SUMMARY

BRE are in the process of determining the methodologies, tools and products that need to be put in place to optimise materials recovery from existing buildings and product recovery from future construction.

This report will give an overview of the waste arisings in the construction and demolition (C&D) industries, the legislative, strategic, fiscal and policy issues relating to deconstruction.

It will also investigate how the deconstruction process can work effectively within the C&D and recycling industries.

KEYWORDS: Deconstruction, demolition, construction, design, recycling, reclamation.

CONTEXT

At last year’s deconstruction closing the loop conference held at the Building Research Establishment (BRE), the definitions of deconstruction, disassembly, demolition, refurbishment, retrofit and adaptable were discussed. A consensus was reached and these are the definitions that will be used throughout the text.

- **Disassembly** - taking apart components without damaging, but not necessarily to reuse them.
- **Demolition** - a term for both the name of the industry and a process of intentional destruction.
- **Deconstruction** - Similar to disassembly but with thought towards reusing the components.
- **Refurbishment** - Improving building performance through partial or complete replacement and/or upgrade of components and services.
- **Retrofit** - Change of use or purpose after construction from which a building was designed (term retrofit rarely used in UK, predominantly a US term).
- **Adaptable Building** - A multi-use building which allows for an easy change in its use.

1. INTRODUCTION

The construction industry is the largest consumer of resources of all UK industries both directly and from its supply chain of material producers, fabricators and stockists. Approximately 6 tonnes of materials are consumed per person per year. At the same time the construction and demolition industry produces large quantities of waste components and
materials. This resource inefficiency is coupled with environmental, economical and social impacts that are rapidly becoming unacceptable.

The source, type, quantity and true cost of demolished components and material are mostly unknown. Despite this, every year in UK approximately 3.3 million tonnes of architectural and ornamental components, 24 million tonnes of recycled aggregates and an unknown quantity of steel and timber is recycled back into production. However, large volumes of potentially reusable components are landfilled and lost to the system only to be replaced with similar components.

With this lack of national and site data, academics and researchers need to be conscious that they don’t try to reinvent the wheel or propose impractical solutions. The demolition industry has known for decades about the key factors that affect the choice of the demolition method and particular barriers to reuse and recycling of components and materials of the structures. The demolition industry itself is best placed to guide current deconstruction and contribute to future technologies.

In recent years there have been an array of current and proposed legislative, fiscal and policy framework affecting the demolition industry, and this will become ever more stringent in the future. To respond in the short term requires integrated waste management systems that are supported by the inherent skills and technologies of the construction, demolition and waste management industries. Longer term solutions need to be incorporated into today’s construction. This is where designing for deconstruction and innovative solutions is a vital key to unlock the potential of mass reuse of components that are shown to be fit for use or purpose.

The BRE Deconstruction group believes that digests, information papers, protocols, quality control schemes, tests for strength, quality and durability, and demonstration projects can help provide the necessary confidence and opportunity in reusing components or recycling materials. The two key areas requiring further investigation and demonstration in order to overcome barriers and factors will be performance-based specifications and the design of deconstructable joints and fasteners.

The future development of a sustainable, efficient and prosperous demolition industry that sees material and component reuse as a key facet, will require considerable investment in terms of time, money, skills, tools, technologies, standards and risk. There are far reaching benefits to more sustainable construction, demolition and waste management industries, not least in terms of employment, market networks and regional/national storage and distribution centres.
2. COMPOSITION OF CONSTRUCTION AND DEMOLITION WASTE.

2.1 Overview

From the numerous attempts to identify UK and European waste arisings in terms of construction and demolition, it is difficult to propose any figures with much confidence.

What is apparent is the complex nature of the wastestream in terms of amounts, composition and waste management routes. In general terms, construction and demolition wastestreams are distinctly different with refurbishment waste forming a grey area in between.

Construction waste: small quantities generated over a long period of time as a by-product of the main process. Opportunity to avoid waste. Some opportunities to reclaim and recycle materials and products.

Demolition waste: large quantities generated over of short period of time as a main part of the process. Little opportunity to avoid waste. More opportunities to reclaim and recycle materials and products.

The area of deconstruction becomes interesting when these two processes are linked into an integral system. When this occurs it is possible to consider the fate of the building at the end of its useful life, i.e. design for deconstruction and adaptable buildings, and consider the reuse of demolition products in new construction and refurbishment, i.e. reuse and recycling within the same site.

A recent survey sponsored by DETR (Department of the Environment, Transport and Regions) and the EA (Environment Agency) will be published in Spring 2001\[1\]. This survey consisted of a postal questionnaire sent out to all known crusher operators, licensed landfills, holders of relevant exemptions. The response rate varied between 20 to 30%. Once these results were extrapolated the following conclusions were made:

- Total production of C&D waste (including excavated soils) in England and Wales estimated to be 72.5 million tonnes (69.2 Mt in England). This figure excludes road planings and materials re-used without processing i.e. crushing and/or screening. The overall waste arisings including all these materials is likely to be between 90 to 100 million tonnes per year.
- 33.8 Mt of C&D waste (mainly hard demolition waste such as concrete and bricks).
- 23.7 Mt of soil (including stones and rock, and coming mainly from excavation).
- 15Mt of mixed C&D waste and soil, plus minor amounts of other inert materials.
- Recovery rate including recycling (35%), landfill engineering (13%), spreading on exempt sites (28%) was estimated to be 76%.

It has to be said that the emphasis of the survey was to determine the inert materials available for recycling and the current methods of waste management. The information on other components of the wastestreams such as timber, plastic, glass and packaging is limited; and information on products and materials suitable for reuse was not collected.
2.2 Construction waste

Obtaining reasonably accurate figures for the composition of construction waste has so far been elusive. 10 million tonnes of UK construction waste per annum is often quoted from various sources, themselves estimated and extrapolated from disparate investigations. More recently, the BRE Centre for Waste and Recycling has been gathering detailed benchmarks of waste arisings from different types and sizes of construction sites. Six of these sites are detailed in Table 1 according to project type. Graph 1 shows the varying composition of construction waste material group based on data collected on the composition of construction waste to date. Incidentally, core inert waste only accounts for 20% of this waste, much less than packaging at around 25%. Further implementation of SMARTWaste™ on various sites is expected to provide a more accurate picture.

Table 1 – Construction Waste by Material Group and Project Type

<table>
<thead>
<tr>
<th>Waste Group</th>
<th>Office A</th>
<th>Housing (1) B</th>
<th>Housing (2) C</th>
<th>Leisure D</th>
<th>Housing E</th>
<th>Restaurant F</th>
<th>Avg</th>
</tr>
</thead>
</table>
| Timber      | 8%      | 33%           | 25%           | 3%        | 15%       | 20%          | 17.3%
| Concrete    | 2%      | 18%           | 0.5%          | 3%        | 10%       | 5.6%         | 5.6%
| Inert       | 1%      | 0.5%          | 11%           | 27%       | 27%       | 11.1%        | 11.1%
| Ceramic     | 2%      |               |               |           | 11%       | 4%           | 2.8%
| Insulation  | 9%      | 2%            | 1%            | 9%        | 1%        | 3.7%         | 3.7%
| Plastic     | 4%      | 17%           | 37%           | 4%        | 5%        | 10%          | 12.8%
| Packaging   | 47%     | 8%            | 22%           | 49%       | 9%        | 32%          | 27.8%
| Metal       | 6%      | 3%            | 0.5%          | 3%        | 1%        | 2.3%         | 2.3%
| Plaster & Cement | 10%   | 1%            | 0.5%          | 3%        | 2%        | 2.8%         | 2.8%
| Miscellaneous| 11%    | 18%           | 13%           | 15%       | 19%       | 7%           | 13.8%
| Total       | 100%    | 100%          | 100%          | 100%      | 100%      | 100%         | 100% |

Graph 1 – Average Composition of Construction Waste by Group
2.3 Excavation waste

30 million tonnes per year of excavated soil/clay waste are estimated to arise from construction site preparation. This could be minimised by appropriate architectural, structural and landscape design. At present, this is not a serious consideration even for environmentally sensitive design teams. Landscaping often provides important opportunities to utilise this type of waste on site, with the added benefit of reduced transport, environmental and social costs including noise, dust and vibration nuisance.

2.4 Demolition waste

Crushing and separation of demolition waste

Demolition waste is taken to include waste from the demolition of structures and parts of structures and include recycled/reclaimed materials where appropriate. The breakdown of the estimated 30m tonnes of demolition waste arising each year is shown in Table 2, itself from a range of sources.

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>concrete</td>
<td>12 million tonnes</td>
</tr>
<tr>
<td>masonry</td>
<td>7.2 million tonnes</td>
</tr>
<tr>
<td>paper, cardboard, plastic and other</td>
<td>5.1 million tonnes</td>
</tr>
<tr>
<td>asphalt</td>
<td>4.5 million tonnes</td>
</tr>
<tr>
<td>wood based</td>
<td>1.0 million tonnes</td>
</tr>
<tr>
<td>other</td>
<td>0.2 million tonnes</td>
</tr>
</tbody>
</table>
2.5 The recycling industry

Approximately 24 million tonnes of inert C&D waste is recycled per annum. This figure is substantiated by three separate investigations by the Quarry Products Association (QPA), BRE\textsuperscript{2} and more recently the EA & DETR\textsuperscript{3} survey. The survey by BRE suggests that the average transport distance to the recycling site and back to customer is 50km.

Crushing and grading of concrete components into recycled aggregates

Timber recycling is now a common route for large amounts of untreated timber waste generated in built up areas. The main market is wood panel product manufacture with virgin feedstock being replaced with up to 30% recycled wood fibre in chipboard. Constraints to this market are the location and quality of the material arising.

Construction timber waste is in the form of timber pallets, crates, cable drums and formwork. Most of this can be reused or recycled, formwork presents problems in the concrete and oil contamination.

Typically materials such as plastics, cardboard and paper are not reaching the recycling sector from C&D. This would require greater segregation and the creation of collection systems that are currently not available. Table 1 and Graph 1 identify that as much as 40% of construction waste is from plastics and packaging alone.

Metals recycling involves traditional recycling routes such as scrap yards. Metal from construction and refurbishment is far less likely to be recycled than that arising from demolition. However, offcuts of copper and aluminium components and pipes may provide a source of revenue under the right market and recycling conditions.
2.6 The reclamation industry

Buildings currently undergoing deconstruction are typically supplying the reclamation market. The main end users of these products are householders and small builders carrying our renovations and extensions to older properties. This is reflected in the disparate nature of the reclamation industry, with around 1500 organisations involved.

Approximately 3.3 million tonnes of C&D waste is reclaimed as per Table 3. This excludes concrete that is accounted for elsewhere. 30% of these components are reclaimed within 30km of its source, 60% within 150km and 10% beyond 150km distance (including import and export). Greater reuse of components in mainstream construction would further increase the amount being reclaimed.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Sales £ million</th>
<th>Employment</th>
<th>Tonnes 000’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural antiques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone</td>
<td>17</td>
<td>2100</td>
<td>69</td>
</tr>
<tr>
<td>Timber</td>
<td>4</td>
<td>1100</td>
<td>7</td>
</tr>
<tr>
<td>Iron &amp; steel</td>
<td>4</td>
<td>800</td>
<td>7</td>
</tr>
<tr>
<td>Clay</td>
<td>1</td>
<td>800</td>
<td>2</td>
</tr>
<tr>
<td>Ornamental antiques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone</td>
<td>16</td>
<td>1170</td>
<td>22</td>
</tr>
<tr>
<td>Timber</td>
<td>36</td>
<td>1740</td>
<td>22</td>
</tr>
<tr>
<td>Iron</td>
<td>9</td>
<td>1000</td>
<td>9</td>
</tr>
<tr>
<td>Clay</td>
<td>1</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Reclaimed materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timber beams</td>
<td>42</td>
<td>3600</td>
<td>133</td>
</tr>
<tr>
<td>Timber flooring</td>
<td>29</td>
<td>2960</td>
<td>101</td>
</tr>
<tr>
<td>Clay bricks</td>
<td>31</td>
<td>4300</td>
<td>443</td>
</tr>
<tr>
<td>Clay roof tiles</td>
<td>63</td>
<td>3600</td>
<td>306</td>
</tr>
<tr>
<td>Clay and stone paving</td>
<td>19</td>
<td>1300</td>
<td>672</td>
</tr>
<tr>
<td>Stone walling</td>
<td>29</td>
<td>2450</td>
<td>1083</td>
</tr>
<tr>
<td>Salvaged materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron and steel</td>
<td>11</td>
<td>2800</td>
<td>75</td>
</tr>
<tr>
<td>Timber</td>
<td>36</td>
<td>7800</td>
<td>371</td>
</tr>
<tr>
<td>Antique bathrooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinks, baths, WC’s</td>
<td>41</td>
<td>1900</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>389</td>
<td>39520</td>
<td>3324</td>
</tr>
</tbody>
</table>

Reclamation involves less processing, greater employment and is often a more efficient use of resources than recycling. For deconstruction, and therefore reuse to increase, there needs to be greater markets for lower value reclaimed materials than is the current scenario. This is where use in main stream construction of reclaimed components and materials are an essential part of creating markets to facilitate further deconstruction.

2.7 Integral waste management

The Netherlands implements an integral waste management system that attempts to reduce as much as practicably possible the extent of C&D waste going to landfill, and encourages the reuse and recycling of components and materials.

*Figure 1* shows the integrated resource use and waste management cycle i.e. a closed loop. This approach to waste management is bolstered by the government’s Ladder of Lansink (Delft Ladder), which includes more options than the UK waste hierarchy. The Delft Ladder sees prevention, construction reuse, element reuse, material reuse,
useful application, immobilisation with useful application, and finally Immobilisation before any of the other options including incineration with energy recovery, incineration with no energy recovery and finally sent to landfill.

Figure 1 – The Netherlands Waste Management cycle

The Delft Ladder re-interpreted in UK terminology might be:
- Waste reduction
- Adaptable buildings
- Components/ module reuse
- Materials reuse
- Recycling/ composting to similar grade application
- Site engineering/ lower grade application
- Incineration/landfill with energy recovery
- Incineration/landfill without energy recovery

In the context of construction and demolition waste, BRE are also distinguishing between on site and off site reuse and recovery (proximity principle) in the determination of BPEO (best practicable environmental option) for waste management. In terms of deconstruction this basically means the on site markets for demolition products are generally preferable, in environmental and costs terms, than off site markets.

3. LEGISLATIVE, STRATEGIC, FISCAL AND POLICY FRAMEWORK AFFECTING DECONSTRUCTION

Current and future legislation can be a key driver in sustainable waste management. The following sections will describe the European and UK legislative, strategic, fiscal and policy issues that may have an impact on the deconstruction process.
3.1 Current EU waste management and legislation

*Overview of EU C&D waste management*

There are increasing restrictions on the disposal of active (mixed) C&D waste in Europe that ought to increase the amount of mono landfills for future recovery. Current mono landfills containing only C&D waste are very limited. Despite a range of Council Directives and Decisions, there is still no common theme. The recent Landfill Directive provides the necessary measures to address the lack of a common theme, and encourages reuse and recycling of components and materials through various means including growing disposal costs.

Subsidies to assist this change are few and far between, however a positive response has been witnessed by member states implementing waste management plans. In some member states, these plans have served to set targets and increase levels of reuse and recycling. In others, there is a growing wealth of information available to help them improve performance.

There is increasing use of tools to facilitate change including waste exchanges to transfer reclaimed components, but the network required to market the materials is predominantly patchy. Funding from the EU and member states helps support R&D in new techniques and technologies, and more recently dissemination of established knowledge.

*Project group on C&D waste*

Most European environmental legislation takes a long time to evolve, normally with plenty of time for input from interested parties and EU member states, similarly for comment on draft European Directives. In 1992 the Commission set up the “Priority Waste Streams Programme” and, following consultation, 6 priority waste streams programmes were initiated. These were:
- Used Tyres
- End-of-Life Vehicles
- Chlorinated Solvents
- Healthcare Waste
- Construction and Demolition Waste
- Waste from Electrical and Electronic Equipment

Project groups were set up for each of the six waste streams to discuss and recommend ways that member states could improve methods of waste management. These needed to respect the objectives and principles of sustainable development, preventative and precautionary action, shared responsibility, and the concept of life-cycle management of products and processes in the most cost effective way.

In April 2000 a working document produced by the C&D waste project group described the measurement of the C&D waste stream in member states, and detailed the aims and instruments that are likely to improve C&D waste management. The document also includes a selection of recommendations which member states need to consider when developing their own waste management policies.
Working group on sustainable construction

As one of the fourteen priority actions for improving competitiveness within construction, a Working Group on Sustainable Construction was established in 1999 which included three Task Groups, one of which was TG3 on C&D waste management. The main function of TG3 is to provide a document of recommendations on how to improve C&D waste management through improved planning, prevention and reclamation. One of its main findings was that “optimal separation of C+DW must take place to maximise recovery of material for reuse and recycling.”

The scope of the document focused on whole construction process including design, pre-construction, construction, demolition, reuse, recycling, final disposal, research and education. Its output was to make recommendations to three core sectors of construction, building on and making use of both the Symonds report and the Priority Waste Stream report. These three core sectors are Industry, Member states and their public authorities, and the European Commission. The recommendations are suitably lengthy and incorporate other requirements of industry and member states that include:

- Waste management plans for C&D waste
- Design for deconstruction, reuse and recycling
- Annual reports
- Appropriate management of hazardous wastes
- Environmental assessments of manufactured materials and products
- Education to the whole supply chain about waste prevention and reclamation
- And many more, relevant recommendations

European waste management plans

Member states are requested to provide waste management plans to facilitate self-sufficiency, reduce movements of waste materials and establish inspections of disposal and reclamation. Reports to the Commission by individual States are submitted every three years, and agglomerated into a single report by the Commission thereafter. Annexes of Waste Categories (Annex I), Disposal Operations (Annex IIA) and Recovery Operations (Annex IIB) are included in the Landfill Directive.

European Waste Catalogue

The European Waste Catalogue (EWC) applies to all wastes whether for disposal or reclamation, and is a harmonised, non-exhaustive list using common terminology across the Community. However the inclusion of a material in the EWC does not mean that it is a waste, only when the relevant definition is satisfied is it considered waste. The EWC is indexed by waste ids, for example:

- ID= 01 04 02 waste sand and clays
- ID= 08 01 05 hardened paints and varnishes
- ID= 08 04 03 waste from water-based adhesives and sealant
- ID= 17 01 01 concrete
- ID= 17 04 05 iron and steel

Hazardous wastes 91/689/EEC & 94/904/EC

Member states are required to implement controlled management of hazardous waste. These indicate the appropriate means necessary to collect, transport, store and manage
hazardous wastes. These are defined in Annexes covering generic types of hazardous waste including pigments, paints, resins, and plasticisers, and properties of waste which render them hazardous including oxidising, harmful, carcinogenic and corrosive substances, as well as substances that yield damaging leachates or ecotoxic risks.

3.2 Current UK waste management and legislation

UK law

Prior to 1972 there were minimal controls over the disposal of wastes. The Public Health Act 1848 was the first attempt at national legislation in the UK. It was this Act which created the term "Statutory Nuisance" in relation to any accumulation or deposit which was prejudicial to health or a nuisance. The Act enabled local government to take action on behalf of the public. Between 1848 and 1936 a series of Acts were enacted before the consolidating Public Health Act 1936. This Act gave local authorities the powers to police and inspect waste arisings. It also gave authorities the power to remove household and trade waste and to inspect for, and require the removal of, noxious materials.

The Environmental Protection Act 1990

The Environmental Protection Act 1990 (EPA 90) was the culmination of a long period of discussion of amendments to environmental law. The Act covers a wide range of environmental topics, not all of which are relevant to waste management. Part I of the Act introduced the system of Integrated Pollution Control (IPC) which is applicable to the release of pollutants to air, water and land from certain processes, establishing the important new criteria of Best Available Technology Not Entailing Excessive Cost (BATNEEC). Part II of the Act deals specifically with the deposit of waste on land (most waste management activities fall under the provisions of Part II). Many of the provisions of the EPA 90 have been implemented by Regulations made by the Secretary of State for the Environment.

The Environment Act 1995

The Environment Act 1995 established the Environment Agency and the Scottish Environment Protection Agency. The creation of these Agencies represented a major step towards truly integrated environmental management and control, as they brought together the regulators responsible for Integrated Pollution Control, water management and waste regulation. The 1995 Act makes numerous amendments to the EPA 90 and the other major environmental statutes. Many of these amendments relate to the powers and duties of the regulators, who now have greater scope to take preventative action when there is a likelihood of pollution.

Development of UK waste classification scheme

Working in partnership with the waste industry, the EA is developing an UK system of classifying waste. The UK system will contain more information about the polluting potential of wastes than the existing EWC. It also differs from the European system in that it presents separate information on:
- the composition of the waste (with 341 available codes)
the industrial process that produced the waste (classified according to the 586 standard industrial classifications).

The aims of the classification scheme are:
- to provide the Agency with better quality data on waste arisings and disposal
- to provide waste holders with better and more consistent hazard information, as part of the existing Duty of Care system.

Once the classification system has been formalised, there is likelihood that waste producers will be given a statutory duty to enter the code on the Duty of Care transfer note.

**Scottish National Waste Strategy**

In May 2000 the Scottish Environment Protection Agency (SEPA) published the Scottish national waste strategy. It contains proposals for meeting the targets in the Landfill Directive as well as covering wider issues of waste reduction, reclamation and recycling and the planning of waste management facilities. The main objective of the waste strategy is to achieve integrated waste management system and services. The strategy also identifies four priority waste stream projects; newsprint, tyres, future (WEEE etc) and C&D waste. The latter C&D project will require the development of a C&D Waste Action Plan that will reflect three key objectives and tasks:
- comprehensive review of volume and location of C&D waste
- levels of C&D waste reclamation, key players and barriers to reuse
- future management and market development of C&D waste

**UK Waste Strategy 2000 (England and Wales)**

The DETR published a statutory waste strategy for England and Wales in May 2000. This strategy describes the government’s vision for managing waste and resources better. It sets out the changes needed to deliver more sustainable development. The strategy stresses that the quantity of waste produced must be tackled by breaking the link between economic growth and increased waste. The main theme of the strategy is ‘where waste is created we must increasingly put it to good use – through recycling, composting or using it as a fuel’. The strategy also recognises the need to develop new and stronger markets for recycled materials. To address this, a major new Waste and Resources Action Programme will be set up. This Programme will deliver more recycling and reuse, help develop markets and end-uses for secondary materials, and promote an integrated approach to resource use.

**Sustainable construction strategy**

The need to reduce waste at all stages of construction was central to the message of *Rethinking Construction* the 1998 report of the Construction Task Force on the scope for improving the quality and efficiency of UK construction. Improving the efficiency of the construction industry is a key objective for the Government, as set out in its strategy for more sustainable construction ‘Building a Better Quality of Life’. The strategy published in April 2000, identifies priority areas for action, and suggests indicators and targets to measure progress. It sets out action that the Government has already taken, further initiatives that are planned, and highlighted what others can do. The Government will use
the strategy as a framework to guide its policies towards construction, and will encourage people involved in construction to do the same.

The sustainable construction strategy emphasises the importance of reducing waste at all stages of construction by focusing on the need to consider long term impacts of design, construction and disposal decisions so that materials and other resource use is optimised. The strategy encourages the industry (including clients) to consider refurbishment or renovation as an alternative to new buildings and structures. It highlights the need to avoid over-specification in materials and the scope for standardisation of components.

### 3.3 Adopted EU directives to be implemented by UK legislation

**Integrated Pollution Prevention & Control (IPPC) (OJ L257 10.10.96)**

The purpose of this Directive is "to achieve integrated prevention and control of pollution" arising from the industrial activities listed in Annex I to the Directive. Also, to "prevent, or where that is not practicable, to reduce emissions in the air, water and land…including measures concerning waste, in order to achieve a high level of protection of the environment taken as a whole". It is very similar in concept to the UK's Integrated Pollution Control (IPC) system, and this Directive will therefore have less impact on the UK than on other member states.

**The Landfill Directive 99/31/EC**

The Directive defines three classes of landfills: for hazardous, non-hazardous and inert waste. The following wastes are banned from landfill:

- explosive, oxidising or flammable wastes
- infectious clinical waste
- tyres (whether whole or shredded)
- liquid wastes, except those suitable for disposal at an inert waste site

The aim of the Directive is to provide measures, procedures and guidance to prevent or reduce negative effects to the global environment and all its cycles from landfilling of waste during the whole lifecycle of the landfill site. All hazardous waste is to be treated before landfilling, although the term "treat" can be taken to mean merely sorting, provided the hazardous character of the waste is reduced. The Directive states that hazardous waste may only be landfilled in a hazardous waste site and therefore rules out co-disposal which must cease by 2004 at hazardous waste sites.

Article 3 of the Directive excludes inert waste suitable for reuse or recycling in redevelopment, restoration, fill or construction purposes. Article 6(a) excludes inert waste requiring treatment prior to landfill, but in Article 6(d) stipulates that landfill sites designed for inert waste are reserved for inert waste. Similar legislation is evident at Member State level, where inert waste (including concrete) in UK is often exempt from landfill tax when used for constructing landfill cells and roads, agricultural road improvements, construction purposes (including high- and low-grade applications) and filling-in disused quarries. Approximately 40 million tons of recycled aggregates are used in the UK each year.
European lists and tests

Annex II of the Landfill Directive requires that a uniform waste classification and acceptance procedure is required. The waste acceptance criteria is to be complete by April 2001, and the waste acceptance procedures by April 2002. In the interim, preliminary waste acceptance procedures are used to separate inert, hazardous and non-hazardous wastes into groups. Eventually this uniform European list will assist member states to define national lists, that individual landfills will use to define site-specific lists. A three-level hierarchy to characterise and test wastes will also be required to validate that waste entering a landfill meets these lists. This hierarchy will include an initial test, an annual test and an at-the-gate test for all loads. It is early days in the development of these lists and tests and there is much scope to influence the final outcome. Yet by April 2002 there may be significant change regarding what type of waste or materials you can dispose of in which landfill, and what preliminary, periodical or spot tests are required.

3.4 Proposed directives

Draft commission white paper on environmental liability

The European Commission has been considering the introduction of a Community-wide scheme of environmental liability since 1989, following a draft Directive issued on civil liability for damage caused by waste. This controversial draft was subsequently dropped, to be replaced by a wider-ranging set of proposals in the 1993 Green Paper on remedying damage to the environment. The current thinking within DGXI is set out in a draft White Paper, the most recent version of which was produced in October 1998. If the Commission accepts the White Paper it will be reissued as a draft Directive, possibly in the year 2000.

3.5 Fiscal

Landfill tax

The landfill tax was introduced on 1st of October 1996 and it applies to waste that is disposed of in licensed landfills. Exemptions for the tax have been provided for dredged waste, mineral waste from mines and quarries, and wastes arising from the clearance of contaminated sites. Exemptions also apply to inert materials that are used for landfill restoration or filling former quarries. The tax seeks, as far as is practicable, to ensure that the price of landfill fully reflects the impact which it has upon the environment. It provides an incentive to reduce the waste sent to landfill sites and to increase the proportion of waste that is managed at higher levels of the waste hierarchy.

There are two rates of tax, a standard rate of £11 per tonne (increased from £7 per tonne in April 1999) and a lower rate of £2 per tonne. The higher rate for mixed waste will increase £1 every year from 2000 until it reaches a rate of £15 per tonne in 2004. The categories of waste to which the lower rate of tax apply – generally inert waste – are set out in the Landfill tax (Qualifying Materials) Order 1996 (SI No 1528). The landfill tax (Contaminated Land) Order 1996 (SI No 1529) sets out the provisions for exempting waste from the clearance of historically contaminated land.
The landfill tax credit scheme was established to permit up to 20% of the taxes collected by landfill operators to be used for the purpose of implementing social and environmental projects complying with specific 'approved objects' in the regulations. The revenue must be used to encourage the use of more sustainable waste management practices and technologies, or to establish partnerships between landfill operators and local communities. The Scheme therefore, benefits both the community and the waste industry by providing opportunities to enhance social and environmental conditions and services at the local level. The landfill tax scheme is managed by ENTRUST and individual projects and funds that are approved by ENTRUST have to be managed by an authorised waste and environment body.

Aggregates tax

In April 2000 the Treasury agreed to introduce an aggregates tax of £1.60 per tonne on primary aggregates from April 2002. Secondary and tertiary aggregates will not be subject to the tax, which should encourage a greater use of recycled aggregates in low- to high-grade applications. A large proportion of the tax will be used for a Sustainability Fund that will be used to support various initiatives that are currently out for consultation. This will include developments, improvements and R&D within the industry, its facilities and its impacts to the local populations. Similar to the landfill tax, it is envisaged that a competent authority will oversee the management and approval of the fund and projects. However, until the aggregates tax is implemented and the fund structure is agreed, there is little benefit in speculating the outcome.

3.6 Policy

New Demolition Code of Practice BS 6187: 2000

This British Standard concerns the process of demolition from initiation, through planning, to the execution stages. The new version of BS 6187:1982 is essentially a re-write which takes into account the advances in technology and equipment that are available to the demolition industry. The application of new techniques and the effect of new legislation that has been introduced, particularly health and safety, and environmental legislation, including the Construction Design and Management (CDM) Regulations 1994, the Construction (Health, Safety and Welfare) Regulations 1996 and the Environmental Protection Act 1990 have been taken into account. The document is written for all – including Clients - involved in demolition (which include partial demolition) projects and gives emphasis to responsibilities from concept stage to completion, starting with clients. The Standard addresses the safety of both those engaged in the demolition process and also those members of the public who may be affected by the demolition activities.

The new edition of BS 6187 has been expanded to cover project development and management, site assessments, risk assessments, decommissioning procedures, environmental requirements and facade retention. Deconstruction techniques are considered, including activities for re-use and recycling. Principles relating to exclusion zones, their design and application have also been added.
3.7 Training

General

The National Demolition Training Group established in 1990 is a recognised body for professional training of the demolition industry that has regional and national outposts in order to satisfy the demand for safer and efficient activities in the construction and demolition sector. Today’s operatives, supervisors and management need to be competent in a range of skills including first aid, specialist plant, asbestos removal, demolition supervision, demolition management, demolition techniques, explosives, scaffolding, product design, working at heights, chainsaws, abrasive wheels, personal protection equipment and other daily skill requirements. Most of these activities require specialist training and testing that is often mandatory and occasionally highly specialised.

Scheme for the certification of competence for demolition operatives

The scheme for the certification of competence for demolition operatives was established in January 1990 and covers training for the three craft levels; demolition 1 (Topman), demolition 2 (Mattockman), demolition 3 (Labourer). The scheme was jointly initiated by the NFDC and the Construction Industry Training Board (CITB), and discussed with the Demolition Industry Conciliation Board (DICB). The essential objectives of the scheme are to ensure that all operatives in the demolition industry are assessed and registered according to their competencies, and that they have received appropriate safety training. The standard of competency is based on a Training Specification as defined by the CITB.

Scheme for the certification of competence for demolition supervision

The scheme for the certification of competence for demolition supervision was developed in May 1997 and is complementary to the scheme for demolition operatives. This scheme offers a natural career progression from the scheme for demolition operatives. It is completed through distance learning by completing twelve modules, a one-day appraisal and final examination.

Scheme for the certification of competence for demolition management

The scheme for the certification of competence for demolition management was developed in May 1998 and is complementary to the scheme for demolition operatives and the scheme for demolition management. The fourteen-week course has been designed for people with more than seven years practical experience in demolition who require training in management. Together these three schemes afford an effective, contemporary and well-trained force in demolition.

Certificate of training achievement (plant) card

The certificate of training achievement (plant) card demonstrates that a plant operative has achieved a level of competence and health and safety in the use of plant on demolition sites as opposed to road building or construction. New health and safety test centres have been established along with driving theory test centres to replace the one-day safety awareness course. An innovative part of the new test is a bank of questions covering all aspects of plant operating duties that is sent to candidates prior to their test.
A random selection of questions from the bank is asked during the theory test and candidates are expected to answer them accordingly. This method of testing requires that operatives are knowledgeable in all areas of plant operation.

4. THE CURRENT INDUSTRY POSITION OF DECONSTRUCTION AND REUSE OF COMPONENTS AND MATERIALS

This section summarises the opinions of BRE experts in their chosen field that is relevant to this report, i.e. steel, masonry, concrete and timber.

4.1 Steel

The steel industry has, for many years, been aware of the environmental and economic impact of waste from C&D processes. Demolition contractors have extensive experience of recycling steel both from structural sections (beams and columns) and reinforcement. The challenge will be to increase the amount of steel re-used rather than recycled. There remains a need to incorporate design for deconstruction for new buildings and to develop new tools and techniques to maximise the re-use of material from existing buildings through deconstruction.

Standards and Specifications

There are no specific national or international standards relating to the disassembly, deconstruction or demolition of steel structures. Design standards make no reference to the re-use of steel members from demolition of existing buildings. The Steel Construction Institute (SCI) and BRE have drawn up proposals to develop a model specification.

Health and Safety

For the reclamation of structural steel members existing techniques are generally remote. Beams and columns are either partially or totally flame cut or, alternatively, cut up using shears attached to a modified excavator. Bolts are rarely removed prior to reclamation. Methods to promote an increase in the amount of steel to be re-used are likely to involve removal of bolts from areas where access and space is restricted. This is likely to involve a greater risk of injury to operatives. The National Demolition Training Group will be of help in this area as they are responsible for the scheme for the certification of competence for demolition operatives which includes health and safety on site. Guidance is also available in BS6187 demolition code of practice.

Building and Planning Control

There are no known restrictions imposed by Building Control or Planning Authorities on the use of steel recovered from existing structures or from demolition sites. Building Control will require evidence that components recovered from one project are capable of meeting the requirements for the new application. This relates to methods for verifying performance.
Deconstruction Tools and Techniques

A number of specialist processes are available for the reclamation of steel from existing structures either for recycling or re-use. Heavy-duty magnets are available to extract reinforcement from floor slabs during crushing the concrete for recycled aggregate. Developments in this area may be restricted by the availability of suitable tools. The provision of a tool for the automated removal of bolts from connections could greatly improve the number of sections available for re-use rather than re-cycling. Current methods for removing beams are likely to lead to distortion in the proximity of the connection, with a subsequent requirement to flame cut the steel on the ground. The demolition industry has developed crushers and pulverisers to allow reinforcing bar (rebar) to be removed from reinforced concrete structures. There have also been recent developments in the rotating crane attached shear that allows the shear to rotate through 360 degrees. This was developed for the demolition of tall buildings. The NFDC (National Federation of Demolition Contractors) and IDE (Institution of Demolition Engineers) are organisations that can assist the development of new and future technological solutions, tools and techniques.

Material Tests to Verify Performance

There are no specific standard tests that have been developed for reusing reclaimed steel components. As long as they have not been highly stressed (inelastically), and do not show any visible signs of plastic deformation, they should be fit for re-use in structural applications. Any out of plane deformations such as buckling in the web of column sections could lead to instability in use. The only source of information on this topic is the ‘Appraisal of existing iron and steel structures’ published by the SCI which gives information on methods of investigation and guidance on calculations for checking structural adequacy.

4.2 Masonry

Standards and specifications

Generally the standards on bricks and blocks are BS3921/85 and BS6100, but most bricks and blocks reclaimed during demolition will possibly not be able to satisfy these standards. There is no official standard that controls the quality of reclaimed bricks and blocks, and generally suppliers of these materials work under the unofficial standard ‘one good face, one good end’. Similar standards apply to slates, tiles and paving stones. Reputable firms that supply reclaimed bricks can attain ISO accreditation under ISO9002 if they set up a Quality Management System of their own to class the bricks, for example premier quality, average quality and below quality. This type of system allows clients to know what to expect and gives potential for customer satisfaction. It allows builders to determine ‘fitness for purpose’.

Health and safety

There are minimal health and safety implications to those already covering demolition sites in Construction (Health, Safety and Welfare) Regulations 9, 10, 11.
Building and Planning control

If buildings on a historic site with special significance to the community are deconstructed and re-built using some of the reclaimed materials and components it gives a feeling of continuity to the area as well as improving it for the future. Nevertheless, there is still a growing need for local plans and planning approvals to include instructions to reclaim and reuse construction and structural components where practicable. Without specifications, the need to assure components are ‘fit for use or purpose’ will be required.

The Planning Policy Guidance (PPG15) and the Planning Act (Historic Buildings and Conservation Areas) 1992 are both responsible for making the re-use of old bricks big business. They encourage a policy of ‘like-for-like’ replacement of materials when repairing a historic structure and the reclamation industry has grown from this need. They don’t specifically enforce the ‘reuse of reclaimed bricks’ but they encourage (i.e. “you will get listed building consent if you agree to use bricks that are similar to these old ones”) using similar old bricks and discourage using new ones. Also under PPG15 if planning officers are considering a development plan anywhere around a listed building they are advised to consider whether it affects the setting of the listed building. One thing that may help an applicant get permission for their development is to create a new building that has similar features or is built of the same material or in the same style as an historic/listed building nearby. This helps the harmony of the street, and will therefore not adversely affect the historical feel of the area.

Deconstruction tools and techniques

It is in the best interests of demolition companies to perform deconstruction in the most careful way possible that leads to the least damage to the components of a building. It is therefore likely that deconstruction is performed by hand. This allows the demolition company to maximise profits through selective demolition so that components are sold to reclamation yards and recycling facilities. This has been a gradual realisation on the part of demolition firms and therefore the quality of bricks for example, which arrive at the reclamation yard has continued to improve over the years. If the demolition company makes more money from hand-cleaned, whole bricks then it will take care in demolition. Some demolition companies clean (remove the mortar) the bricks before selling them on, some supply to established reclamation yards that undertake the cleaning themselves. However one of the limitations to reclaiming bricks is the growth in the use of ordinary portland cement (OPC) rather than lime-based mortars which are easier to separate than OPC. There is need to investigate practicable and cost-effective removal techniques for OPC mortars.

Material tests to verify durability / specification

The same tests that are carried out on new materials and products to determine strength and durability can be carried out on reclaimed products but it is currently not required. Any enforcement of these tests would limit the uptake of reclaimed products. However, practicable and cost-effective tests that demonstrate ‘fit for use or purpose’ would be welcomed and perhaps encourage clients, architects and LA’s to recommend their use.
4.3 Concrete

This section summarises the current issues affecting re-use of concrete components in the construction industry. Concrete constitutes a large proportion of construction waste in the UK and around the world but traditionally little of this has been re-used, or even reclaimed and this has been restricted to use in low-quality sub-base or foundations. A small amount is now crushed and used as aggregate, mainly in bases and in-fill. On rare occasions recycled aggregates are used in high-grade applications, for example the concrete floor slabs of the BRE Environment building and the strong floor at the BRE Cardington test facility.

The demolition industry is becoming increasingly sophisticated but the construction of concrete structures is also becoming increasingly complex with the different types of concrete and construction techniques available to the designer increasing at a rapid pace. Consideration therefore needs to be given to the deconstruction of a structure at the design stage. Clients are also demanding more flexibility from their buildings, as the use (and/or ownership) of a building is likely to change over the life span of a building. The need for partial deconstruction of a building is becoming increasingly important. There is also an increasing amount of interest in countries such as the Netherlands in partial deconstruction of concrete structures and in the use of ‘demountable buildings’ to reduce the amount of concrete waste produced.

The idea of leasing concrete framed buildings has also been discussed, with the frames being deconstructed at the end of their required use and reassembled at a different location for a different customer. However, further work would be needed to develop strategies for assessing the quality of the concrete elements in addition to the financial aspects involved (e.g. maintenance guarantees, insurance etc.).

Standards and specifications

There are no current national or international standards relating to the specific deconstruction and re-use of concrete structures. However, guidance has been published on the demolition of concrete structures by several trade organisations. Significant guidance also exists on the reuse of crushed concrete as aggregate in new concrete, including BRE Digest 433. The DETR (Department of Environment Transport and Regions) Quality control for the production of recycled aggregates and more recently the DETR Protocol for the use of reclaimed product in precast concrete.

Health and safety

Existing health and safety legislation mostly covers the demolition of concrete structures. Some of the international standards mention concrete specifically. Special care has to be taken with pre- and post-tensioned beams and slabs. Health and safety on construction sites is increasingly becoming a political as well as legal and economic issue, with the Deputy Prime Minister John Prescott recently devoting a large proportion of his keynote speech at the Labour Party conference to attack the construction industry on their poor safety record.
Building and Planning control

There is no mention of deconstruction in building or planning controls but minimum *de factor* standards are laid down for the reuse of aggregates in concrete.

Deconstruction tools and techniques

Most commercial concrete buildings are cast in-situ concrete frames and therefore need to be destructively demolished. The concrete components cannot therefore be reused in their original form. Concrete frames incorporating pre-cast concrete beams, columns, stairs and hollowcore floor slabs are simpler to deconstruct if the joints are simply supported. However, these joints are frequently cast in place, usually with concrete or mortar that is stronger than the actual concrete elements. One barrier is that no standard jointing system exists and the joints are not designed with deconstruction in mind, although new and innovative jointing methods are being developed and would hopefully include deconstructable jointing systems.

Pre-cast flooring systems are frequently used and are perhaps the simplest of concrete components to deconstruct and reuse. However, they are sometimes covered with a 50 mm cast-in-place concrete layer to provide a monolithic slab, meaning destructive demolition is then required. Pre-cast beams are often pre- or post-tensioned and can be very hazardous to demolish requiring special care.

High-pressure water-jetting is frequently used to cut concrete in repair situations and it leaves both the reinforcing steel and the surrounding concrete clean and reusable. Thermal lances and other heating methods could be more widely used in the future as the technique develops as they can cut through reinforced concrete whilst leaving the majority of the concrete element intact.

Material tests to verify durability / specification

The main problem with reinforced concrete as a reusable construction material is that it naturally deteriorates with time due to carbonation, although techniques (such as coatings) can be used to extend this finite life span. No specific standard tests have been developed for the assessment of reclaimed concrete components that are to be reused in their original form. However, many standard tests exist to assess the strength, quality and durability of reinforced concrete which could be used together to provide an assessment of the condition and the potential life span of a concrete element.

A potential problem is that many of these tests require a sample of the concrete to be taken (e.g. a core) and the total cost of the range of tests required may negate any financial benefits of reusing the element. Also, many of the problems encountered with reinforced concrete are not immediately apparent and are ‘hidden’ within the element e.g. reinforcement corrosion. Full-scale load testing is possible although it is likely to be prohibitively expensive. However, an approximate (and therefore cheaper) assessment could be made of the quality and strength of the element and the element used in a lower-grade application (with a higher factor of safety). There are also non-destructive testing methods that can be used to determine in-place strength of concrete elements.
General

The industry’s perception and reticence are perhaps the main barriers to the reclamation and reuse of concrete components, unlike the steel industry where steel components are sometimes salvaged and reused. It is also more difficult to assess the quality of a concrete element (whether reinforced or not) compared with a steel element as defects are not immediately apparent without detailed (and expensive) examination and/or testing. Designers are also very wary of specifying reclaimed concrete components in new structures due to safety (and the resulting legal) reasons and no guidance or standards exist to aid them in this task.

The cost savings are also minimal (at the moment) for the reclamation and reuse of concrete components compared with new construction, and until relevant fiscal measures are imposed it is likely to remain this way. On the other hand, the concrete industry is increasingly moving towards the use of more standardised components in order to increase productivity and reduce costs and this will in turn increase the potential for deconstruction and the reuse of concrete components in the future.

One growth area however does exist for the reuse of concrete components in their original form. This is concrete block paving which is being increasingly used in private and commercial driveways and car parks and in the pedestrianisation of town centres. These can be quickly and cheaply dismantled and reused when required.

4.4 Timber

Although timber is a natural renewable resource and as such can have a very low environmental impact, a greater amount of recycling and reuse will obviously benefit the overall environmental audit for building components. Timber product manufacturers already adopt sustainable practices for use and processing of the raw material with any waste being consumed through space heating. This has been driven mainly by sustainable timber certification schemes such as the Forest Stewardship Council (FSC) and customer pressure. The C&D industries have not been influenced by the same economic and customer pressures, and as such have not responded to current national and European initiatives for the reduction of waste. There is however current reuse of high value items such as large section beams and timber flooring, although a potential to greatly increase the amount of timber suitable for reuse in construction still remains.

Standards and specifications

Structural timber for use in construction, be it new or reclaimed, must be strength graded to either BS 4978 for softwoods, or BS 5756 for hardwoods. Machine grading of timber may also be adopted which conforms to BS EN 519. If the timber has been graded then a stamp should provide information on the strength class, species group and origin. This information can be used to ensure that the timber meets an architect’s specification. Engineered wood products such as glulam and some decorative large section beams are not marked with grading stamps even though the lamina or overall beam will have been graded in the past. For the structural reuse of these materials either a paper trail proving the beams origin and strength will be required or the species will need to be determined for allocating a minimum grade stress provided in BS 5268. Non-structural timber may
also be reused in non-structural applications but is not subject to the same stringent rules governing the fitness for purpose. In this case, durability and appearance may be established from the timber species.

Health and Safety

The deconstruction of timber structures is generally covered by the CDM Regulations for ensuring the safe working practices of operatives. Nailed connections used frequently in timber construction offer potential for accidents. Safety clothing such as steel mid-sole boots and protective gloves for handling help to reduce such risks. There is no particular H&S risk that should bar the increased reuse of timber from the deconstruction of buildings.

Building and Planning Control

Some Planning Authorities may be sceptical about the reuse of construction materials on a large or ‘innovative’ scale based on the building industry preference for established products and techniques. This healthy but sometimes restrictive approach should favour increased reuse of materials in the future providing the long-term performance of materials is proven.

Deconstruction Tools and Techniques

Many timber components that are reclaimed from existing structures contain nails and screws that must be removed or made safe for handling before reuse or recycling. This is done by hand which can be time consuming and generally only proves to be economically viable for high value items such as large section beams. Many lower value components such as small section joists and studs will need to be free of nails and screws if they are to be recycled by chipping for the production of boards products. Since nailed and screwed connections should be made into virgin wood to attain the codified values for shear and pullout, either larger diameter nails or reduced capacities should be adopted for the reuse structural. Either option would require research to establish basic rules for reuse performance. An economic way around this problem has been adopted by the Scandinavians. Their approach is to specify ‘connector free zones’ within the timber cross section. This enables any areas containing nails or screws in the reclaimed timber to be easily removed with a rip saw, thus providing defect free timber that may be reused or recycled.

Material Test to Verify Performance

In principle the strength of reclaimed timber can be verified from stress grading. Although the type of defects that may be experienced in reclaimed timber may not be covered by the codes, an experienced visual grader should be capable of determining a suitable strength class for damaged structural timber. Alternatively, component tests could provide data for the reuse of wall panels, trussed rafters, composite beams and studs. These tests only require a few repetitions and may be used to provide generic rules for reuse of timber components.
5. UK CASE STUDY – 2, MARSHAM STREET

The redevelopment of the former Department of the Environment (DoE) HQ offices at No.2 Marsham Street will include the demolition and removal of the current structures. A BRE pre demolition audit made the following recommendations.

The demolition of the former DoE is expected to generate over 250,000 tonnes of concrete alone, and a range of other valuable resources including steel, glass, aluminium and numerous fixtures and fittings.

Possibilities include:
- To recycle 97% by volume and 99% by weight of the former Department of the Environment building at No.2 Marsham Street
- To maximise recovery of materials and products from demolition
- To maximise the use of demolition materials in construction of the Home Office and other high profile projects
- To demonstrate cost-savings

This process could be assisted by use of the following tools and services:

SMARTWaste

SMARTWaste (Site Methodology to Audit, Reduce and Target Waste) has been developed by BRE to provide a robust and accurate mechanism by which C&D wastes arising during the project life-cycle can be benchmarked and categorised by source, type, amount, cause and cost. This data is a springboard to identifying and prioritising actions to reduce waste arisings (producer responsibility), re-use at source (proximity principle), and maximise recovery to extend materials’ life-cycle. The benefits of the tool are to identify the potential true cost savings of projects, and to maximise the reduction, reuse, recycling and recovery of materials over landfill. Current development of the tool will incorporate key performance indicators of material waste arisings from data collected across the industry.

Materials Information Exchange (www.bre.co.uk/waste)

One of the key barriers to the increased use of C&D wastes is the absence of information on the availability, quantity and type of waste. It is this problem which the DETR Materials Information Exchange (MIE) seeks to address, by matching the suppliers of waste with potential users. The MIE provides a free internet site where the user can advertise materials available by geographical location, search for materials wanted, identify where upcoming demolitions are, and access links to other relevant organisations and resources including a searchable database of C&D research.

Speculative recycling targets include.
- 100% In-situ and precast concrete including mullions, columns, beams, stairs, panels, stilts, slabs and walls
- 100% Reinforcing bar
- 100% Assorted furniture
- 100% Non-asbestos insulation
100% Bomb-shield net curtains
100% Bricks and blocks
100% Steel frames
100% Fire fighting equipment
100% Window frames
95% Assorted metals including aluminium, copper, and cast iron
80% Internal timbers
80% Glass from the windows
80% Boilers, radiators and associated piping
75% Sanitary ware
50% Timber panelling
50% Door and window furniture
50% Internal electrical fixtures and fittings
30% Control equipment

Previous UK demonstration projects have managed commendable recycling rates:
IBM’s office at Hursley = 95% by volume
BRE’s Environment Building = 96% by volume
Therefore Marsham Street target = 97% by volume/99% by weight

The use of recycled aggregates (RCAs) in high-grade applications such as structural concrete is feasible with the introduction of BRE Digest 433 and the BRE/DETR Quality Control Scheme for RCAs. The use of these RCAs should be encouraged in high-grade applications rather than low-grade applications such as sub-base fill. Using RCAs from the demolition of Marsham Street would reduce the need for volume and cost of primary aggregates (South East England has few quarries), reduce vehicle movements to and from site, extend the life cycle of reclaimed materials, and offer employment opportunities for the local population.

There is potential to use a nearby site as a staging ground for the crushing, grading and testing of RCAs before using the material for in-situ concrete, pre-fabricated components or other high grade applications. There is also opportunity to establish a temporary plank casting yard for prefabricating components of the new structure, and temporary mixing yard for preparing in-situ concrete. These temporary measures would reduce the need to import materials and components with associated environmental impacts, reduce the distance of vehicle movements, and create employment opportunities for the local population.

**Conclusion**

The demolition process is yet to take place and at this point BRE are not certain of any involvement in a project to maximise materials recovery from these structures. In any event, the concrete panels that make up the four towers will need to be taken apart carefully due to the built up nature of the area. Whether these recommendations are taken up or not, it will be interesting to see what the effect of deconstructing the buildings will have on recovery rates.
6. FUTURE OF THE INDUSTRY

Demolition in the UK is likely to follow the lead being taken by the Dutch. Landfill is becoming gradually more expensive and landfill taxes are continue to increase. There will continue to be a requirement for inert material in landfill engineering and restoration, but this is likely to tail off as landfill space diminishes. This will encourage selective demolition and so increase reuse and recycling rates. The innovations within the industry are likely to come from new mechanical plant, which are rapidly becoming more sophisticated and specialised. The next growth market for plant is likely to be in the area of the soft strip, which is still labour intensive.

A key component to the future of the industry will be free exchange of ideas and technologies, adoption of other proven industrial techniques, best practice guides, demonstration projects and sound auditing/benchmarking of processes. Central to this will be dissemination of gathered information.

Some information sources are listed below:

The International Council for Research and Innovation in Building Construction (CIB) http://www.cibworld.nl/ Task Group 39 on Deconstruction (1999-2003) held its annual meeting in the UK last year. The report of this meeting and relevant information relating to CIB TG39 can be found at http://www.cce.ufl.edu/affiliation/cib/. Similarly, the Conference Proceedings of ‘Deconstruction – Closing the Loop’ held at BRE in May 2000 are also available from BRE gettlesony@bre.co.uk.

The UK EA waste handbook is an excellent source of information and contacts of the waste management industry http://www.recycle.mcmail.com/content.htm. Similarly, the Symonds report http://europa.eu.int/comm/environment/waste/report.htm is of some relevance to the industry although tends to focus on ‘core’ C&D waste. The Salvo website is very popular for reclaimed components www.salvo.co.uk. Finally, the DETR Materials Information Exchange www.bre.co.uk/waste is of great value for exchanging components and materials at no cost.
7. REFERENCES


7 Collins, R: Digest 433 Recycled Aggregates. BRE, Watford, UK. 1998