

## Costs and benefits of reducing waste in construction

### Defence sector new build – Woolwich single living accommodation modernisation (SLAM)



	Value	Percentage of £3.2m construction cost
<b>Cost saving potential</b>	<b>£64,800</b>	<b>2.0%</b>
<b>Additional costs to achieve these savings</b>	<b>£26,600</b>	<b>0.8%</b>
<b>TOTAL POTENTIAL COST SAVING</b>	<b>£38,200</b>	<b>1.2%</b>

#### Introduction

Reducing, reusing and recycling waste can help to reduce costs on construction projects. By asking for good practice from an early stage in the design and planning process, clients and contractors can secure these savings and demonstrate corporate responsibility. Such action lies at the heart of corporate commitments in support of the sector target for halving waste to landfill.

This case study identifies, at design stage, the costs and benefits achievable through waste reduction and recovery in the construction of an accommodation unit at a military barracks. The analysis quantifies savings starting at RIBA stages C/D, i.e. once the overall design has been selected. Therefore it does not include further savings from more fundamental design changes at an earlier stage.

The project is a new build four-storey T-shaped block, £3.2M construction cost, to house up to 72 personnel at the Woolwich site. The construction is based on pre-assembled modular units from Caledonian Building Systems. This assessment does not include abnormal excavations, nor does it include external paving and landscaping or the provision of car parking or access roads. Reuse of demolition materials and use of materials with higher recycled content has been quantified separately.

#### Design potential

Significant savings can be made by targeting good practice wastage rates for the 10 or so components offering the biggest savings in the value of materials wasted.

	Value of materials wasted	Cost of waste disposal	Total cost of waste	Total cost of waste as % of construction value
Baseline practice	£98,967	£17,626	£116,593	3.63%
Good practice (all components)	£40,222	£6,823	£47,045	1.46%
Targeted practice (top opportunities)	£43,479	£8,278	£51,757	1.61%
<b>Improvement over baseline</b>	<b>£55,488</b>	<b>£9,348</b>	<b>£64,836</b>	<b>2.02%</b>

These cost savings will be shared across the supply chain. Clients and principal contractors can increase their share through the procurement process.

In addition to financial benefits, actions to be more resource efficient also deliver the following changes in environmental performance:

	Total waste arisings (t)	Waste sent to landfill (t)	Recovery rate	Carbon (t) <sup>1</sup>	Recycled content
Baseline	174	87	50%	89	14.02%
Good practice	99	26	74%	40	17.13%
Targeted	136	30	78%	48	16.87%
<b>Improvement over baseline</b>	<b>38 (22%)</b>	<b>57 (66%)</b>	<b>28%</b>	<b>41 (46%)</b>	<b>2.85%</b>

### Understanding the costs and benefits

WRAP's Net Waste Tool has been used to quantify the extent of the cost savings possible, and to select the top 11 opportunities. Waste reduction and recovery actions needed to deliver these targeted savings were then identified, and their implementation costs estimated. Costs and benefits are shown in the Tables below.

Achieving cost reductions (BENEFITS)	Baseline	Targeted practice	Improvement
<p><b>Value of materials wasted</b> Construction materials are a valuable resource, yet it is common to see high levels of waste through damage on site, off-cuts, over-ordering of materials and the need for rework. Reducing this waste saves money. Where a trade contractor supplies materials and labour for a lump sum fee, they are likely to retain savings from waste reduction unless the client or contractor takes specific actions through the procurement process.</p>	<b>£98,967</b>	<b>£43,479</b>	<b>£55,488</b>  <i>(1.7% of construction value)</i>
<p><b>Cost of waste disposal</b> Every skip or container of waste carries a cost. Whilst segregated metals are often removed at little or even zero charge, the majority of wastes carry substantial costs – and these are set to rise with the annual increase in Landfill Tax. However, waste disposal costs aren't fixed. Substantial savings are achievable simply by reducing the quantity of waste generated. In addition, the segregation of wastes and finding destinations other than landfill can help further. In this example, the total mass of waste has been reduced by 22%, and a five skip strategy has been chosen instead of a single skip strategy.</p>	<b>£17,626</b>	<b>£8,278</b>	<b>£9,348</b>  <i>(0.29% of construction value)</i>  <i>(£8,269 saved through reduced waste arisings, and £1,079 saved through increased segregation)</i>
	<b>Combined savings</b>		<b>£64,836</b>

<sup>1</sup> Embodied carbon of wasted materials plus carbon impact of disposal route

These savings will only be achieved by taking specific management actions to change behaviour during design and site practice.

Investing to save (COSTS) <sup>2</sup>	Costs
<b>Develop quality SWMP</b> – Additional time beyond minimum legal compliance (England only) to develop plan with quality forecasts (including using the Net Waste Tool) and robust management actions.	<b>£1,640</b>
<b>Develop site logistics strategy</b> – Planning time required to establish how materials are to be delivered, stored and moved around the site	<b>£1,080</b>
<b>Site training</b> – Time to provide training, and site operatives’ time to receive training (5nr ½hr briefings for 10 operatives per session)	<b>£1,530</b>
<b>Materials storage</b> – Nominal allowance for construction of hard standing and temporary shelter for materials (or cabin hire)	<b>£3,200</b>
<b>Management time</b> – Additional time required to ensure SWMP is adhered to, including materials handling, re-use of materials on site, efficient installation and waste segregation (2.5hrs per week for ¾ of the programme)	<b>£6,000</b>
<b>Updating SWMP</b> – The SWMP needs to be reviewed and updated throughout the project. This cost allows for a 4 hour review every 3 months.	<b>£2,133</b>
<b>Site segregation</b> – To ensure good segregation, this cost allows for a single individual to sort and move wastes and monitor the re-use of materials on site. (Included part-time for 50% of the programme as reduced demand during early packages.)	<b>£11,040</b>
<b>Combined costs</b>	<b>£26,623</b>

## Sharing the costs and benefits

On paper there are possible savings of £64,836, but to achieve these savings an estimated £26,623 in costs must be incurred. This Section identifies how to achieve these benefits, who receives the benefits from these savings, and who pays for the improvements.

### The benefits

#### A. Reduction in value of materials wasted

Potential saving: £55,488

The following materials provide the largest cost reduction potential. The values below show the potential savings if wastage rates are improved from a Baseline to a Good practice<sup>3</sup> level. **On this project, some of these savings will be realised through off-site manufacture of the building modules.**

	Baseline wastage rate (%)	Good practice wastage rate (%)	Potential saving
<b>Hot and cold water services</b>	<b>5</b>	<b>2</b>	<b>£17,106</b>
<b>Light and power services</b>	<b>3</b>	<b>1</b>	<b>£10,589</b>
<b>Internal drainage</b>	<b>5</b>	<b>2</b>	<b>£5,376</b>
<b>Expanded polystyrene insulation, 100mm</b>	<b>15</b>	<b>5</b>	<b>£5,288</b>
<b>Facing brickwork</b>	<b>20</b>	<b>10</b>	<b>£3,940</b>

<sup>2</sup> These costs are based upon estimated durations, and have been reviewed with selected contractors.

<sup>3</sup> These wastage rates are based upon primary research carried out by Arup (on behalf of WRAP) with main contractors and sub contractors. Data were gathered on the likely level of waste at Baseline practice (the waste one would expect in normal working conditions) and at Good practice (the reduced level of waste if additional measures are put in place to prevent damage and install efficiently).

	<b>Baseline wastage rate (%)</b>	<b>Good practice wastage rate (%)</b>	<b>Potential saving</b>
<b>Expanded polystyrene insulation, 60mm</b>	<b>15</b>	<b>5</b>	<b>£3,353</b>
<b>Insulation to module ceilings</b>	<b>15</b>	<b>5</b>	<b>£3,299</b>
<b>Plasterboard</b>	<b>22.5</b>	<b>15</b>	<b>£2,621</b>
<b>Glasswool quilt or batt insulation</b>	<b>15</b>	<b>5</b>	<b>£1,367</b>
<b>Carpet roll</b>	<b>20</b>	<b>10</b>	<b>£1,348</b>
<b>OSB board</b>	<b>10</b>	<b>5</b>	<b>£1,201</b>

This list includes a mix of high value items (metal framing and floor finishes), and low value, high quantity items (insulation, brickwork and plasterboard). Focusing efforts on these materials will ensure that the cost of waste is reduced as low as possible.

#### *Who saves?*

Whoever takes the risk for the supply of materials will see these cost savings. This is normally the trade contractor, or the main contractor for bulk products such as aggregates. The extent of waste is rarely reconciled with the original order, meaning that trade contractors often do not know how much waste is costing. To convert this reduction in waste into a reduction in price (for the contractor or client), the trade contractor will need to:

- include a reduced wastage rate in their tender (for more competitive pricing on a lump sum tender); or
- procure less materials, therefore save money, and share this up the supply chain (open book tender).

#### **B. Reduction in cost of waste disposal**

Potential saving: £9,348

A reduction in waste cuts the cost of waste disposal (by £8,269). In addition, several of the largest waste streams can be segregated. By segregating wastes, the value of these waste streams is increased, and therefore the cost of disposal is reduced (£1,079 saving).

On this project the following waste streams would ideally be segregated, and the breakdown of the wastes in each (by volume) is as follows:

<b>Inert</b>	<b>Plasterboard</b>	<b>Timber</b>	<b>Packaging</b>	<b>Mixed</b>
93m <sup>3</sup>	12m <sup>3</sup>	11m <sup>3</sup>	19m <sup>3</sup>	118m <sup>3</sup>

#### *Who saves?*

The main contractor would normally pay for waste disposal on the basis of volume (and type) of waste removed, therefore these savings would normally accrue to the main contractor. The client's ability to share in these savings is determined by the procurement route. Where a form of renegotiated or open book payment structure is used or where waste costs are explicitly considered during tender pricing, there should be an opportunity to share in these cost savings.

#### **The costs**

Most of the costs required to reduce waste or increase recovery are borne by the contractor. These costs are divided into two parts: planning costs and management costs.

**Planning** for waste is a low cost / high impact activity, highlighting the big opportunities such that effort can be focused on these. For example, by planning you might identify that you need better materials storage, hence the allowance of £3,200 for this.

During construction the **management** of wastes is important to ensure that the plan is delivered. This analysis includes an additional amount of management time to oversee the waste management process (including material deliveries, material storage, installation and waste disposal), plus an allowance for a dedicated operative to manage and monitor materials storage and waste segregation (£17,040).

## Conclusion on wastage rates

The main contractor will typically benefit from the reduction in the cost of waste disposal (£9.3k), but from this analysis, will incur costs (£26.6k for waste reduction and segregation) which exceed the saving. To ensure that maximum benefit from good waste practices is realised (and shared), it is therefore important for the client, the contractor and the trade contractor to work together to ensure that *the potential for waste reduction is built into wastage allowances for materials purchasing at the tender stage*, i.e. greater recycling is not enough in itself. For this project the potential reduction in value of materials wasted is £55.5k, which more than justifies the cost of waste minimisation and management. Therefore:

- clients need to instruct designers to look for waste reduction opportunities, plus set threshold waste reduction and recovery targets;
- designers need to look for opportunities to design out waste (such as simplification of the specification);
- contractors need to develop a quality SWMP and a materials logistics plan;
- trade contractors need to ensure that materials are not over ordered, and that the materials brought to site are used as efficiently as possible; and
- the waste management contractor must ensure that all wastes received are recycled wherever possible.

## Methodology

*This cost benefit analysis has been conducted using data taken from WRAP's Net Waste Tool. The Tool is freely accessible on the web at [www.wrap.org.uk/nwtool](http://www.wrap.org.uk/nwtool), and helps project teams to forecast the waste that would be expected on different projects. The Tool works by setting up basic cost plan information to which baseline and good practice industry wastage rates are applied. The analysis identifies which components and specifications offer the greatest opportunities for waste reduction, and proposes a least cost segregation strategy. The Tool forecasts the overall quantities and costs of waste at baseline, good and user-targeted levels of performance, including the value of wasted materials and the cost of waste disposal.*

## Reusing materials on site

A pre-demolition audit generated a demolition Bill of Quantities for the Woolwich site, indicating that 10,700 tonnes of recycled aggregate would be available on site (in addition to reclaimed doors, windows and timber roof trusses). The requirement for such aggregate in the new build was estimated at 3,500 tonnes – for use in pathways and hard standings. (Owing to the modular build, the demand for aggregate within the footprint of the building would be minimal.)

Reuse of 3,500 tonnes of material on site is estimated to save:

- between £26,500 and £42,000 in materials costs and reduced landfill costs; and
- 350 lorry movements and 11 tonnes of vehicle CO<sub>2</sub> emissions.

The pre-demolition audit and early discussion with the prospective demolition contractor enabled the principal contractor to secure agreement to targets for materials recovery and on-site reuse. Due to time constraints, the reclamation of items from the site was anticipated by the demolition contractor to be limited in this case.

	Use of aggregates reprocessed from site-won demolition materials	Landfill of demolition materials and use of imported aggregates	Productive use of demolition materials off-site at zero gate fee, and use of imported aggregates
<b>Landfill costs</b>	None	£15,750 (£4.50 per tonne <sup>4</sup> )	None
<b>Haulage cost taking 3,500 tonnes of demolition materials from site</b>	None	£8,750 (£2.50 per tonne)	£8,750 (£2.50 per tonne)
<b>Cost of producing / buying aggregates</b>	£10,500 (£3 per tonne)	£28,000 (£8 per tonne <sup>5</sup> )	£28,000 (£8 per tonne)
<b>Total cost</b>	£10,500	£52,000	£36,750

### Using building materials with higher recycled content

The modular build construction achieves 14% recycled content (as a percentage of the total value of materials used) if all materials have the industry's "standard practice" level of recycled content. Selecting some alternative products which offer a "good practice" level of recycled content at a competitive cost would increase the overall recycled content for the project to 17% – simply by focusing on the top 10 components where a product substitution would change this metric significantly. This action would result in an additional 61 tonnes of recycled material being used within the building fabric.

The key materials in these 10 components are listed below.

	Standard practice recycled content	Good practice recycled content
<b>Internal drainage (plastic)</b>	<b>0%</b>	<b>10%</b>
<b>Plasterboard</b>	<b>36%</b>	<b>84%</b>
<b>Expanded polystyrene insulation, 100mm</b>	<b>0%</b>	<b>25%</b>
<b>Expanded polystyrene insulation, 60mm</b>	<b>0%</b>	<b>25%</b>
<b>Insulation to module ceilings</b>	<b>30%</b>	<b>50%</b>
<b>Brickwork</b>	<b>0%</b>	<b>9%</b>
<b>Carpet roll</b>	<b>0%</b>	<b>25%</b>
<b>Glasswool quilt or batt insulation</b>	<b>30%</b>	<b>50%</b>

Following the identification of these "Quick Win" opportunities at the design stage, the modular building supplier (Caledonian Building Systems), contractor (Debut Services Ltd – a joint venture between Bovis Lend Lease and Babcock) and client (Defence Estates) have reviewed the choice of products with the aim of switching to higher recycled content options where technically and commercially acceptable to all parties.



<sup>4</sup> Landfill tax of £2.50/tonne and waste gate fee of £40/load or £2/tonne

<sup>5</sup> Assumptions: ex quarry / reprocessor price £5.50/tonne; haul (20 miles round trip) £2.50/tonne; total £8.00/tonne