Practical solutions for sustainable construction

Achieving effective Waste Minimisation

Guidance for construction clients, design teams and contractors
WRAP works in partnership to encourage and enable businesses and consumers to be more efficient in their use of materials and recycle more things more often. This helps to minimise landfill, reduce carbon emissions and improve our environment.

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Implementing good practice waste minimisation and management (WMM) on construction projects will help reduce the significant quantities of construction waste sent to landfill and make a substantial contribution to sustainable development.

The purpose of this guidance is to assist construction clients, design teams and main contractors reduce waste on their construction projects. It sets out what is meant by waste minimisation, why it is important, who should implement it and how it can be made an explicit requirement of the procurement process.

This guidance is part of a suite of three documents that focus specifically on waste minimisation. The other guidance documents are a high-level business case for client decision makers and an in-depth technical document for implementing good practice waste minimisation by the client, design team, contractor and their supply chain.

The guidance documents on waste minimisation are supported by a parallel suite of documents which address waste management and the use of Site Waste Management Plans. Please see WRAP, *Achieving good practice Waste Minimisation and Management: guidance for construction clients, design teams and contractors* for more information available from www.wrap.org.uk

**Key benefits**

Increasing numbers of construction clients, developers, design teams and contractors are looking to reduce waste on their projects. The benefits in doing this include the ability to:

- reduce material and disposal costs through a reduction in the materials ordered and waste taken to landfill;
- increase competitive advantage through differentiation;
- improve performance against CSR objectives;
- lower CO₂ emissions;
- meet planning requirements;
- complement other aspects of sustainable design; and
- respond to and pre-empt changes in public policy, such as increases in Landfill Tax.

**Good practice Waste Minimisation**

Waste minimisation sits at the top of the waste hierarchy – making it the primary objective in any waste strategy.

Waste minimisation involves a range of straightforward methods to ‘design-out’ waste from a project and limit waste arising during the construction phase. Waste management then involves identifying potential waste streams, setting target recovery rates and managing the process to ensure that these targets are met.

Opportunities to reduce waste exist throughout a project, specifically in design, procurement and logistics. Underpinning all of these is a need for effective communication.

Fully benefiting from waste minimisation on a project will mean adopting waste reduction measures at the earliest opportunities. To maximise these opportunities a team approach is required, drawing upon the client, design team, contractor, and subcontractors through all project phases – from outline design to project completion.

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### Executive summary

#### The opportunities to minimise waste arising throughout a project fall into four key categories

<table>
<thead>
<tr>
<th>Communication</th>
<th>Design</th>
<th>Procurement</th>
<th>Logistics</th>
<th>Project timeline</th>
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<td>Planning</td>
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## Achieving good practice Waste Minimisation and Management

<table>
<thead>
<tr>
<th>Client</th>
<th>Design team</th>
<th>Contractor and subcontractors</th>
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<tbody>
<tr>
<td>1. Set project requirement for good practice WMM</td>
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<td></td>
<td>2. Identify key opportunities for waste minimisation</td>
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<td>3. Plan waste management by developing a SWMP</td>
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<td>4. Tender and contractual requirements for good practice SWMP implementation and targeting of Quick Wins</td>
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<td>5. Set targets and Key Performance Indicators</td>
<td>6. Define responsibilities and contracts</td>
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<td>7. Identify waste arising, reuse and recycling routes</td>
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<td></td>
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<td>8. Site design and training</td>
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<td>9. Monitor for waste management</td>
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</tbody>
</table>

The full waste minimisation and management process is outlined above with the waste minimisation element highlighted.

Unlike waste management, waste minimisation does not follow a set process (such as developing a SWMP). Instead, effective waste minimisation requires a change in attitude towards waste. If all members of the project team are committed to identifying and reducing waste then reductions can be made. The benefit of these waste reductions is that it is a direct cost saving to the project – for every skip of waste that is eliminated through waste reduction strategies, so is the associated cost of the procurement and purchase.

This document addresses the roles and responsibilities of the core members of the project team, highlighting the responsibility of the client to demonstrate leadership. The client can do this by establishing a clear mandate for waste minimisation within the project brief, and subsequently within appointments of consultants and contractors.
For example, below is a form of words which the client may choose to use to establish the need for a waste strategy:

...we require a Site Waste Management Plan (SWMP) to be developed from the pre-design stage to inform the adoption of good practice waste minimisation in design, and for the SWMP to be implemented in all construction site activities in line with good practice published by WRAP. The SWMP is required to set targets for waste reduction and recovery based on an assessment of the likely composition and quantity of waste arisings and identification of the most significant cost-effective options for improvement (Quick Wins). This should be supplemented by information on how the targets will be achieved during construction activities and how the actual levels of waste reduction and recovery will be monitored for comparison with the targets set.

This requirement crystallises the client’s project objective for good practice WMM and can be cascaded through the entire supply chain using a suite of procurement clauses to ensure that it is delivered.

**Making it simple**

To help clients, designers, contractors and subcontractors, WRAP have produced a suite of guidance material to assist in achieving good practice waste minimisation: this mid-level guidance and a technical summary for implementation by the contractor and their supply chain.

In addition, WRAP’s construction portal www.wrap.org.uk/construction contains information covering all aspects of materials used in construction, including case studies, reference guides and information on managing specific waste streams.
1.0 Introduction

The construction industry is the UK’s largest consumer of natural resources, using over 400 million tonnes of material per annum. It generates more than one-third of the UK’s waste arisings, of which only half is reused or recycled (primarily aggregates and metals). Over 60 million tonnes of construction sector waste is sent to landfill or similar disposal sites every year.

More efficient use of materials would make a major contribution to reducing the environmental impacts of construction including reducing demand for landfill and the depletion of finite, natural resources. This would also contribute to the economic efficiency of the sector and of the UK as a whole.

Major improvements in materials efficiency are possible, without increasing cost, by:

- minimising the overall creation of waste resulting from, for example, over-ordering or inefficient design;
- reducing the quantity of material sent to landfill during the construction process through effective waste management;
- recycling materials already on the construction site into the new construction project; and
- using more recycled materials and mainstream products with higher recycled content.

Taking action in each of these areas in the sequential order outlined in figure 1.1 opposite, would enable construction projects to achieve good or best practice Waste Minimisation and Management (WMM) and overall resource efficiency. Waste minimisation can be seen in the context of overall materials efficiency and wider sustainability goals in figure 1.2 opposite.

This document provides guidance specifically to support waste reduction. It includes model forms of words which may be set in contract (or project briefing, etc) such that all parties have formal commitments to reduce waste. The guidance provides direction towards the benefits of waste reduction and opportunities on how to realise these benefits.
2.0 Good practice Waste Minimisation

The primary aim is to reduce the total quantity of waste produced throughout a project.

Opposite is an illustration of the waste hierarchy (figure 2.1). This follows the principle of ‘reduce, reuse, recycle’. At the top of this list, and therefore the top priority, is waste reduction.

Implementing strategies to minimise waste is the first step towards materials efficiency and is one of the most effective ways to solve the waste problem in the construction industry. Minimising waste eliminates the need for subsequent handling.

After opportunities in waste minimisation are exhausted, waste that is produced can be subsequently managed. The primary focus of this document is on the range of opportunities for waste minimisation in construction. Further guidance on waste management can be found in WRAP documents referenced at the end of the guidance.

Figure 2.2 summarises the key steps and responsibilities for achieving good practice waste minimisation within the framework for good practice WMM.

Waste minimisation should be addressed through questioning and review of the design and construction process at regular intervals; at pre-design, design and procurement, pre-construction and construction stage. Waste figures and lessons learnt should also be collected at post-construction.

All opportunities for waste minimisation should be exhausted so that any waste that is produced is inevitable and can subsequently be managed. For guidance on waste management and good practice WMM, please see WRAP, Achieving good practice Waste Minimisation and Management: guidance for construction clients, design teams and contractors on www.wrap.org.uk/construction
Clients can provide a mandate for action on all construction projects by setting a requirement for waste minimisation (and waste management). This simple action will be the crucial first step in realising the key benefits of becoming efficient in materials usage.

The client’s core requirement can be set as follows:

...we require a Site Waste Management Plan (SWMP) to be developed from the pre-design stage to inform the adoption of good practice waste minimisation in design, and for the SWMP to be implemented in all construction site activities in line with good practice published by WRAP. The SWMP is required to set targets for waste reduction and recovery based on an assessment of the likely composition and quantity of waste arisings and identification of the most significant cost-effective options for improvement (Quick Wins). This should be supplemented by information on how the targets will be achieved during construction activities and how the actual levels of waste reduction and recovery will be monitored for comparison with the targets set.

A high-level requirement will provide a mandate for action so that waste minimisation (and management) is included in all aspects of project procurement as seen in figure 3.1. For example, emphasising waste in the project brief will ensure contractors invited to tender are qualified and experienced in waste minimisation. Furthermore, setting targets and requirements in contract clauses will hold the contractor and their supply chain accountable. In essence, waste minimisation can cascade throughout all aspects of project procurement. This will ensure roles and responsibilities for implementing waste minimisation strategies are clear and actionable. For more information on setting requirements and exemplar forms of words, please see Procurement solutions on page 15.
4.1 Key benefits
Waste minimisation delivers a compelling range of benefits. In particular, reducing waste has two principle benefits:

- a reduction in the amount of material entering the waste stream reduces the environmental impact of construction; and

- a reduction in waste can result in significant cost savings – see ‘The true cost of waste’ below.

In addition, there are some other considerable benefits which, when combined provide a strong incentive to reduce waste, including:

- **minimising environmental damage** – reduced waste means less quantity of landfill space used and reduced environmental impacts associated with extracting, transporting and manufacturing/processing the raw materials of the construction process;

- **conserving natural resource** – a reduction in the amount of materials actually required for a project and the specification of re-used and recycled materials and packaging on-site results in less demand for virgin materials, thereby stimulating the market for recycled materials amongst product manufacturers and encouraging higher levels of recycling throughout the economy;

- **increased competitive differentiation** – benefits both developers and contractors, in terms of project efficiency through a reduction in construction costs and programme. This is particularly so where waste minimisation opportunities will help to meet prospective client’s sustainability objectives;

- **responding to and pre-empting public policy** – those organisations responding to the thrust of public policy for increased sustainability in construction and the built environment will be in an advantageous position in comparison with those that wait until they are compelled to act by legislation;

- **increased performance against CSR objectives** – real performance against corporate responsibility and sustainability policies can be quantified, thereby meeting the expectations of external stakeholders and employees and enhancing corporate image; and

- **lower CO₂ emissions** – avoiding the need to transport wasted materials both to and from site results in a drop in CO₂ emissions.

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**The true cost of waste**
The cost of waste is not just a waste contractor’s fee; to this one must add the cost of the materials being wasted and the time and resources going into the process of disposal. The true cost of filling and disposing of one skip with mixed construction waste in one study was found to be £1,343. Although the skip hire was only £85, the labour cost to fill it was £163 whilst the cost of unused material in the skip was the most significant at £1,095.

<table>
<thead>
<tr>
<th>Purchase cost of the delivered materials wasted</th>
<th>Cost of waste storage, transport, treatment and disposal</th>
<th>Loss of not selling waste for salvage or not recycling</th>
</tr>
</thead>
</table>

Other additional costs not covered in the above include:

- the time taken on-site sorting, handling and managing waste; and

- poor packaging or overfilling of skips leading to double handling (this cost is very difficult to quantify).
4.2 Key public policy drivers
There is an increasing thrust of European, UK national and local policies and legislation to achieve greater resource efficiency and reduce waste sent to landfill from the construction industry. In addition to mandatory targets, many organisations are voluntarily applying targets to their projects to demonstrate their corporate social responsibility. While there is currently no regulatory obligation to reduce and manage waste, there are some obvious shifts towards greater efficiency across the industry.

Landfill Tax was introduced to encourage organisations to reduce the amount of waste disposed to landfill. There are two rates of tax: a standard rate of £24 per tonne for active waste (substances that either decay or contaminate land) and a lower rate of £2 per tonne for inert materials (including rocks, soils, ceramics and concrete). The standard rate is due to increase by a rate of £8 per tonne until 2010/11 and the lower rate will increase from £2 to £2.50 per tonne in 2008. The proposed increases therefore provide a strong financial incentive to reduce waste with immediate effect.

Site Waste Management Plans (SWMPs) – It is expected that the use of SWMPs will become a mandatory requirement for many projects throughout the UK in the near future. Although SWMPs relate primarily to managing waste produced on-site, they should be developed during the design stage to act as an effective tool to inform the design process and address the waste problem at its source. The SWMP will provide information, such as potential waste streams and their likely quantity, to enable strategic decisions to be made regarding the design and supply chain.

The Code for Sustainable Homes is a voluntary scheme developed by the Government and Industry, and is expected to become mandatory in 2008. The Code focuses on new build housing with the expectation that it will be adapted to apply to all buildings in the longer term. A specific requirement within the Code is for a SWMP to be developed. Further points are awarded where the SWMP includes procedures and commitments that minimise waste in accordance with WRAP/Envirowise guidance.
To reduce waste one must address briefing, design, procurement, logistics and site activities, targeting waste generating activities in each. Best results are achieved when all members of the design and construction team work together to reduce waste through the construction process.

**How is waste generated?**
The main origins of waste found in construction projects determined by previous WRAP studies\(^1\) include:

- **over-ordering** – inaccurate materials estimates and the surplus ordering associated with the low prioritisation of material costs (as compared to labour costs) leading to chronic over-ordering;
- **damage** – to materials either during delivery or during storage on-site (handling errors, inadequate storage, poor co-ordination with other trades);
- **off cuts** – of materials resulting from inefficient design and construction practices;
- **design changes** – leading to reworking and wasted materials;
- **temporary works materials** (e.g. formworks, hoarding, etc); and
- **packaging**.

**How to minimise waste**
Opportunities to reduce waste are presented in guidance sheets across four broad areas:

- communication;
- design;
- procurement; and
- logistics.

Each of these areas contains several opportunities that can help reduce waste on your project. Not every opportunity is applicable in all cases but this guide should give you sufficient information to begin to make real changes on your project.

Table 5.1 on the following page provides a ‘snapshot’ of where the key opportunities are to reduce waste – divided across the above categories.

**Waste minimisation opportunities**
The majority of opportunities to reduce waste exist up-front during the design stage, when either the design process or the design itself can be altered to take into account solutions to reduce waste. However, opportunities also exist when the design is already formulated and construction is underway. It is also important to consider procurement and logistics early on in the project to achieve the greatest impact.

Some opportunities to reduce waste may require more consideration to achieve than others. Specific opportunities do exist that involve simple changes or ‘tweaks’ to the design or construction process.

However, some of the larger opportunities may require a little more consideration to be realised as they may involve more fundamental changes, either to the way in which the design is produced, or to the design itself.

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\(^1\) WRAP, ‘Reducing material wastage in construction, Guidance for clients, contractors and subcontractors on how to deliver good practice in material call-off, buying and usage’
For example, a discreet change to a design which resulted in reduced off cuts could be termed an immediate opportunity. However, to achieve significant improvements in waste reduction it is likely to require a team effort and some fundamental reviews of the design and construction process, for example, establishing a process of waste reviews by the design team on an ongoing basis. These require earlier consideration and a holistic approach but with a potentially larger and more lasting impact.

The key message here is that specific and immediate opportunities do exist and should be pursued wherever possible. In addition, clients should challenge their project teams to pursue some of the larger opportunities as these can have significant impacts upon waste, and in turn, upon cost.

Table 5.1: Areas of waste minimisation opportunities: communication, design, procurement and logistics, with an example of a solution to reduce a specific waste

<table>
<thead>
<tr>
<th>Waste</th>
<th>Areas where you can make a change</th>
<th>Possible solution to reduce waste</th>
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<tbody>
<tr>
<td>Demolition of existing structures</td>
<td>Communication</td>
<td>Design</td>
</tr>
<tr>
<td>Materials from demolition/site clearance</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Temporary structures</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Excavated material</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Waste Arisings from Design Change</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Waste Arisings from the Design Itself</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Off cuts</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Surplus materials</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Damaged materials</td>
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<tr>
<td>Packaging</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Contamination of ‘clean’ waste</td>
<td>✔</td>
<td></td>
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</tbody>
</table>
6.0 Roles and responsibilities

Effective waste minimisation requires a team approach. All members of the design and construction team can contribute to waste minimisation either directly, or indirectly by supporting others in the supply chain. Of particular importance in this team is the client who sets the agenda for the project.

**Client**
Setting a waste minimisation agenda early in the project provides a clear mandate to all parties that good practice is to be implemented at every stage of the project. In particular, using the following form of words in the project brief will ensure that waste (including waste management) is addressed throughout:

- efficient design and stock control to minimise the use and waste of materials;
- reuse and refurbishment of existing infrastructure;
- use of reclaimed products and materials;
- use of renewable materials from legal and sustainable sources (such as timber with appropriate certification);
- waste minimisation on-site;
- recycling of construction, demolition and excavation waste; and
- procurement of products and materials with good practice levels of recycled content (relative to other products meeting the same specification).

These objectives should be pursued while avoiding adverse impact on cost, quality or other requirements in this brief, and minimising transport (especially road transport of heavy materials) where feasible.

**Designers**
Fundamental design decisions about building form and shape can have dramatic effects on the waste likely to be generated. At outline design stage, the designer has a significant opportunity to influence the waste likely to be generated – this includes the reutilisation of existing building stock or materials.

In addition, consideration of the construction process at outline design stage can identify substantial opportunities to minimise waste (and associated costs) during construction.

As the design develops, opportunities to eliminate design waste must be identified and pursued. In addition, good design coordination is required to ensure that unnecessary changes and site modifications are eliminated. The designer should not work in isolation on this and should be supported by the client and contractor.

**Contractor**
The contractor’s main role is to develop the SWMP. This focuses upon site and should address both waste reduction and management. However, it is the contractor who sees where waste is generated on-site and who should be able to support the designer in looking for waste within the design.

Rather than just focusing upon a waste management strategy, the contractor should also identify a waste reduction strategy by which the total quantity of waste will be reduced. In particular, this strategy should reflect the considerations and design decisions taken earlier in response to waste reduction. It is good practice for a contractor to name an individual who is responsible for the development of the SWMP.

**Subcontractor**
The subcontractor is the party that actually orders, and handles the materials. For this reason the subcontractor has a large part to play in delivering the clients objectives and should be engaged early in the waste planning process. In particular, the earlier their involvement, the greater the impact their input will have.

Some trades are likely to be able to provide very focused advice. For example, dry-liners and flooring contractors will be able to produce very accurate estimates of materials required, and should be able to identify exactly what waste will be generated – in turn they will be able to recommend ways to reduce this waste.
Central to waste minimisation is communication. Reducing waste is not a difficult challenge on most projects – what is more challenging is that to achieve reductions project teams need to think about waste differently. Waste needs to be raised up the agenda so that when design decisions are being made, or logistic strategies developed, the impact upon waste is considered and appropriate action is taken. All team members need to understand and share a common goal – that of waste minimisation. Only by working together will this be possible.

**Project briefing**

The catalyst to waste reduction is the client. As part of the pre-project brief and outline concept, the client needs to establish that waste is an important issue and challenge the project team to deliver a project that uses materials efficiently. This can be achieved through:

- requiring the design team to identify and reduce waste wherever possible; and
- requiring the main contractor to develop and implement a SWMP which includes waste minimisation measures.

This guidance provides model forms of words for project briefing on page 17.

**Appointments**

The involvement of stakeholders with the knowledge, capabilities and willingness to reduce construction waste is essential. Second to client buy-in, appointment of appropriate designers and contractors is a key requirement to fulfil the waste minimisation agenda. The project briefing and setting robust contractual requirements are hard communication mechanisms which ensure the appropriate approach to waste minimisation is taken.

Model clauses for procurement contain model forms of words which may be used in both the appointment of a designer and of a contractor. Specific wording is included to address the design and build procurement route.

**Waste minimisation targets**

Setting targets for waste reduction can be an effective incentive to improve. However, this requires careful consideration. For example, if the contractor has an incentive to reduce waste, is a realistic benchmark available from which improvement can be measured. Also, does the contractor have absolute control over the waste quantities – recognising that the design is a major contributing factor? Data on waste minimisation is limited and evidence to show that incentive clauses work is scarce. For this reason, it is recommended that targets are only set for defined elements of work where good data exists. To obtain this data it may be necessary to begin recording a baseline of performance from which improvement targets can be agreed, via negotiation, with contractors and/or subcontractors.

**Soft communication and ways of working**

There are some simple steps that the project team can take to ensure that waste is elevated up the agenda and is addressed robustly. One such solution involves simply adding a waste item to team meetings. If waste is discussed as part of the general project development (whether during design, procurement, or in site meetings), then it cannot be ignored. As an agenda point at each meeting it would ensure that it stays within the core scope of the project, and does not become a ‘sustainability bolt-on’.
SWMPs

A site waste management plan should be developed from the pre-design stage by an appointed member of the design team and passed on to the contractor. SWMPs often focus exclusively upon site activities and how waste streams can be recycled. To get the most out of a SWMP it should also address waste minimisation issues.

If developed by a contractor, it is important that the SWMP looks back to design and is used to capture all actions and decisions made by the design team which affect waste. It is crucial that these are carried through and maximised by the contractor on-site.

At the end of a project, the SWMP should be used as a mechanism to feed back lessons learnt to the design team.

Things to consider:

- Ensure the project brief has clear requirements to minimise (and manage) waste effectively.
- Ensure consultants and contractors have contractual obligations to participate in waste reduction.
- Consider setting waste minimisation targets where there is sufficient data to do so.
- Encourage project teams to think about and discuss waste minimisation options – either as part of regular meetings or within defined waste minimisation workshops.
- Use contractors and subcontractor knowledge early in projects to maximise their input.

Another aspect is partnering across the design and construction team. Contractors and subcontractors have first hand knowledge of what causes waste and how this could be reduced. Sharing this information with designers is essential. In addition, thinking about logistical and procurement issues early on ensures that decisions are not made which later compromise waste reduction initiatives. A key part of this is therefore early contractor involvement so that they may contribute to early waste identification and decision making.

One specific solution that could be used is to hold discreet waste workshops. These would be an effective method of sharing ideas in an open and neutral forum. Again, giving waste such a platform and encouraging participation is likely to generate useful ideas. It also reinforces the message that waste is not just an issue for contractors, but for everyone.

Waste minimisation strategy

Having committed to reducing waste and having identified ways to do it, it is important that these discussions and actions are recorded. What is needed is a waste minimisation strategy. It is likely that this will be linked into the SWMP however often the development of the SWMP begins with the appointment of a contractor. If decisions on waste are being made before this point then they should be captured and then bolted into the SWMP on appointment of a contractor.

A waste minimisation strategy should identify the following:

- where waste arises in design, procurement and logistics;
- waste reduction opportunities and targets;
- an approach to communicate waste minimisation solutions to project stakeholders;
- an approach to monitor their implementation throughout the project life cycle; and
- mechanisms to feedback lessons learnt to the design team.
Design presents some of the greatest opportunities to influence waste. The design of a building determines the size, the shape and the materials required. The principle of waste minimisation in design involves ‘designing out waste’ so to reduce the quantity of waste before it arrives on site.

Getting the design right – i.e. ensuring that wasteful elements have already been addressed – means that the contractor’s role is much simpler on-site. Failure to think about waste at design stage means that, conversely, the contractor will often be unable to reduce some of the wasteful elements which have been ‘locked in’ by the designer.

Below are some of the headline opportunities open to designers. Further information is available in the waste minimisation technical guidance document and WRAP, *Designing out waste in construction*.

Designers need to be flexible in their approach and begin from a position of understanding what is available from the site. Following this, designs need to develop so that they can effectively deliver a wide range of sustainability requirements. Early consideration of issues such as waste is essential. For example, decisions to use offsite, modular construction can often impact upon multiple other elements and so would need to be taken early in the design process.

### Opportunity Description

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>Fundamentals</strong></td>
<td>Fundamental design decisions, such as whether to demolish an existing facility or not, will have the greatest impact on waste. Thus, it is at concept stage where the greatest opportunities lie. For example, a simple structure should have less waste than a complex structure. This is because almost all interfaces require materials to be cut, and every cut results in waste. The simpler the interface, the less cutting and less waste.</td>
</tr>
<tr>
<td><strong>Onsite reuse of materials</strong></td>
<td>Maximising the reuse of materials on-site can significantly reduce the amount of waste generated from the enabling works. For example, careful cut and fill analysis can ensure ground excavated from cuttings can be used as fill material elsewhere such as within embankments, so that no waste is sent to landfill and there is no need to import fill. Not only can demolition materials be processed for aggregates and fill materials, designers should also seek to incorporate other materials such as reclaimed bricks, steel sections, salvageable timbers etc. Where these can’t be used they can often be sold for reuse elsewhere. Many of these decisions are recurrent in regeneration projects. For more information specific to regeneration please see WRAP’s guidance document Efficient use of materials in regeneration projects.</td>
</tr>
<tr>
<td><strong>Standardisation of building form and layout</strong></td>
<td>Repetition of design and element dimensions, either within a building layout or across a range of buildings reduces waste by reducing the number of variables and associated offcuts. Standardisation also allows for the reuse of formwork and falsework and a reduction in mistakes and reworking.</td>
</tr>
<tr>
<td><strong>Standardisation of building materials</strong></td>
<td>Not only can the building form be standardised, but so can the use of materials. For example, limiting the number of cladding solutions should mean that this limited range of materials can be used more efficiently (i.e. less off cuts). Simplification of material choice can increase opportunities for use of off cuts and surplus materials. For example, rationalising the number of concrete mixes can ensure surplus for a particular pour can be used in other parts of the concrete works having the same specified mix reducing the need for expensive part-loads or wastage due to over-ordering. As well as incorporating common materials within the design and specification, the construction programme should be planned so that elements with the same material type are either constructed at the same time or a provision is made for storage and later use of the surplus material.</td>
</tr>
<tr>
<td><strong>Designing to standard material sizes</strong></td>
<td>Designers have the ability to design building layouts to fit the manufactured dimensions of the materials that will be used. For example, wall dimensions may be designed to incorporate standard plasterboard sizes. Conversely, it may be possible for the supplier or manufacturer to cut plasterboard to meet the dimensions and fittings required of the design.</td>
</tr>
<tr>
<td><strong>Offsite/Modern methods of Construction</strong></td>
<td>Designing for the preferential use of prefabricated units can eliminate or reduce the site cutting and handling of materials, having dramatic effects on waste. Offsite manufacture has been shown to reduce waste by up to 90% (volumetric building systems versus traditional) as seen in figure 8.1. The decision to use offsite construction is often cost led, determined by a critical number of units. Rarely is the cost of waste considered in this equation, however, if waste costs were reduced by 90%, the threshold for using offsite construction could drop dramatically and have an associated impact on waste.</td>
</tr>
<tr>
<td><strong>Change management</strong></td>
<td>Designs are often changed throughout the site works with the resultant rework generating considerable volumes of waste. Freezing designs and eliminating variations can significantly improve the waste profile (along with reducing cost). Where it is known the site will face particular constraints which may impact on waste, then the design should accommodate strategies to manage this.</td>
</tr>
<tr>
<td><strong>Maintaining flexibility</strong></td>
<td>Conversely, where feedback from site suggests that waste could be reduced if the design were amended then designers should be willing to explore these opportunities. In this sense the design should not be too prescriptive, allowing adjustments to be made on-site with minimal consequence on time, cost and quality.</td>
</tr>
</tbody>
</table>

**Figure 8.1: Waste reduction potential of offsite construction (%)**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Reduction Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumetric</td>
<td>70–90</td>
</tr>
<tr>
<td>Framing systems</td>
<td>40–70</td>
</tr>
<tr>
<td>Pods</td>
<td>40–50</td>
</tr>
<tr>
<td>Panel Systems</td>
<td>20–60</td>
</tr>
<tr>
<td>Other MMC</td>
<td>30–60</td>
</tr>
</tbody>
</table>
9.0 Procurement solutions

Far too often materials are brought to site only to then be wasted. Waste minimisation in procurement involves producing accurate and reliable estimates of material quantities required on a project. Contingency ordering to account for waste is often inaccurate and unreliable and results in over ordering and material wastage.

An accurate assessment of the materials required should be made, along with an informed allowance for wastage. This is primarily a subcontract issue as it is subcontractors who usually place orders for materials with suppliers. The earlier in the project timeline this is considered, the greater the impact on waste minimisation.

Below are some of the key actions that can help reduce waste on-site.

If subcontractors are serious about this issue they have a real opportunity to improve their core working practices and drive down their tender prices. Regularly evaluating actual wastage against forecasts will mean that sub contractors can focus on where they are inefficient and take action to improve.

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produce accurate materials estimates</td>
<td>To avoid over-ordering, subcontractors need to produce accurate estimates of the materials they require. To do this they need accurate information from which they can produce their own take-off, converting project requirements into a materials allowance. (i.e. converting a m² of brick wall into X number bricks). For most trades this can be very accurate, especially where specialist estimating software is available. The main problem usually arises in subcontractors being given inadequate information. Design teams and main contractors should ensure that subcontractors receive the information they need, and if not, sub contractors should be encouraged to ask for it. Again, a collaborative approach is required. Material estimates can be further improved through using more precise measuring tools such as CAD and bespoke digital estimating software.</td>
</tr>
<tr>
<td>Informed waste forecasts</td>
<td>Subcontractors are going to be unwilling to completely eliminate a wastage allowance. In some instances wastage is unavoidable where designs require materials to be cut. However, to this subcontractors need to add an allowance for site damage, faulty materials etc. This allowance should be as low as possible and well informed. Too often subcontractors use arbitrary wastage allowance with little consideration of the project. The result is that materials are either over or under ordered. Instead, the subcontractor should record how much waste they generate (a useful figure to measure business performance) as a baseline, and to that then modify the allowance up or down depending upon site conditions. For example, if there is an efficient logistics plan that will eliminate damage of materials to the work face then this should be reflected in the wastage allowance (and also in the tender price). Data on wastage rates relative to a baseline including the reconciliation of materials ordered and material used should be shared and communicated so to inform subsequent projects.</td>
</tr>
</tbody>
</table>
10.0 Logistics solutions

Around 15% (by value) of materials delivered to construction sites are wasted. Efficient logistics can play a big part in reducing this figure. Logistics addresses how materials are moved to, from and on-site and how they are stored.

The development of a robust logistics plan should begin early on in the project timeline and is fundamental to effectively reducing waste. This plan should address how waste can be mitigated, and how cost, time and quality can also be improved. Essentially, the logistics plan must address damage to materials, either being delivered to site, being stored on-site or being transported to the workface.

Most construction projects involve complex materials supply arrangements. Below are some waste reduction opportunities which can be considered when developing a logistics plan.

By adopting more efficient logistics, many construction projects could reduce their waste by one-third, within a year. Furthermore, in terms of environmental gain, if loads were consolidated, CO₂ emissions from deliveries to site would fall by up to 70%. WRAP, Efficient Construction Logistics

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply of materials to site</td>
<td>Consolidation centres are offsite distribution facilities that receive and deliver materials, equipment and plant. Materials can be delivered to site from the consolidation centre as and when they are required and in consolidated loads to ensure efficient use of resources and transport. The benefit of a consolidation centre is that it provides a secure environment for materials storage with efficient handling procedures. It also reduces the volume of materials being stored on-site and so can help reduce accidental damage.</td>
</tr>
<tr>
<td>Just in time delivery</td>
<td>Just-in-time (JIT) delivery involves the delivery of materials to site only when they are required for installation. When rigorously applied, JIT logistics is one of the most effective techniques to minimise waste arising from over-ordering, damage, design change, and programming and planning because, by definition, it permits the delivery of only those materials that are immediately required for construction. JIT delivery can take place through a consolidation centre or direct from suppliers.</td>
</tr>
<tr>
<td>Take back schemes</td>
<td>Take back schemes with suppliers can be set up so surplus materials are returned and do not enter the waste stream.</td>
</tr>
<tr>
<td>Site demand smoothing</td>
<td>Demand smoothing is a technique which involves analysing the project programme and smoothing the peaks and troughs in demand for either materials or labour. By smoothing out these peaks, ‘pinch points’ can be reduced as these high areas of activity often result in errors and waste.</td>
</tr>
<tr>
<td>Integrated ICT</td>
<td>Using an integrated ICT system is a powerful tool used to manage materials flow. Particularly useful for large, complex projects, this provides a highly transparent picture of what materials are required when.</td>
</tr>
<tr>
<td>Packaging</td>
<td>Wherever possible, packaging should be either eliminated, or returned to the manufacturer. In practice this is often difficult to achieve with the resultant solution being to bale packaging on-site for recycling.</td>
</tr>
<tr>
<td>Materials on-site</td>
<td><strong>Materials handling strategy</strong> Simply moving materials around site results in damage. For example, insulation boards get crushed and plasterboard edges become damaged. Using small, moveable trolleys that are designed to carry the appropriate materials ensures that materials can be moved around site with ease. In addition, if these are kept to a manual handling size then there is less chance of accidents (both to the materials and the workforce). Furthermore, a total reduction in material handling through, for example, delivering materials direct to point of use or the use of appropriate mechanical plant will also reduce waste.</td>
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<tr>
<td></td>
<td><strong>Logistics specialist</strong> By having a specific person or team allocated to receive deliveries and distribute materials, equipment and plant – just in time – will make sure that operatives handle materials only when assembling or installing.</td>
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<td></td>
<td><strong>Fourth party logistics</strong> When there is more than one supply chain it is important to ensure there is some kind or strategy or centralised coordination of the many logistics providers.</td>
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<tr>
<td></td>
<td><strong>Materials storage</strong> Too often materials are seen on sites sitting in the mud, or out in the rain. If materials are kept on-site it is important that they are stored in an ordered and protected environment. Materials like plasterboard require weatherproof environments whilst blocks and aggregates ideally require an area of clean, hard-standing.</td>
</tr>
<tr>
<td></td>
<td><strong>Culture and training</strong> To ensure that sites operate efficiently a programme of education and awareness raising can help reduce waste. By briefing site operatives that waste minimisation is an important objective and that accidental damage should be reduced, hopefully operatives will take greater care when handling and installing materials.</td>
</tr>
</tbody>
</table>
11.0 Model clauses for procurement

This section provides a ‘family’ of good practice waste minimisation requirements which build upon good practice WMM requirements found in WRAP document, *Achieving good practice Waste Minimisation and Management, Guidance for construction clients, design teams and contractors*. This guidance can be used in conjunction to the waste management guidance and will help strengthen the delivery of waste minimisation objectives.

Organisations wishing to reduce waste are encouraged to make use of the model wording and insert as appropriate in their documentation and processes. Specific waste minimisation clauses are included for the appointment of designers and contractors. These are prefaced by wider project briefs which address both waste management and minimisation.

Figure 11.1 illustrates the project stages for which model wording can be applied.

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<th>Policy statements</th>
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<td>Design/pre-construction</td>
<td>Traditional procurement</td>
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<td></td>
<td>Appointment of designers</td>
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<tr>
<td></td>
<td>Appointment of contractors</td>
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<tr>
<td></td>
<td>Tender specifications/ briefs</td>
</tr>
<tr>
<td></td>
<td>Contract clauses</td>
</tr>
<tr>
<td></td>
<td>Employer’s requirements</td>
</tr>
</tbody>
</table>

**Use of model wording**

Users are referred to the Disclaimer at the back of this guidance document. The model clauses are not intended to replace standard Terms and Conditions of Contract. They are intended for use as part of the client’s specification of the works that define the required output and performance, alongside other clauses on sustainability such as minimum performance on energy and water efficiency. Any organisation or other person should take their own legal, financial and other relevant professional advice when considering the use of the model clauses in any procurement process.

**11.1 Policy statement**

Here is a model statement that can be used in environmental or procurement policies to signal intention and provide a mandate for action:

As part of its commitment to sustainable construction, [Organisation name] aims to improve its efficiency in the use of material resources. One targeted outcome is to continuously reduce the quantity of waste arising and increase the recovery of materials for reuse and recycling on all construction projects. Therefore, in its procurement, [Organisation name] will set requirements for its projects to incorporate good practice waste minimisation techniques and to plan and implement good practice waste management and recovery in accordance with WRAP guidance.
11.2 Project information/briefs

Where the client establishes a high-level brief to the design team or contractor (in the case of design and build and PFI processes), the following wording can be included to define the overall objectives and requirements for environmental performance – thereby providing the mandate for appropriate technical solutions to be offered:

Under general project objectives, the following text is appropriate:

- waste minimisation on-site;
- recycling of construction, demolition and excavation waste; and
- procurement of products and materials with good practice levels of recycled content (relative to other products meeting the same specification).

These objectives should be pursued while avoiding adverse impact on cost, quality or other requirements in this brief, and minimising transport (especially road transport of heavy materials) where feasible.

Where there is a specific outcome for good practice waste minimisation and management, it can be phrased as follows:

As a minimum, we require a Site Waste Management Plan (SWMP) to include a Waste Minimisation Strategy and be developed from the pre-design stage to inform the adoption of good practice waste minimisation in design, and for the SWMP to be implemented in all construction site activities in line with good practice published by WRAP. The Plan is required to set targets for waste reduction and recovery based on an assessment of the likely composition and quantity of waste arisings and identification of the most significant cost-effective options for improvement (Quick Wins). This should be supplemented by information on how the targets will be achieved during construction activities and how the actual levels of waste reduction and recovery will be monitored for comparison with the targets set.

Alongside information on energy efficiency, water efficiency and other environmental performance criteria, the following text can be used to describe aims for materials resource efficiency:

In respect of the efficient use of materials, our aim is to minimise the consumption of finite natural resources and to minimise the quantity of waste being sent to landfill sites. Therefore, as general design principles, we seek the following where commercially viable (in accordance with the waste hierarchy):

- efficient design and stock control to minimise the use and waste of materials;
- reuse and refurbishment of existing infrastructure;
- use of reclaimed products and materials;
- use of renewable materials from legal and sustainable sources (such as timber with appropriate certification);
11.3 Pre-qualification
Assessment of capacity and competence to respond to a requirement for waste minimisation (and management) should be included in pre-qualification processes for all parties involved in delivering a project (e.g. designers, contractors, subcontractors and consultants). Generally speaking, information on ability to reduce wastage and increase recovery of materials should be included alongside other information on environmental performance criteria for the project, such as recycled content in construction projects.

It is expected that pre-qualification processes will include a questionnaire (PQQ) and may be followed by an interview to explore issues in more depth. If the issue of waste minimisation is to be raised during a supplier interview, it is good practice to flag up its importance by including it within the PQQ, thereby providing an opportunity for suppliers to prepare a response.

Following are some examples of PQQs which might be suitable for different members of an organisation or project-specific supply chain. They are followed by guidance on how to interpret different responses and pursue the matter further at interview.

11.3.1 Designers, contractors, subcontractors and consultants
Pre-qualification question:

Does your company have the skills and experience to implement good practice waste minimisation and management in accordance with WRAP guidance during the design and/or construction phase?
See www.wrap.org.uk/construction

Although it is clearly of benefit for the professional consultants to have a good understanding of WMM, it is of most importance if the designers, contractors and subcontractors are able to implement good practice WMM and identify waste recovery Quick Wins. Therefore, they should be able to demonstrate an appropriate awareness and working knowledge accordingly, such as the WRAP guidance.

Should any party fail to respond appropriately to the question, it may be appropriate to refer that party to WRAP’s resources, making it clear that ability to address this issue would be a necessary component of successfully meeting the contract requirements.

If a specific design team member or contractor is identified to take overall responsibility for delivering good practice WMM, it is particularly important that this individual has a good grounding in the processes described in this guidance.

If an interview stage is included, questions could check the specific skills and knowledge levels required by each type of consultant. Whilst it is important that all consultants and contractors understand the issue of good practice WMM, specific skills are required by certain roles. For example, the designer should have a good working knowledge of waste minimisation methods in design and be able to begin the development of the SWMP. Similarly, the contractor should demonstrate experience of operating a site waste management plan in line with published good practice, and know how to manage subcontractors and waste service providers to deliver the required data and site practices.

Identified below are some model questions to be included in the interview guidance:

1. Which good practice WMM processes do you think are applicable to this project and why?
2. What knowledge and experience do you have in developing and/or implementing site waste management plans to good practice levels on construction projects?
3. What is your experience in setting waste recovery targets, measuring waste streams on-site and implementing review processes?

These questions encourage the respondent to expand upon and be specific about the skills and knowledge which they possess.
11.4 Tender specifications, contracts and appointments

The key requirement at this stage is to set out clearly what is expected of the design team and main contractor and how they will demonstrate that they have fulfilled their role in meeting the requirement for waste minimisation. The requirements are formulated in different ways for traditional procurement versus design & build, in order to set out responsibilities clearly. These requirements are supplemental to the core requirements for waste management found in the parallel guidance document.

11.4.1 Traditional procurement

Under the traditional procurement process, the client is involved in separate tendering and appointment processes for the design team and for the contractor. As a result, there are two phases of appointment into which the requirement for waste minimisation should be incorporated – first the designer and then the contractor.

Appointment of designers

The design team has a pivotal role in minimising waste. Including specific requirements for the designer to identify opportunities to reduce waste in their appointment is the best way of ensuring opportunities are maximised (without cost or risk).

After pre-qualification, the following wording may be incorporated in the designer’s form of appointment. This wording is written such that it may form a ‘shopping list’ from which clients can add or remove specific requirements.

This project is committed to materials efficiency. A key aspect of this is reducing the volume of waste generated. The Designer has a key role to play in identifying the sources of waste and in advising on design solutions which will reduce the volume of waste generated on-site.

The Designer shall:

- identify key sources of waste at each design sign off stage;
- work with other members of the project team to identify sources of waste and mitigating solutions (including the contractor when appointed); and
- propose waste reduction solutions advising upon impacts on performance, cost and quality.

In order to achieve the above the designer shall:

- include waste as a formal agenda item at design team meetings;
- identify opportunities to reuse existing materials on-site and provide justification for the non-reuse of materials (where applicable);
- explore opportunities to simplify and standardise design solutions and provide justification where this is not appropriate;
- explore and advise upon the benefits of offsite manufacture of components or elements, commenting upon waste, cost, time and quality; and
- optimise design solutions such that the site cutting of materials is eliminated as far as is practicable.

This should be done in line with WRAP guidance.

The above statement applies to framework and traditional contracts.
Appointment of contractors – tender specifications/briefs

Here is some model wording that can be incorporated into the tender specification for the procurement of a construction project:

Under the preliminaries section or general conditions, introduce the following wording:

[Organisation name] is seeking to minimise the amount of waste generated during the Works. Not only is this an environmental benefit, it will also reduce costs. In addition to the development of a Site Waste Management Plan the Contractor is required to:

- be proactive in supporting the designer to identify causes of waste within the design and agree methods of waste reduction;
- work with subcontractors before starting on-site to identify areas of waste and agree methods of waste reduction; (Note that this may require revisiting the design.)
- negotiate and agree reasonable wastage allowances with subcontractors; (This includes requesting and documenting within the SWMP accurate forecasts of waste from each subcontractor)
- explore and propose construction solutions which will enable a reduction in waste (including off site construction options); and
- develop and implement a logistics plan which addresses both where waste will arise and how it may be reduced. This is to be included within the SWMP and made available to the client on request.
11.4.2 Design and build procurement

Design & build poses a different challenge to the setting of requirements for good practice WMM as the client (Employer) is responsible for the project brief and contractor appointment, and it is the contractor that subsequently owns the processes of design and construction. The contractor should take on the designer’s responsibilities and any negotiations regarding the agreement of waste recovery targets should be carried out during the design stage and negotiated with the Employer’s Agent on the client’s behalf. Similarly the Employer’s Agent should be responsible for advising the client on the validation evidence at contract completion.

The vehicle for setting minimum requirements is the Employer’s Requirements. The Employer’s Requirements contain a set of performance criteria which the contractor must meet. The contractor is responsible for developing these criteria into a suitable design and then for constructing the building.

**Employer’s Requirements**

The tender documentation can include the following wording within the Employer’s Requirements:

- [Organisation name] is seeking to minimise the amount of waste generated during the Works. Not only is this an environmental benefit, it will also reduce costs. In addition to the development of a Site Waste Management Plan the Contractor is required to:

  - identify key sources of waste at each design sign off stage; and
  - propose waste reduction solutions advising upon impacts on performance, cost and quality.

In order to achieve the above during the design stage the contractor shall:

- include waste as a formal agenda item at design team meetings;
- identify opportunities to reuse existing materials on-site and provide justification for the non-reuse of materials (where applicable);
- explore opportunities to simplify and standardise design solutions and provide justification where this is not appropriate;
- explore and advise upon the benefits of offsite manufacture of components or elements, commenting upon waste, cost, time and quality; and

- optimise design solutions such that the site cutting of materials is eliminated as far as is practicable.

And in addition, the Contractor shall:

- work with subcontractors before starting on-site to identify areas of waste and agree methods of waste reduction (Note that this may require revisiting the design);
- negotiate and agree reasonable wastage allowances with subcontractors; (This includes requesting and documenting within the SWMP accurate forecasts of waste from each subcontractor);
- explore and propose construction solutions which will enable a reduction in waste (including offsite construction options); and
- develop and implement a logistics plan which addresses both where waste will arise and how it may be reduced. This is to be included within the SWMP and made available to the client on request.

This should be done in line with WRAP guidance.
12.0 Conclusion

This guidance provides a summary for construction clients, design teams and main contractors for achieving good practice waste minimisation on their construction projects. This will help reduce the amount of construction waste sent to landfill, thus demonstrating a contribution to sustainable development and reducing project costs.

Good practice Waste minimisation can be achieved on all forms of project without a fundamental change in working practice. In summary, key aspects of achieving good practice waste minimisation include:

- early project implementation by the client to maximise potential benefits;
- setting requirements for its delivery by the entire supply chain;
- ensuring that waste minimisation becomes part of the agenda of the project; and
- adopting a SWMP in accordance with good practice to inform design and manage waste on-site.

WRAP have produced two further guidance documents for achieving good practice waste minimisation: a high-level business case for client decision makers and a technical summary for implementation by the contractor and their supply chain. In addition, WRAP’s construction portal www.wrap.org.uk/construction contains extensive related information covering all aspects of materials use in construction, including case studies, reference guides and managing specific waste streams.
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