Actions:
During the outline stage:
- ensure that core materials resource efficiency features are understood;
- consider materials resource efficiency objectives in the outline design;
- include materials resource efficiency in the pre-qualification information; and
- undertake a pre-demolition audit.

During the detailed design:
- consider materials resource efficiency factors;
- estimate and set project KPI targets;
- address materials resource efficiency in tender documents; and
- address materials resource efficiency in the planning submission.

Who needs to act?
- Clients
- Project Managers
- Architects
- Designers
- Contractors
- Demolition Contractors.
The Design phase includes the outline design, the development of the detailed design, the planning application and the tender phase. This is the most extensive part of the guidance, reflecting the importance of embedding materials resource efficiency early in the project. Design Phase information is applicable to all parties involved in the design and implementation of regeneration projects.

Consultants who implement efficient use of materials in regeneration projects help ensure that the client’s objectives are met in the most efficient manner, and that the approach is propagated along the rest of the supply chain.

Actions:
During the outline stage:
- Ensure that core materials resource efficiency features are understood.
- Consider materials resource efficiency objectives in the outline design.
- Include materials resource efficiency in the pre-qualification information.
- Undertake a pre-demolition audit.

During the detailed design:
- Consider materials resource efficiency factors.
- Estimate and set project KPI targets.
- Address materials resource efficiency in tender documents.
- Address materials resource efficiency in the planning submission.

Who needs to act?
- Clients
- Managers
- Architects
- Designers
- Contractors
- Demolition Contractors.

If the pre-demolition audit is undertaken during the design phase then the recovery of material from the demolition works can be maximised.
9.1 Outline design factors

There are a range of factors that should be considered at the outline / conceptual design phase of the project. These should be considered by architects and consultants providing professional advice to their clients and considering the way forward for the project with respect to the materials resource efficiency objectives.

When undertaking an architectural design the efficient use of materials needs to be borne in mind for both the existing structure and the new build. Factors that should be considered include:

- off-site / modern methods of construction;
- minimising waste as part of the design process, for example, by designing to match standard component sizes;
- designing for adaptability / deconstruction;
- specifying sustainable materials and components;
- considering products / elements with higher recycled and reclaimed content; and
- considering elements and materials that can be derived from the existing building.

When considering these factors in the design a range of questions can be asked, some of which are outlined below.

- How well is the composition of the existing structure and infrastructure understood? Perhaps a visit to the existing structure to consider materials resource efficiency aspects might produce ideas that could be incorporated into the new design.
- Can materials resource efficiency objectives, such as the reclamation of existing structures or parts of structures (facades, for instance), be incorporated?
- Can aged components, [bricks, tiles, slabs and so on] from the existing structure be used for an aesthetic effect?
- Are there reclaimed materials available from the existing structure? Are there materials that can be reclaimed intact from the existing structure in the new build?
- Is there a feature of the existing structure that can be incorporated into the new build to give a sense of historic continuity with the previous use of the site?
- Can topsoil be retained for landscaping? If not, can fines be retained for the creation of topsoil with imported compost?

If not integrated early into the design, the reclamation of components becomes more difficult as it is unlikely that the existing materials will match the selected design choice.

Example:

A particular style of roof tile could be chosen as part of the design, but the probability of this matching the existing roof tile is low. However, if the existing roof tile had been considered earlier, then it is possible that the design could have been influenced to make use of the existing roof tiles.

Even if limited quantities of materials can be reclaimed from the demolition for inclusion in the new build, the material used in the new build can deliver upon the objectives on the efficient use of materials. If the potential for on-site reclamation is limited, the on-site recycling of materials will tend to be focused towards aggregates as the processes and technologies for the on-site production of these materials are well established, and there will be a demand for aggregates in the new build. This is of less interest to architects, but their support for the use of on-site recycled material will help to ensure that the project (and client’s) materials resource efficiency objectives are met.

In addition to this architectural design focused set of questions, there are a number of other factors to be considered early in the design. These are presented in section 9.5.
9.2 Pre-qualification information
The pre-qualification process helps clients decide whether contractors bidding for the work have the necessary attributes. As such, pre-qualification can be used to interrogate a bidder’s commitments to, and capabilities in, materials resource efficiency.

Example pre-qualification questions for project and / or demolition procurement are given in the box below.

Example pre-qualification questions concerning materials recovery, for use in the procurement of demolition and new build services.

- During demolition what steps does your organisation take to maximise materials recovery and reduce waste sent to landfill?
- What steps does your organisation take to minimise and recover waste generated during construction?
- Does your company have the ability to measure and improve the recycled and reclaimed content in construction projects?

The following categories should be evaluated:

**Demolition**
- Experience in the recovery of demolition arisings for subsequent use in the new build.
- Demonstrable track record in waste segregation and material recovery.
- Company policies to enhance recovery of demolition arisings.

**New build**
- Experience in the implementation of Site Waste Management Plans and the use of WRAP’s RC Toolkit.
- Demonstrable track record in waste minimisation through the supply chain, waste segregation on-site and material recovery.
- Verifiable track record of specifying or using products with higher than average recycled and reclaimed content in new build construction.
- A Sustainable Construction Policy that includes reference to materials use and waste.

**Scoring of responses should be broadly in accordance with the following system:**

- **maximum points** – fulfilling all three demolition categories and all four new build categories;
- **medium points** – fulfilling two out of three demolition categories and two out of four new build categories; and
- **minimum points** – not fulfilling any of the categories.
9.3 Pre-demolition audit

Pre-demolition audits would normally be undertaken during contract bidding or at the start of the demolition phase of the project. However, if the pre-demolition audit is undertaken during the design phase then the recovery of material from the demolition works can be maximised. This approach is outlined below. It can be used by designers collecting information and data to allow them to take account of materials resource efficiency in the design, and estimate KPI requirements. If the alternative approach, of undertaking the pre-demolition audit during bidding or at the start of the demolition, is adopted the approach will be of interest to contractors.

A key element in maximising the recovery of demolition arisings at source is ensuring that sufficient time is available to complete a pre-demolition audit and prepare a plan for material recovery. This process is enhanced by ensuring that the requirements for material recovery are included within the procurement of demolition services. These could be stated as simple requirements, or presented as a detailed list of recovered materials required in the new build.

The current approach to a pre-demolition audit includes the assessment and agreement of requirements between the demolition contractor and the developer, and draws on the processes identified in the online AggRegain guidance ‘Demolition: Implementing Best Practice’. The AggRegain guidance also considers the role of Health and Safety in demolition and material recovery, the potential for on-site recycling, and includes a ‘walk-through’ example of a pre-demolition audit.

Outline of proposed pre-demolition audit timeline

- Developer appoints design team to undertake an initial pre-demolition audit
- Design team undertakes an initial pre-demolition audit and produces minimum Demolition Recovery Index (DRI) target for project
- Design team supplies demolition contractors with pre-demolition audit data, building drawings and proposed targets
- Demolition contractors can:
  - undertake their own pre-demolition audit and demonstrate to design team where further increases to the DRI can be made; and
  - opt to simply meet the recovery targets proposed by the design team based on the initial pre-demolition audit.
- Design team selects a demolition contractor based upon the contractor evaluation criteria
- The developer, design team and demolition contractors meet to further discuss revised DRI and feasibility stages of the project
The preferred approach would be to commission a pre-demolition audit as part of the design stage. This would provide:

- data on the potential range and quantities of recovered materials available for the new build, allowing the designer to modify the new build design to maximise the amount of on-site recovered materials; and
- data for inclusion in the tender documents, removing the need for multiple ‘pricing audits’ to be undertaken by the contractors bidding for the work and maximising the likelihood of innovative proposals for the demolition which improve the quantity of recovered materials.

The pre-demolition audit method is the same as that proposed by the ICE Demolition Protocol:

1. produce a Bill of Quantities of the different materials in the building to be demolished;
2. identify the tonnages of material that can be recovered; and
3. determine the percentage of materials recoverable.

It is also similar to the approach adopted in the preparation of Site Waste Management Plans, which requires an estimation of the quantities of arisings that will be generated during the demolition process and identification of methods to deal with them.

An alternative approach can be used when it is not feasible to undertake a pre-demolition audit during the design phase. In this case, the tender documents can request indicative KPI targets be submitted as part of the contractor’s bid. These indicative KPI targets can then be used as (a) part of the bid assessment or (b) the basis for negotiation when the pre-demolition audit is undertaken by the successful contractor on possession of the site.

Further information on demolition and deconstruction is available through a range of publications from construction industry organisations.

9.4 Example pre-demolition audit

A pre-demolition audit will either be undertaken by the designer during the outline design phase of the project (if the preferred approach is adopted) or by the contractor during the tendering or at the start of the demolition (if the alternative approach is adopted). It will enable the collection of information to address the efficient use of materials in the project and estimate KPI requirements.

Case study

Light industrial units, Cwmbran, South Wales

A pre-demolition audit was undertaken on a series of small light engineering units earmarked for demolition and replacement with an office building. The pre-demolition audit was undertaken in accordance with the BRE SmartAudit methodology. This generated a demolition Bill of Quantities as shown opposite.

In addition, WRAP is developing a module, complementary to its ‘Recycled Content (RC) Toolkit’ which aims to value the materials generated by building demolition.
### Pre-Demolition Audit data

<table>
<thead>
<tr>
<th>Product</th>
<th>Volume [m³]</th>
<th>Approx. quantity available (tonnes)</th>
<th>Recycled material</th>
<th>Recovery potential</th>
<th>Approx. quantity for recovery (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramics (bricks)</td>
<td>8.8</td>
<td>16</td>
<td>RA</td>
<td>95%</td>
<td>15</td>
</tr>
<tr>
<td>Concrete (blocks)</td>
<td>26</td>
<td>57</td>
<td>RCA</td>
<td>95%</td>
<td>54</td>
</tr>
<tr>
<td>Metals</td>
<td>3.2</td>
<td>25</td>
<td>Metal</td>
<td>95%</td>
<td>24</td>
</tr>
<tr>
<td>Plaster/cement (boards)</td>
<td>19</td>
<td>29</td>
<td>N/R</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Timber</td>
<td>1</td>
<td>1</td>
<td>Wood</td>
<td>100%</td>
<td>1</td>
</tr>
<tr>
<td>Concrete (ground slab)</td>
<td>100</td>
<td>240</td>
<td>RCA</td>
<td>95%</td>
<td>228</td>
</tr>
<tr>
<td>Asphalt</td>
<td>80</td>
<td>176</td>
<td>RA</td>
<td>95%</td>
<td>167</td>
</tr>
<tr>
<td>Subbase</td>
<td>200</td>
<td>360</td>
<td>RA</td>
<td>85%</td>
<td>306</td>
</tr>
<tr>
<td>Total</td>
<td>904</td>
<td>796</td>
<td></td>
<td></td>
<td>796</td>
</tr>
</tbody>
</table>

**Projected Demolition Recovery Index** 88%

**Combined totals**

<table>
<thead>
<tr>
<th>Recycled Materials</th>
<th>Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>488</td>
</tr>
<tr>
<td>RCA</td>
<td>282</td>
</tr>
</tbody>
</table>

From the data presented, a total material recovery potential of 88% was estimated (quantity of materials for recovery divided by total materials available). This could be used as a basis for negotiation with the client to agree a project DRI requirement.
9.5 Detailed design factors to consider

This information will be primarily of interest to architects and designers providing professional advice to their clients when working on a project where objectives on the efficient use of materials have been set. There are a number of factors that should be addressed early in the design process to ensure that the project meets these objectives, including:

- ensuring that the project fits within the client’s policy and objectives. The design team should be fully aware of the client’s policy and objectives with respect to the efficient use of materials, in order to address them through the design and also to ensure all other parties in the project team are working towards them. If the client has no materials policy or objectives, the design team should draw attention to the advantages to be gained through the efficient use of materials within the project;

- raising awareness of the efficient use of materials and the wider recycling and sustainability agenda within the whole design team. Extensive introductory and detailed guidance is available from a number of other documents and web pages (see Section 14, Additional Resources);

- recognising the potential to use recovered materials from the demolition in the new build. The design team should adopt the specific objective of using as much recovered material from the demolition in the new build as practicable; and

- identifying as early as possible the additional tasks that the efficient use of materials introduces to the regeneration project. This will ensure that these tasks are undertaken in an efficient and timely manner, minimising the work and possibly eliminating certain tasks and saving money later in the project.

Additional tasks can include:

- introduction of objectives and requirements into the contract documentation;

- inclusion of objectives and requirements in planning submissions, as required by Planning Authorities;

- RC Quick Wins assessment using the RC Toolkit;

- pre-demolition audits to gather information on materials available from the demolition;

- defining the minimum requirements for the KPIs; and

- early adoption of requirements that will cascade good practice throughout the project.
9.6 How to set KPI requirements

This information will be primarily of interest to architects and designers working on projects where the procurement route is traditional. The objective is to set an achievable KPI requirement combined with a requirement to identify and subsequently adopt the cost-competitive reclamation and recycling options (see Section 5, Key performance Indicators). Three KPI requirements should be set as early in the project as possible:

1. Demolition Recovery Index (DRI), based on the ICE Demolition Protocol.
2. Retained Material (RM), a new KPI proposed by this MRER approach.
3. Recycled (and reclaimed) Content (RC), from the WRAP Quick Wins approach.

For Design & Build and PFI procurement routes reference should be made to Section 8, Feasibility Stage.

The guidance in this section addresses specific issues related to producing estimates for inclusion in tender documents. A number of data sets are required.

- A listing of the type and quantity of materials that can be recovered from the demolition. This includes materials that can be recovered for use on-site (Q1) and those recovered for use elsewhere (Q2). This could be generated from (a) a pre-demolition audit or (b) knowledge of materials produced by demolition on similar projects.
- The total amount of other materials (arising) that will be produced by the demolition (Q3). This could be generated from (a) a pre-demolition audit or (b) knowledge of materials produced by demolition on similar projects.
- An estimate of the baseline RC for the project and a listing of the top 10 opportunities to increase the overall RC (that is, Quick Wins including recovered materials and manufactured products). This can be rapidly determined from the outline design using WRAP’s RC Toolkit.

From the Quick Wins identified, a listing of the recovered materials from the demolition that can be used in the new build (Q1).

Data sets Q1, Q2 and Q3 are required for an estimation of the DRI. Data sets Q1 and Q2 are required for an estimation of the RM. The RC Toolkit provides considerable assistance with the estimation of RC and, as such, the calculation of RC is unlikely to be a problem.

If Q1, Q2, Q3 and the Quick Wins listing are available, then KPIs can be calculated, as defined in Section 5, Key Performance Indicators, and included with confidence in any procurement and planning documentation.

If these quantities are not available, the alternative approaches are:

- set requirements based on past experience or other information, such as case studies; or
- ask the contractor to provide an indicative requirement as part of their bid submission. This could be used to assess bids or as a basis for negotiation when more information is available.

This information will be primarily of interest to architects and designers working on projects where the procurement route is traditional. The objective is to set an achievable KPI requirement combined with a requirement to identify and subsequently adopt the cost-competitive reclamation and recycling options.
9.7 Planning applications

Depending on the requirements of the local Planning Authority, the efficient use of materials may need to be taken into account in the early stages of project design to ensure that the project adheres to the relevant planning requirements for instance, producing a material strategy. This guidance will mainly be of interest to clients and consultants.

The government has set out national policies to drive sustainable development. Planning policies require high quality development through good and inclusive design, and the efficient use of resources. Such policies could see the adoption of materials resource efficiency in regional plans and local development frameworks and guidance.

The local Planning Authority for the project should be consulted to establish whether they have set any materials efficiency requirements (for both the demolition and the new build). To demonstrate a commitment to efficient use of materials in regeneration, the planning submissions should outline the processes proposed for:

- setting objectives;
- defining requirements for materials resource efficiency KPIs;
- addressing materials resource efficiency in the design; and
- propagating materials resource efficiency down the supply chain via the tender and contract documents.

9.8 Invitations to Tender

This section presents information on invitations to tender during the outline design phase of the project, which will be primarily of interest to consultants acting on behalf of clients and developers and to contractors issuing tenders to demolition sub-contractors.

The Invitation to Tender (ITT) usually includes an Output Specification (OS) that quantifies the service and performance requirements of the project. This could include a KPI requirement for DRI, RM and RC. Example OS requirements for the demolition, based around the project objectives on the efficient use of materials (see Section 5, Feasibility Stage), are included in the box here.

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Example Output Specification for inclusion in an Invitation to Tender for demolition services.

Anticipated demolition arising recovery outcomes:

- the contractor will measure the Demolition Recovery Index (DRI) performance of the project, achieve a minimum of 75% [or other specified amount], and demonstrate that higher levels of recovery have been achieved where technically and commercially viable. The contractor will provide evidence of what is achievable prior to commencing works on-site;

- preparation and implementation of a Site Waste Management Plan; and

- assessment and agreement of a quantity of recovered material to be retained for use in the new build phase of the project, the Retained Materials (RM) KPI.

Monitoring, verification and reporting of performance on the DRI and RM KPIs.
For the new build, the OS should also include a requirement to implement Site Waste Management Plans to facilitate effective waste minimisation and management, and should specify a percentage value requirement for the use of recycled and reclaimed materials in the new build construction. Model OS clauses are listed below. (For updates visit www.wrap.org.uk/construction).

Example Output Specification for inclusion in an Invitation to Tender for new build

Anticipated outcomes for waste minimisation and management during construction:

- preparation and implementation of a Site Waste Management Plan to facilitate the measuring of waste and recovery levels. The plan is required to evaluate what level of waste reduction, reclamation and recycling is possible, measure waste arising from the project and set targets for material diverted from landfill and waste reduction.

Anticipated outcomes for the inclusion of recycled and reclaimed content in the new build construction:

- [organisation name] is committed to improving the environmental performance of their construction projects. Designs and specifications should consider the environmental impact of all elements of the design including choice of materials. One important contribution to sustainability goals is the efficient use of material resources thus diverting waste from landfill. This can be achieved by using materials that have above-average recycled and reclaimed content;

- those materials with a higher recycled and reclaimed content, with comparable performance and availability and which are cost-neutral are referred to as ‘Quick Wins’;

- in accordance with the recommendations of the government’s Sustainable Procurement Group and Sustainable Buildings Task Group, this project is required to achieve a minimum 10% (or other specified level) of recycled and reclaimed content as a percentage of the total value of materials used in construction activities. This has been shown to be feasible and affordable in a wide range of case studies which can be downloaded from the WRAP website (www.wrap.org.uk);

- the contractor must demonstrate that the most effective cost-neutral opportunities to increase the value of materials deriving from reclaimed and recycled content (for example, the top 10 Quick Wins) have been identified and considered, that good practice has been implemented where technically and commercially viable, and that the targeted improvements made in the total recycled and reclaimed content above ‘baseline practice’ for the project have been quantified. Clauses defining the minimum level of recycled and reclaimed content to be achieved on each of the selected Quick Wins should be inserted into the contractor’s specification; and

- tools and resources for evaluating Recycled (and Reclaimed) Content (RC) and identifying Quick Wins with minimum effort are available from WRAP (www.wrap.org.uk).
9.9 Contract clauses

When producing contract documents as part of the design process, consultants should include contract clauses on the efficient use of materials.

The OGC-Defra Joint Note on Environmental Issues in Purchasing states that: “Contract conditions should be relevant to the performance of the contract and the achievement of value for money. As a general rule, contract conditions should be used sparingly, as they will be unlikely to contribute to cost-effectiveness or affordability.” Clauses could be included into the relevant section of any tender document for projects involving both demolition and new build, which use common conditions of contract such as NEC, ICE 7th, JCT and the NFDC. The example demolition contract clauses given opposite reflect this approach.

Example contract clauses

Demolition

Definitions

- Demolition Recovery Index (DRI). The ratio of the quantity of recovered materials produced from the demolition, to the total quantity of materials available from the demolition works, expressed as a percentage.

- Retained Material (RM) quantity. The ratio of the quantity of the recovered materials from the demolition used in the new build, to the total quantity of recovered materials produced from the demolition, expressed as a percentage.

Performance criteria

- Assessment and agreement of the DRI and RM requirements to be achieved as part of the demolition process.

- Monitoring, verification and reporting of the levels of material recovery and retention achieved.

- Preparation and implementation of a Site Waste Management Plan, which embeds the DRI and RM requirements.

New Build

Definitions

- Recycled Content (RC): The ratio of the value of recycled and reclaimed content in the new build, to the total value of the materials used, expressed as a percentage.

Performance Criteria

- Preparation and implementation of a Site Waste Management Plan to facilitate the measuring of waste and recovery levels.

- Assessment and agreement of the Recycled Content (RC) requirements to be achieved in the new-build.

- Monitoring, verification and reporting of the levels of recycled content achieved.

Further guidance on RC contract clauses is available from WRAP.

9.10 Example assessment of tender KPI requirements

Contractors responding to a tender invitation will need to assess the KPI requirements specified, or requested as indicative values, in a tender document. The assessment process is set out in the worked example below. This information will also provide guidance to consultants who are estimating KPI values.

An Invitation to Tender was received by a contractor to construct a two-storey office block on the site of a series of four small light industrial units. The tender stated that the Recycled Content (RC) requirement for the new build was 10%. A Quick Wins assessment, carried out by the design team in advance of the Invitation to Tender using WRAP’s RC Toolkit, had indicated that a RC of 19% was achievable with standard practice and 25% with good practice. The tender also included indicative values for the Demolition Recovery Index (DRI) KPI of 75% and Retained Material (RM) KPI of 30%. To establish these indicative values an initial pre-demolition audit was conducted by the design team to assess the likely quantities of material arising from the demolition. The design team pre-demolition audit is outlined below.

### Pre-Demolition Audit data – materials available in demolition

<table>
<thead>
<tr>
<th>Element</th>
<th>Approx. quantity available (tonnes)</th>
<th>Recycled material</th>
<th>Recovery potential</th>
<th>Approx. quantity for recovery (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramics (bricks)</td>
<td>16</td>
<td>General fill</td>
<td>94%</td>
<td>15</td>
</tr>
<tr>
<td>Concrete (blocks)</td>
<td>57</td>
<td>RCA</td>
<td>95%</td>
<td>54</td>
</tr>
<tr>
<td>Metals</td>
<td>25</td>
<td>Metal</td>
<td>96%</td>
<td>24</td>
</tr>
<tr>
<td>Plaster/cement (boards)</td>
<td>29</td>
<td>N/R</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Timber</td>
<td>1</td>
<td>Wood</td>
<td>100%</td>
<td>1</td>
</tr>
<tr>
<td>Concrete (ground slab)</td>
<td>240</td>
<td>RCA</td>
<td>95%</td>
<td>228</td>
</tr>
<tr>
<td>Asphalt</td>
<td>176</td>
<td>General fill</td>
<td>95%</td>
<td>167</td>
</tr>
<tr>
<td>Subbase</td>
<td>360</td>
<td>Subbase</td>
<td>85%</td>
<td>306</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>904</strong></td>
<td></td>
<td></td>
<td><strong>796</strong></td>
</tr>
</tbody>
</table>

RCA = Recycled concrete aggregate
N/R = Non-recoverable

The totals produced from this pre-demolition audit allow a projected value for the DRI KPI to be calculated as shown below.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total potential recoverable materials from demolition</td>
<td>796 Tonnes</td>
</tr>
<tr>
<td>Total potential arisings from demolition</td>
<td>904 Tonnes</td>
</tr>
<tr>
<td>Projected DRI</td>
<td>88 %</td>
</tr>
</tbody>
</table>
Dividing the total recoverable materials by the total amount of arisings available gives a projected DRI of 88%. The level to be set as an indicative value for the DRI KPI in tender documentation is a function of the confidence that can be placed in the data. Factors to consider in assessing the data confidence are:

- the assessment of element quantities;
- the amount and quality of recycled and reclaimed materials created by the reprocessing; and
- the practicality of producing the recycled and reclaimed materials.

Following the assessment of these factors and the competitive position, it was decided to state an indicative value for the DRI KPI of 75% in the tender documentation.

The pre-demolition audit also shows that the demolition could potentially produce the following types and quantities of materials, which in turn allow the Retained Materials (RM) KPI to be calculated.

A new build elements list (Bill of Quantities) was also supplied to the demolition contractors to indicate which types of materials were needed in the new build. An extract from this new build listing is shown below.

<table>
<thead>
<tr>
<th>Element</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab reinforced in situ concrete BS 5328, C30 or higher, 20 mm aggregate, 100 mm</td>
<td>m²</td>
<td>824</td>
</tr>
<tr>
<td>General fill</td>
<td>m³</td>
<td>144</td>
</tr>
<tr>
<td>Reinforced in situ concrete C30 or higher, 225 mm slab</td>
<td>m²</td>
<td>785</td>
</tr>
<tr>
<td>Block paving</td>
<td>m²</td>
<td>1800</td>
</tr>
<tr>
<td>Bedding sand, 50 mm</td>
<td>m³</td>
<td>90</td>
</tr>
<tr>
<td>Unbound subbase, 300 mm</td>
<td>m³</td>
<td>540</td>
</tr>
<tr>
<td>Suspended ceiling; concealed grid; mineral wool based tile</td>
<td>m²</td>
<td>1570</td>
</tr>
<tr>
<td>Radiator heating system including heat source heat only offices</td>
<td>m²</td>
<td>1570</td>
</tr>
<tr>
<td>Expanded polystyrene (EPS) zero ODP 50 mm</td>
<td>m²</td>
<td>785</td>
</tr>
</tbody>
</table>

Examining the list, it was apparent that the only materials needed in the new build that could be supplied from the demolition were recycled concrete aggregate (RCA) and general fill, producing a limited design recycled materials list as shown below.

<table>
<thead>
<tr>
<th>Recycled product</th>
<th>Mass (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCA</td>
<td>282</td>
</tr>
<tr>
<td>Subbase</td>
<td>306</td>
</tr>
<tr>
<td>General fill</td>
<td>182</td>
</tr>
<tr>
<td>Metal</td>
<td>24</td>
</tr>
<tr>
<td>Wood</td>
<td>1</td>
</tr>
</tbody>
</table>

The quantities in the list were calculated from the Bill of Quantities, above, using approximate densities. RCA is assumed to have a density of 1.7 t/m³, and general fill, density of 1.8 t/m³.
The efficient use of materials in regeneration projects: 9. Design phase

Design recycled materials list

<table>
<thead>
<tr>
<th>Required element</th>
<th>Quantity (m³)</th>
<th>Mass (tonnes)</th>
<th>Recovered materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unbound Subbase, 300 mm</td>
<td>540</td>
<td>918</td>
<td>Subbase and RCA</td>
</tr>
<tr>
<td>General fill</td>
<td>306</td>
<td>259</td>
<td>General fill</td>
</tr>
</tbody>
</table>

The concrete specification used in the new build meant that RCA from the demolition is unlikely to be suitable as an aggregate in this application. Instead, the RCA would be used in the unbound subbase layer of the office car park.

If processed and stockpiled on-site, demolition arisings could produce approximately 588 tonnes of material suitable for use as subbase (282 tonnes of RCA and 306 tonnes of subbase), and approximately 182 tonnes of general fill that could be used in the new build.

Dividing the required materials (182 tonnes of general fill, 282 tonnes of RCA and 306 tonnes of subbase) by 796 tonnes of recovered materials gives a projected value for the RM KPI of 97%.

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subbase</td>
<td>306</td>
<td>Tonnes</td>
</tr>
<tr>
<td>RCA</td>
<td>282</td>
<td>Tonnes</td>
</tr>
<tr>
<td>General fill</td>
<td>182</td>
<td>Tonnes</td>
</tr>
<tr>
<td>Total on-site recovered material to be used in new build</td>
<td>770</td>
<td>Tonnes</td>
</tr>
<tr>
<td>Total potential recovered materials from demolition</td>
<td>796</td>
<td>Tonnes</td>
</tr>
<tr>
<td>Projected Retained Material (RM)</td>
<td>97</td>
<td>%</td>
</tr>
</tbody>
</table>

Again, the level to be set as an indicative value in tender documentation for the RM KPI is a function of the confidence that can be placed in the estimated data.

The factors to consider are similar to those for the DRI with the addition of:

- practicalities of on-site processing and stockpiling; and

- the cost-effectiveness of the extra on-site processing versus sale and later purchase of recycled materials.

Following the assessment of these factors, it was decided that on-site reprocessing of the concrete arisings from the demolition was not cost-effective, so it was decided to state an indicative value for the RM KPI requirement of 30% in the tender documentation.

Additional resources (See section 14)

| AR1  | WRAP, The Demolition Protocol [all volumes]. |
| AR2  | WRAP, Setting a requirement for recycled content in building projects. |
| AR8  | WRAP, RC Toolkit. |
| AR10 | WRAP, AggRegain web pages [demolition]. |
| AR13 | DTI, Site Waste Management Plans. |
| AR14 | ICE, The Demolition Protocol. |
| AR19 | NEC, Contract. |
| AR20 | ICE, Conditions of Contract. |
| AR21 | JCT Contract Suite. |
| AR22 | National Federation of Demolition Contractors. |
This is one of a series of booklets which together form WRAP’s guide: The efficient use of materials in regeneration projects. While this booklet is designed to be used separately it may refer to sections in the main guide.

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