MEASURING & MINIMISING WASTE

Lessons from the HEEPI Project

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HEEPI is a project funded under the Good Management Practice initiative of the Higher Education Funding Council. The work described in this report took place in its first stage, when it was a partnership of four universities - Bradford (the project leaders), Gloucestershire, Leeds Metropolitan and UMIST - together with the Yorkshire Universities Association and the Joint Procurement Policy and Strategy Group. The second stage - which began in 2003 and extends until 2005 - is being run in collaboration with the Association of University Directors of Estates (AUDE), the Building Research Establishment (BRE), the Environmental Association for Universities and Colleges (EAUC) and the Standing Conference of Principals (SCOP). The project aims to improve the environmental performance of higher education institutions by a) stimulating environmental benchmarking, for example by collecting energy and water data for individual buildings and b) by developing the capacity of staff with environment-related responsibilities to achieve positive environmental change within their institutions (through workshops, best practice case studies and other means). See www.heepi.org.uk for more information.

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Introduction

UK further and higher education produces large quantities of solid waste. No one knows how much because very few universities or colleges collect data. But they will need to know more about their total waste volumes, and the individual fractions (such as recyclable paper) within it, in the future as a result of:

- More stringent regulation, which requires more detailed knowledge of how waste is being handled and disposed of (see appendix 1 for a summary of these)
- General social - and therefore political - concern about waste disposal, resulting in demands to minimise waste generation and increase levels of recycling (which reduces requirements for landfill and conserves resources)
- Rising costs as a result of higher operating standards for disposal of trade waste; increases in landfill tax; shortages of landfill sites (especially in South East England) and other factors.

There is therefore a need for standardised waste indicators which universities and colleges can use to understand their current performance, to track changes over time, and to compare themselves with other institutions. As a contribution to this topic, the HEEPI project mapped waste quantities and costs at five universities - Bradford, Derby, Gloucestershire, Leeds Metropolitan and UMIST. Although a complete mapping proved impossible, the exercise was successful in demonstrating that better information can be relatively straightforward to achieve. It also showed how better information on waste can:

- Highlight its financial importance to the organisation
- Identify opportunities for improvement
- Ensure that the growing volume of waste regulation is being complied with.

This Guide summarises the insights gained from the work, supplemented by relevant material from other sources. The work has been done in collaboration with EAUC, whose Practical Guide to Waste Management provides a more detailed introduction to the topic.[1]

[1] Bob Gilmour and Helen Manns. *A Practical Guide to Waste Management for Universities and Colleges,* Environmental Association for Universities and Colleges. See www.eauc.org.uk.

Waste Mapping Pays Off At Gloucestershire

The University of Gloucestershire worked with the HEEPI project on identifying and measuring its waste streams. For Andy Simpson, the University's Operational Services Manager, the exercise "proved really valuable. It was eye opening to see the amount of waste we were disposing of, and the costs of doing so. The topic has definitely become higher profile as a result. One immediate action we took after seeing the figures was to invest in front-end loaders at several sites to reduce the frequency of lifts and thereby save money. The findings have also been very helpful in shaping our tendering for, and negotiation of, a new waste contract. The fact that we can give a precise idea of workloads means that there's less risk of being overcharged. And we can also include targets to encourage performance improvement."

1. Drivers for Waste Management

These include:

- The European Landfill Directive
- Landfill Tax
- The European Waste Electrical and Electronic Equipment (WEEE) Directive.

The European Landfill Directive

The European Landfill Directive - incorporated into UK law as the 2002 Landfill (England and Wales) Regulations - aims to minimise the health and safety impacts of landfilling waste, and to reduce the amount of waste which is landfilled through greater recycling and reuse. The main practical implications are:

- Creating three categories of landfill site - for inert waste, hazardous waste or non-hazardous waste (which includes most biodegradable waste)
- Ending the common UK practice of putting both hazardous and non-hazardous waste into the same landfill
- The banning of certain wastes from landfill (including hospital and other clinical wastes from premises dealing with infections)
- More sorting and other pre-treatment of wastes going to landfill.

The UK implementation of the Directive has targets of reducing the amount of biodegradable municipal waste landfilled to 75% of the 1995 level by 2010, and 35% of the 1995 level by 2016-2020 (precise date to be determined).

These measures will impinge on higher education in several ways:

- Increased costs of landfill created by higher standards (estimated by DEFRA at an additional £2-40 per tonne, depending on the waste stream)
- The need for more waste sorting to enable local authorities and landfill operators to meet their obligations, and to demonstrate good standards to stakeholders.

Landfill Tax

The explicit aim of this tax is to discourage landfill and encourage waste minimisation. It was introduced at a rate of £7 per tonne for non-inert wastes in 1996 and has been raised annually since 1999 to a level of £15 per tonne in 2004. Inert wastes are charged at £2 per tonne thereby creating a considerable incentive to separate inert from non-inert wastes. The rate for inert waste is planned to increase further to £18 per tonne in 2005-06 and by at least £3 per tonne each year thereafter, with a medium-long-term rate of £35 per tonne.

The European Waste Electrical and Electronic Equipment (WEEE) Directive

The WEEE Directive - which is expected to be implemented in UK law by 2005 - is intended to boost recycling and reuse of electronic equipment (which includes much more than IT, for example, motors and medical equipment) and thereby conserve landfill. The Directive requires producers of electrical and electronic equipment to finance collection arrangements for their products at the end-of-life. This includes the costs of appropriate treatment and meeting specific targets for recycling and recovery. The Directive applies to both new products and those already on the market.

The DTI estimates that the total cost of the Directive in the UK will be £217-£455 million per annum. Inevitably much of this will be passed on to consumers. However, it will probably be possible to avoid some or all of these costs by optimal choices of electronic equipment.

2. Measuring Waste

Three basic forms of waste information are required for effective management:

- Quantities - both mass and volume
- Financial costs
- Scale of organisational activities which generate waste.

The final item is important because the effects of waste management can be obscured by changes in it (for example, a small decline in the amount of waste generated may seem good in isolation, but much less so if it is learnt that the number of students has halved).

Possible measures of organisational activity include financial turnover, floor space occupied, and total numbers working on campus. However, full time equivalent students is probably the best because it is simple to calculate and captures what is probably the most important driver of waste creation - people.

There are three main levels of waste data:

- First tier data is aggregated 'headline' data which provides a simple overview of performance, and can - when normalised (e.g. per FTE student) - allow broad brush comparisons to be made between further and higher education institutions (FHEIs)
- Second tier data - first tier data is an aggregation of more detailed information about the main categories of wastes, recyclates and financial costs
- Third tier data is very detailed information about these topics.

Some of this data can be obtained by direct measurement. Waste disposal and landfill costs can be gathered from contractor's invoices and waste transfer notes, which may also contain data on waste quantities (although if this is volume based it will require conversion - see below). Internal records can also provide data on some waste quantities, especially for specific wastes which are covered by regulation. (If these don't exist then the institution may be breaking the law). FHEIs with 'pay by weight' contracts should also have detailed data on quantities of general waste (see below).

In many cases, however, costs and quantities will have to be estimated. The following pages provide guidance on how this can be done.

3. The Costs of Waste

The starting point for total quality management has always been the identification of the full costs of 'non-quality'. The assumption is that these are usually under-estimated so that making them apparent undermines any arguments against improvement based on the costs of doing so. The relevant costs are usually identified as:

- Failure - the costs of putting right or otherwise dealing with problems
- Management and monitoring - the costs of ensuring that problems are identified and managed
- Prevention - the costs of ensuring that problems do not occur.

Generally speaking, total costs are minimised when the emphasis is placed on prevention rather than managing and bearing the costs of failure.

In the UK waste costs have historically been low compared to many other north European countries because landfill sites have been plentiful, and therefore cheap. However, as the following pages show, this situation is changing and the costs of dealing with waste are much higher than generally assumed. Hence, waste minimisation should be a key objective for all FHEIs.

There are five main categories of waste cost for FHEIs:

- Waste contractor's fees
- Landfill tax
- Labour costs
- Equipment and materials costs
- Purchase costs of materials and equipment which end up as waste.

Thinking about purchasing costs often highlights opportunities to rethink purchasing or to enable reuse. However, for everyday environmental management purposes the first four categories are the most relevant, and therefore the focus of the following discussion.

Sheffield Makes Waste Charges More Transparent

Waste costs can often be difficult for contractors to break down, and there may be hidden charges. For this reason, a recent tender round by University of Sheffield asked contractors to breakdown costs for residential waste disposal by:

- Bin container rental/day
- Lift cost
- Transport cost
- Disposal cost/tonne
- Landfill tax/tonne.

This enabled the University to model the costs of different lifting patterns.

Andy Nolan, the University's Environmental Manager, notes that, "At first glance the prices used by the tendering companies looked relatively similar. However, on further investigation it was evident that the pricing structures used varied quite dramatically. By running the projected costs through a simple spreadsheet model some alarming differences were highlighted. What looked on the face of it to be little difference in price was actually a variance of £55.25 tonne (based on a 40 kg/bin scenario) between the cheapest and most expensive tenders! The University of Sheffield now knows that The Price Is NOT Always Right! Service levels, commitment to waste reduction, management reporting, audits and awareness raising and training were also taken into consideration when awarding the contract."

Waste contractors fees

The more sophisticated 'pay by weight' contracts typically have monthly invoices itemising the following costs:

- Hire charges for skips and other waste containers
- The number of lifts made
- The weight of waste moved (with different charges for different kinds of waste)
- Transporting waste to disposal sites - charged per kilometre so that the location of the landfill site to which waste is being transported can make a considerable difference
- Landfill costs (including tax).

Landfill tax

As noted above, this is a substantial cost. It is usually paid by waste contractors, and then reclaimed in their invoices to FHEIs.

Labour costs

These include:

- The time of porters and other staff in collecting waste, transferring to or between storage areas, running compacting and other equipment, checking waste sites and other activities
- Preparation and handling of relevant documentation
- Management of, and liaison with, waste contractors.

Whilst it is difficult to estimate these accurately it is probably the equivalent of several full-time staff in larger FHEIs. At the University of Bradford, for example, the collection and transferring of residential and general waste alone equates to one full-time position per year.

Equipment and Materials Costs

The annual depreciation and running costs of equipment such as compactors should be included here. For tax purposes, equipment is usually depreciated over a five year period so 20% of the purchase cost is a rough rule of thumb.

The main materials costs will probably be for baling.

4. Waste Streams

The legal classification of wastes is a complex topic, which is well covered in the EAUC Guide.[2] One important distinction is between:

- Controlled wastes - those dealt with by the 1990 Environmental Protection Act
- Other wastes (for example, agricultural and radioactive) which are covered by specific legislation.

Both kinds of waste can be further sub-divided into:

- General wastes - i.e. that which can be put into skips or bins for collection by waste contractors or local authorities
- Special wastes, which require specified types of handling, documentation etc.

The following sections describe the main types of waste to be found in FHEIs and how they can be mapped.

Waste Awareness at the University of Bath

Peter Jewell, the University's Hazardous Waste Manager, posts the university's waste figures onto a special section on its Intranet.[3] The mini-site also contains definitions and explanations of waste streams, guidance on dealing with hazardous waste, and other useful information.

General Waste Collected by Local Authorities

At present, most FHEIs have waste arising from student and other residences collected by local authorities, or their sub-contractors. The costs of this are normally absorbed in the Business Rate tax, which FHEIs pay for their residences. However, some local authorities are deeming some of this waste to be 'trade waste', which they are unwilling to collect. This has been the case at the University of Sheffield, which now has 2 contractors - one on behalf of the local authority collecting 'municipal' residential waste, and another collecting trade waste on behalf of the University.

General Waste Collected by Waste Contractors

Waste from non-residential FHEI facilities is usually collected by contracted waste management companies. Their invoices should therefore contain data on the quantity and type of waste collected. In practice, the Finance office usually holds these.

[2] Bob Gilmour and Helen Manns. *A Practical Guide to Waste Management for Universities and Colleges*, Environ mental Association for Universities and Colleges. See www.eauc.org.uk.
[3] See http://internal.bath.ac.uk/waste.

Data on this waste stream can be gathered in numerous ways (although generally achieved by volume-weight conversions):

- Pay-by-weight systems that provide actual weight of waste removed from residences
- Waste contractor weighbridge waste figures[4]
- Calculating your own estimated weights using the conversion formulas.

One common problem is that much data on waste quantities will measure volume rather than weight. Whilst volume information can be useful in its own right, for consistency it is desirable to convert it into mass. Appendix 2 provides standard information on conversion factors for different kinds of waste. The standard conversion factor for general waste from industry is 40 kilograms per cubic metre but Dave Bowden, former Procurement Manager of Leeds Metropolitan University, believes that this is inappropriate for FHEIs. He used a 'rule of thumb' of 40 kilograms per 1100 litre bin instead.

Understanding the composition of general waste requires some kind of sampling. Not many will volunteer for this, but it's often a task that can be achieved as part of student projects. Bishop Burton College, University College Dublin and Universities of Bath and Bradford are some FHEIs that have used this means to analyse their wastes. The exercise at Bradford found that a number of bins had been 'overfilled', both through squashing waste inside them and leaving bags by their side. Hence their real weight was considerably above 40 kilograms.

Appendix 3 provides data on national averages, and samples from some UK FHEIs, for their waste composition.

Special Wastes

The main areas generating these in FHEIs are laboratories and medical facilities. The University of Bath, for example, collects figures on:

- Scintillation vials
- Clinical waste - sharps
- Clinical waste - cytotoxic and antibiotic waste and aerosol cans
- Clinical waste - organic materials from research
- Miscellaneous wastes.

As there are strict legal requirements to document the movement and disposal of these wastes the data should be available in the institution. However, it may often be held at school or other lower levels and therefore requires some detective work to locate. Mapping all special waste streams can sometimes reveal that they are handled under a number of different contracts, creating opportunities to reduce costs and improve control by consolidating them. If people at lower levels are not 'waste aware' it may also be that some general waste is being mixed in with special waste, thereby making bills higher than they need to be.

[4] Unless your contractor can guarantee that the waste at the weighbridge is from your own institution, this measure isn't to be relied on.

Construction and Demolition Waste

This is waste arising from the construction, repair, maintenance and demolition of buildings and structures. It is mainly brick, concrete, hardcore, subsoil and topsoil, but it can also include quantities of timber, metal, plastics and (occasionally) special waste materials such as asbestos. (If so correct disposal procedures should be enforced immediately).

Usually disposal of this waste will be the responsibility of contractors rather than the FHEI itself. However, it can be a major - and, on occasion, even the largest - waste stream on campuses with lots of building work and so should be mapped if possible. One reason for doing this is to ensure that disposal is addressed in any future construction contracts.

How to Map Waste

The Government's Envirowise programme estimates that the true cost of waste in UK businesses is usually over 4% of turnover. However, waste minimisation initiatives have shown that this figure can often be reduced by 25%. Its Waste Mapping publication provides simple mapping techniques to build up a picture of an organisation's waste creating activities - and to see more clearly where it is wasting resources.[5] It also provides ideas on how this can be reduced which are summarised as:

- Walk around your site and identify sources of potential waste.
- Get senior management commitment by telling them about the cost of waste and potential savings available.
- Talk to other employees about their ideas for reducing waste.
- Talk to relevant departments and people and draw up a list of inputs, outputs and known wastes from your organisation's processes.
- Measure wastes, even if this provides only rough estimates at this stage.
- Put as many figures on the waste map as possible.
- Write down ideas for reducing wastes.
- Calculate the real cost of waste.
- Prioritise areas for action.

[5] Envirowise, Waste Mapping: Your route to more profit, Downloadable from www.envirowise.gov.uk. Also available from the Environment and Energy Helpline on 0800 585794.

5. Where Next?

Once the waste data is completed, it is likely to highlight a number of strategic options which could be taken, including:

- Setting and achieving targets
- Creating incentives
- Improving relationship with contractors to get better data
- Compaction
- Segregation/recycling
- Waste minimisation initiatives.

Setting and Achieving Targets

Many commercial organisations have found this to be a powerful means of driving improvements in waste performance. However, few FHEIs have set waste targets. A successful approach at Sheffield College[6] can be seen below.

Of course, setting targets is pointless if no one is responsible for achieving them. There needs to be someone in senior management charged with overall responsibility, and a lower level person tasked with implementation, for them to be effective. Most successful waste minimisation initiatives also involve a steering group, and/or network of champions, in key sections of the organisation, who can support implementation. Consultation with the people who can influence success - such as cleaners and students - is also important.

Creating Incentives

One means of motivating people to achieve targets is to make them aware of the costs of their waste activities by recharging waste costs. The most obvious method of doing this is to charge individual faculties or departments for it. However, some doubt if the amounts involved are sufficient to influence decision-making. There is also a danger that the units involved will start making their own arrangements, so that central control is lost.

Improving Relationships with Contractors

Some FHEIs have experienced problems with getting data from their waste contractors. This isn't the norm so if it happens you should make clear that you will go elsewhere if it can't be provided.

[6] CH127 College Establishes Base-line and Makes Significant Cost Savings. Downloadable at http://www.envirowise.gov.uk/envirowisev3.nsf/0/AAAE6D3FF3B44DE280256CE5004C70A0/$File/CH127.pdf

Dave Bowden, formerly of Leeds Metropolitan University, believes that "one secret of getting good data is to have a nominated manager at the waste contractor who is responsible for your university's business. We also linked with Bradford University to give us more clout in purchasing terms - which has paid off both in lowering costs and getting better information."

The Bradford/Leeds Metropolitan consortium has recently established a 'pay by weight' waste contract with Shanks Waste Solutions (now taken over by Onyx). To provide the data Shanks installed a SULO Container Weighing and Identification System. This fits a microchip to bins or smaller waste containers to identify their location, size and type of waste contained. There is an automatic weighing system and on-board computer on each collection vehicle. The weight of waste in each container can then be measured and recorded.

The information is transferred into a central database, which provides the information for a monthly invoice to the universities. The breakdown sheet attached to this can be tailored to a specific FHEI's own needs. It might include data such as prices/tonnage by site, daily/weekly collections, and even the number of miles covered by waste truck. Waste disposal costs can be reduced in three main ways:

- By installation of on-site compactors (which reduces cost associated with transport and disposal, which are based on volume rather than weight)
- By increased separation of recyclable materials
- By reduced generation of waste.

Reducing Waste Costs at Derby

'Pay-by-weight' contracts were pioneered by the University of Derby. Their environmental manager Jo Seabrook believes that the new system "is much more transparent and allows me to match collections with demand. So we now have less frequent collections in the summer months when students are away. In the first year of the contract we disposed of around 800 tonnes of waste at a total cost of approximately £100,000. Over the second year these figures only rose by 25 tonnes and £500 despite a substantial increase in student numbers and space. The combination of this type of contract and good recycling practice means we have an average annual save of 10% of the waste budget, or around £10,000."

In fact, over the last 3 years, by analysing and benchmarking the data, Derby have been able to reduce the average number of bin empties per week by approximately 20% and the average monthly number of bins on site by 13%.

Compaction

Reducing the bulk of waste by compressing creates both economic and environmental benefits:

- It enables trucks to pick up more materials, potentially reducing transportation costs and saving time, money and fuel (and therefore vehicle emissions) - an important consideration given the low fuel efficiency and the diesel engines of most waste disposal vehicles.
- It reduces any storage constraints which make it difficult to achieve greater separation of waste.
- If less waste is sent to landfill sites (as is usually the case in the UK) their capacity is consumed less quickly and therefore less new capacity is needed.

Against this are one actual and one potential disadvantage:

- Compactors have considerable running costs, including use of energy
- Compaction could potentially reduce the rate of decay in landfill, thereby requiring more overall capacity. However, contractors believe that this doesn't happen because they they often compact themselves at transfer stations, and waste compacts naturally in landfill sites[2]. Also because health and safety requirements usually dictate that they minimise light, air and high humidity so that biodegradation only occurs slowly anyway.

Waste Compaction at UMIST

For some years UMIST has operated a 27 cubic metre capacity static compactor, which has generated considerable savings in disposal costs. In 2002 it decided to supplement this with a mobile compaction unit, which is capable of carrying 15 tons of waste. Bins are emptied into this rather than a waste contractor's skip. This greatly reduces the number of uplifts needed and therefore travel by contractor's vehicles - certainly more than enough to compensate for the additional fuel used by the compactor.

Roy Smith, UMIST's General Services manager notes that "when the mobile compactor is full it goes to a transfer station where the waste is tipped and then separated. All recyclable material is removed before the remainder goes to landfill. We also benefit because Greater Manchester has more local transfer stations than landfill sites, so our transport costs are less. Less vehicles going to landfill sites is also good because the access roads are often poor, resulting in higher maintenance costs."

Segregation/Recycling

Segregating waste into different streams usually increases costs - except when it prevents general waste from entering expensive to dispose of special waste streams - but does facilitate

recycling and reuse, and thereby opens up potential revenues. Unfortunately prices for recycled materials have been volatile and often low, in recent years so that few if any FHEIs will gain much income from them. However, it is still important to maximise recycling and reuse because:

- It means reduced costs of waste disposal, especially if these increase as predicted.
- It is a high profile issue for students, especially those coming from Northern Europe or North America.
- The Packaging Recovery Note system provides a mechanism for increasing the returns from recycling and could be extended to other areas in future (see box).

Dave Bowden, when at Leeds Metropolitan University, noted that "we already have a recycling rate of around 30%. We hope to push up to the 40-50%, which is probably the upper limit for universities. We keep moving through the different waste streams to find solutions. Currently our big problem is glass, because we don't have enough space to store it separately, but we will find a solution."

In the case of the Bradford and Leeds Metropolitan 'pay by weight' contracts, no attempt was made to derive income from recycling. Instead it was left to the contractor, in the hope that it would provide an incentive to increase rates.

Derby took a different approach by sub-contracting collection of recyclable materials - which comprise around 15% of total waste volumes - to local enterprises. Jo Seabrook believes that "this allows us to better support the local economy and also saves the university money through lower transport costs and a quicker collection time."

Potentially Recyclable Waste Streams

The Bradford/Leeds Metropolitantender document identified the following as waste streams which they would like the contractor to recycle or dispose of in an environmentally friendly manner:

- Fluorescent/sodium tubes
- Aluminium/steel cans
- Paper
- Polystyrene
- Food oils
- Furniture
- Batteries
- Chemicals
- Construction Waste
- Glass
- Obsolete PC's/Computer Equipment
- Laser/inkjet cartridges
- Cardboard
- Plastics
- Motor oils
- Refectory waste
- Mobile Telephones
- Garden Waste
- Sensitive/Confidential Waste
- Newspaper/Magazines

Packaging Recovery Notes

The Packaging Waste Regulations have introduced market incentives into recycling by the creation of packaging recovery notes (PRNs). Recyclers when receiving recycleable material issue these. The notes can be traded, with the potential buyers being companies with legal responsibilities under the regulations to recycle their packaging. Ownership of PRNs provides legal proof that this happened. The table indicates the prices obtained for PRNs in November 2003. The money realised by this mechanism can then be used by waste contractors or specialist contractors to subsidise their collection and segregation activities.

Table 1 PRN Prices in 2003

Waste type	£ per PRN/one tonne
Glass	7-10
Paper (including cardboard)	2-5
Aluminium	9-12
Steel	2-5
Plastics	3-6
Mixed waste - energy recovery	2-6
Wood - energy recovery	2-6

(Source: LetsRecycle.com)

Priority should obviously be given to those waste streams that can be easily, safely and cleanly segregated to maximise recycling rates. These are likely to be aluminium, glass, plastics and paper.

Aluminium Cans

WasteWatch estimate that aluminium cans have a value worth 6-20 times that of any other used packaging material. Alcan, a UK based aluminium-recycling company, were offering the following trade prices in December 2003 to high volume collectors of used beverage cans:

- Densified and strapped: £700/tonne.
- Loose and Flattened/Whole: £650/tonne.

Leeds Metropolitan University calculates that if it could segregate and recycle the 169,000 aluminium cans that are purchased annually, this could potentially generate revenue of approximately £1250 per year for reprocessors and reduce landfilling costs. However, recycling aluminium cans requires high levels of segregation whilst contamination can often reduce its value.

Glass

Container glass, e.g. bottles from Student Union bars or jars from supermarkets, is the dominant waste source for glass recycling. As this type of glass falls within the packaging regulations, it has a commercial value under the PRN system. The value of glass PRNs has shown wide fluctuations and they fell during 2003 from an estimated £15/tonne in April, to the figures shown in the table at its end.

Plastics

As there is a current trend towards the use of plastic bottles in Student Union shops and even vending machines, this waste stream should be given consideration for recycling as well. As segregation within FHEIs is difficult, the percentage of mixed plastic waste will be high, making it less valuable to reprocessors and therefore even less revenue could be generated.

Prices of Recyclable Plastics

Material	**Current price UK material (£/tonne delivered)**	**Prices reported by Reprocessors (£/tonne delivered)**
HDPE mixed colours	£120-165	£160 UK material £100-125 European material.
HDPE natural	£130-165	£175 UK sourced material £100-125 European material.
PET colourless	£115-165	£100-150 for UK material
PVC	£15-55	
Mixed	£40-60	**£60-90 for UK material**
(Source: WRAP - Barriers to Plastic Bottle Recycling in the UK, March 2002)		

Paper

Paper can typically make up between 30-50% of FHEI general waste, and recycling can save considerable waste management costs. Simon Duarri, Ancillary Services Manager at Bradford University calculates that, in 2002, "it cost us around £3,000 in collection, staff time and storage to segregate around 140 tonnes of paper waste for recycling. Luckily our local recycling company collects the paper waste free of charge. I'd estimate that this more or less matched what we'd have paid to landfill the paper as part of our general waste stream."

However, free collection isn't standard and FHEIs may find themselves having to pay for the collection of paper due to the low merchant prices offered to accredited recyclers/collectors at the paper mills. In November 2003 Letsrecycle.com estimated these as:

- Mixed paper - up to £7 per tonne.
- Mixed office waste - £20-23 per tonne.
- White officer paper - £45-55 per tonne.

Waste Minimisation

The ultimate ambition of waste management within any sector or industry is to be able to produce minimal - or even no waste whilst being able to go about its normal business operations. However, this is difficult to achieve in practice and requires the support of all parties, from senior management to students.

Zero Waste at Massey University

One University that has begun to implement a zero waste policy is Massey University in New Zealand, which aims to be a zero waste campus by 2015. Student concern at the lack of recycling facilities led to the formation of an environmental advisory board containing senior management, facilities and academic staff, and the student association environmental issues officer. The environmental board submitted a proposal to the Zero Waste NZ Trust for funding into researching the development of a zero waste campus, which was successful.

This allowed the implementation of:

- An organic residuals study in which food residuals, green waste and animal manure production were quantified, appropriate composting options designed and a demonstration composting 'park' established.
- Installation of recycling bins, with signage designed to encourage good source separation practice, on selected parts of the Turitea campus and the running of an associated educational campaign conducted.

Waste Minimisation at Sheffield College

An initial review was carried out to identify sources of waste and areas of significant utility consumption. Data on waste amounts and costs were obtained from all sites to establish a base-line against which to measure progress. The approach to waste minimisation taken by the College is based on that recommended for any organisation:

- Collect and analyse existing data
- Establish base-line costs
- Carry out an initial assessment to identify priority areas for action
- Investigate these areas more closely
- Identify and evaluate possible waste minimization options
- Implement preferred options, starting with those that will produce immediate savings.

Data analysis revealed two main areas for action:

- Improved control of waste to reduce both purchasing costs and disposal charges;
- Improved utility management.

Measures, selected for their ability to produce immediate savings, included procedural changes and no-cost or low-cost modifications. For example:

Paper - particularly photocopying paper - is now reused for printing out draft documents. A segregated waste paper collection system has been instigated so that fully used paper can be collected for cost-effective recycling. Bins for high and low quality waste paper are now provided throughout the College. The cleaners' duties have been modified to include emptying these bins and taking the waste paper to collection points.

Aluminum cans - The College's 35 000 students consume some 200 000 canned drinks each year. Collection boxes for empty beverage cans have been placed strategically around the various sites. The collected cans are sold to an aluminum recycling company for recovery.

Engine oil - Oil is now ordered centrally and each department is charged for the oil it uses. Old oil is now removed by a waste oil contractor for recovery and resale. The amount of oil used has halved and there is good reconciliation between the amount of oil purchased and the amount of oil sent for disposal off site.

These and other simple measures have enabled Sheffield College to:

- Significantly reduce skip disposal charges;
- Significantly reduce the amount of photocopying paper purchased;
- Improve its environmental performance.

More Information

There are numerous organisations that provide waste management resources such as best practice case studies, site visits and even registers for trading waste. Some of the more prominent organisations are listed below:

BREMAP SMARTwaste - is a web based Geographical Information System (GIS) pin pointing waste management facilities and materials/products within a region or radius of your chosen distance by postcode - see www.smartwaste.co.uk

Envirowise - Government programme giving practical environmental advice mainly to the private sector with a focus on waste management - see www.envirowise.gov.uk

The Institute of Wastes Management - is the professional body which represents over 5,500 waste management professionals - see www.iwm.co.uk

LetsRecycle.com - the UK leading waste recycling community - see www.letsrecycle.com

Waste and Resources Action Programme (WRAP) - Government programme to promote sustainable waste management by creating markets for recycled materials - see www.wrap.org.uk

Waste Traders - is a register of companies, whose waste may be another company's raw material - see www.wastetraders.com

Waste Watch - a leading national organization promoting and encouraging action on the 3R's - waste reduction, reuse and recycling with government, public and private sector support - see www.wastewatch.org.uk

General Info on UK Waste

DEFRA (Department for Environment, Food and Rural Affairs) - see www.defra.gov.uk/environment/waste/

Waste Strategy 2000 - England and Wales Part 2, see www.defra.gov.uk/environment/waste/strategy/cm4693/pdf/wastv2_1.pdf

Specific Topics

The European Landfill Directive
- see www.defra.gov.uk/environment/waste/topics/landfill-dir/landfilldir.pdf

The European Waste Electrical And Electronic Equipment (WEEE) Directive
- see Envirowise, Directive on Waste Electrical And Electronic Equipment (WEEE), GG415. Downloadable from www.envirowise.gov.uk (registration required).

Appendix 1 - Main Waste Legislation and Regulations

Control of Pollution (Amendment) Act 1989 makes it a criminal offence for a person who is not a registered carrier to transport controlled waste to or from any place in Great Britain.

Environmental Protection Act 1990 gives organisations a 'duty of care' to minimise adverse environmental impacts. In the case of waste, this duty applies to all stages up to final disposal so that an organisation cannot assume that its responsibilities are ended when waste is handed over to a contractor. Their practices need to be vetted to ensure that they are satisfactory.

Environmental Protection (Duty of Care) Regulations 1991 requires that, when waste is passed from one person to another, the person taking the waste must have a written description of it and a transfer note must be filled in and signed by both persons involved in the transfer.

Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991 establish a system for registration of carriers of controlled waste. The Regulations also set out the various groups who are exempt from the requirement to register.

Special Waste Regulations 1996 (which implemented the European Hazardous Waste Directive) regulates documentation and handling of substances which have hazardous properties such as being flammable, toxic or irritant.

Appendix 2 - Composition of General Waste Streams

Table 2 UK Waste Recovery and Disposal Routes 1998 (million tonnes)

Waste type	Waste recovered:			Waste disposed:		
	Recycled	Other	Total	Landfill	Other	Total
Inert, in-house construction	0.78	0.00	0.78	1.12	0.10	1.22
Paper and card	5.32	0.07	5.39	1.54	0.07	1.61
Food	2.07	0.33	2.40	0.21	0.39	0.60
Other general and biodegradable	3.78	1.89	5.67	2.34	0.99	3.33
Metals and scrap equipment	5.34	0.00	5.34	0.60	0.06	0.66
Contaminated and healthcare	1.70	0.10	1.80	2.10	1.10	3.20
Mineral waste and residues	2.28	0.00	2.28	3.72	0.00	3.72
Chemicals	0.84	0.28	1.12	1.80	1.08	2.88
General commercial	4.14	0.92	5.06	17.94	0.00	17.94
General industrial	1.43	0.26	1.69	11.18	0.13	11.31
Total commercial and industrial	27.68	3.85	31.53	42.55	3.92	46.47
Total percentages	35.49%	4.94%	40.42%	54.55%	5.03%	59.58%

Source: DEFRA, Waste Strategy 2000, London, 2000.

Sample University Waste Streams

Category as a % of waste stream	University of Bradford[7]	University College Dublin[8]	Leeds Metropolitan University[9]	EAUC[10]
Paper/Card	32	48	20	50-78
Glass	4	3	10	3-8.5
Metal	3	4		2
WEEE	1			
Organics	18	30		
Wood	5			
Plastics	34	6		3-7
Textiles		1		1
Other (inc wood)		8		4-10

[7] Environment Agency Survey - December 1998

[8] From 'Waste Management at University College Dublin', Helen Barrett, 2003 - personal correspondence with Rosaleen Loughman

[9] Figures from the joint Leeds Metropolitan/Bradford waste management invitation to tender issued in August 2001, available in the HEEPI Case Study No 1 'Saving Money by Measuring Waste. The figures are based upon a visual estimate of % volume in waste receptacles

[10] From the EAUC - A practical guide to waste management for universities and colleges 2001 (compositional data from Universities of Edinburgh, Cambridge, Bradford and Glasgow Caledonian).

Appendix 3 - Conversion Factors

There are no universally correct conversion factors for waste - what is most important is that year on year the same conversion factors are used.

General Waste

The most popular volume to weight conversion factor, and that used for the waste mapping exercise, is the industry standard:

- 40 kg per cubic metre

There were concerns however that, because this is an industry standard across all sectors from catering to construction, it may prove too heavy for FHEI use.

Recent analysis of 6 months' pay-by-weight data from Leeds Metropolitan and Bradford for their general waste has revealed that the average weight disposed of from 1100 litre bins is 45.77 kg. This equates to 41 kg per cubic meter for HE general waste (generally excluding paper and card).

Therefore it would seem based on initial data, that the industry standard is acceptable for estimating the majority of general waste streams in the sector.

DETR Conversion factors

The DEFRA conversion factors for estimated volume to weight conversions for several waste streams. They are:

- Household - 0.27
- Paper/card - 0.6
- Wood - 0.7
- Glass - 0.75
- Construction - 1.2

Taking household waste i.e. halls of residences it is possible to estimate the different types of waste weight produced.

Container	Volume m3/yd3		Waste type	(CF) Tonne	(75% CF) Tonne
Front end loader	7.7	10.09	Household	2.079	1.559
Rear end loader	10.7	14.02	Household	2.889	2.166
Euro bin	1.1	1.44	Household	0.297	0.222

EW = (CFWS * V) * Ln * NW
EW = Estimated weight (tonnes)
CF = Conversion factor waste stream
V = volume of container
Ln = Lifts in a week per no. of bins
NW = No of Weeks

Residential Waste

Dave Bowden at Leeds Metropolitan applied the following calculation/assumption for his residential waste:

> Take a standard 240-litre household wheelie bin. Assume that most households will not fill more than one bin per week. Assume therefore that one student will not produce as much waste as the average household. However, two students could reasonably fill a wheelie-bin per week. 240 litres equates to 0.24 cubic metres; so 4 x students will produce approx 1 cubic metre of waste every week.
>
> Using the industry standard of 40 kg per cubic metre, the following mathematical model is produced:
>
> RW = (S/4) x 40 kg x n
>
> Or RW = S x 10 kg x n
>
> RW = Residential waste
> S = Number of students on site
> N = Number of weeks students in residence

As more and more institutions begin to operate pay by weight systems, especially on residences, it may be possible to produce a nominal figure of waste produced per bed space for residences. Sheffield Hallam, Derby and more recently Sheffield operate such systems on some of their residences. Data from the first 2 HEIs has indicated the following figure for self catered residences:

> 157 kg per bed space[11]

Based on accurate figures an institution will be able to multiple the above kg figure by the number of bed spaces to get an average total waste produced.

[11] Data provide from both Sheffield Hallam and Derby for 2 self catered residences, averages calculated from Aug 01-Jul 02. Data includes some residential workshops/conferences.

Appendix 4
- Waste Disposal Data for HEEPI Partners, 2001-2002

Indicators		BRADFORD	DERBY	GLOUCS	LEEDS MET	UMIST
Total Cost (£ inc VAT) for tutorial waste management		£48,568	£74,907	£34,442	£88,331	£30,620
Total Cost (£ inc VAT) for residential waste management		£8,590	£32,541	£19,726	£3,517	£17,563
GRAND TOTAL		**£57,158**	**£107,448**	**£54,168**	**£91,848**	**£48,183**
Breakdown	Compactor Costs	£400	£14,781		0	
	Skip Hire	£9,934		£2,808	0	
	Transport	£23,806	£11,174		£13,571	
	Lift	£7,986	£53,172		£66,138	£23,595
	Rental	0	£5,077	£1,368	£1,284	
	Landfill Tax	£7,861	£14,755	£4,077	£10,857	£12,288
	Other costs	£7,171			0	£8,000
		£57,158	£98,959	£8,253	£91,850	£43,883
Total Tonnage Landfill - tutorial		374	807	309	707	499
Total Tonnage Landfill - residential		540	328	203	63	328
GRAND TOTAL		**914**	**1,135**	**512**	**770**	**827**
Total tonnage - Incinerated				0.05		0.3
Total tonnage - Special Waste						2.5
Total tonnage - Radioactive Waste						
Total tonnage - Clinical Waste		9		0.03		0.1
Total tonnage - Recycled Waste		132	112	50	100	44
Indicators		**BRADFORD**	**DERBY**	**GLOUCS**	**LEEDS MET**	**UMIST**