

## **Circular Economy Statement**

### **Harefield Grove**

**Stroma Reference: OPP-089359**  
**Date: 01/09/2023**  
**Prepared for: Comer Homes Group**

# 1. Executive Summary

## 1.1. Scope

This Circular Economy Statement has been commissioned on behalf of Comer Homes Group to support the planning submission for the proposed development of Harefield Grove.

This report has been prepared in line with the guidance given in the GLA Document 'Circular Economy Statement guidance, March 2022' and against the requirements of London Plan Policy SI7 Reducing waste and supporting the circular economy .

## 1.2. Circular Economy Approach

The construction industry generates about 35% of waste to landfill across the globe (Solís-Guzmán et al., 2009). In the UK, out of 100% of waste generated in 2013, 44% was due to construction and the rest was as a result of commercial, industrial, household, mining and agricultural activities (Ajayi and Oyedele, 2017). More than half of construction and demolition waste (C&DW) is disposed directly to landfills In the UK (Chinda, 2016). C&DW generation for the UK in 2014 was 58 million tons (Menegaki and Damigos, 2018). Integrated and optimised management of this waste is one of the pillars of strategy 2020, "A Roadmap to a Resource-Efficient Europe", whose goal is to reduce, reuse and recycle the waste (European Commission, 2011, Rodríguez et al., 2015).

Policies worldwide recognise that the construction sector needs immediate mitigation actions for reducing greenhouse gas (GHG) emissions, climate change and resources depletion, with a focus on adopting circular economy approach to ensure sustainable use of construction materials (Hodge et al., 2010, Sieffert et al., 2014). Circular economy is an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes (Kirchherr et al., 2017). The circular economy model tries to keep the products and materials 'in flow' by means of effective and smart re-use strategies, therefore, reducing the use of virgin materials and negative environmental impacts (Mirata, 2004). (Ghaffar, Burman and Braimah, 2020).

Opportunities for retaining and refurbishing the existing buildings and materials on site have been assessed to maximise the potential residual value of the existing structures and conserve resources by reducing the need to new materials. An assessment was made of the existing site to determine if any of the existing structures and hard landscaping could be retained, reused, or recycled.

The existing building will be retained to provide residential development with the creation of 6 apartments.

The new buildings will avoid unnecessary materials use arising from over specification without compromising structural stability durability or the service life of the building.

This will be achieved through:

1. Reduce cost as a result of a reduction of material use in building design.
2. Encourage the reuse of existing materials.
3. Encourage the use of materials with higher levels of recycled content.
4. Improve understanding of, and the performance of, alternative design and construction methods that result in lower material usage and waste levels.

A project specific Waste Management Strategy will be developed for the operation stage of the development to ensure that waste arising can be accommodated during occupancy stage of the development.

An initial assessment has been prepared against local, regional and national policy to determine the optimum sizing of waste storage areas on the site.

A Sustainable Procurement plan will be developed for the project. This plan sets out a clear framework for the responsible sourcing of construction products to guide procurement throughout a project and by all involved in the specification and procurement of construction products. The plan may be prepared and adopted at an organisational level or be site or project specific.

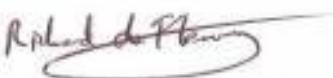
The plan will include the following criteria:

1. Include sustainability aims, objectives and strategic targets to guide procurement activities.
2. Include a requirement for assessing the potential to procure construction products locally. This includes a policy to procure construction products locally where possible.
3. Include details of procedures in place to check and verify the effective implementation of the sustainable procurement plan.

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## 2. Quality Management

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### 3. Development Site

Stroma Built Environment has been commissioned on behalf of Comer Homes Group to prepare a Circular Economy Statement in support of the planning application for the proposed development at Harefield Grove, Middlesex.

The site is situated some 1km to the north of Harefield Village on the eastern side of Rickmansworth Road. The site extends to approximately 7.8 hectares and is accessed via a long driveway from Rickmansworth Road. The site is currently vacant, although it is used sporadically for film and television sets. The site's last permanent use was for office purposes in c. 2002.

This planning application includes the Subdivision and conversion of the Main House into 6no. residential units; demolition of the existing extension of the Main House and erection of a three storey 'stable block' building containing 29no. residential units; construction of a new dwellinghouse to the south-east (Orchard House); extension of Garden House to provide a new single storey dwelling; internal alterations to Cottage House to provide anew two storey dwelling; demolition of Conservatory building and replacement with a new two storey dwelling (Lake View House); and associated alterations to landscape, access and parking. The total Gross Internal Area for the refurbished main house is 1,260m<sup>2</sup> and 3,180m<sup>2</sup> for the new build Stable Block. The other buildings on the site consist of a refurbished Cottage House to form a single dwelling, an extension to Garden House to provide a single dwelling, a new build Lake View House and a new build Orchard House.



Figure 1. Application Site Plan

## 4. Planning Policy

The London Plan 2021 includes the following policies in relation to the Circular Economy.

### **SI7 Reducing waste and supporting the circular economy**

Resource conservation, waste reduction, increases in material re-use and recycling, and reductions in waste going for disposal will be achieved by the Mayor, waste planning authorities and industry working in collaboration to:

- 1) promote a more circular economy that improves resource efficiency and innovation to keep products and materials at their highest use for as long as possible
- 2) encourage waste minimisation and waste prevention through the reuse of materials and using fewer resources in the production and distribution of products
- 3) ensure that there is zero biodegradable or recyclable waste to landfill by 2026
- 4) meet or exceed the municipal waste recycling target of 65 per cent by 2030
- 5) meet or exceed the targets for each of the following waste and material streams:
  - construction and demolition – 95 per cent reuse/recycling/recovery
  - excavation – 95 per cent beneficial use
- 6) design developments with adequate, flexible, and easily accessible storage space and collection systems that support, as a minimum, the separate collection of dry recyclables (at least card, paper, mixed plastics, metals, glass) and food.

## 5. Method Statement

### 5.1. Assessment Process

The following process has been followed in developing the Circular Economy Strategy for the development:

- Key stakeholders within the design team have been consulted to develop an overall sustainability vision for the development. This early stakeholder engagement ensures that key project stakeholders are identified and engaged to determine end user requirements and operational adaptability, allowing them to be taken into account throughout the project.
- Adopting integrated design and engagement processes has been demonstrated to result in improved operational performance, greater project efficiencies, and reduced risks to performance, time and cost. Following an integrated design process, maximises the opportunities for performance and minimises risks of design conflicts appearing later on in a project when risks to time and cost are higher.
- A Sustainability Workshop is to be held during the concept design stages, in collaboration with the client and project team to help define the sustainability strategy.
- The strategy approach is summarised within table 1 (adapted from the Draft GLA Guidance document on preparing Circular Economy Statements).
- The proposals include demolition of some parts of the existing buildings and thus a pre demolition audit will be undertaken by the demolition contractor as part of this application.
- The new buildings will avoid unnecessary materials use arising from over specification without compromising structural stability durability or the service life of the building. This will be achieved through:
  - Reduced cost as a result of a reduction of material use in building design.
  - Encourage the reuse of existing materials.
  - Encourage the use of materials with higher levels of recycled content.
  - Improve understanding of, and the performance of, alternative design and construction methods that result in lower material usage and waste levels.
- A project specific Waste Management Strategy will be developed for the operation stage of the development to ensure that waste arising can be accommodated during occupancy stage of the development.
- The strategy will be prepared against local, regional and national policy to determine the optimum sizing of waste storage areas on the site.
- A Sustainable Procurement plan will be developed for the project. This plan sets out a clear framework for the responsible sourcing of construction products to guide procurement throughout a project and by all involved in the specification and procurement of construction products. The plan will include the following criteria:
  - Include sustainability aims, objectives and strategic targets to guide procurement activities.
  - Include a requirement for assessing the potential to procure construction products locally. This includes a policy to procure construction products locally where possible.

- Include details of procedures in place to check and verify the effective implementation of the sustainable procurement plan.

These key commitments are summarised in Table 2

## 5.2. Circular Economy Approach for the Project

A Circular Economy is defined in London Plan Policy SI7 '**Reducing waste and supporting the Circular Economy**' as one where materials are retained in use at their highest value for as long as possible and are then reused or recycled, leaving a minimum of residual waste.

It is a new economic model that moves away from this current linear economy, where materials are mined, manufactured, used and thrown away, to a more circular economy where resources are kept in use and their value is retained.

For buildings, this means creating a regenerative built environment that prioritises retention and refurbishment over demolition and rebuilding. It means designing buildings that can be adapted, reconstructed and deconstructed to extend their life and that allow components and materials to be salvaged for reuse or recycling.

Designing buildings for a circular economy can increase their value by avoiding depreciation and can help to stave off obsolescence. It can even secure a positive residual value at end-of-life.

In a circular economy, built environment assets are designed so that whole buildings, and materials, components and parts can be continually and easily recycled.

A workshop was held with the project team on the 6<sup>th</sup> October 2022 to establish the Circular Economy targets and aspirations. A summary of the points discussed is given below:

How can circularity be achieved?

- Examples of what is currently being done/ implemented
- What should/could be done to enhance circularity?
- How is product selection affected?
- What might the cost implications be?
- Target and metric setting and

## 6. Strategic Approach Summary

### 6.1. Materials Assessment

An Assessment has been undertaken within the OneClick LCA Tool to establish the Circular Economy Design Principles by Building Layer.

The OneClick Tool Building Circularity score represents the total materials circularity both in use of materials for the project as well as end of life handling. It is calculated as the average of Materials Recovered (representing use of circular materials in the project) and Materials Returned (representing how effectively materials are returned, instead of disposed of or downgraded in value). The calculation is purely mass-based without material weighting. The image below shows the overall building Circularity of the proposed Stage 2 design.

The chart shows the materials specification for the development shows the potential to achieve a 37% Building Circularity Score with the intention to incorporate 32% reused materials in the

construction materials. This is achieved by reusing the existing Mansion house building, and using crushed demolishing materials obtained on site for fill and sub base materials in the landscaping.

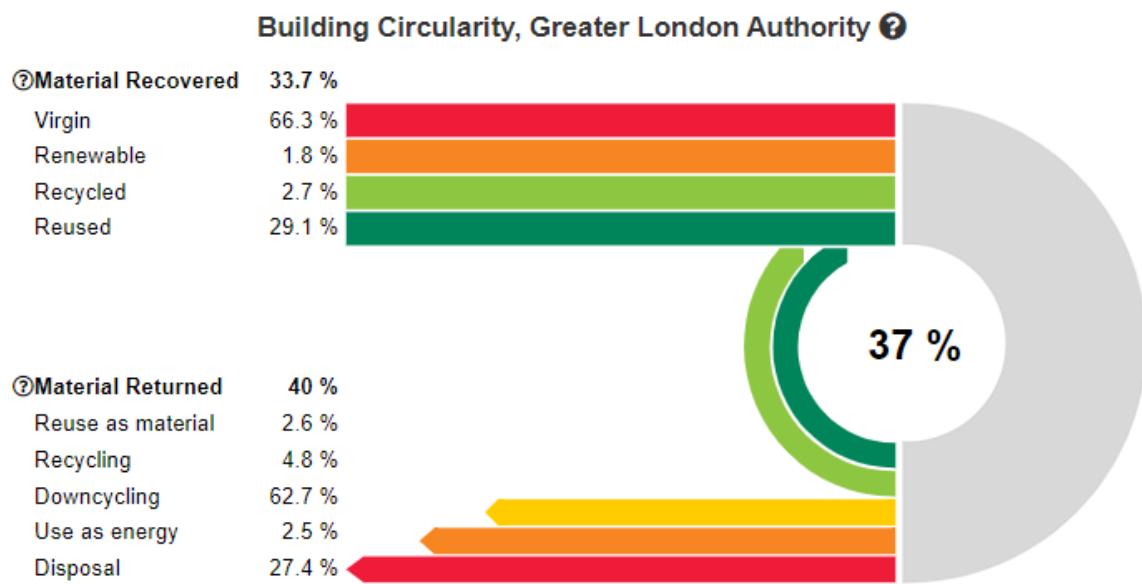


Figure 2. OneClick Building Circularity Score

The bubble chart and pie chart below shows the life cycle impacts of the different materials within the building specification. As can be seen from the charts, the material with the most life cycle impact is that of concrete and ready mix used within floor slabs, ceilings, roofing decks, beams and floors.

**Bubble chart, total life-cycle impact by resource type and subtype, Total**

Hover your mouse over legends or the chart to highlight impacts. Bubble minimum and maximum sizes constrained for readability

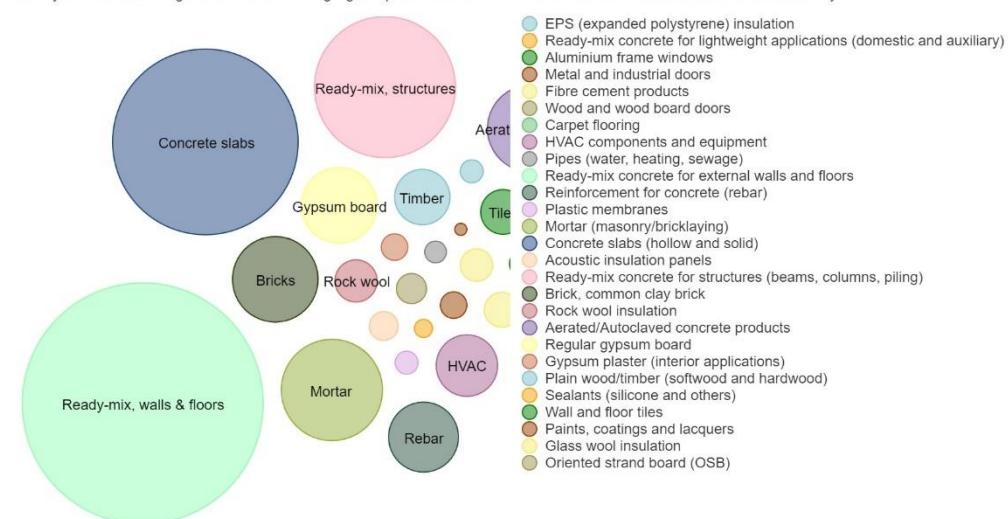


Figure 3. Bubble chart showing total life cycle impact by resource type and sub type

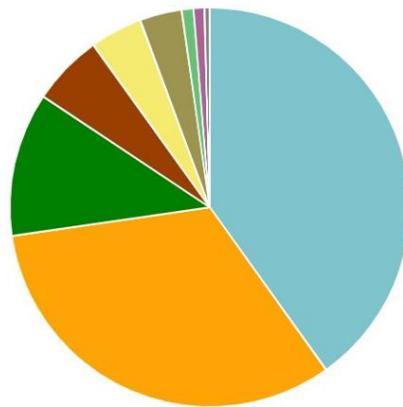
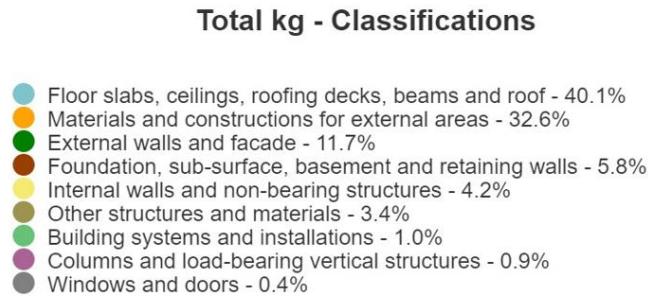


Figure 4.Total tonnes of materials

This strategic assessment has informed the Circular Economy approach and further actions taken to reduce the impact associated with the development. The assessment has shown that the concrete materials have the highest life cycle impact and the floor slabs, ceilings and roof structure within the building has the largest amount of embodied carbon.

This has allowed the circular economy aims to be focused on areas with the highest impact.

## 6.2. Circular Economy Narrative

### 6.2.1. Existing development

The site is occupied by a former mansion house in extensive grounds, is situated on the eastern side of Rickmansworth Road, approximately half a mile to the north of Harefield village, with Colne Valley, the Union Canal and M25 to the west, Rickmansworth and Watford to the north, Northwood and Ruislip to the east and Denham and the M40/A40 to the south. Images of the site are shown below.



The Design and Access Statement for the application states the following:

This new application proposes significant enhancement of the landscaped grounds and including a more appropriate restoration of the mansion house.

Consequently, the mansion house is to be restored and subdivided into 6No. apartments. The existing office and stable blocks are to be demolished and replaced with a new courtyard stable block.

The proposed stable block is a mixture of 1, 2 and 3 bedroom apartments across 3No. floors creating 29No. spacious units. In all, 39No. residential units will be provided with 56No. open car spaces. The total gross area of the proposed residential accommodation will be 4,400m<sup>2</sup> compared with an approved gross area of 3,930m<sup>2</sup>.

The proposed scheme returns the site to its original purpose and seeks to make the best use of the attractive landscape and in particular removing the unsightly 1980's glazed extension. 7

To align the proposals with the decision tree for existing structures and buildings the design team have opted to retain and retrofit the existing building on site. The extract below shows how this has been followed:

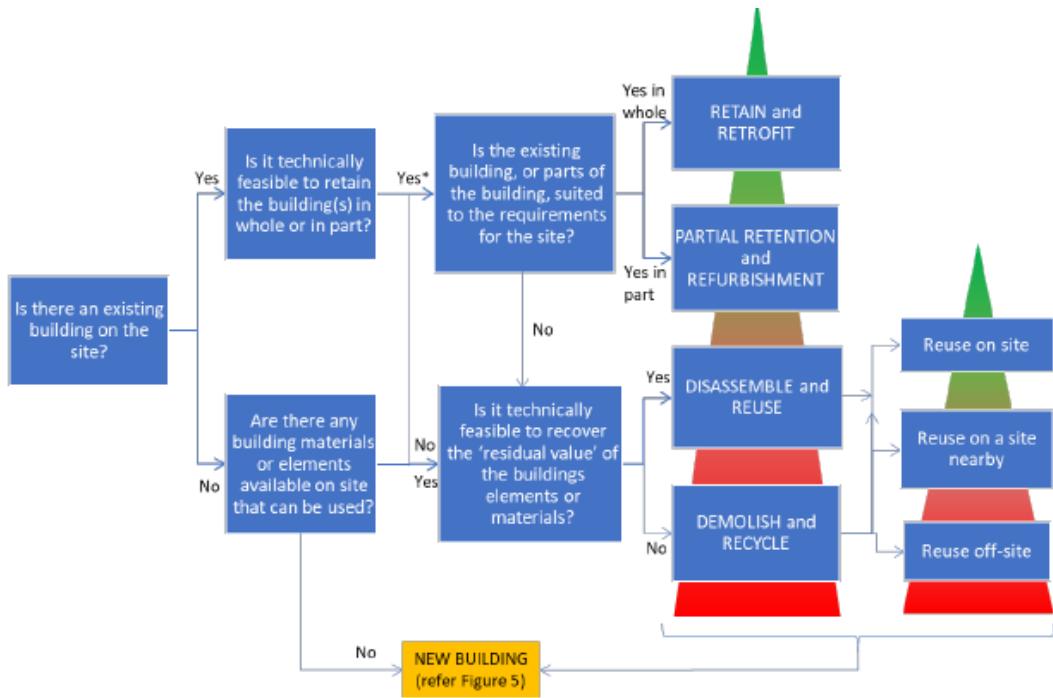


Figure 5. Decision Tree for design approaches for existing structures

1. Is there an existing Building on the site? – Yes
2. Is it technically feasible to retain the building in whole or in part – Yes
3. Is the existing building or parts of the building suited to the requirements for the site – Yes in part
4. Partial Retention and Refurbishment

### 6.2.2. Circular Economy Design Approach Existing Building

The main existing buildings on the site are retained and will be retrofitted to form 6 apartment buildings. These will be retrofitted with fabric improvements and services to comply with current Building Regulations. This will return the Main House at Harefield Grove to residential use, as apartments. This refurbishment repairs the historic fabric of the building, retaining detail and primary layouts. The proposal is to remove of the large extension and stables. The extension is currently attached to its south elevation, which will halt damage currently being inflicted by the frame of the building undermining the historic building fabric of the main house.

A later Office Extension to the building is to be removed and demolished. The Heritage Statement confirms this building has little heritage value and its removal enhances the value of the Mansion House. Any suitable material from the existing hardstanding and existing buildings will be processed to be used as a piling mat by the Main Contractor where required. All excavated material will be utilised where feasible for filling and subbases during construction. Any surplus material will be removed by licenced waste contractors and reused on other construction sites in the immediate and local area.

This approach ensures the retention of a building that would otherwise face demolition.

### 6.2.3. New Development Strategic Goals

The overall strategy for the development is to reduce material usage, minimise waste and embed longevity, flexibility and adaptability into the buildings design.

In line with Policy SI7, the newly constructed elements have been assessed to demonstrate how the material demands will be reduced and how building materials, components and products will be disassembled and reused at the end of their life. A Bill of Materials table has been produced in Appendix 1 which demonstrates how material demands have been minimised and on-site reuse and recycling maximised.

The proposed scheme design has been broken down into building layers to design out waste, optimise material use and keeping building elements/materials in use after the end of their life cycle. Please refer to the summary of strategies in section 6.3. The existing substructure and superstructure are being retained for the Mansion House.

The design objective for the elements with longer life cycle (more than 25 years) is to design for longevity, adaptability and flexibility. Concrete provides longevity and high thermal mass whilst steel is highly recyclable.

Building layers with shorter life expectancy (less than 25 years) will be designed for ease of maintenance, reuse and recoverability. The plant will be made accessible for replaceability and maintenance. In terms of building services, a water based wet system is proposed for the communal network thus reducing the use of refrigerant in the building. The proposed Exhaust Air Heat Pumps to the new buildings mean straight forward maintenance and replacement can occur.

Cooling has been designed-out of the assessment.

Opportunities will be explored for reusing hoardings and scaffoldings. Discussions with suppliers with regards to the possibility of sending back the packaging for reuse will be explored. Offsite and modern methods of construction may be considered to further optimise material use and waste minimisation.

The new building has been designed to incorporate the below Circular Economy approaches and principles from Policy SI7 of the London Plan. Following Figure 5 from the GLA Circular Economy Guidance (extracted below) the development will follow the below design approaches.

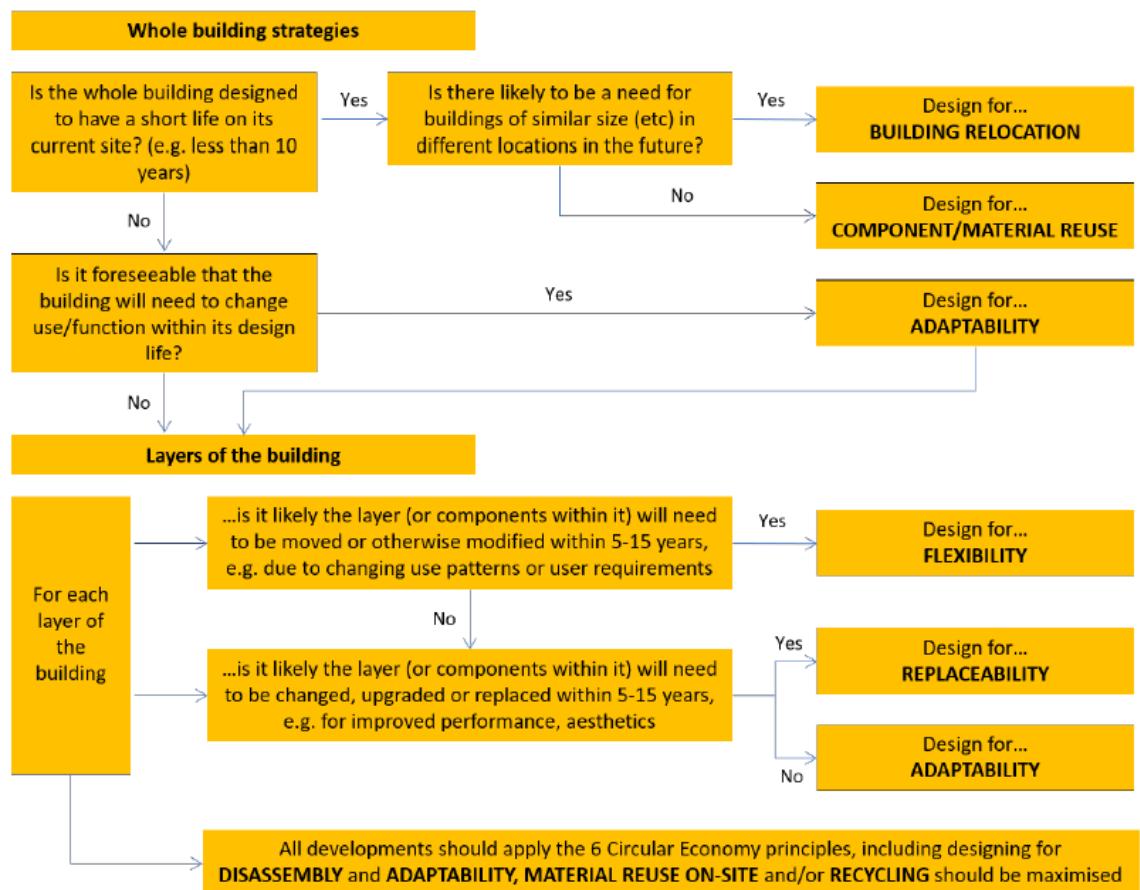


Figure 6. Decision tree for design approached for new buildings over the lifetime of development

The decision tree has been followed as below:

- The buildings are not designed to have a short life
- It is not foreseeable that the buildings will need to change their function over its lifetime
- For each layer of the building there are none that will need to move within 5-15 years
- There are no layers that will need to be changed, upgraded or replaced within 5-15 years

The building will therefore be designed for adaptability, disassembly, material reuse on-site and recycling in line with the design approach for new buildings and definitions from the GLA Circular Economy Guidance

#### 6.2.4. Designing Out Waste

The initial approach for improving materials efficiency into the project is to include feasible options from the below commitments:

1. Increasing the utilisation factor of structural members.
2. Designing to standard material dimensions to reduce off-cuts and waste on site.
3. Removing redundant materials from the design.
4. Using materials that can be recycled or reused at the end of their service life.
5. Making use of recycled or reclaimed materials.
6. Designing for deconstruction and material reuse.
7. Using pre-fabricated elements where appropriate to reduce material waste. This will be explore to utilise off site construction for building elements such as pre fabricated concrete for floor and wall constructions.
8. Consider using an 'exposed thermal mass' design strategy to reduce finishes.
9. Avoiding over-specification of predicted loads.
10. Using lightweight structural design strategies.
11. Making use of bespoke structural elements where this will reduce overall material use.
12. 'Rationalisation' of structural elements.
13. Optimising the foundation design of the new construction for embodied environmental impact.

#### 6.2.8. Designing out construction, demolition, excavation, industrial and municipal waste arising

Any suitable material from the existing hardstanding and existing building elements to be demolished will be processed to be used as a aggregate use by the Main Contractor where required. All excavated material will be utilised where feasible for filling and subbases during construction. Any surplus material will be removed by licenced waste contractors and reused on other constructions sites in the immediate and local area.

Making use of bespoke structural elements where this will reduce overall material use and a pre-fabricated envelope to the commercial spaces will be explored, both of which will result in less material wastage on site

Suppliers will be encouraged to take back all packaging for re use such as delivery pallets and plastic wrapping. Sufficient space will be set aside for the storage of construction waste during construction and municipal waste during operation.

A pre-demolition audit of any existing buildings, structures or hard surfaces being considered for demolition. This will be used to determine whether refurbishment or reuse is feasible and, in the case of demolition, to maximise the recovery of material for subsequent high grade or value applications. The audit will be:

- Carried out prior to strip-out or demolition works.
- Guide the design, consider materials for reuse and set targets for waste management.

- Engage all contractors in the process of maximising high-grade reuse and recycling opportunities.

The Pre-Demolition Audit will:

- Identify and quantify the key materials where present on the project see table 2.
- Establish potential applications and any related issues for the reuse and recycling of the key materials in accordance with the waste hierarchy.
- Research opportunities for reuse and recycling within the site boundary.
- Identification of local reprocessors or recyclers for recycling of materials.
- Commit to achieve at least 95% of all non-hazardous demolition waste diverted from landfill.

European Waste Catalogue	Key group	Examples
170102	Bricks	Bricks
170101	Concrete	Pipes, kerb stones, paving slabs, concrete rubble, precast and in situ
170604	Insulation	Glass fibre, mineral wool, foamed plastic
1501	Packaging	Paint pots, pallets, cardboard, cable drums, wrapping bands, polythene sheets
170201	Timber	Softwood, hardwood, board products such as plywood, chipboard, medium density fibreboard (MDF)
1602	Electrical and electronic	Electrical and electronic TVs, fridges, air-conditioning units, lamps equipment
1301	Oils	Hydraulic oil, engine oil, lubricating oil
1703	Asphalt and tar	Bitumen, coal tars, asphalt
170103	Tiles and ceramics	Ceramic tiles, clay roof tiles, ceramic, sanitary ware
1701	Inert	Mixed rubble or excavation material, glass
1704	Metals	Radiators, cables, wires, bars, sheet
170802	Gypsum	Plasterboard, plaster, fibre cement sheets
170101	Binders	Render, cement, mortar
170203	Plastics	Pipes, cladding, frames, non-packaging sheet
1705	Soils	Soils, clays, sand, gravel, natural stone
Most relevant	Liquids	Non-hazardous paints, thinners, timber treatments
Most relevant	Hazardous	Defined in the Hazardous Waste List (HWL) of the

Most relevant	Floor coverings	Carpets, vinyl flooring
Most relevant EWC	Architectural features	Roof tiles, reclaimed bricks, fireplaces
170904 (Mixed)	Mixed or other	Efforts will be made to categorise waste into the above categories wherever possible.

Figure 7.Waste Streams to be identified during demolition

The Main Contractor will be required to monitor, report and set targets on the generation of construction and demolition waste in line with the following project targets:

- **3.2 tonnes/100m<sup>2</sup> GIA of construction waste generated.**
- **95% of Non-Hazardous Construction and demolition waste to be diverted from landfill.**

### Operational Waste

A Waste Management Strategy will be undertaken during detailed design stage and will take into account the need to lessen the overall impact of waste generation through the recycling of materials from the operational phase. The building will be design to ensure all Operational waste will be managed in accordance with the waste hierarchy (extract below):

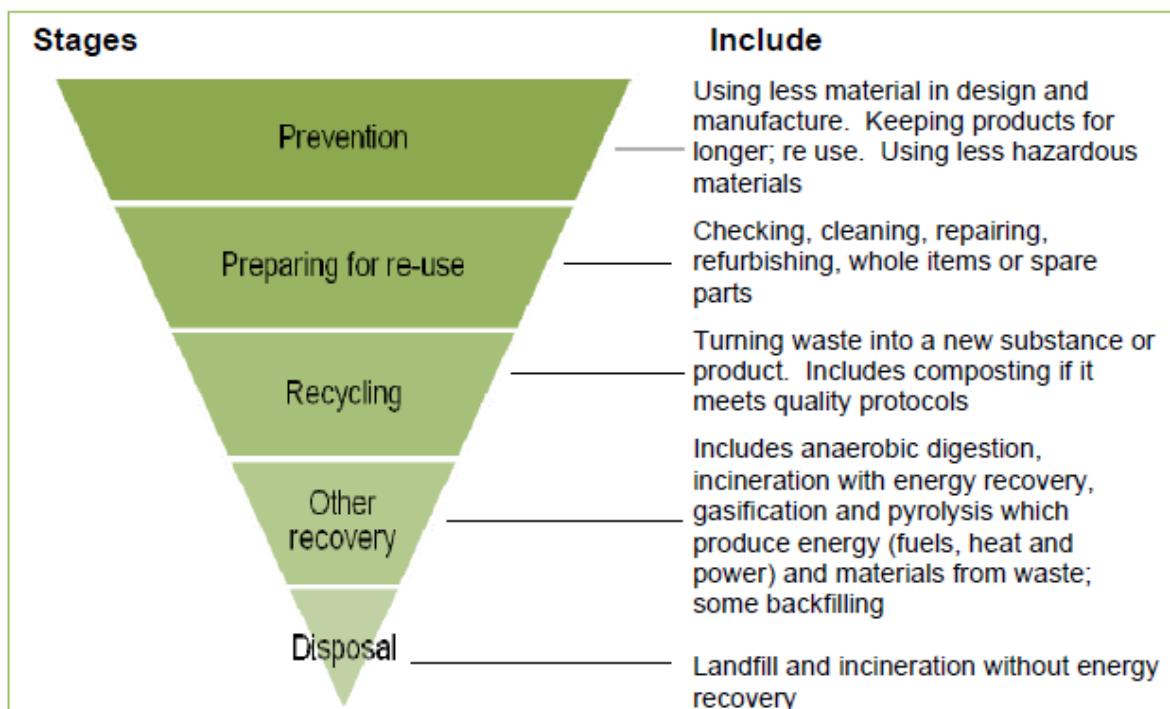


Figure 8.Extract from Waste Hierarchy Defra Guidance on Applying Waste Hierarchy

The proposals set out in this strategy will meet the requirements of relevant waste policy and follow applicable guidance. The strategy will consider the flow of waste from waste generator (i.e. residents/tenants and hotel guests) through to storage and collection. The strategy outlines how the development has been designed to be sustainable and forward-thinking in its approach to waste and recycling, whilst remaining workable during operation.

Sufficient storage for the segregation and storage of at least three waste streams (recycling, food and residual waste) in both individual units and communal bin stores will be provided to enable effective waste segregation and promote higher recycling and composting rates. Separate dry recyclable waste storage will be provided for car, paper, mixed plastics, metals and glass. Space will be allocated for food waste storage and collection for both the internal kitchen layouts and communal bin storage area

Whilst a detailed design for the space has not yet been undertaken. Waste commitments and storage areas have been allocated based on the following calculations:

- 1-4 bedroom houses are allocated 2 x 240 litre storage per dwelling + 140 litre organic waste
- Apartments are allocated 250 litres per dwelling

The development has allowed for the following waste provision based on the above allocations. This assumes 35% standard waste, 60% dry recycling and 5% food waste to be processed off site. The waste storage within the scheme on the drawings will incorporate 8 x 1,100 litre bins. The calculations in table 3 show 8 x 1,100 bins and 4 x 140l bins assuming weekly collections. Houses will required 1 x 240 litre dry recycling, 1 x 240 litre general waste and 1 x 140 litre food waste.

Dwelling Type	Calculation	Waste calculations							
		Total		General		Dry Recycling		Organic	
		Litres	1100 bins	Litres	1100 bins	Litres	1100 bins	Litres	140 l bins
Apartment	250 litres per dwelling	8750	8	3062	3	5250	5	437	4

Dwelling Type	Calculation	Waste calculations							
		Total		General		Dry Recycling		Organic	
		Litres	240 bins	Litres	240 bins	Litres	240 bins	Litres	140 l bins
Houses	480 litres per dwelling	1920	8	672	4	1152	4	96	4

Figure 9.Waste sizing requirements

## 6.2.5. Minimise the quantities of other resources used

The Contractor will monitor and set targets against their energy, water and log all transportation data of material deliveries and waste collections. This will be achieved by appointing an individual to be responsible for monitoring, recording and reporting energy use, water consumption and transportation data resulting from all on-site construction processes (and dedicated off-site manufacturing) throughout the build programme. To ensure the robust collection of information, this individual will have the appropriate authority and responsibility to request and access the data required.

The project will set targets for the site energy consumption in kWh (and where relevant, litres of fuel used) as a result of the use of construction plant, equipment (mobile and fixed) and site accommodation. During construction the Contractor will monitor and record data for the energy consumption and report the total carbon dioxide emissions (total kgCO<sub>2</sub>/project value) from the construction process.

In order to reduce the energy usage, the Contractor will investigate features which minimise energy wastage such as occupancy controls to switch off unnecessary lighting within site cabins.

The project will set targets for the potable water consumption (m<sup>3</sup>) arising from the use of construction plant, equipment (mobile and fixed) and site accommodation.

During Construction the Contractor will monitor and record data for the potable water consumption described and report the total net water consumption (m<sup>3</sup>), i.e. consumption minus any recycled water use from the construction processes.

A rainwater harvesting system for use in equipment and vehicle washing will be investigated by the Main Contractor along with the use of recycling water systems for processes such as wheel washing.

## 6.2.6. Specify and source materials responsible and sustainably

A Sustainable Procurement Plan will be developed for the project. This will include sustainability aims, objectives and strategic targets to guide procurement activities.

There will be a policy to procure construction products locally where possible.

The plan will include details of procedures in place to check and verify the effective implementation of the sustainable procurement plan.

Most construction products involve long and complex supply chains that result in a wide range of impacts locally and globally. These might include environmental (e.g. toxicity or biodiversity), economic (e.g. corruption) or social (e.g. slave labour, equality) issues and can occur during the extraction, processing, manufacturing or supply chain stages. The increasing globalisation of supply chains increases the difficulty of tracing the supply chain and mitigating negative impacts caused by it.

Credible certification schemes exist to increase confidence to specifiers that risks are being minimised or avoided and their use ensures that specifiers are able to demonstrate the responsible nature of their selection decisions.

It will be a requirement of the project to ensure the Main Contractor ensures the following criteria is met:

- 100% of timber and timber-based products used on the project are 'Legal' and 'Sustainable' as per the UK Government's Timber Procurement Policy through purchasing timber with Third party, independent forest certification schemes—Category A (e.g. FSC or PEFC).
- At least 25% of all major building elements must be sourced from suppliers demonstrating compliance with auditable third party responsible sourcing certification schemes such as BES6001 and ISO14001.

### 6.2.7. **Design for longevity, adaptability or flexibility and reusability or recoverability**

A project functional adaptability assessment will be undertaken which will cover the following main items:

- **Feasibility:** The likelihood to contain multiple or alternative building uses, area functions and different tenancies over the expected life cycle, e.g. related to the structural design of the building.
- **Accessibility:** Design aspects that facilitate the replacement of all major plant within the life of the building, e.g. panels in floors and walls that can be removed without affecting the structure, providing lifting beams and hoists. Accessibility also involves access to local services, such as local power, data infrastructure etc.
- **Versatility:** The degree of adaptability of the internal environment to accommodate changes in working practices.
- **Adaptability:** The potential of the building ventilation strategy to adapt to future building occupant needs and climatic scenarios.
- **Convertibility:** The degree of adaptability of the internal physical space and external shell to accommodate changes of in-use.
- **Expandability:** The potential for the building to be extended, horizontally or vertically.
- **'Refurbishment potential':** The potential for major refurbishment, including replacing the façade

The report will follow the BREEAM framework to future adaption as per the below table:

Item	Accessibility	Spatial Adaptability	Expandability
Fabric and structure: - External walls. - Cladding. - Ground and first floor. - Roof.	Use of products or systems which allow easy replacements.	Location of structural components within the floor space.	Provision to add extensions or alterations to increase building capacity.
Core and local services: - Mechanical and electrical. - Plumbing. - Stairs and lifts. - Fire.	Inclusion of facilities management requirements and construction design management feedback for future operational needs.		Provision of capacity in infrastructure to enable future expansion and adaptation.
Interior design: - Finishes. - Floors. - Interior walls. - Connections.	Use of products or systems which allow easy replacements.	- Layout in standardised grids. - Use of inherent finishes to allow replacement. - Use of standardised material sizes.	- Identifying or recognising potential future <b>functional</b> requirements. - Efficient use of space to allow for any increase in occupancy.

Table 1. Design measures consider to allow future adaption

An ease of disassembly study will be undertaken that includes as many of the following concepts as possible:

- **Accessibility** (see Functional adaptation strategy study on the previous page).
- **Durability**: use of materials which require less frequent maintenance, repair or replacement, considering them within the context of the life span of the building.
- **Exposed and reversible connections**: making the connections more visible provides opportunities to optimise material and product reuse. Welded connections prohibit disassembly and it is preferable to use screws and bolts to allow for disassembly and material reuse.
- **Layer independence**: designing building systems and components in layers so that removal, adjustment or replacement of some elements is feasible, especially when different components have different life spans and maintenance needs.
- **Avoidance** of unnecessary toxic treatments and finishes. Some finishes can contaminate the substrate in a way that they are no longer reusable or recyclable. This should be avoided unless finishes serve a specific purpose.
- **Standardisation** can accommodate reuse and upgrading. It involves aspects such as dimensions, components, connections and modularity.

### 6.3. Summary of Strategic Approach to the Circular Economy

ASPECT	STEERING APPROACH	EXPLANATION	TARGET	SUPPORTING ANALYSIS / STUDIES / SURVEYS / AUDITS
<b>Circular economy approach for the new development.</b>	<p>The development will follow best practice principles and adopt the guidance from BS 8895 Designing for material efficiency in building projects.</p> <p>Utilising the BREEAM methodology to select suitable credit criteria to follow to ensure opportunities to embed circular economy principles are included.</p>	<p>Consideration for the circular economy implementation will be made at each stage of the project design and construction process. Active engagement will continue to be required for key stakeholders engaged in the design and procurement of materials for the site, and the waste management of materials taken off site. These include, but are not limited to:</p> <ul style="list-style-type: none"> <li>• Main contractor and sub-contractors</li> <li>• Lead architect</li> <li>• Structural engineer</li> <li>• Civil engineer</li> <li>• Landscape architect</li> <li>• Operational waste consultant</li> </ul>	<i>95% diversion from landfill at end of life</i>	<ul style="list-style-type: none"> <li>• Sustainable Procurement Plan.</li> <li>• Materials Efficiency Report.</li> <li>• Energy Statement.</li> <li>• Demolition Environmental Management Plan</li> <li>• Construction Environmental Management Plan.</li> </ul>
<b>Circular economy approach for the existing site.</b>	<p>The development will produce a pre demolition audit in addition to a project site waste management plan and environmental management plan.</p>	<p>A pre-demolition audit will be undertaken to identify opportunities for reuse, recycling or recovery, disposal and opportunities for reuse within development works.</p> <p>Initial commitments for the project include</p> <p>Reuse</p> <ul style="list-style-type: none"> <li>• Use of re-usable hoardings, in non-aesthetic locations.</li> <li>• Recycle/ recover.</li> <li>• Rainwater harvesting system for use in equipment and vehicle washing will be investigated by contractors.</li> <li>• Use of recycling water systems such as wheel washes will be investigated by contractors.</li> </ul> <p>Opportunities for reuse within the development works</p> <ul style="list-style-type: none"> <li>• Any suitable material from the existing hardstanding and existing buildings undergoing demolition will be processed to be used as aggregate on site.</li> <li>• Excavated material will be utilised where feasible for filling and sub bases.</li> </ul>	95% diversion from landfill	<p>Pre demolition Audit.</p> <p>Construction environmental management plan.</p> <p>Demolition environmental management plan.</p>
<b>Circular economy approach for municipal waste during operation.</b>	<p>A project-specific Operational Waste Management Strategy will be prepared in accordance with relevant requirements, in order to embed and enable sustainable waste management in operation.</p> <p>This Strategy provides an overview of how the Scheme has been designed to consider the flow of waste through the development, from waste generator (i.e. residents/tenants) through to storage and collection, in a sustainable manner during its operation.</p> <p>The Strategy outlines how the Scheme has been designed to be sustainable and 'forward-thinking' in its approach to waste and recycling, whilst remaining 'workable' during the operation of the Scheme.</p>	<p>Waste arising and storage requirements have been calculated based on the requirements from the Local Authority.</p> <p>Waste arisings have been forecasted for general and recyclable waste.</p>	65% diversion from landfill	<p>Operational waste management strategy.</p> <p>Waste storage and collection requirements and calculation.</p>

#### 6.4. Summary of Key commitments for the Project from Circular Economy Workshop

	Site	Substructure	Super-structure	Shell/Skin	Services	Space	Stuff	Construction Stuff	Summary
Designing Out Waste Module A Product Sourcing and Construction Stage	<p>The development retains as much of the existing structures and buildings on site as is practical</p> <p>A Sustainable Procurement Plan will be developed for the project. This will include sustainability aims, objectives and strategic targets to guide procurement activities.</p> <p>There will be a policy to procure construction products locally where possible.</p>	<p>During detailed design stage the design team will investigate the use of a concrete substructure that is designed to accommodate minimum 50% GGBS content. The use of recycled aggregate within the concrete will be considered in line with permitted quantities as defined by BS 8500, with an initial target of 30%.</p> <p>100% of timber and timber-based products used on the project are 'Legal' and 'Sustainable' as per the UK Government's Timber Procurement Policy through purchasing timber with Third party, independent forest certification schemes—Category A (e.g. FSC or PEFC).</p> <p>At least 25% of all major building elements must be sourced from suppliers demonstrating compliance with auditable third party responsible sourcing certification schemes such as BES6001 and ISO14001.</p> <p>Recycled steel will be used</p>	<p>The design will seek to increase the utilisation factor of structural members.</p> <p>Designing to standard material dimensions to reduce off-cuts and waste on site.</p> <p>Removing redundant materials from the design.</p> <p>The concrete superstructure will be designed to accommodate 50% GGBS. The use of recycled aggregate within the concrete will be considered in line with permitted quantities as defined by BS 8500, with an initial target of 30%.</p> <p>Utilising high quality materials requiring minimal replacement over the building lifespan.</p>					<p>The Contractors Sustainable Procurement Plan will seek to utilise supplier packaging take back scheme, just in time material delivery to minimise waste and risk of damage and disposal on site.</p> <p>The contractor will be required to monitor and report energy and water use during construction works on-site. This will involve setting targets and monitoring progress</p> <p>The Contractor will be required to source their construction products in accordance with the project Sustainable Procurement Plan</p> <p>The Main Contractor will be required to achieve a construction waste target 3.2 tonnes/100m<sup>2</sup> o GIFA for non hazardous construction waste.</p> <p>95% of all construction waste will be diverted from landfill.</p> <p>Sort waste materials into separate key waste groups in below table either on-site or through a licensed contractor for recovery.</p>	<p>Lean design principles adopted, and elements prefabricated offsite where possible. Refinement of material quantities will be reviewed as design proceeds.</p> <p>Structural design to explore possibility of using cement replacements, Main Contract to contain requirements for Contractor to implement actions on site.</p>

Designing Out Waste Module B In-Use Stage	N/A	N/A	N/A	<p>Residential areas will target a water consumption of 105 l/p/day or less.</p> <p>The development is being designed to be highly energy efficient, as confirmed within the Energy Strategy, submitted in support of the Planning Application.</p> <p>Use of low GWP Refrigerant for heat pump systems will lower the in use refrigerant emissions</p>	N/A	N/A	N/A	<p>A Functional Adaptation Strategy Study and Plan will be adhered to. Monitoring and reporting of energy and water use during construction works.</p>
Designing Out Waste Module C End of Life Stage	<p>The concrete and steel elements of the sub structure will be extracted and reprocessed. Concrete elements will be crushed and resued off site. Steel work will be recycled</p>	<p>Window frames and glazing demounted for reuse or disassembled and recycled in component parts (steel / glass);</p> <p>Concrete elements crushed on-site to secondary aggregate</p> <p>Brick and stonework reclaimed where possible</p> <p>Steel reinforcement recycled;</p>	<p>Gypsum recycled, Floor finishes recycled,</p>	<p>Products and MEP reclaimed or recycled where possible.</p>	N/A	N/A	N/A	
Designing for Longevity				<p>The building has been designed with the use of products or systems which allow easy replacements.</p> <ul style="list-style-type: none"> <li>– Layout in standardised grids.</li> <li>– Use of inherent finishes to allow Replacement.</li> <li>– Use of standardised material sizes.</li> <li>– Identifying or recognising potential future Functional requirements.</li> <li>– Efficient use of space to allow for any increase inoccupancy.</li> </ul>	<p>The design will incorporate decision to ensure the potential for major refurbishment, including replacing the façade elements such as windows is incorporated.</p>	<p>The development will include design aspects that facilitate the replacement of all major plant within the life of the building, e.g. panels in floors and walls that can be removed without affecting the structure, Accessibility also involves access to local services, such as local power, data infrastructure etc.</p>		<p>The design and construction will follow Layer independence: designing building systems and components in layers so that removal, adjustment or replacement of some elements is feasible,</p> <ul style="list-style-type: none"> <li>– Avoidance of unnecessary toxic treatments and finishes.</li> <li>Avoid finishes that contaminate the substrate in a way that they are no longer reusable or recyclable. purpose.</li> </ul> <p>Standardisation can accommodate reuse and upgrading.</p> <p>It involves aspects such as dimensions, components, connections and modularity.</p>
Designing for adaptability or flexibility	<p>The position of the building on the site should take into consideration where an extension would be placed if it was proposed. Where a building sits tight up against a boundary this will prohibit the possibility of increasing the footprint of the building. Positioning of green area, car parking, external buildings and stores will also need to take into consideration where an extension would be placed if it was proposed</p>			<p>The building layers have been designed for replaceability. Windows can be remove and deconstructed into their component parts.</p> <p>Roofing materials including tiles and timbers can be removed and reclaimed for use elsewhere.</p>	<p>The main plant consists of standalone exhaust air heat pumps within each apartment. These can be altered and replaced without any fabric implications</p> <p>WC's are stacked through the building where possible to minimise fixed items to the ground and first floor level to allow maximum flexibility of the floor plate to adapt to future changes in use.</p>			

<b>Designing for disassembly</b>		Footing foundations would be dug out and reprocess on or off site	<p>The disassembly of the building structure can be achieved by removing all fixtures, fittings and services following which the building envelope can then be removed, see Building Envelope below.</p> <p>Once the steel frame is revealed the pre cast floors and stairs can be lifted out using a crane and removed from site for recycling.</p>	<p>The disassembly of the envelope would follow the reverse form of the build. This require that the windows and doors be removed first. These are fixed using bracket fixings screwed to the external walls.</p> <p>Party wall are formed comprising two skins of blockwork. Disassembly/ alterations would require the erection of a scaffold to both sides of the party wall to allow the blocks to be removed, coarse by coarse with the scaffolding being adapted to provide a safe working platform. The materials can be removed from site for recycling.</p>	<p>The services provided are such that they can be easily accessed for maintenance, adaptions and or removal. Isolation of the services will require to be undertaken by specialised and or licenced contractors. These will include working with refrigerant, gas and electricity.</p> <p>Once the service is isolated they be safely removed or adapted.</p>	<p>Internal finishes selected are non toxic and as such can all be safely removed and recycled.</p> <p>Generally, the finished can be removed with out much destruction. The exceptions being ceramic wall and floor tiles and plaster board internal walls.</p> <p>Plaster board which would likely be destroyed during disassembly can be segregated and recycled.</p>		Designing out waste through regular / modular design. Consideration for just-in-time delivery, reducing packaging, and supplier takeback schemes.
<b>Excavation waste (how waste from excavation will be managed).</b>	The site is likely to be made up of made ground and undisturbed soils. The new buildings and site levels will require excavation and fill material.	The substructure of the current buildings are likely to be shallow strip foundations, which will be dug out and crushed to be re-used on this site or off site.	N/A	N/A	N/A	N/A	N/A	Excavated materials will be reused on site wherever possible.

	Site	Substructure	Super-structure	Shell/Skin	Services	Space	Stuff	Construction Stuff	Summary																																																															
<b>Construction waste (how waste arising from construction of the layers will be reused or recycled.)</b>	<p>The Main Contractor will be required to achieve a construction waste target 3.2 tonnes/100m<sup>2</sup> o GIFA for non hazardous construction waste.</p> <p>95% of all construction waste will be diverted from landfill.</p> <p>Sort waste materials into separate key waste groups in below table either on-site or through a licensed contractor for recovery.</p> <table border="1"> <thead> <tr> <th>European Waste Catalogue</th> <th>Key group</th> <th>Examples</th> </tr> </thead> <tbody> <tr><td>170102</td><td>Bricks</td><td>Bricks</td></tr> <tr><td>170101</td><td>Concrete</td><td>Pipes, kerb stones, paving slabs, concrete rubble, precast and in situ</td></tr> <tr><td>170604</td><td>Insulation</td><td>Glass fibre, mineral wool, foamed plastic</td></tr> <tr><td>1501</td><td>Packaging</td><td>Paint pots, pallets, cardboard, cable drums, wrapping bands, polythene sheets</td></tr> <tr><td>170201</td><td>Timber</td><td>Softwood, hardwood, board products such as plywood, chipboard, medium density fibreboard (MDF)</td></tr> <tr><td>1602</td><td>Electrical and electronic equipment</td><td>Electrical and electronic TVs, fridges, air-conditioning units, lamps equipment</td></tr> <tr><td>1301</td><td>Oils</td><td>Hydraulic oil, engine oil, lubricating oil</td></tr> <tr><td>1703</td><td>Asphalt and tar</td><td>Bitumen, coal tars, asphalt</td></tr> <tr><td>170103</td><td>Tiles and ceramics</td><td>Ceramic tiles, clay roof tiles, ceramic, sanitary ware</td></tr> <tr><td>1701</td><td>Inert</td><td>Mixed rubble or excavation material, glass</td></tr> <tr><td>1704</td><td>Metals</td><td>Radiators, cables, wires, bars, sheet</td></tr> <tr><td>170802</td><td>Gypsum</td><td>Plasterboard, plaster, fibre cement sheets</td></tr> <tr><td>170101</td><td>Binders</td><td>Render, cement, mortar</td></tr> <tr><td>170203</td><td>Plastics</td><td>Pipes, cladding, frames, non-packaging sheet</td></tr> <tr><td>1705</td><td>Soils</td><td>Soils, clays, sand, gravel, natural stone</td></tr> <tr><td>Most relevant EWC</td><td>Liquids</td><td>Non-hazardous paints, thinners, timber treatments</td></tr> <tr><td>Most relevant EWC</td><td>Hazardous</td><td>Defined in the Hazardous Waste List (HWL) of the European Waste Catalogue (EWC)</td></tr> <tr><td>Most relevant EWC</td><td>Floor coverings (soft)</td><td>Carpets, vinyl flooring</td></tr> <tr><td>Most relevant EWC</td><td>Architectural features</td><td>Roof tiles, reclaimed bricks, fireplaces</td></tr> <tr><td>170904 (Mixed)</td><td>Mixed or other</td><td>Efforts should be made to categorise waste into the above categories wherever possible.</td></tr> </tbody> </table>	European Waste Catalogue	Key group	Examples	170102	Bricks	Bricks	170101	Concrete	Pipes, kerb stones, paving slabs, concrete rubble, precast and in situ	170604	Insulation	Glass fibre, mineral wool, foamed plastic	1501	Packaging	Paint pots, pallets, cardboard, cable drums, wrapping bands, polythene sheets	170201	Timber	Softwood, hardwood, board products such as plywood, chipboard, medium density fibreboard (MDF)	1602	Electrical and electronic equipment	Electrical and electronic TVs, fridges, air-conditioning units, lamps equipment	1301	Oils	Hydraulic oil, engine oil, lubricating oil	1703	Asphalt and tar	Bitumen, coal tars, asphalt	170103	Tiles and ceramics	Ceramic tiles, clay roof tiles, ceramic, sanitary ware	1701	Inert	Mixed rubble or excavation material, glass	1704	Metals	Radiators, cables, wires, bars, sheet	170802	Gypsum	Plasterboard, plaster, fibre cement sheets	170101	Binders	Render, cement, mortar	170203	Plastics	Pipes, cladding, frames, non-packaging sheet	1705	Soils	Soils, clays, sand, gravel, natural stone	Most relevant EWC	Liquids	Non-hazardous paints, thinners, timber treatments	Most relevant EWC	Hazardous	Defined in the Hazardous Waste List (HWL) of the European Waste Catalogue (EWC)	Most relevant EWC	Floor coverings (soft)	Carpets, vinyl flooring	Most relevant EWC	Architectural features	Roof tiles, reclaimed bricks, fireplaces	170904 (Mixed)	Mixed or other	Efforts should be made to categorise waste into the above categories wherever possible.								
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<b>Municipal and industrial waste (how the design will support operational waste management)</b>	<p>Provide a dedicated space for the segregation and storage of operational recyclable waste generated. The Space will be: Clearly labelled, to assist with segregation, storage and collection of the recyclable waste streams.</p> <p>Accessible to building occupants or facilities operators for the deposit of materials and collections by waste management contractors.</p>					<p>1-4 bedroom houses are allocated 2 x 240 litre storage per dwelling + 140 litre organic waste</p> <p>Apartments are allocated 250 litres per dwelling</p>	<p>Each residential kitchen will be design to include dedicated storage space for recyclable, food and general waste.</p>																																																																	

## 6.5. Bill of Materials

A summary of the Bill of Materials is shown below. This is taken from the approved One Click LCA Software and has been entered into the GLA Circular Economy Spreadsheet tool to demonstrate the quantity of materials used in each 'layer' of the building (kg), the material intensity (kg/m<sup>2</sup> GIA) and set targets for the minimum amount of recycled content to be used (% by value).

The following evidence is displayed in the table:

- Building weight calculation (load take-down) to be used in calculating material intensity.
- Reused or recycled content calculations

The detailed bill of materials provided within Appendix A shows the individual materials specified, their recycled and reused content and their end of life strategy

Section	Result category	Material quantity kg	Material intensity kg/m <sup>2</sup> Gross Internal Area	Recycled content by value %	Reused content by value %	Estimated reusable materials kg/m <sup>2</sup>	Estimated recyclable materials kg/m <sup>2</sup>
1	1 Substructure	1031851.56	372.24	17.56	0		370.56
21	2.1 Superstructure: Frame	436830	157.59	42.53	0		157.59
2.2	2.2 Superstructure: Upper Floors	1187019	428.22	4.47	0		425.37
2.3	2.3 Superstructure: Roof	37241.9	13.44	2.89	0		
2.4	2.4 Superstructure: Stairs and Ramps	53452	19.28	28.26	0		19.28
2.5	2.5 Superstructure: External Walls	354554.76	127.91	1.03	0		117.02
2.6	2.6 Superstructure: Windows and External doors	1740	0.63	0	0		0.63
2.7	2.7 Superstructure: Internal Walls and Partitions	54097.47	19.52	3.33	0		14.33
2.8	2.8 Superstructure: Internal doors	68678.07	24.78	0	0		
3	3 Finishes	95227.33	34.35	0.28	0		21.03
4	4 Fittings, furnishings & equipments						
5	5 Services (MEP)	63699.26	22.98	0	0		22.98
6	6 Prefabricated buildings and building units						
7	7 Work to existing building						
8	8 External works						
0	0 Unclassified / Other						
total	Total	3498006.5	1261.91	7.43	0		1189.25

Table 2. Bill of Materials

## 6.6. Recycling and Waste

The table below sets out targets for reporting the total amount of waste / material generated during excavation, demolition, and management methods construction.

CATEGORY	TOTAL ESTIMATE	OF WHICH...				
			% reused or recycled onsite	% reused or recycled offsite	% not reused or recycled max 5%	
	Tonnes/100m2 Gross Internal Area (GIA)				% to landfill	% to other management (e.g. incineration)
Excavation waste	TBC	TBC	remainder	5% (Hazardous Waste only)		
Demolition waste	TBC	20%	remainder	N/A	<i>N/A assume all non reusable and non recyclable waste is sent to landfill.</i>	
Construction waste	6.5 tonnes/100m2	0	95%	5% (Hazardous Waste only)		
	t/annum	% reused on or off site	% recycled or composted, on or off site	% not reused or recycled		
				% to landfill	% to other management (e.g. incineration)	
Municipal waste	1-4 bedroom houses are allocated 2 x 240 litre storage per dwelling + 140 litre organic waste Apartments are allocated 250 litres per dwelling	0%	65%	35%	<i>N/A assume all non reusable and non recyclable waste is sent to landfill.</i>	

## 7. Plan for Implementation

### 7.1. Short and Medium Term

The project team will incorporate the requirements of this strategy into their specifications and contract documents during the next design phases. The performance targets and proposals outlined by this document will be used to specify suitable materials and design solutions as appropriate. The design parameters that require review during the next phase include:

- Replace the district heating system in the new build stable block with individual exhaust air heat pumps to each dwelling
- Introduce a solar photovoltaic array to all new buildings
- GGBS and admixture content within structural concrete;
- Recycled Steel within structural elements
- Explore use of offsite construction for components of major building elements including floors and external wall
- Recycled aggregate content within concrete;
- Opportunities for use of recycled material within landscaping;
- Use of modular bathroom pods; and
- Consideration of consolidated and smart logistics.
- In order to reduce the energy usage, the Contractor will investigate features which minimise energy wastage such as occupancy controls to switch off unnecessary lighting within site cabins.
- The project will set targets for the potable water consumption (m<sup>3</sup>) arising from the use of construction plant, equipment (mobile and fixed) and site accommodation.

### 7.2. Post Completion

Following project completion, the Circular Economy Statement will be reviewed and updated to measure against the predicted performance. The specified targets and commitments will be compared during each phase and reported to relevant bodies in accordance with any conditions stipulated by the planning process.

A Post Completion Report will be produced, as per the CE Statement Guidance.

### 7.3. End of Life Strategy

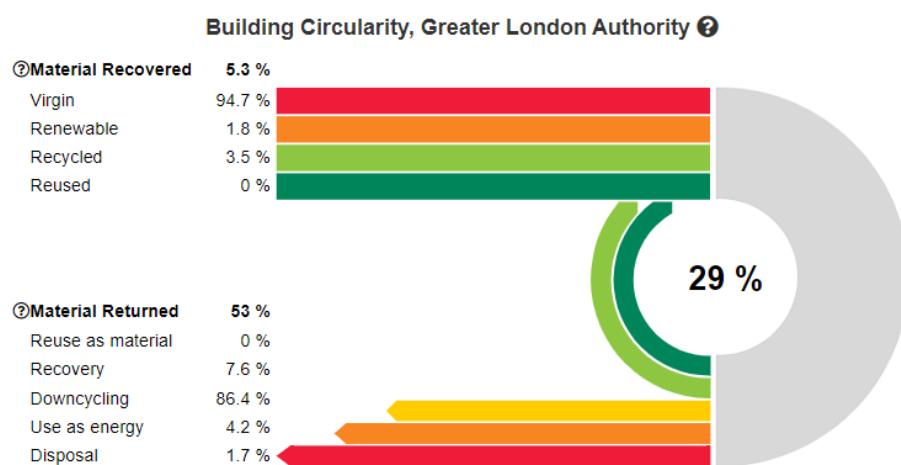
This strategy sets out how the building materials, components, and products will be deconstructed and at the end of their useful life. As set out in the previous sections, material demand has been minimised by the building design and construction methods. It is anticipated that the following activities will be conducted at the end of life:

- Curtain Walling façade demounted for reuse or demounted for reuse or disassembled and recycled in component parts (steel / glass)

- Window frames and glazing demounted for reuse or disassembled and recycled in component parts (steel / glass);
- Concrete elements crushed on-site to secondary aggregate;
- Cement/mortar use in a backfill
- Gypsum recycled;
- Steel reinforcement recycled;
- Bricks reclaimed;
- Products and MEP reclaimed or recycled where possible.

The One Click LCA Building Circularity tool was used to estimate the opportunity for returning the material at the end of life of the building. The results presented here for the development based on the inputs used for the whole life carbon analysis of the development. The material quantity and specification inputs are in alignment with the bill of quantities. Though, it is impossible to predict construction processes and minimum recycling rates in 60 years times but based on current practices and industry benchmarks applied by default by the One Click tool results have been included.

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It is estimated that 3.5% of the materials used will be recycled materials. This includes the recycled content within the steel rebars. The End of Life (EoL) scenarios are noted within Appendix A for each materials proposed

This building circularity is being mainly evaluated in terms of the mass of the recovered building material as compared to virgin material likely to be used in the building construction and the percentage of the material that can be returned to building construction at the end of life of the building.

#### **Material Recovered**

The calculation takes into account the reused, recycled and renewable materials to ascertain the mass of the recovered material as compared to virgin material..

#### **Material Returned**

As mentioned earlier, it is impossible to predict the recycling rates in 60 years' time, however, it has been considered that at least current rates of recycling will be achievable. The inputs used for materials returned are based on industry benchmarks applied by the software.

## References

Ghaffar, S., Burman, M. and Braimah, N., 2020. Pathways to circular construction: An integrated management of construction and demolition waste for resource recovery. *Journal of Cleaner Production*, 244, p.1187

## **Appendix 1 – Bill of Materials includes building weight calculations and reused or recycled content calculations**