \ldots x_n]}{\text{Max}[x_1, x_2, \ldots x_n] - \text{Min}[x_1, x_2, \ldots x_n]}$$

As an example, an imaginary set of energy savings and costs is provided for five options below. These are normalised in the table (with the costs being inverted, since low costs are better). Because it is easier to visualise the results, the process is also presented graphically.

	Energy Saving (kJ)	Cost (£)	Normalised Energy Saving	Normalised Cost
Option 1	-20	£20 000	0.00	1.00
Option 2	0	£40 000	0.31	0.81
Option 3	15	£125 000	0.54	0.00
Option 4	45	£100 000	1.00	0.24
Option 5	5	£80 000	0.38	0.43



C1.9.2 Apply the Decision Criteria Weighting

If all DC were equally important, no further calculations would be required, beyond working out the average normalised DC score of each option. This would be a number between zero and one, that determines how close each option is to being the theoretically ideal option (a value of one).

However, the DC are not equally important, and were therefore weighted in *Step 6* - either by scoring them between one and a hundred or (preferably) allocating a set number of points between the criteria. These relative importances must now be applied to the Normalised Option Scores, to generate Final Option Scores.

Briefly, each Normalised Option Score is multiplied by the DC Weighting, to generate 'Matrix Scores', and these results are summed. To convert the sums into Final Option Scores between zero (worst option on all counts) to one (best option on all counts), they must be divided by the sum of all the DC Weighting. Again this is most easily illustrated with an example, presented in *Box CC1.6*.

Box CC1.6 Example of Calculating Final Option Scores

The Table below presents imaginary Normalised Option Scores that four options have been awarded against four Decision Criteria (DC). In addition, the second column shows the DC Weightings that were assigned to the four DC, by sharing 200 points between them.

Decision Criteria	DC Weighting	Option 1	Option 2	Option 3	Option 4
DC 1	100 [A]	0.0 [B]	0.6	0.2	1.0
DC 2	10	0.7	0.0	1.0	0.0
DC 3	60	0.0	1.0	0.6	0.8
DC 4	30	0.9	0.0	1.0	0.7
Total	***200*** [C]	***1.6***	***1.6***	***2.8***	***2.5***

The Final Option Score must reflect both the score that the option achieved against each DC, and how important that DC is in comparison with the others. 'Matrix Scores' (Main Table values below) are generated by multiplying the Normalised Option Scores by the DC Weighting. To generate a Final Option Score between zero (worst on all counts) and one (best on all counts), sum the Matrix Scores and divide by the sum of the DC Weightings:

Decision Criteria	Option 1	Option 2	Option 3	Option 4
DC 1	0 [=AxB]	60	20	100
DC 2	7	0	10	0
DC 3	0	60	36	48
DC 4	27	0	30	21
Total	***34*** [D]	***120***	***96***	***169***
Final Option Score	**0.17** [=D/C]	**0.60**	**0.48**	**0.85**

In the example presented above, Option 3 is more highly rated that Option 4, in terms of points awarded (2.8 versus 2.5). However, Option 4 scores heavily on the more important DC, and is therefore a clear overall winner.

C1.10 STEP 8: SENSITIVITY ANALYSIS

The essence of sensitivity analysis is to investigate how susceptible the Final Option Scores are to the ratings assigned along the way. The intention is to address such questions as, would the lead option still be most favoured if it hadn't been rated so highly for 'Cultural Heritage', or if the seventh DC had been deemed less important?

The easiest way of assessing the effects of the scoring process is to analyse the Matrix Scores (the products of the DC Weightings and Normalised Option Scores, presented in the second Table of *Box CC1.6*, above). These instantly show where the options have scored well and poorly. In particular, examine such instances as where the most highly rated option has scored significantly better than the next best option. Are the premises behind these scores justified? How much do the weightings have to be changed before the overall rankings are reversed? *Box CC1.7* presents one example of how this works.

Box CC1.7 Sensitivity Analysis Example

To give an example of how sensitivity analysis works, consider the example presented in *Box CC1.6*. Here, Option 4 is more highly rated overall than Option 3 mainly because DC 1 (the DC on which Option 4 is most highly rated) is deemed to be ten times more important than DC 2 (for which Option 3 is a best option). What if DC 1 was not such a clear favourite?

As the proportion of the 110 points awarded to these two DC shifts from DC 1 to DC 2, the difference between the Final Option Scores of Option 3 and Option 4 decreases, as shown in the Table below. However, it is not until the two DC are almost rated equally that Option 3 becomes more preferred.

Title	Score					
DC 1	100	90	80	70	60	55
DC 2	10	20	30	40	50	55
Option 3	0.48	0.52	0.56	0.6	0.64	**0.66**
Option 4	**0.85**	**0.80**	**0.75**	**0.70**	**0.65**	0.62

Given that the initial assessment rated DC 1 to be ten times more important than DC 2, it is unlikely that the *direction* of the preference is in doubt. What we see is that, whether it is ten times more important or just twice as important, Option 4 is still the lead option. We can therefore conclude that the preference of Option 4 is relatively insensitive to the weightings of DC 1 versus DC 2.

During this first round of option assessment, sensitivity analysis should focus on the clear winners and losers, to confirm that their Final Option Scores are robust. Where Matrix Scores are particularly high for lead options, or particularly low for least preferred options, confirm that both the DC Weighting and the Normalised Option Score are justified.

DC Weightings are all qualitative, so should be subjected to some sensitivity analysis. For the Normalised Option Score, if it is quantitative, it is more likely to be acceptable. If it is qualitative, recheck the notes from Workshop 3, and assess how united opinion was in the rating of that option. If there was some dissension, again further sensitivity analysis is required.

C1.11 STEP 9: CREATE SHORTLIST/ITERATE

The process of creating the shortlist and refining options ready for iteration is covered completely in the main text of the report.

C1.12 STEP 10: IDENTIFY THE BPEO

The final selection and endorsement of the BPEO should be done in a last workshop. Box CC1.8 presents the recommended procedure.

Box CC1.8 Workshop 5 - Identification of BPEO

Steps 1-9, probably with a least one iteration stage, will have evaluated a set of lead options for the BPEO plan for the area. The final selection of the BPEO is best done during a workshop session, to try to maximise the stakeholder acceptance. The participants at this final workshop should be as diverse as possible.

1. Start by introducing the BPEO process, and explaining what work has already been completed, and the workshops that have preceded this last workshop.

2. Introduce the options that were evaluated in the latest assessment. Explain any aims that they were intended to fulfil (such as 'Maximum Recycling').

3. Present the Matrix Score Tables for each option, so that it can be seen what each option scored against each Decision Criteria and what weighting each Decision Criteria received. Explain the results of the sensitivity analysis, so that the participants are clear where the possible areas of uncertainty lie. Indicate how the ratings translate into Final Option Scores and the indicated BPEO.

4. At this stage, depending on numbers, it may be worthwhile breaking into smaller groups, which should maintain the diversity of the participants as far as possible.

5. In groups or as a whole, debate the final options and the selection of the BPEO, in the light of the sensitivity analysis. Note the results of the debate on flipcharts or whiteboards, which should be photographed to record the discussions.

6. If the above stage was done in groups, reconvene into a plenary session, and ask each group to present their thoughts. Try to pull these altogether into a consensus opinion on the BPEO.

Our aim is to protect and conserve the natural and built environment and to promote its appreciation for the benefit of present and future generations.

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