A strategy for construction, demolition and excavation waste as recycled aggregates

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Executive Summary

This report is the Final Project Report for the DTI/WRAP Aggregates Research Programme project *Addressing the Barriers to Construction and Demolition Waste as Recycled Aggregates*. The objective of the DTI/WRAP Aggregates Research Programme is to support the sustainable development of construction markets for recycled and secondary materials as aggregates. This project will support the development of a strategic research framework that will provide a co-ordinated approach to ensuring more efficient uses of recycled and secondary resources as aggregates in construction. The project focuses on the assessment of existing and potential construction, demolition and excavation (CD&EW) streams as potential supplies for aggregate markets. This report represents the final strategy for encouraging the use of CD&EW as recycled aggregates.

Construction, demolition and excavation waste (CD&EW) is the largest stream of recycled materials in the UK. Arisings in England and Wales are thought to be about 100 million tonnes per annum, including asphalt planings. Existing data on the arisings, composition and utilisation of CD&EW is presented and gaps in the knowledge base are identified. Much recycled CD&EW is thought to be used as low value fill, with some used as intermediate value applications such as capping and unbound sub-base in road foundations but very little used as coarse aggregate in concrete or for other high value applications.

There are a number of issues that are currently limiting, or could do in the near future, the utilisation of recycled CD&EW. Several of the issues also affect the utilisation of other recycled and secondary aggregates. The issues are:
- The waste/product issue and the application of the waste management licensing regulations to the recycling of CD&EW and other materials;
- The lack of awareness of recycling and the measures needed to implement it across all sectors of construction;
- Forthcoming implementation of harmonised European Standards for aggregates;
- Need for guidance for planners to ensure adequate recycling facilities are available in a local area to cope with supply and demand;
- Lack of detailed data about arisings, composition and utilisation of CD&EW at local level;
- Need to implement measures to segregate materials at source so that 'soft' and 'hard' materials do not become mixed;
- Need to assess the risk of contamination of CD&EW from old industrial sites;
- Need for markets for by-products from processing CD&EW, especially processing for higher value applications;
- The cost of equipment needed to process CD&EW, especially processing for high value applications;
- The ending of the Landfill Tax Credit Scheme, which has funded much research in this area.

A total of 44 actions were identified to address these issues; of these, 25 were assessed as being of level 1 priority, 12 as level 2 priority and 7 as level 3 priority. The actions include:
- Promotion of existing tools, or tools currently under development, for activities such as waste audits, pre-demolition surveys and risk assessments for contamination;
- Continuing financial support for infrastructure to process CD&EW;
- Continuing and extending a range of education, training and dissemination activities, including developing strategies for reaching the small construction and skip operator sectors;
- Engaging with the Environment Agency, other government departments and industry to resolve the waste/product issue, possibly using the CE marking system in the new European Standards as a way forward;
- Liaising with ODPM to develop better data collection procedures at all levels;
- Funding research on a range of topics, often in collaboration with other bodies, both as short term and longer term projects, including complete surveys of the CD&EW waste stream for several urban areas, demonstration projects for higher value applications of recycled CD&EW and developing markets for the by-products of processing CD&EW.

Some of the actions should be taken forward by parties other than DTI and WRAP, such as ODPM, others require a collaborative approach to defining the precise actions and providing funding. Some are dependent on the output from other projects in the DTI/WRAP Aggregates Research Programme. All these are indicated where appropriate. The following are considered to be the main areas, within the remit of this project, where DTI and WRAP have the greatest need to initiate action. This will help to achieve the desired increase in the quantity of CD&EW recycled as aggregate and the quality of the end uses to which it is put.
- Collaborate with the Environment Agency, DEFRA, industry and others to produce an appropriate system of regulation for recycled aggregates, possibly based on the system of CE marking under European Standards;
- Develop and promote risk assessment methodologies for contamination of CD&EW, agree with the Environment Agency and implement;
• Continue to carry out programmes of education and training on recycling, particularly for the small construction sector;
• Carry out detailed surveys of CD&EW arisings, composition and utilisation at local - that is, city - level; use results to identify ways to increase the quantity and quality of recycling;
• Major campaign to promote use of pre-demolition audits and waste minimisation tools on construction and demolition sites;
• Carry out demonstration projects for higher value applications of recycled aggregates such as coarse aggregate in concrete to BS 8500;
• Develop applications and markets for by-products from processing of CD&EW, especially fines from production of concrete aggregate;
• Develop a funding mechanism for collaborative industry/research projects to replace the Landfill Tax Credit Scheme.

To achieve real progress, the results of this and the other projects in the 2002/03 DTI/WRAP Aggregates Research Programme need to be brought together into a coherent strategy with one body, such as WRAP, responsible for implementing it and with a remit to co-ordinate action across the various government departments involved.

This report was prepared for DTI. The views expressed are those of the author and not necessarily those of DTI.
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1 Introduction

This report is the Final Project Report for the DTI/WRAP Aggregates Research Programme project *Addressing the Barriers to Construction and Demolition Waste as Recycled Aggregates*.

The objective of the DTI/WRAP Aggregates Research Programme is to support the sustainable development of construction markets for recycled and secondary materials as aggregates. This project will support the development of a strategic research framework that will provide a co-ordinated approach to ensuring more efficient uses of recycled and secondary resources as aggregates in construction. Construction, demolition and excavation waste (CD&EW) represents by far the largest potential source of recycled aggregates in the UK, as shown by recent surveys by the Office of the Deputy Prime Minister (ODPM, 2002a & b). The project focuses on the assessment of existing and potential CD&EW streams as potential supplies for aggregate markets.

The project has proceeded in two phases. In the first, existing information was reviewed and consultations were held with key players to identify the material streams contributing to CD&EW and to unpack the key issues that represent barriers to greater use of the materials as recycled aggregates. The second phase was the development of a strategy to address these issues.

The nature of CD&EW and the various components of the material streams contributing to it are discussed in Chapter 2. The key issues relating to utilisation of CD&EW as recycled aggregate, particularly in relation to reduction of contamination, use as higher value materials and collection of relevant data are discussed in Chapter 3. To address these issues, a number of actions are recommended and these are presented in Chapter 4. The actions have been ranked into three levels of priority and a table is presented to summarise the key issues and actions. The level 1 actions are summarised in Chapter 5, the level 2 actions in Chapter 6 and the level 3 actions in Chapter 7. Suggestions are made for funding and delivery mechanisms, who the instigators should be and which key stakeholders need to be involved. A summary of the main conclusions and recommendations is given in Chapter 8.

A list of the individuals and organisations consulted during the project is given in Annex 1. The consultees included key players in the recycling industry, trade organisations, universities and research organisations. A list of relevant references, surveys and specifications is given in the Bibliography in Annex 2. Only the most up-to-date references are given; hence a number of well-known and highly respected reports have been omitted because they have been superseded by more recent publications. The report has been put together on the basis of information from the above sources and personal knowledge of the industry by the authors.

This report was prepared for DTI. The views expressed are those of the author and not necessarily those of DTI.
2 What is CD&EW?

2.1 Composition

The recent survey by ODPM (2002a) indicated that the production of CD&EW in England and Wales in 2001 was 93.91 million tonnes (Mt) ± 15% at a confidence level of 90%. This does not include the figure for asphalt planings, which are estimated as 5 million tonnes per annum (Mta) (Barritt, 2003) to 7 Mta (Environment Agency, 2001). The combined total is thus nearly 100 Mta. This represents by far the largest stream of any recyclable material in England and Wales (ODPM 2002a and b).

The figures for England and Wales were collected for individual planning regions and aggregated to give national figures. The confidence limits for the regional estimates for England range from ± 37% to ± 69% and for Wales from ± 90% to ± 135%. Compared to a similar survey for England and Wales carried out for 1999 (Environment Agency, 2001), the total of CD&EW increased from 72.5 Mt to 93.9 Mt, though the error margins are so wide that the increase is not statistically significant. Clearly, the figures can only be regarded as rough estimates, but they indicate the scale of the material stream.

The surveys for England and Wales were designed to generate estimates for recycled aggregate and soil, CD&EW used and disposed of at landfills and CD&EW spread on registered exempt sites. But how are these terms defined and how well do they cover the range of materials that come under the general heading of ‘construction, demolition and excavation waste'? Such a large waste stream must consist of a number of different components. It is necessary to identify what they are, how and by whom they are processed and how the end products are utilised if it is hoped to make a significant increase in utilisation of these materials as recycled aggregates and to ensure they are used as effectively as possible.

The ODPM survey (2002a) gives the following definition: "'C&D waste' means waste materials which arise from the construction or demolition of buildings and/or civil engineering infrastructure, including hard C&D waste and excavation waste, whether segregated or mixed." WRAP prefers the term 'Construction, demolition and excavation waste (CD&EW)' as this more accurately defines the waste stream. The ODPM survey also gives definitions of hard construction and demolition waste and excavated soil. Hard construction and demolition waste is defined with reference to the European Waste Catalogue and includes categories for uncontaminated and contaminated concrete, bricks, tiles, bituminous mixtures and railway ballast and mixtures of the various components. Excavation waste is defined as both clean and contaminated soil, stone and rocks arising from land levelling, filling and/or general foundations.

For the purposes of the present study, it was felt that it would be more useful to identify a number of sources of CD&EW and the destinations to which they might be subjected. This provides a basis for investigating the issues surrounding the utilisation of the materials as recycled aggregates. The issues will inevitably vary from one source and destination to another. The main sources and destinations are identified in Figure 1, with summary sheets for each source and destination given in Figures A3.1 to A3.13 in Annex 3, which identify the materials, issues, existing and potential uses, barriers and relevant references.

The main sources of CD&EW identified for this study are:
- Utility arisings: material resulting from small excavations in streets, footways and open areas for repair of existing services or installation of new services;
- Bituminous planings: asphalt arising from the planned renewal of existing roads;
- Highway Maintenance Arisings: mixed materials arising from repairs and renewals to roads and footways;
- Excavation material: soil, made ground and existing foundations resulting from excavations for new construction;
- Construction arisings: surplus materials, offcuts, packaging and so on, resulting from construction or renovation works;
- Demolition arisings: material resulting from the demolition of existing structures;
- Skip waste: assorted material including some construction, demolition and excavation waste plus garden waste, soil, furnishings, etc, - highly variable material generally arising from small sites.
Figure 1  Summary chart of sources and destinations for CD&EW with approximate arisings for England and Wales
The main destinations that the material streams can be subjected to include:

- Disposal to licensed landfill sites, where some of the material may be reused for engineering purposes;
- Spread on Paragraph 9 & 19 registered exempt sites;
- High-level processing at a large recycling facility, effectively an aggregate production plant;
- Low-level processing at small scale local recycling facility such as a waste transfer station;
- Material recycled and used on site in new construction;
- Sold directly off site for use in new construction (for example, ornamental stone, slate tiles: reclaimed materials).

In the breakdown given above, it is assumed that construction, demolition and excavation waste are generally produced from medium to large projects with a reasonably high degree of engineering control. For these projects clients, contractors and designers are part of the mainstream of the construction industry and are open to messages from government, professional institutions and research organisations on recycling, waste minimisation and sustainability. Material from these projects is more likely to go to high level recycling centres, which are generally run by aggregate producers who are also in the mainstream of the industry and are likely to be looking to maximise the value of the incoming material as recycled aggregates.

There is a large sector of the construction industry, principally concerned with the building, repair, maintenance and renovation of individual houses and other small buildings, that operates on a much smaller scale and is not open to influence in the same way as for medium and large companies. The material derived from this sector has been categorised as skip waste. It is likely to be highly variable, with inert and active material mixed together. It largely goes to waste transfer stations, where the recycling facilities, if any, are likely to be much less sophisticated than for high level recycling centres and consequently the opportunities for output of high value recycled aggregates are much less.

The distinction between these two types of CD&EW producer is somewhat arbitrary, but it is important as it affects the nature of the arisings and the opportunities for production of recycled aggregates. Different strategies are required to reach the different sectors.

Illegal tipping and unlicensed disposal have not been considered, as it is presumed that it is desired to eliminate these options by application of the law.

A summary of the composition by mass of construction waste and demolition waste (Hurley, 2001) and material arriving at waste transfer stations in Nottingham (APT Environmental, 2002) is shown on Table 1.

### Table 1. Comparison of construction waste from individual projects (Hurley et al., 2001), demolition waste (Hurley et al., 2001) and material arriving at waste transfer station in Nottingham (APT Environmental, 2002)

<table>
<thead>
<tr>
<th>Waste group</th>
<th>Construction waste</th>
<th>Demolition waste</th>
<th>Waste transfer station</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% by mass</td>
<td>% by mass</td>
<td>% by mass</td>
</tr>
<tr>
<td>Timber</td>
<td>11 - 33</td>
<td>19.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.5 - 18</td>
<td>5.9</td>
<td>40</td>
</tr>
<tr>
<td>Inert 1</td>
<td>0.5 - 27</td>
<td>11.1</td>
<td>24</td>
</tr>
<tr>
<td>Asphalt</td>
<td>0 - 7</td>
<td>0 - 7</td>
<td>15</td>
</tr>
<tr>
<td>Ceramic</td>
<td>3 - 11</td>
<td>3.0</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Insulation</td>
<td>1 - 11</td>
<td>2.5</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Plastic</td>
<td>4 - 37</td>
<td>13.0</td>
<td>17</td>
</tr>
<tr>
<td>Packaging</td>
<td>8 - 49</td>
<td>25.7</td>
<td>17</td>
</tr>
<tr>
<td>Metal</td>
<td>0.5 - 8</td>
<td>2.6</td>
<td>17</td>
</tr>
<tr>
<td>Plaster &amp; cement</td>
<td>0.5 - 12</td>
<td>3.1</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>7 - 19</td>
<td>13.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>99.50</td>
</tr>
</tbody>
</table>

Note:  
1. Inert material includes bricks, masonry, rubble, hardcore, sand and stone
2. Included in figure for miscellaneous
3. Included in figure for inert

In this project only applications as recycled aggregates in construction have been considered, in accordance with the project objectives. Applications for materials such as glass, plastic, timber and metal, which are contaminants in the context of CD&EW, as waste streams in their own right have not been considered. However, it should be noted that the
viability of some recycling options depends on the development of markets for these materials, where they form a significant part of the waste stream. This is noted at appropriate points in the text. WRAP is already undertaking substantial market development work for other recyclable material streams.

### 2.2 Arisings

Using data from various sources, estimated figures for arisings at a national level can be allocated to most of the sources and destinations and these are shown in Figure 1. The derivations of the data are listed below:

- **Utilities**: no data available. Probably significant, possibly in range 5 - 10 million tonnes per annum (Mta)? Research needed on arisings and composition.
- **Asphalt planings**: figure from reports by Environment Agency (2001) for England and Wales.
- **Highway maintenance arisings**: no data available. Possibly in range 0.25 - 1 Mta, may be included in figure for asphalt planings. This material is sought by recycling contractors for production of recycled aggregates; some Local Authorities have entered into agreements with recycling contractors to take all their highway maintenance arisings. Research needed on arisings and composition.
- **Excavation**: figure from Hurley et al. (2001), based on survey of 1200 UK businesses. Mostly soil and clay, some used as landscaping.
- **Construction**: figure from Hurley et al., (2001), based on survey of 1200 UK businesses. See Table 1 for composition.
- **Demolition**: figure from Hurley et al., (2001), based on survey of 1200 UK businesses. See Table 1 for composition.
- **Skip waste**: no data, assumed to be included in construction, demolition and excavation waste figures. See Table 1 for example of composition.
- **Licensed landfill**: figure from ODPM survey for 2001 for England and Wales. Includes material used for landfill engineering and restoration, material used to backfill quarry voids and material disposed of at landfills.
- **Exempt site**: figure from ODPM survey for 2001 for England and Wales.
- **Recycling centres/ recycled on site**: figure from ODPM survey for 2001 for England and Wales. Includes material used as recycled aggregate (38.02 Mt) and recycled soil (7.05 Mt).
- **Sold directly off site**: figure from Hurley et al. (2001), based on survey of 1200 UK businesses. Breakdown of composition in Hurley et al. (2001), Table 1.

Most of the figures relate to England and Wales, but those from Hurley et al. (2001) are for the UK as a whole. Data on CD&EW arisings for Scotland are available from Winter and Henderson (2001), so overall figures for the UK could be estimated. It may also be possible to break down the data in Hurley et al (2001) to give figures for England, Wales and Scotland, so that data for each country and possibly for regions in England could be produced. This would be of value to the devolved administrations in Wales and Scotland and to central government in England to develop overall strategies for sustainable construction. The figures have large error margins, but provide sufficient information for strategic purposes.

The flows of materials between sources and destinations can be complex, as illustrated on Figure 2 for demolition material. The proportion going to different destinations will vary depending on the materials on site, the timescale for demolition and, crucially, the relative distances to recycling centres, landfills and exempt sites. Similarly, material arriving at a recycling centre, Figure 3, will come from a variety of sources, which will themselves vary over time. The uses to which the materials are put as recycled aggregates, also shown on Figure 3, will also vary with time depending on the nature of the incoming materials and the construction projects available within an economic distance of the recycling centre - usually considered to be in the order of 25 to 30km (Symonds Group, 1999).

Existing surveys give an indication of the composition of various components of the waste stream, for example, construction waste and demolition waste (Hurley et al., 2001) and material arriving at recycling centres (waste transfer stations and landfills) in a typical urban area (APT Environmental, 2002) (Table 1). Data on quantities of arisings is limited and dispersed, for example, Local Authority Highway Departments will know their own production of asphalt planings and highway maintenance arisings, but there is no central collation of this data. Data from the national/regional surveys is of little use at this level because the error margins get wider and wider the smaller the sample. With a response rate of only 20% overall (ODPM, 2002a), some local areas would have no reliable data at all.

Data from the ODPM survey (2002a) suggests that most hard CD&EW that can be recycled is being recycled and that there is limited scope for increasing the amount of recycled material from the other categories because of mixing with soil and contaminated materials. The largest potential source of recycled aggregate is probably from material that is currently sent to exempt sites. The issue is therefore principally to make better use of recycled aggregates from CD&EW rather than to only seek to increase the overall amount recycled.
Figure 2 Typical flow pattern for demolition material

Figure 3 Typical inputs and outputs from a high level recycling centre
2.3 Utilisation

There are no formal statistics on the end use of recycled aggregates from CD&EW, or other recycled materials. Consultations for this project suggests that most of the recycled aggregate produced is utilised as general fill, capping and unbound sub-base in road foundations. Some of the larger aggregate producers are investing in plant to process recycled aggregates for use as coarse aggregate in concrete and asphalt planings as reclaimed bituminous material in new asphalt.

Barritt (2003) made estimates of the end use of recycled and secondary aggregates from a survey of 260 suppliers of recycled aggregates. This showed that:

- 70% was used as 'fills'; this includes general fill, capping and structural backfills (Series 600 of the Specification for Highway Works), that is, processed aggregates. It does not include unprocessed CD&EW used as fill.
- 18% was used as sub-base (Types 1, 2 and 4 in Series 800 of the Specification for Highway Works).
- 5% was used in asphalt.
- 7% was used in concrete or as graded coarse aggregate.

The figures for CD&EW are probably similar to the overall figures. The proportions used in asphalt and concrete may be less, as some secondary materials (steel slag and blastfurnace slag) are used principally in these applications.

It is important to avoid a narrow distinction between 'low' and 'high' value applications and in particular to assume that only 'high' value applications such as aggregate for concrete or asphalt are worth pursuing for CD&EW. The concept of utility (Winter, 2002) for the recycling of aggregates is helpful here. Winter uses the terms 'low utility', 'intermediate utility' and 'high utility' to describe a typical range of applications in relation to the potential of a given aggregate type. The levels correspond to increasingly critical applications in terms of their environmental value and, in general, to low, intermediate and high economic values. Examples of low, intermediate and high utility applications for construction, demolition and excavation waste and bituminous planings are given below (Winter, 2002).

<table>
<thead>
<tr>
<th>Material</th>
<th>Low utility</th>
<th>Intermediate utility</th>
<th>High utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bituminous planings and breakout</td>
<td>Haul road; general fill</td>
<td>Capping layer; sub-base</td>
<td>Hot and cold recycled bituminous materials</td>
</tr>
<tr>
<td>Construction, demolition and excavation waste (excluding soil)</td>
<td>General fill</td>
<td>Building and road foundation materials, excluding concrete foundation aggregates and additives</td>
<td>Building and structural units (for example, blocks); concrete and cement constituents; structural road construction layers</td>
</tr>
</tbody>
</table>

There will always be a market for low grade general fill and CD&EW is as suitable as any other material to satisfy that need. However, if properly processed, CD&EW is capable of producing recycled aggregates that are suitable for a wide range of end uses and it is important that the material is not needlessly confined to low level end uses. Recycled aggregates are now permitted constituents for most applications in the Specification for Highway Works and as coarse aggregate for concrete in BS 8500: Part 2 (2002), so there is no longer a specification barrier to the use of these materials. The aim should be to use materials to their optimum economic potential and that may be low, intermediate or high utility applications depending on the circumstances.

The key to utilisation in higher value (that is, intermediate and high utility) applications is the removal of contaminants, either before the material enters the waste stream or when it arrives at a recycling centre for processing. This study looked at the issues relating to the segregation and treatment of CD&EW and these are presented in Chapter 3.
3 Key issues

3.1 General

The key issues arising from the study are summarised below. The specific actions to address the issues are discussed in Chapter 4 and are summarised in Table 2.

There has been increasing interest in the use of CD&EW as aggregate over the last 15 years and a number of studies have been carried out. These include Arup (1991), MPG 6 (1994), BRE (1993), Howard Humphreys (1994), BS 6543 (1985), Symonds Group (1999), Sherwood (2001), Environment Agency (2001), Reid and Chandler (2001) and ODPM (2002a). Some of the issues raised in earlier reports, for example, lack of specifications, have now largely been resolved, whilst others, such as the waste/product issue, have developed. Thus many of the issues and suggested actions given in this report have been raised in previous reports, but are still valid.

3.2 Waste/product issue

This is an issue that affects all recycled and secondary materials. It was raised so often in consultations that we have no hesitation in putting it at the head of the list of issues to be addressed, even though CD&EW is at present less affected than some other material streams. The issue has a long history, but in recent years it has become a very serious problem and threatens to undermine government initiatives to increase the use of recycled and secondary aggregates in construction.

The root of the problem is the definition of waste in the European Commission Waste Framework Directive of 1975, under which any material that is discarded, or is required to be discarded is classed as a waste. This is the so-called 'Directive Waste'. Whether a material is waste or not depends on the intentions of the producer at least as much as whether it is potentially harmful. This replaced the previous definition of waste in the UK under the Control of Pollution Act (COPA) which defined controlled waste as household, commercial or industrial waste. The EC definition was implemented in the UK by the Environmental Protection Act 1990 and the Waste Management Regulations 1994.

Recycled and secondary materials are classed as waste under the 1994 Regulations and subject to a duty of care. The materials may only be transported by licensed waste carriers and can only be stored or disposed of at sites with a waste management licence.

A number of activities were established as being exempt from the Regulations. These are generally waste recovery operations, such as the processing of construction, demolition and excavation waste. These sites should not be confused with the exempt sites under Paragraphs 9 & 19 of the Regulations, referred to in Chapter 2, which relate to the spreading of material on land for the purposes of reclamation or improvement. In practice, waste recovery operations are usually only carried out at sites which have a waste management licence, such as a landfill site, or are registered as benefiting from an exemption from licensing. A great deal of the recycling of construction, demolition and excavation waste takes place at registered exempt sites in urban areas. Some takes place at licensed landfill sites around the edge of urban areas.

At the time of the introduction of the 1994 Regulations, the understanding was that a material that had been subject to a waste recovery operation would no longer be a waste but a product. In Circular 11/94 (Department of the Environment, 1994), which was issued to explain the intentions and operation of the waste management licensing regulations, it states in Annex 2, Clause 2.47: "It follows that the recovery of waste occurs when its processing produces a material of sufficient beneficial use to eliminate or diminish sufficiently the threat posed by the original production of the waste. This will generally take place when the recovered material can be used as a raw material in the same way as raw materials of non-waste origin by a person other than a specialised waste recovery establishment or undertaking."

Thus, untreated construction, demolition and excavation material delivered to a recycling centre would be a waste. However, after it had been processed to remove impurities and to comply with the requirements of the Specification for Highway Works or BS 8500: 2002, it would no longer be a waste, as it could be used in construction in exactly the same way as a natural aggregate.

More recently, the regulatory authorities are regarding material as waste until such time as the waste is fully recovered, thus for aggregates, when it has been placed in an engineering structure, regardless of whether it has been processed and is capable of beneficial use or not. This has financial implications, as the carrier of the material from the reprocessing centre to the site where the material will be used has to be a registered waste carrier if the material is still classed as waste and the attendant paperwork has to be in place. This makes the use of recycled aggregates less attractive than primary aggregates and creates a conflict within the principles of sustainable construction.

Wrap
A strategy for construction demolition and excavation waste as recycled aggregates
The regulatory situation has been driven by court cases in the UK and Europe, especially the Palin Granite case where the European Court ruled that a stockpile of granite at a quarry in Finland was waste because the re-use of the material was uncertain and only foreseeable in the long term. The issue of whether the stockpile could cause harm to human health or the environment was not considered sufficient grounds to change the status of the material from waste to product. As a result, the regulatory authorities are interpreting the term ‘discard’ more broadly and applying the definition of waste to a wider range of circumstances. This is leading to uncertainty among recyclers and contractors as to possible financial and regulatory burdens and to clients being concerned about future liabilities if recycled materials are at some point classed as waste even after they have been incorporated in an engineering structure. This fear may seem illogical, given that recycled aggregates have clearly not been discarded but have re-entered the ‘chain of utility’, however, given the recent court decisions, and their interpretation by the regulatory authorities, it is perhaps not surprising.

3.3 Education, education, education

The perception of recycled and secondary materials by clients, designers, specifiers and regulators is important if they are to be used as aggregates in construction. The problems of perception and lack of awareness were highlighted by Reid and Chandler (2001) for transport infrastructure and similar considerations apply in other sectors. The need for dissemination of information has been recognised by initiatives such as the Aggregates Information Service, AggRegain (www.aggregain.org.uk) and the CIRIA register of recycling sites. Numerous conferences, seminars and workshops on sustainable construction have been held in various locations over the last few years and the Sustainable Construction in Practice (SCiP) roadshow has been developed to take information out to practising engineers throughout the country.

The consultations for this project and the feedback from the SCiP workshops in the winter of 2002/03 suggest that the situation is improving. Many major clients and contractors are keen to use recycled materials and there is general acceptance that this is the correct environmental choice. There is great interest in the mechanisms whereby recycled and secondary materials can be used in construction and most of the concerns relate to waste management issues. Suppliers of recycled aggregates report that some Local Authorities are still reluctant to use recycled aggregates and are imposing onerous conditions additional to those in the Specification for Highway Works, even though neighbouring authorities will happily use them. Clearly this is a sector that needs to be targeted.

Other sectors that were identified by the consultations as being in need of targeted training are Building Control and Environment Agency staff. They are often poorly informed about recycling of CD&EW and tend to be very conservative. Operators of recycling centres also need training, so that they understand the material properties that are required to meet the specifications and the actions they must take to meet these requirements.

The largest numbers of delegates at the SCiP workshops have been from major contractors, with major consultants next and smaller numbers from Local Authorities, SMEs and Utility Companies. SCiP is clearly meeting a need, as shown by the attendance of 513 delegates over the nine workshops, but it is reaching the top end of the market, which understands engineering issues.

This study has highlighted the need to target the small house building and repair and maintenance markets, as this contributes significantly to the overall volume of construction waste. Usually this sector is extremely bad at segregating materials prior to disposal, which restricts the uses to which the materials can subsequently be put. The sector is not open to the kinds of information dissemination techniques that are used for companies working on larger projects, such as professional institutions, technical guidance, client pressure or supply chain management. The sector runs on very low profit margins, yet it is ignoring opportunities to reduce costs by waste minimisation and recycling. A strategy should be developed specifically to reach this sector, either directly or via skip operators.

3.4 Specifications

This is an area that has seen massive progress in recent years and was not regarded as a barrier by any of the practitioners we consulted. Further dissemination of the existing guidance is required, along with ongoing updating of the specifications. The introduction of ‘recycled aggregates’ as a permitted constituent in the Specification for Highway Works, complete with limiting values on foreign materials and the requirement for quality control has been enormously helpful, both in convincing clients and giving industry clear standards to aim for.

The only suggestions we received on specifications were:

- It was necessary to ensure that the specifications and quality plans were monitored, or there would be temptation to lower standards;
- Specific clauses may be required for particular materials; for example, for crushed glass sand it is important that it is crushed properly so that it is rounded and not sharp, but there are no test methods or specification requirements to cover this at present.
Another issue is the planned withdrawal of the current British Standards for aggregates from 1 June 2004 and the introduction of the new harmonised European Standards. These introduce a number of new concepts and ways of expressing test results and specification requirements. The role of the new European Standards is the subject of another 2002/03 DTI/WRAP Aggregates Research Programme project and is not considered further here.

3.5 Planning issues

Several other issues that affect the overall picture are discussed briefly here. The intermixed issues of economics, transport costs and planning permission for recycling centres require consideration. All other things being equal, the choice of whether to use recycled or primary aggregates will come down to cost. This depends critically on the transport distances for the material from the source of production to the point of use. The choice of whether materials from demolition or construction sites are sent to recycling centres or landfill/exempt sites is governed by the same considerations. In urban areas, recycled aggregates and recycling will be at an advantage compared to primary aggregates and landfill so long as there is an adequate supply of recycling centres near to the sources of production of the material. However, there are often objections by the local community to the location of recycling centres in urban areas because of concerns about dust, noise, mud on roads and traffic. Recycling centres are often perceived as similar to landfill sites, though they have a completely different function and do not accept municipal solid waste. It can therefore be hard to obtain planning permission for recycling centres in the areas where they are most needed.

The government commissioned research and published a guidance document on the factors that should be considered by planners when deciding applications for recycling centres (DETR, 2000). The draft revisions to MPG6 also suggest that councils should seek to maximise the utilisation of recycled aggregates in their areas before considering applications for new quarries or extensions to existing quarries. However, there is anecdotal evidence that difficulties are still being experienced in some cases, even for operators with a good environmental record. While such applications are often likely to be controversial and need to be handled with sensitivity, there is a need Local Authorities to ensure that an adequate number of properly equipped and operated recycling centres are available to ensure maximum utilisation of arisings of CD&EW. To do this, Local Authorities will need to have accurate methods of predicting the amount and quality of arisings in their areas. This brings us to the issue of surveys and data collection methods, which is dealt with in the next section.

The role of the new planning system in the production and use of recycled and secondary aggregates is the subject of other 2002/03 DTI/WRAP Aggregates Research Programme projects and the findings of this report will need to be considered in tandem with the planning-specific research.

3.6 Data collection

The surveys of CD&EW arisings in England and Wales for 1999 (Environment Agency, 2001) and 2001 (ODPM, 2002a) have been discussed in Chapter 2. The surveys provide a much clearer picture than existed previously and give a reasonably good picture at national level. At regional level, however, the confidence intervals on the data become very wide and it is not possible to split the data down to the level of individual cities, counties, boroughs or unitary authorities in a meaningful way. The high error margins on the estimates are due to the low response rate to the surveys, which was only about 20%. The problems associated with surveys of this type and how they may be addressed, are discussed in the ODPM report (2002a).

Crude data on arisings of most of the material streams shown in Figure 1 is available at national and in some cases regional level. No data has been discovered on utility and highway maintenance arisings. The destinations of these materials will, however, be included in the ODPM survey for 2001, unless they are replaced in the excavations without being treated.

Data at regional and national level are useful for central government for strategic purposes, but in order to drive changes at local level data is needed for individual sites or areas such as cities, counties, boroughs or unitary authorities. An example of this type of study is that of Greater Nottingham by APT Environmental (2002). Waste audits have also been carried out at county and regional level and have yielded useful information on ways to utilise recycled and secondary materials and minimise use of primary aggregates (for example, Viridis waste audit of Northamptonshire). A standard methodology is required, so that studies of different areas can be compared.

At the individual site level, there are a number of data collection measures that can be taken to minimise waste and maximise recycling. These include waste audits on construction sites using SMARTWaste and SMARTStart, pre-demolition audits and use of the Health and Safety File on demolition sites. EnviroCentre is undertaking work on pre-demolition protocols and we understand the results will be produced in the summer of 2003. The use of these tools should be encouraged.
The data requirements discussed so far have focused on the sources of material or the composition of materials available for recycling, but there is a shortage of data on the utilisation of recycled aggregates from CD&EW. Barritt (2003) has used data from suppliers to obtain a general picture of the overall utilisation of recycled and secondary aggregates (see Chapter 2).

To increase the amount of CD&EW used in higher value applications it would be very useful to have time series data showing how the amounts used in different applications have changed over time. This would make it easier to set targets and monitor progress, both nationally and locally. There is no legislative requirement for producers or users (clients, contractors) to record this information and while some may do so for specific projects (for example, Wessex Water) this is the exception rather than the rule. The issues of commercial confidentiality, identifying a complete list of producers and (probable) low response rate would make this a major undertaking and it must be questioned if the results would be worth the effort. It would be necessary to repeat the survey at regular intervals to monitor progress and this would lead to similar concerns as with the recent national survey (ODPM, 2002a).

An important point arising from the Greater Nottingham surveys is the need to develop markets for the non-inert fraction and this would lead to similar concerns as with the recent national survey (ODPM, 2002a).

3.7 Segregation of foreign material

One of the main reasons for the lack of acceptance of CD&EW as recycled aggregate is the presence of foreign material such as wood, paper, cardboard, plastic and metal. Many of these materials are lightweight compared to brick and concrete and hence are highly visible even at low levels. The new specifications (Specification for Highway Works, BRE Digest 433, BS 8500:2002) all have strict limits on the content of foreign materials and require the use of quality control plans to eliminate variability and unsuitable materials. However, there is still a perception in the construction industry that CD&EW is the dirty material seen in skips on construction and demolition sites rather than a clean processed material meeting the requirements of the specification. This can partly be addressed by education, but also requires producers and contractors to supply material that conforms to the specifications. This requires segregation of foreign material from the hard CD&EW.

Segregation can be carried out at source - during demolition or construction activities - or can be achieved by processing the mixed material to remove the foreign materials. Segregation at source is most efficient in terms of energy utilisation, economics and time. A number of tools for waste minimisation and auditing on construction sites are available, which emphasise the need to segregate inert material from non-inert. For demolition sites, it is important to strip out the ‘soft' materials - wood, glass, cabling, plastic, plasterboard and so on - before demolition in order to produce recycled aggregate that will meet the specification requirements. This is already good practice in the demolition industry. Protocols for pre-demolition audits are being produced, which should encourage the proper assessment of a structure prior to demolition with a view to maximising the recycling of the components.

The principles of pre-demolition audits should be applied to other areas, such as utility arisings, highway maintenance arisings and the small house building sector. The large aggregate producers who operate high level recycling centres undertake testing of road pavements in advance of renewal works, so that they can handle the resulting planings as efficiently as possible. This may not apply in the other sectors, especially in the small house building sector. There is also a lack of small multi-compartment containers that would enable materials from utility excavations or house building to be easily segregated without significantly delaying the progress of the work.

Despite the available tools, much of the CD&EW that arrives at recycling centres contains significant amounts of foreign material and requires further processing to meet the composition requirements of the specifications. This has obvious implications for the cost of the material compared to primary aggregates. However, an increasing amount of mechanical equipment has become available in recent years to help remove foreign materials from inert CD&EW. These range from picking stations that allow the removal of plastic, cardboard and paper by hand to air blowers that utilise the low density of many foreign materials to separate them from brick and concrete. Magnets can effectively separate ferrous metals. Washing stages can also be used to separate low and high-density materials from the main CD&EW stream. Much of this equipment has been developed in Europe in countries that have much higher recycling rates than the UK. This equipment is costly and represents a significant investment for recycling contractors. However, for most operators it will be essential to enable them to meet the composition requirements for recycled aggregates.

The requirement for more sophisticated equipment in order to be able to process more of the CD&EW waste stream is illustrated by Figure 9.1 of the Final Report to the European Commission on Construction and Demolition Waste Management Practices and their Economic Impacts (Symonds Group, 1999), which is reproduced below. With basic crushing and sieving plant it is only possible to treat inert CD&EW, but with more sophisticated equipment all kinds of CD&EW can be treated.
A = Mobile crusher and sieving plant

'BLevel 1'

Inadequate Quality Control

B = A plus metal removal and more complex sorting/sieving

'Level 2'

Excessively Expensive

C = B plus hand sorting, washing plant and facilities for other C&DW streams (wood etc)

'Level 3'

Inert C&DW Mixed (mainly inert) C&DW All types of C&DW

Copy of Figure 9.1: Matching recycling technology to circumstances
Final Report to the European Commission on Construction and Demolition Waste Management Practices and their Economic Impacts (Symonds Group, 1999)

The cost of investing in this equipment is a barrier to processing more of the CD&EW stream as recycled aggregates.

Most of the equipment necessary for producing material that will be satisfactory for unbound applications such as general fill, capping and sub-base is already available. The basic requirement is to reduce the content of all foreign materials to less than 1%. However, producing material that meets the composition requirements for some of the higher value applications is more difficult. Recycled aggregates for coarse aggregate in cement bound material also have a limiting value of 5% for asphalt, while a number of structural backfills to metallic elements and culverts require no recycled asphalt. Recycled Concrete Aggregate (RCA) has a maximum asphalt content of 10%, whereas Recycled Concrete Aggregate (RCA) has a maximum asphalt content of 5% and a maximum content of brick and masonry of 5%. As brick, masonry, asphalt and concrete all have similar densities, it is very difficult to separate these materials once they are mixed. By the nature of CD&EW it is always changing in composition, so the relative proportions of brick and concrete will vary with time, even if the requirements for foreign materials are met. Equipment that can separate these materials would enable greater amounts of higher value materials to be produced.

### 3.8 Contamination

Most demolition material is not contaminated. However, where buildings have been used for industrial purposes that generate polluting materials, the building materials may have absorbed some contamination. When these materials are then crushed and screened to produce a granular fill, there may be concerns about risks to human health from dust generation and to controlled waters from leaching of contaminants. This is being investigated by the Universities of Manchester and Newcastle in conjunction with BRE (Lawson et al., 2001; Vetterlein et al., 2002) and a BRE Digest will be produced on risk assessment of contamination in recycled aggregate arising from demolition works. Preliminary results (Vetterlein et al., 2002) indicate that the total concentrations of metals in demolition material on old industrial sites can be in excess of the Inter-Departmental Committee on the Redevelopment of Contaminated Land (ICRCL) guidelines. However, the water-soluble fraction appears to be very low, which reduces the risks of leaching.

As with other waste streams, it is important to keep clean and contaminated materials separate. This requires thorough investigation of the materials in advance of the development or redevelopment and if necessary testing of material as it is excavated to determine the degree, if any, of contamination. Pre-demolition audits should take the possibility of contamination into account.

Risk assessment tools such as Contaminated Land Exposure Assessment (CLEA) and ConSim, which are accepted by the Environment Agency, are available and there is a great deal of published guidance on sampling strategies, typical contaminant profiles for old industrial sites, risk assessment methodologies and legislation, for example, the DETR Contaminated Land Reports (CLRs). The BRE Digest will provide a bespoke system for demolition material. However, further data from a wider range of structures may be necessary to validate the system.
It will be necessary to agree the use of the risk assessment methodology with the Environment Agency. It will be important to develop a methodology that is acceptable to all parties. It should not impose excessive testing and assessment procedures or impose unnecessary delays on contractors, or it will provide a further inhibiting factor to the use of recycled aggregates, but it has to be robust enough to identify materials that could cause harm to the environment.

A particular problem for asphalt planings and highway maintenance arisings is the possible presence of tar and tar-derived compounds. Recycled asphalt must not contain any of these compounds, but at present there is no quick test to tell if tar is present in a core or loose sample. Developing such a test would aid the utilisation of recycled asphalt.

### 3.9 Higher value materials

As discussed in Chapter 2, the situation at present requires that CD&EW be reused as higher value applications where appropriate. The sections above (3.6 & 3.7) have been principally concerned with the requirements for producing recycled aggregates that can be used for unbound granular applications as general fill, capping and sub-base to the requirements of the Specification for Highway Works. These are the main applications for the bulk of recycled CD&EW and it is envisaged that this will continue to be the case. These should not be regarded as low value applications. Unbound sub-base and selected granular fills (Class 6 in the Specification for Highway Works) should be regarded as intermediate value applications (Winter, 2002), as they have tight grading limits and requirements for particle strength and other properties. They can thus command a higher price than general fill. In many cases this will be the most appropriate use of the materials. However, there will be situations where it is appropriate to use recycled aggregates for higher value applications, such as coarse aggregate in concrete, asphalt or cement bound material and to use recycled asphalt as reclaimed bituminous material in new asphalt.

Despite the production of BS 8500, use of recycled aggregate as Recycled Aggregate (RA) and Recycled Concrete Aggregate (RCA) in concrete is still fairly limited. This may partly be attributed to the complexity of BS 8500, which is perceived as difficult to apply in practice. This may be a circular argument, so the best way to overcome the perception is to have a number of well publicised and clearly documented demonstration projects illustrating the use of RA and RCA in typical situations. There may also be a need to address related issues such as the assumption that recycled aggregates will be particularly susceptible to alkali silica reaction. At present, RA and RCA are assumed to be of high reactivity and this leads to restrictions in the design mixes that can be used. Work is under way in some of these areas at present, but more may be required to tie up all the issues.

BS 8500 allows the use of up to 20% RA or RCA in the coarse aggregate without altering the composition of designated mixes. Producers of ready mix concrete are keen to utilise this opportunity in urban areas where recycled aggregates are readily available and primary aggregates may be expensive. However, most ready mix plants do not have the equipment to introduce RA/RCA into the mix in a controlled manner. Investment in capital equipment is therefore required. To be effective, the facilities would need to be available at a number of plants, not just one or two, so the scale of the investment in equipment is significant.

In a similar way, the use of recycled asphalt planings as reclaimed bituminous material in new asphalt requires equipment to mix the reclaimed material into the asphalt plant. Again, to be worthwhile the facilities have to be installed at a number of plants, thus entailing considerable expenditure.

The uniformly graded coarse aggregate for use as RA and RCA in concrete can also be used as pipe bedding and other applications as a high value unbound material. Recycled aggregates and recycled asphalt have been used as coarse aggregate in hydraulically bound sub-base and roadbase layers.

A problem with the production of uniformly graded coarse aggregate from CD&EW is that it leaves a lot of fine aggregate behind, for which there is no market at present. Some recycling contractors prefer to use all their CD&EW as well graded sub-base or capping. This is an intermediate value material, but they have no residue to dispose of afterwards. This is considered more economic than producing a limited amount of high value uniformly graded coarse aggregate, which costs more to produce than the well graded sub-base or capping and having to dispose of the fines to landfill. Fine recycled aggregate is not permitted in concrete, as it has various undesirable properties. If the use of high value uniformly graded coarse aggregate is to increase, it will be necessary to research and develop applications for the fines produced.

A related point is the need to develop markets for the waste products from the processing of CD&EW as recycled aggregates, such as wood, paper, plastic and plasterboard. Some recycling centres also handle these materials as waste streams in their own right. However, it is necessary to separate the various components from processing of CD&EW before they can be assigned to the correct material stream.
3.10 Economic aspects

One obvious way in which the use of recycled aggregates can be encouraged is by varying the Landfill Tax and Aggregates Levy to make recycling a more attractive option than using primary aggregates and disposing of CD&EW to landfill. The Chancellor gave some indication of likely future increases in Landfill Tax in the pre-budget statement in November 2002, but no indication was given of the future level of the Aggregates Levy.

In a crude way, a massive increase in the Landfill Tax could be used as a counterbalance to the problems of waste management regulation. However, the rate of increase proposed in the pre-budget statement is thought to be too little to produce a step change in behaviour and increased costs will simply be passed on to the customer, or lead to an increase in fly tipping. If this approach were to be adopted it would be important to maintain a significant differential between the costs of disposing of inert and mixed wastes to continue encouraging separation. The proposed level of the Landfill Tax is still very low compared to many European countries and the United States. An independent study is required to assess what the effects of varying the Landfill Tax and Aggregates Levy would be on the use of recycled aggregates.

Over the last few years, a number of very important research projects have been funded wholly or partly by the Landfill Tax Credit Scheme. In the area of CD&EW and recycled/secondary materials generally, these include:

- Demonstration project to increase the use of recycled resources in construction in the Greater Nottingham area: APT Environmental, funded by shanks.first.
- Mass balance of the construction industry: Viridis and CIRIA, funded by Biffaward.
- Recycling in transport infrastructure: TRL, funded by the Hanson Environmental Trust.
- The Aggregates Information Service: Viridis, funded by the RMC Environment Trust.
- Foamix: Pilot scale trials and design considerations: TRL and Scott Wilson, funded by Tarmac.

This brief list illustrates the range of types of project funded, from desk studies to surveys and field trials, the range of funders and the range of organisations involved. There are many more examples that could be quoted. However, the Landfill Tax Credit Scheme, or the part of it dealing with sustainable waste management, under which all the above projects were funded, is being wound up. It is not clear what, if anything, will replace it as a means of funding. The scheme, while cumbersome and bureaucratic in some ways, provided a means of funding innovative and ground-breaking research that would not have been possible under existing government research programmes with their restricted agendas. It was also very useful as a way of obtaining balancing funds for collaborative research projects, such as the DTI’s Partners in Innovation (PiI) scheme and of involving industry in addressing many of the technical barriers to use of recycled and secondary aggregates. With the demise of the scheme, it is already proving harder to get balancing funds from industry for collaborative projects.

It is important that the momentum built up by the Landfill Tax Credit Scheme, in bringing industry, research organisations and government together to address issues of common concern, is not lost. Consideration should be given to a replacement scheme for funding practically based research that would build on the best aspects of the Landfill Tax Credit Scheme, particularly the collaboration between industry and research organisations and the opportunity to attempt innovative work.

3.11 Exemptions from Waste Management Licensing Regulations

The issue of the interpretation of the waste management licensing regulations (1994) in regard to use of CD&EW as recycled aggregates has been discussed in Chapter 3.1. A related issue is the use of paragraph 9 & 19 exempt sites, which cover the spreading of material on land for the purposes of reclamation or improvement. There is a widespread view that many of these sites are no more than surrogate landfills, which are taking material that could be recycled. The figures for the 1999 and 2001 surveys for England and Wales indicate the scale of the exempt sites, with estimates of 20.3 Mta in 1999 and 23.68 Mta in 2001 spread at registered exempt sites out of totals of 72.5 Mta and 93.91 Mta respectively. There is considerable uncertainty about the figures (ODPM, 2002a). Because the sites are exempt from the regulations, they are not subject to inspection by the Environment Agency in the way that landfill sites are.

The government has been working on revisions to the exemptions to take account of these perceived abuses of the system, but there is no indication of when they will be implemented. Given the scale of material going to these sites, confirmed by the 2001 survey, it is important that a better system is put in place as soon as possible to encourage as much of the material as possible to be recycled. This will require stricter regulation. There is a conundrum here, in that the purpose of ‘exempt’ sites was to put them outside the waste management licensing regulations. However, it is essential to learn from experience and adapt the system where necessary to avoid abuse and encourage recycling.
3.12 Conditions of contract

Prior to starting this project, it had been anticipated that the conditions of contract used in the demolition industry would be a barrier to recycling, because of the insistence on site clearance in as short a timescale as possible (Hurley et al., 2001). However, during consultations with demolition contractors it was found that this was not a major issue in most cases. The National Federation of Demolition Contractors (NFDC) has produced a set of "Conditions of Contract" for demolition that encourages recycling. Most demolition contractors go for a 'soft strip' approach that maximises the amount that can be recovered as recycled aggregate - up to 98% in some cases. The material is largely used in road foundations as sub-base and capping in the local area. The main issues appear to be encouraging greater use of the NFDC Conditions of Contract, better training for demolition contractors to bring the rest up to the standard of the best and encouraging the use of pre-demolition audits to maximise opportunities for recycling.
4 Actions

In this chapter, various actions that address the issues identified in Chapter 3 are summarised. The actions are classified into three categories - Level 1, 2 and 3 - depending on their perceived priority. The issues, actions, priority levels and comments are summarised in Table 2. The priority levels are qualitative judgements and are to some extent subjective, but are included to give an indication of the relative importance of each action. Those listed as Level 2 or 3 should not be regarded as unimportant; all the actions are important.

A number of the recommendations relate to actions that are already underway, such as the development of pre-demolition audits and risk assessments for contamination of CD&EW. The main activity required is to promote the use of existing tools or ones that are in the process of development. Other recommendations require research in new areas, a range of dissemination activities or high level discussions between government departments to resolve apparent conflicts in policy.

The earlier studies on CD&EW listed in Chapter 3.1 derived a number of recommendations to increase the amount recycled and the value of the recycled materials. Some of these recommendations have been addressed, such as the development of specifications and the provision of information via the Aggregates Advisory Service, Aggregates Information Service and AggRegain. Many others have not been addressed, however. The recommendations listed below will therefore include a number that have been made in previous reports, particularly the Report to the European Commission by Symonds (1999), but which remain valid. The situation with respect to CD&EW and the use of recycled materials generally, has developed rapidly over the last decade and the recommendations given below are those that are considered relevant to the current situation.

4.1 Waste/product issue

The new interpretation of the regulations, uncertainty over the situation and concerns over possible delays, expense and liabilities are significantly limiting the use of recycled and secondary materials in construction projects in the UK. The problem is compounded by significant variations from region to region in the approach of the regulatory authorities to the use of particular materials. This problem is not restricted to the UK and action is needed at EC level to ensure that opportunities to use recycled and secondary materials are not lost because of waste management regulation. Action is also needed in the UK to clarify and simplify the situation and ensure that a consistent approach is taken that will encourage recycling while protecting the environment.

Opinion is divided on the most appropriate action to take. Options range from taking court action against the Environment Agency to challenge their interpretation of the regulations to accepting that this is the system, it cannot be changed, how can we learn to live with it. Both extremes seem unlikely to yield satisfactory results. The first will only enrich the lawyers and could produce some judgements on 'interesting points of law'; the courts are very unpredictable. The second is a counsel of despair that ignores the problems and burdens that the system imposes on producers and contractors using recycled and secondary aggregates compared to those using primary aggregates.

Our proposed solution avoids these extremes, though it is nearer to the second option. It involves negotiation between the Environment Agency, DTI, WRAP, relevant construction industry stakeholders (such as the Quarry Products Association) and other government departments as necessary to develop a system that will satisfy the need for regulatory control without imposing excessive burdens on producers, suppliers and end-users of recycled and secondary aggregates.

The DoE Circular 11/94, after restating the government's commitment to the waste hierarchy of reduction, reuse, recovery and disposal only as a last resort, it states in Clause 10:

"It is also the Government's more general policy that where regulation is necessary: -
(a) it should be proportionate to the risks involved and the benefits to be obtained;
(b) It should be goal based. That is to say, it should have an objective and a means of ensuring the fulfilment of that objective;
(c) it should not serve as an end in itself;
(d) it should not be over-prescriptive; and
(e) It should not impose an unjustifiable or disproportionate burden on those regulated - especially small businesses."

These principles are appropriate to guide the development of a new system of regulatory control for aggregates. We also recommend supporting research to illustrate the scale of the problem and provide the business case for the development of a more satisfactory system.

A strategy for construction demolition and excavation waste as recycled aggregates

16
Table 2. Summary of issues and actions for CD&EW as recycled aggregates

<table>
<thead>
<tr>
<th>Issue/product issue</th>
<th>Action</th>
<th>Priority Level</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste/product issue</td>
<td>Develop rational approach to waste management regulation that protects the environment without imposing unnecessary burdens on recyclers</td>
<td>1</td>
<td>This issue is urgent and requires high level government input, collaboration with the Environment Agency and industry to develop system acceptable to all parties. Could be based on CE marking for aggregates under European Standards.</td>
</tr>
<tr>
<td></td>
<td>Research into reduction in use of recycled and secondary aggregates under current interpretation of regulations</td>
<td>2</td>
<td>Short term action to provide evidence for the need to reform the system.</td>
</tr>
<tr>
<td></td>
<td>Seek clarification from EC on definition of waste (long term)</td>
<td>3</td>
<td>This is a common problem across Europe and should be addressed at a European level as well as nationally.</td>
</tr>
<tr>
<td>Education</td>
<td>Dissemination to construction professionals</td>
<td>2</td>
<td>Build on success of existing programmes to address lack of awareness.</td>
</tr>
<tr>
<td></td>
<td>Training/dissemintion to small construction sector</td>
<td>1</td>
<td>New strategy required to reach target audience.</td>
</tr>
<tr>
<td></td>
<td>Training for other construction professionals such as planners, building control officers and regulators</td>
<td>3</td>
<td>This audience is not familiar with construction. Training concerning aggregate recycling and quality control.</td>
</tr>
<tr>
<td>Specifications</td>
<td>Ensure existing specifications allowing use of recycled aggregate are used</td>
<td>2</td>
<td>Ongoing action for clients and trade associations.</td>
</tr>
<tr>
<td></td>
<td>Implement transition to harmonised European Standards for aggregates</td>
<td>1</td>
<td>Considered in another DTI/WRAP Aggregates Research Programme project.</td>
</tr>
<tr>
<td></td>
<td>Develop additional specification clauses as necessary</td>
<td>3</td>
<td>Example: standardised crushing method for glass. Ongoing action for clients, consultants and contractors.</td>
</tr>
<tr>
<td>Planning</td>
<td>Improve data collection on recycled/secondary aggregates from RAWPs</td>
<td>2</td>
<td>Action for ODPM. Planning is considered in another DTI/WRAP Aggregates Research Programme project.</td>
</tr>
<tr>
<td></td>
<td>Develop model for planners to predict supply &amp; demand for recycled aggregates at local level</td>
<td>3</td>
<td>Establish what planners would find useful. Planning is considered in another DTI/WRAP Aggregates Research Programme project.</td>
</tr>
<tr>
<td></td>
<td>Ensure adequate recycling centres available to cope with local supply and demand</td>
<td>1</td>
<td>Planning is considered in another DTI/WRAP Aggregates Research Programme project.</td>
</tr>
<tr>
<td>Data Collection: National level</td>
<td>Repeat surveys for recycled &amp; secondary aggregates every 4 years</td>
<td>2</td>
<td>Avoids survey fatigue; action for ODPM.</td>
</tr>
<tr>
<td></td>
<td>Undertake surveys for utility &amp; highway maintenance arisings</td>
<td>1</td>
<td>Information gap identified from study; short term research project.</td>
</tr>
<tr>
<td></td>
<td>Review available data on sources &amp; destinations for England, Wales &amp; Scotland</td>
<td>3</td>
<td>Short term project to get more information from existing data.</td>
</tr>
<tr>
<td>Data Collection: Local level</td>
<td>Carry out urban surveys of CD&amp;EW composition, arisings and utilisation in different areas</td>
<td>1</td>
<td>Build on previous projects. Lack of good data at local level. Medium term project.</td>
</tr>
<tr>
<td></td>
<td>Develop standard methodology for of urban areas</td>
<td>1</td>
<td>Essential to go along with item above, builds on previous studies.</td>
</tr>
<tr>
<td>Data Collection: Site Level</td>
<td>Develop and promote use of pre-demolition audits</td>
<td>1</td>
<td>Build on previous and current work.</td>
</tr>
<tr>
<td></td>
<td>Develop and promote use of waste audit tools on construction sites</td>
<td>1</td>
<td>Build on previous work and existing tools.</td>
</tr>
<tr>
<td>Data Collection: Recycled Aggregates</td>
<td>Carry out survey of utilisation of recycled aggregates in several local areas</td>
<td>1</td>
<td>Lack of data in this area; could be done as short term project or as part of urban scale surveys (see above).</td>
</tr>
<tr>
<td></td>
<td>Analyse data from WRAP capital grant scheme for CD&amp;EW</td>
<td>2</td>
<td>Utilise information as it becomes available to illustrate growth in quantities and quality of recycled aggregates reaching the market.</td>
</tr>
<tr>
<td></td>
<td>Analyse information from suppliers on what products they are offering (see Barritt, 2003)</td>
<td>3</td>
<td>Ongoing action or short term project.</td>
</tr>
<tr>
<td>Segregation of Material</td>
<td>Develop and promote use of pre-demolition audits</td>
<td>1</td>
<td>Removing contaminants before demolition ensures a higher value product. Build on work by EnviroCentre.</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------------------------------------</td>
<td>---</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Develop and promote use of waste audit tools on construction sites</td>
<td>1</td>
<td>Encourage segregation of waste materials on site. Build on work of BRE, CIRIA and others.</td>
</tr>
<tr>
<td></td>
<td>Develop and promote recycling plans for utility excavations</td>
<td>1</td>
<td>New short term project that will require implementation action.</td>
</tr>
<tr>
<td></td>
<td>Develop new equipment to separate mixed material</td>
<td>2</td>
<td>Need for equipment to separate components of waste stream. DTI may support development.</td>
</tr>
<tr>
<td></td>
<td>Develop and promote multi-compartment skips for excavated material, small house builders and so on</td>
<td>2</td>
<td>Need for equipment that can be used easily and will not hold up work on site. DTI may support development.</td>
</tr>
<tr>
<td></td>
<td>Provide capital grant assistance for equipment to process CD&amp;EW</td>
<td>1</td>
<td>Essential to provide capacity for recycling centres to remove contaminants and produce higher value materials. May be within WRAP’s remit.</td>
</tr>
<tr>
<td></td>
<td>Training for site staff on segregation and waste minimisation</td>
<td>1</td>
<td>Segregation at source is best policy; organisations can train workforce with support of BRE, CIRIA and others.</td>
</tr>
<tr>
<td>Contamination</td>
<td>Develop and promote risk assessment methodology for contamination of CD&amp;EW; tie in with CE marking and waste/product issue</td>
<td>1</td>
<td>Work in progress by BRE and others.</td>
</tr>
<tr>
<td></td>
<td>Extend research to greater range of sites and validate risk assessment methodologies</td>
<td>1</td>
<td>Further work is likely to be necessary to back up the current work, especially on use of leaching tests.</td>
</tr>
<tr>
<td></td>
<td>Agree protocols with EA on use of CD&amp;EW and other secondary/recycled aggregates</td>
<td>1</td>
<td>General action that affects use of all recycled and secondary aggregates. Action for industry and EA.</td>
</tr>
<tr>
<td></td>
<td>Develop rapid test for tar in asphalt</td>
<td>2</td>
<td>Important for the reuse of asphalt planings.</td>
</tr>
<tr>
<td>Higher value materials</td>
<td>Demonstration projects on use of RA &amp; RCA in concrete &amp; asphalt and other higher value applications</td>
<td>1</td>
<td>To help industry become confident with use of BS 8500 and other applications. Develop on from previous demonstration projects.</td>
</tr>
<tr>
<td></td>
<td>Develop design methods and specifications for concrete containing higher proportions of RA &amp; RCA</td>
<td>3</td>
<td>Longer term research project. Some work ongoing.</td>
</tr>
<tr>
<td></td>
<td>Research into alkali silica reactivity of RA and RCA containing concrete</td>
<td>2</td>
<td>Longer term project to enable use of RCA in high strength concrete. Some work ongoing.</td>
</tr>
<tr>
<td></td>
<td>Develop products and markets for fines left from production of RA</td>
<td>1</td>
<td>Short and long term projects possible. Essential if want to increase use of coarse recycled aggregate for concrete, asphalt and pipe bedding.</td>
</tr>
<tr>
<td></td>
<td>Develop products and markets for glass, plastic, wood and so on from CD&amp;EW processing</td>
<td>1</td>
<td>Short and long term projects possible. WRAP is working in many of these areas.</td>
</tr>
<tr>
<td></td>
<td>Provide capital grant for RA/RCA production and reclaimed bitumen use</td>
<td>1</td>
<td>May fall under WRAP’s remit.</td>
</tr>
<tr>
<td>Economic Instruments</td>
<td>Research effect of increasing Landfill Tax and/or Aggregates Levy on CD&amp;EW use</td>
<td>1</td>
<td>Short term project to inform policy decisions.</td>
</tr>
<tr>
<td></td>
<td>Develop new source of collaborative funding for research to replace the Landfill Tax Credit Scheme</td>
<td>1</td>
<td>To ensure continuity of funding for research projects funded by LTCS.</td>
</tr>
<tr>
<td>Exemptions</td>
<td>Complete review of Paragraph 9 &amp; 19 exempt sites</td>
<td>1</td>
<td>Work on Para 9 &amp; 19 sites ongoing, needs to be agreed and implemented.</td>
</tr>
<tr>
<td></td>
<td>Revise other exemptions as necessary to encourage recycling</td>
<td>2</td>
<td>May be overtaken by waste/product actions.</td>
</tr>
<tr>
<td>Conditions of Contract</td>
<td>Promote use of conditions of contract that encourage recycling</td>
<td>2</td>
<td>Ongoing work for NFDC and other trade associations and clients.</td>
</tr>
</tbody>
</table>
The nub of the problem is: when does a 'waste' become a 'product'? In engineering terms, this is taken to be when the material complies with a specification for the given application. Thus for CD&EW, when the material complied with the requirements for 'recycled aggregate' in terms of composition and other relevant properties it would be acceptable for use in the same way as primary aggregate. However, current engineering specifications such as the Specification for Highway Works and BS 8500 do not include consideration of the environmental impacts of the materials. The Environment Agency has therefore been reluctant to accept that compliance with the engineering specifications alone will render a material sufficiently harmless to the environment that it can be classed as a product rather than a waste.

The Environment Agency considers that waste becomes product when the process applied to it enables it to be 'fully recovered'. This would require consideration of the environmental as well as engineering properties. However, the new European Standards for aggregates, which will supersede current British Standards on 1 June 2004, include consideration of environmental effects as well as engineering properties. We understand that the environmental requirements are still under discussion within Europe and it is important that the UK is fully involved in these discussions.

The Standards also include requirements for producers to validate that their products are in conformity with the declared properties. This process is known as attestation of conformity and involves initial type testing and routine testing, known as Factory Production Control (FPC). This applies to both engineering and environmental properties and provides a quality system for demonstrating conformity of ongoing production. The requirements apply to all aggregates, whether primary, recycled or secondary. Conformity with these Standards may provide sufficient evidence that the materials have been ‘fully recovered’ and could be classed as products rather than waste.

Following on from Attestation of Conformity the producer has the opportunity to apply for CE marking of products. CE marking is a form of 'product passport' that will allow free movement of products across Europe. It takes the form of a harmonised data sheet with declared values of all relevant properties. Any aggregates, whether primary, recycled or secondary, carrying a CE mark can be marketed across the EU as they comply with the same Standards, supporting the argument that they are products not wastes.

The route of using conformity with European Standards for aggregates to demonstrate that recycled and secondary aggregates are not wastes but fully recovered products seems to offer a sensible way of resolving the waste/product issue while ensuring protection of the environment. We recommend that this be pursued as a matter of urgency. It is very important that the Environment Agency is fully involved in the discussions from the outset. The key factors to agree will be the test methods for contaminants, which are decided at European level and the setting of limiting values for the various contaminants, which are set at national level and will be included in UK guidance documents.

We agree that it is almost certainly futile to attempt to change the definition of waste in the EC Framework Directive in the short term. However, the problems raised by the interpretation by the courts of the definition should be conveyed to the EC at the highest level and attempts made to get clarification on how it should be interpreted. This is a long term project, but ultimately is just as important as the measures described above. This is a Europe-wide problem and there will be support from industry in many other countries to address this issue.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRAP, DTI, DEFRA and EA to work together with industry to develop a rational approach to waste management regulation that protects the environment without imposing unnecessary burdens on recyclers. This could be based on the system of CE marking for all aggregates under the forthcoming European Standards.</td>
<td>1</td>
</tr>
<tr>
<td>WRAP/DTI to commission research to illustrate the reduction in use of recycled and secondary aggregates that will result from the current interpretation of the regulations.</td>
<td>2</td>
</tr>
<tr>
<td>DTI and DEFRA to work with other European countries to clarify the interpretation of the definition of waste to avoid the problems listed above.</td>
<td>3</td>
</tr>
</tbody>
</table>

### 4.2 Education

We have identified education as one of the crucial issues in this programme of research projects. As with waste/product issue, it applies to all recycled and secondary aggregates, not exclusively to CD&EW. However, as the largest single waste stream and the material most likely to be encountered on construction sites, it is particularly important. Education, training and dissemination of information are what turn policy into practice; without it, the best of ideals can fail to translate into reality.

We have identified three main audiences for education and dissemination activities:
- Construction professionals in contractors, clients, designers, Local Authorities, aggregate producers, utilities and research organisations;
- The small house building sector, skip operators, waste transfer centre operators and material suppliers;
• Professionals in ancillary trades such as environmental regulators, planning and building control officers.

The first audience is familiar with engineering concepts and is receptive to messages via established routes such as professional institutions, trade associations and supply chain management. It will be familiar with organisations such as CIRIA, BRE and TRL and the reports they produce. The need here is to deliver effective guidance on how to use recycled and secondary aggregates; the basic concept is established, it is practical information that is needed. The 2002/03 SCiP roadshow has proved very successful in providing practical guidance of this type, by means of a one-day workshop involving presentations and exercises. There is a need to continue this dissemination, targeting some of the construction sectors where the response has been patchy, such as Local Authorities and visiting all parts of the UK to enable as many professionals as possible to attend.

The second audience is entirely different. It is not easily reached by the methods listed above, as shown by the very limited number of SMEs that have attended the SCiP workshops. The basic concepts of sustainable construction may not be understood or accepted and the practical application of them not considered. Training here should start at a very basic level, perhaps best organised by the Construction Industry Training Board or similar organisations that can penetrate the sector. Recycling and waste minimisation could be included in the syllabus of NVQs and similar courses that young people entering the sector might attend. Such training for staff could also be made a condition of approval by Building Control Authorities. There could also be a public information campaign, possibly involving television ads, to get the message about recycling across in a positive way, for example, showing the financial benefits from segregating and recycling material on site instead of throwing everything into the same skip.

The third audience includes professionals who are involved marginally with construction but whose activities can have a major effect on the use of recycled and secondary materials, such as planners, building control officers and environmental regulators. This audience can be reached through established training and dissemination pathways for each profession, as for the first audience. There is a need for education generally about construction as well as specifically on the use of recycled and secondary aggregates. The training would have to be tailored to the audience, to address the particular concerns they may have when faced with a request to use recycled or secondary aggregates.

### 4.3 Specifications

The main issue with specifications concerns the implementation of harmonised European Standards for aggregates over the next two years. This is the subject of a separate project and is also discussed in the context of the waste/product issue in Chapter 4.1.

It is important that the new specifications that have been developed in recent years to enable the use of recycled aggregates are used, along with the requirements for quality control from producers. There is an innate conservatism in the construction industry, particularly among consultants and some clients, to stick with specifications and conditions of contract that are well established. It is important for clients, professional institutions and trade associations to promote the use of the new specifications.

As time goes by, there will be a need to update specifications to cope with new circumstances, for example, to introduce a specification for the crushing of glass to ensure that rounded material rather than sharp material is produced.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continued dissemination to construction professionals via roadshows and similar events.</td>
<td>2</td>
</tr>
<tr>
<td>Concentrated programme of training and awareness raising for the small construction sector.</td>
<td>1</td>
</tr>
<tr>
<td>Targeted training for professionals in related organisations that affect the use of recycled and secondary aggregates.</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement transition to harmonised European Standards for aggregates.</td>
<td>1</td>
</tr>
<tr>
<td>Ensure specifications allowing use of recycled aggregates are used.</td>
<td>2</td>
</tr>
<tr>
<td>Develop additional specification clauses as necessary.</td>
<td>3</td>
</tr>
</tbody>
</table>
4.4 Planning Issues

The main planning concern for any given area is to ensure there are an adequate number of recycling centres to process the material that is available. The consultations indicated that there can still be difficulties getting planning permission for recycling centres in urban areas.

Planners would be aided in making decisions if they had better information on arisings of recycled and secondary aggregates. At present, this data is collected by the Regional Aggregate Working Parties (RAWPs), but it is incomplete and inconsistent. A priority should therefore be to improve the existing data collection methods.

The RAWP data is at a regional level, which is often too general for planners at local level, as the maximum distance that recycled aggregates will be traded is generally in the range 25 to 30 km (Symonds Group, 1999). Planners would be aided if they had models that could predict the likely supply of and demand for recycled aggregates. The model would be based on surveys of arisings and composition of the waste streams for construction, demolition and so on, as shown on Figure 1, related to population and industrial activity for a local area such as a city, small county, borough or unitary authority.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve data collection for recycled and secondary aggregates by RAWPs.</td>
<td>2</td>
</tr>
<tr>
<td>Develop model for planners to predict supply and demand for recycled aggregates at local level.</td>
<td>3</td>
</tr>
<tr>
<td>Ensure adequate recycling capacity is available to cope with local supply and demand.</td>
<td>1</td>
</tr>
</tbody>
</table>

4.5 Data collection

Collection of data is essential to inform policy decisions about where action is required and to monitor the effects once measures have been implemented. The study has shown the need for improvements in data collection at national, local and site level and in the utilisation of CD&EW and other recycled and secondary aggregates.

4.5.1 National level

The surveys for 1999 and 2001 have yielded very valuable data, but there are signs of ‘survey fatigue’ among respondents. The surveys should be carried out at fixed periods (say every 4 years) and should incorporate the amendments suggested in the ODPM (2002a) report.

Examination of the sources and destinations of the various components of CD&EW (Figure 1) indicates a lack of knowledge of the quantities and detailed composition of utility excavation material and highway maintenance arisings. This should be addressed by a short term research project.

A review of existing data on sources and destinations would enable figures to be prepared at regional level throughout the UK (Scotland, Wales, England as a whole and English Regions). This should be addressed by a short term research project.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry out survey of CD&amp;EW similar to the 2001 survey at intervals of 4 years, incorporating amendments noted in the report (ODPM, 2002a).</td>
<td>2</td>
</tr>
<tr>
<td>Implement surveys to establish quantity and composition of utility excavations and highway maintenance arisings for all regions of the UK.</td>
<td>1</td>
</tr>
<tr>
<td>Review available data on sources and destinations (Figure 1) to establish quantities for Scotland, Wales, England and English Regions.</td>
<td>3</td>
</tr>
</tbody>
</table>

4.5.2 Local level

Because CD&EW is traded over short distances, typically 25 to 30 km, local circumstances are critical in terms of availability of recycling facilities compared to distances to landfill and exempt sites. Local studies, on the scale of individual urban areas, are therefore particularly useful to identify the factors that need to change to increase recycling in any given area. The study of Greater Nottingham by APT Environmental (2002) provides an excellent example. Data from studies such as this can be used as the basis for the models for predicting supply and demand discussed in Chapter 4.4. A standard methodology is needed to enable one area to be compared with others.
Uncover further studies of urban areas to gain a broader understanding of the material available for recycling, how it varies seasonally and across the country, where it comes from and how it is utilised (sources & destinations, Figure 1).

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undertake further studies of urban areas to gain a broader understanding of the material available for recycling, how it varies seasonally and across the country, where it comes from and how it is utilised (sources &amp; destinations, Figure 1).</td>
<td>1</td>
</tr>
<tr>
<td>Develop a standard methodology for studies of urban areas.</td>
<td>1</td>
</tr>
</tbody>
</table>

4.5.3 Site level

Measurement is the first step towards waste minimisation and segregation at source. A number of tools are available for use at site level, developed by BRE, CIRIA and others. The use of these tools should be encouraged, even if the data remains within the company concerned for reasons of commercial confidentiality. Where possible, users should be urged to send the data to a central body where it can be added to a database and analysed without the identity of individual sites or companies being revealed. This would give useful information to quantify the reduction in waste and increase in value of recycled materials as a result of using the tools.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and promote use of pre-demolition audits. Tie in with existing documentation such as Health &amp; Safety File.</td>
<td>1</td>
</tr>
<tr>
<td>Promote use of waste audit tools on construction sites to minimise waste and maximise recycling of hard materials.</td>
<td>1</td>
</tr>
</tbody>
</table>

4.5.4 Utilisation of recycled aggregates

Direct data on utilisation of recycled aggregates is not collected centrally and although some companies may possess such data they may regard it as commercially sensitive and be unwilling to place it in the public domain. Data may be obtained by detailed studies of local areas, as outlined in Chapter 4.5.2, or by proxy measures as set out below.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry out survey of utilisation of recycled aggregates in several local areas.</td>
<td>1</td>
</tr>
<tr>
<td>Analyse data from WRAP capital grant scheme.</td>
<td>2</td>
</tr>
<tr>
<td>Analyse information from suppliers on what products they are offering (see Barritt, 2003).</td>
<td>3</td>
</tr>
</tbody>
</table>

4.6 Segregation of material

A lot of the recommendations in this section are not new and many relate to promotion of existing tools and methods rather than to fundamentally new research. Because this has been recognised as a critical aspect of recycling, much work has already been undertaken and hence dissemination and training are particularly high on the agenda. Concepts from demolition and construction could be extended to other areas such as utility excavations to encourage greater recycling in this sector. These are also covered to some extent in Chapters 4.2 and 4.5.3 above. The other main recommendation is for financial assistance with the capital equipment needed to segregate mixed materials. Suggestions are also made for improved equipment to aid segregation at source and of mixed materials of similar density.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and promote use of pre-demolition audits.</td>
<td>1</td>
</tr>
<tr>
<td>Develop and promote use of waste audit tools on construction sites.</td>
<td>1</td>
</tr>
<tr>
<td>Develop and promote recycling plans for utility excavations.</td>
<td>1</td>
</tr>
<tr>
<td>Develop new equipment to separate mixed materials.</td>
<td>2</td>
</tr>
<tr>
<td>Develop and promote multi-compartment skips for excavated material, small house building sites and so on.</td>
<td>2</td>
</tr>
<tr>
<td>Provide capital grant assistance for equipment to process CD&amp;EW to produce recycled aggregate.</td>
<td>1</td>
</tr>
<tr>
<td>Training for staff on construction and demolition sites on minimisation and segregation of waste.</td>
<td>1</td>
</tr>
</tbody>
</table>
4.7 Contamination

This is an area where work is already underway. This needs to be completed and extended, involving discussions with the Environment Agency, to tackle what could become a major limiting factor in the use of CD&EW as recycled aggregate. In this report, ‘contamination’ is used to denote concentrations of compounds such as metals and organics that could potentially cause significant harm to human health and/or the environment. The phrase ‘foreign materials’ is used for components of the waste stream such as paper, wood, metal, glass, plastic and plasterboard. These materials are often referred to as contaminants, but here they are differentiated from contamination as described above.

This work should be co-ordinated with the proposals for using CE marking as a means of establishing that recycled aggregates are fully recovered products (Chapter 4.1).

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and promote current work on risk assessment methodology for contamination of CD&amp;EW, tie in with CE and waste/product issue.</td>
<td>1</td>
</tr>
<tr>
<td>Extend research to greater range of sites and validate risk assessment methodology.</td>
<td>1</td>
</tr>
<tr>
<td>Agree protocols with Environment Agency for use of CD&amp;EW and other recycled and secondary materials.</td>
<td>1</td>
</tr>
<tr>
<td>Develop rapid test for tar in asphalt.</td>
<td>2</td>
</tr>
</tbody>
</table>

4.8 Higher value materials

Recent data (ODPM, 2002a; Barritt, 2003) suggests that the main challenge is making better use of the CD&EW that is already available for recycling. Most of this material is used for relatively low level applications at present, such as general fill. Work is required to ‘open up’ intermediate and high value applications such as unbound sub-base and aggregate in concrete. This is less of a problem for unbound applications such as sub-base, as no new technology or modifications to design or equipment are needed. For Recycled Aggregate (RA) and Recycled Concrete Aggregate (RCA) in concrete, however, these are important considerations.

Although recent specifications allow the use of recycled aggregate for applications such as coarse aggregate in concrete, they have not been taken up in significant amounts to date. Demonstration projects will provide the necessary confidence in potential producers and users and capital grant assistance for the encourage investment in the necessary plant. Related issues such as concerns about the potential alkali silica reactivity of RA and RCA also need to be addressed. It is also important to develop markets for the materials left over from the processing of CD&EW. In the longer term, design issues for use of greater proportions of RA and RCA than currently permitted in BS 8500 have to be addressed.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry out demonstration projects on use of RA and RCA in concrete using BS 8500. Carry out similar demonstration projects for other high value applications (asphalt aggregate, pipe bedding).</td>
<td>1</td>
</tr>
<tr>
<td>Develop design methods and specification for concrete with higher levels of RA and RCA than permitted in BS 8500. Long term project(s).</td>
<td>3</td>
</tr>
<tr>
<td>Research into potential alkali silica reactivity of concrete containing RA and RCA.</td>
<td>2</td>
</tr>
<tr>
<td>Develop products and markets for fines resulting from processing of CD&amp;EW to produce uniformly graded coarse aggregate for concrete and other high value applications.</td>
<td>1</td>
</tr>
<tr>
<td>Develop products and markets for glass, plastic, wood, and so on left over from processing of CD&amp;EW to remove foreign material.</td>
<td>1</td>
</tr>
<tr>
<td>Provide capital grant assistance for equipment to incorporate RA and RCA as coarse aggregate in correct proportions at ready mix concrete plants and to incorporate reclaimed bituminous material in new asphalt.</td>
<td>1</td>
</tr>
</tbody>
</table>

4.9 Economic Aspects

The most direct way government can affect behaviour is by varying the levels of tax to favour one course of action over another. Research should be carried out to consider the effects of varying the Landfill Tax and Aggregates Levy in relation to other factors, such as the problems posed by the waste/product issue, as a means of increasing the amount of CD&EW (and other recycled materials) recycled as aggregate.

The Landfill Tax Credit Scheme has funded a number of very useful projects in the field of recycled and secondary aggregates. However, the scheme is being wound up and it is not clear what, if any, funding will be available for such
projects in future. Research should be carried out as a matter of urgency to develop alternative methods of funding for collaborative industry/research projects on recycled and secondary materials.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research into effect of varying Landfill Tax and Aggregates Levy on use of CD&amp;EW as recycled aggregates.</td>
<td>1</td>
</tr>
<tr>
<td>Develop alternative funding mechanism for collaborative industry/research organisation research projects to replace Landfill Tax Credit Scheme.</td>
<td>1</td>
</tr>
</tbody>
</table>

### 4.10 Exemptions from Waste Management Licensing Regulations

A review of paragraph 9 & 19 exempt sites has been in progress for some time and should be concluded and changes implemented as soon as possible to discourage the use of such sites as surrogate landfills. The other exemptions relating to recycling should be reviewed to see if the wording and limits on time and material stored are still appropriate. New exemptions may be required for some activities, such as processing of used tyres for civil engineering purposes.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete revision of Paragraph 9 &amp; 19 exempt sites and implement changes.</td>
<td>1</td>
</tr>
<tr>
<td>Review other exemptions, adapt as necessary to encourage recycling.</td>
<td>2</td>
</tr>
</tbody>
</table>

### 4.11 Conditions of contract

Conditions of contract that encourage recycling exist and their use should be encouraged. Other conditions should be reviewed to ensure they do not discriminate against recycling, for example, by the imposition of excessive liquidated damages.

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promote use of conditions of contract that encourage recycling.</td>
<td>2</td>
</tr>
</tbody>
</table>
5 Level 1 actions

Waste/product issue:

WRAP, DTI, DEFRA and EA to work together with industry to develop a rational approach to waste management regulation that protects the environment without imposing unnecessary burdens on recyclers.

Comment: This requires urgent action at the level of government departments (DTI and DEFRA) to ensure that the EA and industry come up with a system that is acceptable to all and then to implement it as rapidly as possible. The use of an independent body as secretariat could help the process and this body could draft proposals for both sides to consider. The use of the CE marking system for aggregates under harmonised European Standards offers a way of ensuring that the environmental and engineering properties of materials are considered so that they can be classed as fully recovered products rather than wastes.

Education:

Concentrated programme of training and awareness raising for the small construction sector.

Comment: This requires a completely different approach from current programmes of dissemination to reach the target audience.

Specifications:

Implement transition to harmonised European Standards for aggregates.

Comment: The role of the new European Standards is the subject of another 2002/03 DTI/WRAP Aggregates Research Programme project.

Planning:

Ensure adequate recycling capacity is available to cope with local supply and demand.

Comment: The role of planning in the production and use of recycled and secondary aggregates is the subject of another 2002/03 DTI/WRAP Aggregate Research Programme project.

Data collection: National level

Implement surveys to establish quantity and composition of utility excavations and highway maintenance arisings for all regions of the UK.

Comment: Could be undertaken as a short term research project.

Data collection: Local level

Undertake further studies of urban areas to gain a broader understanding of the material available for recycling, how it varies seasonally and across the country, where it comes from and how it is utilised (sources & destinations, Figure 1).

Comment: Studies of this scale would require a timescale of 2 or 3 years. They provide opportunities for collaboration between various stakeholders. Formerly this type of study would have been partly or wholly funded by the Landfill Tax Credit Scheme; any successor scheme should also be able to contribute to the funding of projects of this type. Other sources of funding include EPSRC (if universities are involved), DTI, WRAP, Regional Development Agencies and Local Authorities.

Develop a standard methodology for studies of urban areas.

Comment: This is an essential first step towards the type of studies listed above. It would build on existing work on standardisation of mass balances and waste audits and could be carried out as a short term research project.
Data collection: Site level

Develop and promote use of pre-demolition audits. Tie in with existing documentation such as Health & Safety File.
Comment: Build on ongoing work by EnviroCentre and others.

Promote use of waste audit tools on construction sites to minimise waste and maximise recycling of hard materials.
Comment: Build on existing work by BRE, CIRIA and others.

Data collection: Recycled aggregates

Carry out survey of utilisation of recycled aggregates in several local areas.
Comment: This could form part of the local level studies described above, or could be carried out as one or more short term projects, which would then supply data to larger scale projects of the overall CD&EW waste stream.

Segregation of material

Develop and promote use of pre-demolition audits.
Comment: Build on existing work by EnviroCentre and others.

Develop and promote use of waste audit tools on construction sites.
Comment: Build on existing work by BRE, CIRIA and others.

Develop and promote recycling plans for utility excavations.
Comment: Could be undertaken as a short term research project, but would need follow-up action to ensure the plans are implemented.

Provide capital grant assistance for equipment to process CD&EW to produce recycled aggregate.
Comment: This may fall under the remit of WRAP.

Training for staff on construction and demolition sites on minimisation and segregation of waste.
Comment: Part of ongoing training and dissemination at all levels. Best carried out by individual firms acting with support from CIRIA, BRE, CITB or others.

Contamination

Develop and promote current work on risk assessment methodology for contamination of CD&EW.
Comment: Build on ongoing work by BRE and Universities of Manchester and Newcastle. Need to link in with work on CE marking and European Standards.

Extend research to greater range of sites and validate risk assessment methodology.
Comment: Further work will almost certainly be required to validate the risk assessment methodology. Dependent on results of previous project and discussions with Environment Agency on implementation.

Agree protocols with Environment Agency for use of CD&EW and other recycled and secondary aggregates.
Comment: Action primarily for material producers, possibly via trade associations (such as the Quarry Products Association) and the Environment Agency.

Higher value materials

Carry out demonstration projects on use of RA and RCA in concrete using BS 8500. Carry out similar demonstration projects for other high value applications (asphalt aggregate, pipe bedding.)
Comment: Build on existing demonstration projects, such as Kingston University, Day Aggregates and London Remade. The projects are likely to require 2 to 3 years to be effective. Formerly this type of study would have been partly or wholly funded by the Landfill Tax Credit Scheme; any successor scheme should also be able to contribute to the funding of projects of this type. Other sources of funding include EPSRC (if universities are involved), DTI, WRAP, Regional Development Agencies and Local Authorities.
Develop products and markets for fines resulting from processing of CD&EW to produce uniformly graded coarse aggregate for concrete and other high value applications.

Comment: This could be carried out in stages, with a short term project to look at possible applications and carry out market research. Later projects could investigate the best options by laboratory tests and field trials. Formerly this type of study would have been partly or wholly funded by the Landfill Tax Credit Scheme; any successor scheme should also be able to contribute to the funding of projects of this type. Other sources of funding include EPSRC (if universities are involved), DTI, WRAP, Regional Development Agencies and Local Authorities.

Develop products and markets for glass, plastic, wood and so on left over from processing of CD&EW to remove foreign material.

Comment: This could be carried out in the same way as the project on CD&EW fines above. WRAP is working to developing sustainable markets for these recyclables.

Provide capital grant assistance for equipment to incorporate RA and RCA as coarse aggregate in correct proportions at ready mix concrete plants and to incorporate reclaimed bituminous material in new asphalt.

Comment: This may fall under the remit of WRAP.

**Economic aspects**

Research into effect of varying Landfill Tax and Aggregates Levy on use of CD&EW as recycled aggregates.

Comment: This could be carried out as a short term project to inform policy decisions.

Develop alternative funding mechanism for collaborative industry/research organisation research projects to replace Landfill Tax Credit Scheme.

Comment: In view of the amount of valuable research in this area funded by the Landfill Tax Credit Scheme, it is important that any successor scheme makes provision for funding these types of projects. If not, some alternative funding mechanism must be put in place.

**Exemptions**

Complete revision of Paragraph 9 & 19 exempt sites and implement changes.

Comment: This has been ongoing for some time and must be concluded soon, or material that could be recycled will continue to be disposed of at these sites.
6 Level 2 actions

Waste/product issue:

WRAP/DTI to commission research to illustrate the reduction in use of recycled and secondary aggregates that will result from the current interpretation of the regulations.

Comment: This could be undertaken as a short term research project to support the business case for reform of the system (see Level 1 Actions), but should not be used as an excuse for delay in tackling the issue.

Education

Continued dissemination to construction professionals via roadshows and similar events.

Comment: This continues to be important to enable the construction industry to use more recycled and secondary aggregates. Existing mechanisms, such as SCiP, using organisations such as Viridis, TRL, CIRIA, BRE, CITB and others should be supported in the short and medium term.

Specifications

Ensure specifications allowing use of recycled aggregates are used.

Comment: Ongoing action for clients, consultants, contractors and material suppliers.

Planning

Improve data collection for recycled and secondary aggregates by RAWPs.

Comment: Primarily an action for ODPM and Local Authorities. The role of planning in the production and use of recycled and secondary aggregates is the subject of another 2002/03 DTI/WRAP Aggregates Research Programme project.

Data collection: National level

Carry out survey of CD&EW similar to the 2001 survey at intervals of 4 years, incorporating amendments noted in the report (ODPM, 2002a).

Comment: Primarily an action for ODPM.

Data collection: Recycled aggregates

Analyze data from WRAP capital grant scheme.

Comment: This should be led by WRAP but will need to wait for a year or more until the full data concerning quantities and quality of recycled aggregates reaching the market is available.

Segregation of material

Develop new equipment to separate mixed materials.

Comment: DTI could provide support to plant manufacturers to develop new equipment.

Develop and promote multi-compartment skips for excavated material, small house building sites and so on.

Comment: DTI could provide support to plant manufacturers to develop new equipment. Funding for promotion of such systems would need to be found.

Contamination

Develop rapid test for tar in asphalt.

Comment: Could be funded by infrastructure owners and operators, such as the Highways Agency, Local Authorities, recycling companies and the Environment Agency.
Higher value materials

Research into potential alkali silica reactivity of concrete containing RA and RCA.

Comment: There is ongoing research in this area, involving TRL, BRE, various universities and work has been done in North America and Europe. Funding from EPSRC (for universities), DTI, WRAP or any successor to the Landfill Tax Credit Scheme.

Exemptions

Review other exemptions, adapt as necessary to encourage recycling.

Comment: This may be overtaken by the actions under waste/product issue, but if not would need to be reviewed by industry, the Environment Agency and central government (DEFRA).

Conditions of contract

Promote use of conditions of contract that encourage recycling.

Comment: Primary action for trade associations and professional institutions, with support from dissemination and training activities supported by DTI and others.
7 Level 3 actions

Waste/product issue:

DTI and DEFRA to work with other European countries to clarify the interpretation of the definition of waste.

Comment: This is a long term action but one which should be undertaken. This is a common problem across Europe and should be addressed at a European level as well as nationally.

Education

Targeted training for professionals in related organisations that affect the use of recycled and secondary aggregates.

Comment: This will involve collaboration with the relevant institutions and trade associations for those professions. Existing training material could be adapted for use in these contexts.

Specifications

Develop additional specification clauses as necessary.

Comment: Ongoing action for clients, consultants and contractors.

Planning

Develop model for planners to predict supply and demand for recycled aggregates at local level.

Comment: Need to establish what kind of model planners would find useful and could then build on results of surveys at local level. Longer term project, could be funded wholly or partly by ODPM. The role of planning in the production and use of recycled and secondary aggregates is the subject of another 2002/03 DTI/WRAP Aggregates Research Programme project.

Data collection: National level

Review available data on sources and destinations (Figure 1) to establish quantities for Scotland, Wales, England and English Regions.

Comment: This could be undertaken as a short term project, with funding from the devolved administrations as well as central government.

Data collection: Recycled aggregates

Analyse information from suppliers on what products they are offering (see Barritt, 2003).

Comment: Ongoing action, could be undertaken as short term project, but level of detail available may be limited.

Higher value materials

Develop design methods and specification for concrete with higher levels of RA and RCA than permitted in BS 8500. Long term project(s).

Comment: There is ongoing research in this area, involving TRL, BRE, various universities and work has been done in North America and Europe. Funding from EPSRC (for universities), DTI, WRAP or any successor to the Landfill Tax Credit Scheme.
8 Summary and conclusions

Construction, demolition and excavation waste (CD&EW) is a broad waste stream with a number of different components, including 'soft' materials such as packaging, plasterboard, paper, wood, cabling and wiring, insulation, plastic and glass as well as 'hard' material such as concrete, brick, stone, asphalt planings, ceramics, tiles and soil. The total amount of CD&EW produced annually in England and Wales, including asphalt planings, is thought to be about 100 million tonnes.

The composition of CD&EW varies widely, depending on the origin of the material. A total of seven main sources of CD&EW were distinguished:
- Utility excavations;
- Asphalt planings;
- Highway maintenance arisings;
- Excavation material;
- Construction waste;
- Demolition material;
- Skip waste from small construction sites.

Approximate figures for the arisings and composition of most of these sources are available at national level, with the exception of utility excavations and highway maintenance arisings. The material may be disposed of in the following ways:
- Disposed of at licensed landfill sites, or used for engineering at landfill sites;
- Spread at registered exempt sites;
- Processed at a high level recycling centre similar to an aggregate plant;
- Processed at a low level recycling centre such as a waste transfer station with limited facilities;
- Recycled on site and used in a new development;
- Sold directly off site for reuse, for example, ornamental stone, slate tiles.

The sources and destinations are illustrated on Figure 1. Approximate data for the arisings and composition of most of these destinations at national level are available as a result of recent surveys and are shown on Figure 1. However, there are only a few studies on the sources and destinations at local level. As most CD&EW is traded within 25 to 30 km of its place of origin, this data is important if the amount of material recycled and the level of application for which the recycled aggregate is used, is to be increased. There is a lack of data on the utilisation of recycled CD&EW, but it appears that most of it is used for low level purposes such as general fill, landscaping or hardstanding, with some being used as capping and unbound sub-base in road foundations. Very little is used as coarse aggregate in concrete, although this is now permitted by recent specifications. Some asphalt planings are recycled into new asphalt as reclaimed bituminous material.

Government policy on sustainable construction supports greater use of recycled and secondary aggregates, such as CD&EW, as a replacement for primary aggregates. Many aggregate companies and demolition contractors have moved into the recycling market. They are particularly interested in CD&EW because it is such a large material stream and because it is available in urban areas where transport distances for primary aggregates and haulage to landfill are greatest. They are interested in increasing not only the total production of recycled CD&EW, but also the level of application for which the recycled material is used. In many cases the most appropriate level may be unbound sub-base (Types 1, 2 & 4) or selected granular fills such as capping or structural backfill. There will also be situations where high value applications such as coarse aggregate for concrete and reclaimed bituminous material for asphalt planings, will be appropriate. Barriers to these intermediate and high value applications should be addressed to ensure that recycled aggregates are used to their optimum economic potential.

There are a number of issues that are currently limiting, or could do in the near future, the utilisation of recycled CD&EW. Several of the issues also affect the utilisation of other recycled and secondary aggregates. The issues are:
- The waste/product issue and the application of the waste management licensing regulations to the recycling of CD&EW and other materials;
- The lack of awareness of recycling and the measures needed to implement it across all sectors of construction;
- Forthcoming implementation of harmonised European Standards for aggregates;
- Need for guidance for planners to ensure adequate recycling facilities are available in a local area to cope with supply and demand;
- Lack of detailed data about arisings, composition and utilisation of CD&EW at local level;
Need to implement measures to segregate materials at source so that 'soft' and 'hard' materials do not become mixed;
Need to assess risk of contamination of CD&EW from old industrial sites;
Need for markets for by-products from processing CD&EW, especially for higher value applications;
Need to encourage industry to use recycled aggregates for high value applications by demonstration projects;
The cost of equipment needed to process CD&EW, especially for high value applications;
The ending of the Landfill Tax Credit Scheme, which has funded much research in this area.

A total of 44 actions were identified to address these issues; of these, 25 were assessed as being of level 1 priority, 12 as level 2 priority and 7 as level 3 priority. The actions are summarised in Table 2 and include:

- Promotion of existing tools, or tools currently under development for activities such as waste audits, pre-demolition surveys and risk assessments for contamination;
- Continuing financial support for infrastructure to process CD&EW;
- Continuing and extending a range of education, training and dissemination activities, including developing strategies for reaching the small construction and skip operator sectors;
- Engaging with the Environment Agency, other government departments and industry to resolve the waste/product issue, possibly using the CE marking system in the new European Standards as a way forward;
- Liasing with ODPM to develop better data collection procedures at all levels;
- Funding research on a range of topics, often in collaboration with other bodies, both as short term and longer term projects, including complete surveys of the CD&EW waste stream for several urban areas, demonstration projects for higher value applications of recycled CD&EW and developing markets for the by-products of processing CD&EW.

Some of the actions should be taken forward by parties other than DTI and WRAP, such as ODPM, others require a collaborative approach to defining the precise actions and providing funding. Some are dependent on the output from other projects in the DTI/WRAP aggregates research programme. All these are indicated where appropriate. The following are considered to be the main areas, within the remit of this project, where DTI and WRAP have the greatest need to initiate action. This will help to achieve the desired increase in the quantity of CD&EW recycled as aggregate and the quality of the end uses to which it is put.

**Issue:** 'Waste/product issue'

**Evidence:** Consultations with industry

**Recommendation:** Set up working group with Environment Agency, DEFRA, DTI, WRAP and relevant construction industry stakeholders (such as the QPA) to agree protocols for use of recycled and secondary aggregates in construction. An independent body with suitable understanding of the issues could undertake secretariat and drafting of protocols. The use of the CE marking system for aggregates under harmonised European Standards may offer a mechanism of ensuring that both the environmental and engineering properties of materials are known so that they can be classed as fully recovered products rather than wastes.

**Aim:** Resolve confusion over waste management regulation issues and provide simple, standardised procedures to be adopted by industry and regulators.

**Links:** This issue applies to all recycled and secondary aggregates and is of the highest priority.

**Issue:** Environmental impacts from use of CD&EW

**Evidence:** Research by Manchester & Newcastle Universities, experience from ALT-MAT and other projects, consultations with industry

**Recommendation:** Commission research to assess the potential impacts on human health (dust) and the environment (leaching) from use of recycled aggregates in construction. Use actual case studies as well as laboratory tests and modelling. Adapt existing risk assessment protocol (in production by BRE) or develop new ones as necessary. Involve EA in research and development of protocols. Need to co-ordinate with work on CE marking under European Standards for aggregates.

**Aim:** Provide simple system, backed by evidence from case studies, to assess whether a proposed use of recycled aggregates is acceptable environmentally.

**Links:** This work could usefully be extended to other recycled and secondary aggregates. A standard procedure is needed.
Issue: Education
Evidence: Feedback from SCiP seminars, professional institutions and industry
Recommendation: Fund programmes of targeted dissemination on practical aspects of how to use recycled CD&EW to key sectors in the construction industry, including Local Authorities, consultants, clients, buyers and specifiers and small construction companies. May need several programmes to cover all the target audiences and information needs. Use range of methods as appropriate, but one-day workshops with interactive exercises very useful in getting key points across.
Links: This work should also cover other recycled and secondary aggregates.

Issue: Data on CD&EW at local level
Evidence: Study of Greater Nottingham by APT Environmental/Nottingham Trent University, lack of reliable data at local level on sources, destinations and utilisation of CD&EW.
Recommendation: Carry out surveys in several urban areas with different characteristics to identify the arisings and composition of CD&EW, how it is processed and what it is used for. Use to inform decisions on local measures to improve quantity and quality of recycling such as provision of facilities and targeted education and training of key personnel.
Links: Could be carried out in collaboration with Regional Development Agencies, Local Authorities, EPSRC and ODPM.

Issue: Segregation at source
Evidence: Consultations with industry, surveys showing recycled aggregates used dominantly for low value applications
Recommendation: Major campaign to promote use of demolition protocols being developed by EnviroCentre, waste auditing tools for construction sites developed by BRE, waste minimisation tools by CIRIA and other methods to improve segregation of materials in construction and demolition operations. Emphasis on achieving changes at site level, need senior management buy-in.

Issue: Increasing amounts of RA & RCA in concrete
Evidence: Consultations with industry and academics
Recommendation: Fund programme of demonstration projects on design and use of recycled aggregates in concrete to give confidence in use of BS 8500. Build on existing projects, for example, Kingston University.
Links: Collaborate with Regional Development Agencies, Local Authorities, EPSRC and industry.

Issue: Markets for fines and associated materials from CD&EW processing
Evidence: Consultations with industry
Recommendation: Research to develop applications and markets for materials produced as by-product of processing CD&EW to produce recycled aggregates, for example, fines left after production of coarse RA & RCA, glass, plastic, timber, soil, and so on. Essential to economics of producing high-value recycled aggregates from CD&EW.
Links: Build on work completed within WRAP materials programmes.

Issue: Funding mechanism to replace Landfill Tax Credit Scheme
Evidence: Record of research carried out under the scheme, difficulty in obtaining funding for research from industry without the scheme.
Recommendation: Develop alternative method for funding collaborative projects between industry and research organisations that address the use of recycled and secondary aggregates.
Links: Industry, other government departments.

The study has shown that there are a number of issues that could limit the use of CD&EW as recycled aggregates and a large number of actions, spread over a number of different areas, are required to address them. Previous studies (for example, Symonds Group, 1999; Reid and Chandler, 2001) have come to similar conclusions. One reason for the apparent lack of progress on many issues is that no one body has taken responsibility for producing a co-ordinated programme. To achieve real progress, the results of this and the other projects in the current programme need to be brought together into a coherent strategy with one body, possibly WRAP, responsible for implementing it and with a remit to co-ordinate action across the various government departments involved.

It is important that the strategy does not place a disproportionate burden on any one sector but brings all stakeholders together to work collaboratively to solve the problems. In the absence of a co-ordinated initiative it is unlikely that significant progress can be made by a series of small, unconnected measures, however worthwhile they may be individually. The only other measures that will make a significant difference are regulation - for example, a ban on landfill or a requirement to segregate material at source - or fiscal measures (increased taxation). This report prefers a more positive, proactive approach to achieving more sustainable construction.
Annex 1: Consultations

The following individuals were consulted during the research for this report. We would like to express our thanks to them for their generosity with time and expertise, without which this report would have been much poorer and less well informed.

Dr Rod Collins, Building Research Establishment
Mr Malcolm Anderson, Building Research Establishment
Mr Chris Worthy, Tarmac Recycling Ltd.
Mr Chris Curtis, Hanson plc
Mr Adam Day, Day Group
Mr David Coleman, Coleman & Co.
Ms Christine MacFarlane, National Federation of Demolition Contractors
Dr Nigel Lawson, University of Manchester
Professor David Manning, University of Newcastle
Mr Brian Menzies, EnviroCentre
Mr Andrew Herbert, Symonds Group
Dr Mukesh Limbachiya, University of Kingston
Mr Tony Trevorrow, Nottingham Trent University/APT Environmental
Annex 2: Bibliography


Big Issue. Where there's muck there's brass, October 30-November 5 2000, pp22-23.


A strategy for construction demolition and excavation waste as recycled aggregates


Annex 3: Summary figures

### Utility Arisings

**Materials**
- Asphalt, concrete, granular fill, soil, clay, ceramic, plastic

**Issues**
- Material may be wet
- Different materials are mixed in the excavation process
- May contain impurities and/or contamination
- Difficult to process - may include clay

**Existing Uses**
- General Granular Fill
- Selected Granular Fill
- Type 1 sub-base
- Stabilisation/Solidification for utility trench backfill

**Potential Uses**
- Recycled concrete aggregate
- Reclaimed bituminous material
- Pipe bedding

**Barriers**
- Difficulty of sorting material to meet spec. requirements, e.g. asphalt content
- Limited amount of single-size material and large amount of unusable fines
- Cost of equipment to process material to required standard

**References**

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### Asphalt planings

**Materials**
- Bituminous materials from renewal of existing roads by Local Authorities and Maintaining Agents

**Issues**
- Possible presence of tar in older roads
- Storage and handling problems when large amounts arise from major roadworks: capacity of recycling centres

**Existing Uses**
- Hardstanding and general fill
- Capping (Class 6F3)
- Unbound sub-base (Type 4)
- Reclaimed bituminous material in new asphalt

**Potential Uses**
- Reclaimed bituminous material in new asphalt
- Aggregate in hydraulically bound base and sub-base
- Unbound sub-base

**Barriers**
- Cost of equipment to utilise reclaimed bituminous material
- Variable composition of some material, especially small roads and old roads
- Asphalt composition has changed over the years: currently mostly hot rolled asphalt, good source of bitumen. Some modern pavements use modified emulsion binders, which cannot be handled by current processes
- Requirement to monitor and control emissions to meet PPC conditions

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A strategy for construction demolition and excavation waste as recycled aggregates
### Highway Maintenance Arisings

#### Materials
Mixture of concrete (e.g. kerbs), granular sub-base, asphalt, soil from reconstruction and repair of existing roads by Local Authorities

#### Issues
Materials may be mixed with soil, e.g. clay lumps

#### Existing Uses
Dominantly recycled into road foundations:
- Capping, 6F1 & 6F2
- Sub-base Type 1

### Excavation Material

#### Materials
Soil, made ground, old foundations, may include clay, organics and contamination

Arises from redevelopment of old sites and development of new sites

#### Issues
Materials may be mixed: need to separate clean from contaminated, soil from organics, etc.
- Material may be wet or become wet on exposure to the atmosphere
- Material traditionally disposed of to landfill or exempt sites, particularly from small sites

#### Existing Uses
- Mostly sorted on site into contaminated and clean fractions
- Clean material used for landscaping and general fill
- May be used for road foundations and structural backfill if quality good enough

### Potential Uses
- Pipe bedding
- Aggregate for cement bound and hydraulically bound base and sub-base
- Aggregate for concrete and asphalt

### Barriers
- Cost of equipment to process material to required single-size grading & purity
- Processing would leave large amount of fines for which there is no market: existing uses ensure that all material is reused

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**Figure A3.3** Highway maintenance arisings

**Figure A3.4** Excavation material
<table>
<thead>
<tr>
<th><strong>Construction Material</strong></th>
<th><strong>Potential Uses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
<td>Ideally should be used on site and not become waste</td>
</tr>
<tr>
<td>Surplus bricks, tiles, concrete, timber, etc.</td>
<td></td>
</tr>
<tr>
<td>Packaging and breakages: pipes, glass, etc.</td>
<td></td>
</tr>
<tr>
<td>Offcuts of timber, plasterboard, etc.</td>
<td></td>
</tr>
<tr>
<td><strong>Issues</strong></td>
<td>If goes to recycling centre, hard C&amp;DW can be recycled as general fill and capping 6F2, possibly as recycled aggregate for low strength concrete</td>
</tr>
<tr>
<td>Material often mixed in skips on site</td>
<td></td>
</tr>
<tr>
<td>Limited amount of hard C&amp;DW</td>
<td></td>
</tr>
<tr>
<td>No systems for dealing with waste on many sites, so goes to landfill by default</td>
<td></td>
</tr>
<tr>
<td><strong>Existing Uses</strong></td>
<td>Barriers</td>
</tr>
<tr>
<td>Limited: some surplus materials may be used later on the same site, transferred to other sites or returned to the supplier</td>
<td>Waste hierarchy should apply and efforts should be focussed on minimising this waste stream rather than utilising it</td>
</tr>
<tr>
<td>Most probably goes to landfill or low-level recyclers</td>
<td>High brick content limits applications as sub-base because likely to fail frost heave test, and for fill below floor slabs because of concerns over possible expansion. Also limits concrete strength if used as recycled aggregate</td>
</tr>
</tbody>
</table>

**References**
- Bovis Lend Lease: Construction - The Price of Waste
- CIRIA: Publications on waste minimisation
- APT Environmental: Reports on Nottingham case study

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<table>
<thead>
<tr>
<th><strong>Figure A3.5</strong> Construction material</th>
<th><strong>Figure A3.6</strong> Skip waste</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skip Waste</strong></td>
<td>Potential Uses</td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td>Concrete as recycled aggregate and recycled concrete aggregate</td>
</tr>
<tr>
<td>Concrete, bricks, masonry, asphalt, soil, stone, topsoil, vegetation, glass, plasterboard, timber, plastic, metal (ferrous and non-ferrous), packaging, paper and card, cables, asbestos, textiles, tarmac, fibreglass.</td>
<td>Temporary roads</td>
</tr>
<tr>
<td>Issues</td>
<td>Pipe bedding</td>
</tr>
<tr>
<td>Need equipment to remove wood, paper, plastic, soil and other lightweight material to make best use of incoming material.</td>
<td>Aggregate for cement bound and hydraulically bound material</td>
</tr>
<tr>
<td>Need markets for non-inert materials separated, etc. and fines from processing of material.</td>
<td>Barriers</td>
</tr>
<tr>
<td>Construction site staff need to be educated in waste awareness and minimisation.</td>
<td>Cost of plant to produce single-size material and production of large amount of unusable fines</td>
</tr>
<tr>
<td>Potential safety risks from asbestos, drums, unknown fluids and materials</td>
<td>Current apathy of contractors and industry as a whole to on site segregation of materials.</td>
</tr>
<tr>
<td><strong>Existing Uses</strong></td>
<td>Wastage generally accepted as 8-10% of the contract price.</td>
</tr>
<tr>
<td>Crushed aggregate for low grade applications</td>
<td>Time constraints/liquidated damages necessitate speed rather than segregation.</td>
</tr>
<tr>
<td>Type 1 sub-base</td>
<td>Cost and technology for cleaning of hard C&amp;DW to remove contaminants</td>
</tr>
<tr>
<td>Capping 6F1</td>
<td>References</td>
</tr>
<tr>
<td>Capping 6F2</td>
<td>APT Environmental (Various 2000 to 2002)</td>
</tr>
</tbody>
</table>

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Demolition material

**Materials**
Concrete, bricks, masonry, stone, glass, plasterboard, timber, plastic, metal, asbestos

**Issues**
Have to remove soft material on site during demolition to obtain maximum amount of aggregate
Important not to mix with lower quality material at recycling centres or waste transfer stations
Check for asbestos or contaminated material
Need protocol for pre-demolition audits

**Existing Uses**
Dominantly used for road foundations:
- General Fill
- Selected Fill (capping, etc.)
- Type 1 sub-base
- Ornamental/architectural reclaimed materials

**Potential Uses**
Concrete: Recycled aggregate and Recycled concrete aggregate
Pipe bedding
Asphalt aggregate
Aggregate for cement bound and hydraulically bound material

**Barriers**
High proportion of brick limits use as sub-base - fails frost heave test - fill below floor slabs and usefulness as aggregate for concrete
Cost of equipment to produce single-size material and production of unusable fines
Risk assessment procedure needed to assess risks from contamination of materials

**References**
BR418: Deconstruction and reuse of construction materials

Licensed landfills

**Materials**
All C&DW materials including concrete, bricks, masonry, asphalt, soil, stone, topsoil, vegetation, glass, plasterboard, timber, plastic, metal (ferrous and non-ferrous), packaging, paper and card, cables, asbestos, textiles, tarmac, fibreglass.

**Issues**
Acceptance of material on site is guided by EA acceptance criteria and the Landfill Directive.
Low cost of inert landfill provides an effective route for C&DW in comparison with alternatives.
Landfill is often the simplest place to send unsegregated materials from site.
Potential for hazardous materials to enter the site.
Material acceptable in inert landfill sites could go to recycling.

**Existing Uses**
General fill in landfill engineering and cell construction.
Construction of on-site haulage roads.
Daily cover material for landfill operations.

**Potential Uses**
Construction of site roads.
Hardstanding and plant areas.
Gas venting/surround to vent pipes.
Permeable cell base below water.
Capping (soils).

**Barriers**
Landfill Tax still too low to divert C&DW from landfill to recycling.
Lack of segregation on site makes separation difficult, thereby increasing the disposal fraction.
Such materials are required for use in the engineering and operation of landfill sites.
Material acceptable for use as daily cover in landfill operations may attract the lower rate of landfill tax, even if disposal costs for the same material would incur the higher rate.

**References**
Guidance On The Disposal Of “Contaminated Soils”, EA 2001
The Landfill (England and Wales) Regulations, 2002
### Exempt Sites

**Materials**
All inert C&DW materials including concrete, bricks, masonry, asphalt, soil, stone, topsoil, glass, plasterboard, tarmac, fibreglass, timber.

**Issues**
- Exemptions only conferred on limited basis, as set out in Schedule 3 of the regulations and likely to become more highly regulated.
- Widespread perception that system is being abused as cheap alternative to landfill or recycling
- Material accepted on exempt sites should be inert, with insignificant contamination from other materials.
- No requirement for landfill tax, and hence provides even cheaper option than inert landfilling.
- Material acceptable on exempt sites could go to recycling.
- There are storage limitations for materials on exempt sites prior to their use.

**Existing Uses**
General fill.

**Potential Uses**
- Selected fill (capping, sub-base)
- Drainage material
- Pipe bedding

**Barriers**
- No requirement to pay landfill tax provides even less incentive to divert inert C&DW to recycling.
- Lack of definitive regulation of exempt sites does not provide for diversion of materials.
- There is a demand for inert C&DW as general fill material for land reclamation and redevelopment.
- Reduction in the volume of C&DW going to exempt sites could increase demand for low grade primary aggregates for reclamation purposes.

**References**
- Waste Management Licensing Regulations 1994

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### High-Level Recycling Centres

**Materials**
Concrete, bricks, masonry, asphalt, soil, stone: may include some topsoil, vegetation, glass, plasterboard, timber, plastic, metal, packaging.

High-level recycling centres are generally operated by aggregate producers who understand the engineering issues with use of recycled aggregates

**Issues**
- Material must be assigned to the correct stockpile: keep clean material away from contamination
- Need equipment to remove wood, paper, plastic and other lightweight material to make best use of incoming material
- Need markets for wood, etc. and fines from processing of material
- Recycling covered by exemption but require licence for crusher

**Existing Uses**
- Dominantly used as unbound granular material, mostly as General Fill (75mm down) and hardstanding.
- Limited amount used as capping and Type 1 sub-base

**Potential Uses**
- Concrete as recycled aggregate and recycled concrete aggregate
- Pipe bedding
- Asphalt aggregate
- Aggregate for cement bound and hydraulically bound material

**Barriers**
- Mixture of material and high brick content limits the amount suitable for higher value applications
- Cost of plant to produce single-size material and production of large amount of unusable fines
- Regulatory issues over definition of waste and licence requirements for screeners, etc.
- Can be difficulties getting planning permission for recycling centres in some areas

**References**
- BR418: Deconstruction and reuse of construction materials
### Low-Level Recycling Centres

**Materials**
Concrete, bricks, masonry, asphalt, soil, stone: may include some topsoil, vegetation, glass, plasterboard, timber, plastic, metal, packaging.

Low-level recycling centres are generally operated by small to medium sized operators, as a small business unit of a larger organisation, or on-site during C&D operations.

**Issues**
- Material must be assigned to the correct stockpile: keep clean material away from contamination
- Primarily act as pre-treatment before use in low level applications, or landfill disposal.
- Quality of incoming material of less concern than for high level recycling.
- Recycling covered by exemption but require licence for crusher.

**Existing Uses**
- General Fill for onsite use
- Landfill engineering

**Potential Uses**
- Concrete as recycled aggregate and recycled concrete aggregate
- Pipe bedding and asphalt aggregate
- Selected fill (capping and sub-base)
- Aggregate for cement bound and hydraulically bound material

**Barriers**
- Higher levels of contamination than for high level recycling centres limits proportion that can be recycled to high value applications
- Cost of plant to produce single-size material and production of large amount of unusable fines
- Regulatory issues over definition of waste and licence requirements for screeners, etc.
- Can be difficulties getting planning permission for recycling centres in some areas

**References**
- Howard Humphreys, 1994
- APT Environmental, 2002

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### Recycled on Site

**Materials**
Primarily excavated materials but may include concrete, bricks, masonry, soil, stone, glass: may include very limited volumes of topsoil, vegetation, plasterboard, timber, plastic, metal, packaging.

On-site recycling is generally operated by small to medium sized operators during C&D operations. Some contractors also hire or own equipment for these purposes.

**Issues**
- Primarily act as pre-treatment before use in low level applications.
- Use on site must be for uses agreed within the existing planning permission.
- Good quality material is required, although processing will be limited.
- Recycling covered by exemption but require licence for mobile plant.
- Some chemical testing may be required to prove acceptability of material for on-site use.

**Existing Uses**
- General Fill for onsite use including bunds, over-site fill, site roads, landscaping.

**Potential Uses**
- Concrete as recycled aggregate and recycled concrete aggregate
- Pipe bedding and asphalt aggregate
- Selected fill (capping, backfill to foundations, sub-base)
- Aggregate for cement bound and hydraulically bound material

**Barriers**
- Use on site under existing planning permission provides cheap alternative to removal off site, and reduces import of suitable material.
- There is a demand for inert C&DW as general fill material for land reclamtion and redevelopment.
- Cost of equipment and H&S requirements for high level recycling may be excessive for current operators
- Lack of space for equipment to produce material for higher value applications

**References**
- Howard Humphreys, 1994
Sold Directly off Site

Materials
Primarily materials reclaimed from demolition including concrete, bricks, masonry, soil, stone, glass. Some salvage of timber, ferrous metal. Specific architectural components may also be removed and sold on.

Selling materials off site requires careful separation during site activities.

Issues
Materials removed off site for direct re-use and therefore do not enter the waste stream. Primarily a salvage operation, with good on site practices increasing yield. Materials unlikely to require major pre-treatment prior to reuse. Good quality material is required. Provides a more efficient means of management than C&DW recycling.

Existing Uses
Reclamation and reuse of materials for a variety of uses.

Potential Uses
Reclamation of materials allows for their use in high level applications without significant processing or treatment. Existing uses for most materials will be high level.

Barriers
Reclamation of materials can be hampered by a reliance upon old style demolition techniques. The costs of separation may hamper the recovery of materials from a site. Contractual issues, including liquidated damages for late completion will hamper reclamation.

References
Howard Humphreys, 1994
Hurley, J. W. et al, 2001; Deconstruction and Reuse of Construction Materials, BRE.

Figure A3.13  Sold directly off site