151 Shaftesbury Avenue

Whole Life Carbon and Circular Economy Statement

A6 – Issued for Planning Submission

29th May 2024

MAX FORDHAM

MAX FORDHAM

Max Fordham LLP
St Andrews House
59 St Andrews Street
Cambridge
CB2 3BZ

T 01223 240 155

maxfordham.com

ISSUE HISTORY

Issue	Date	Description
C01	29/05/2024	Issue for planning

MAX FORDHAM

CONTENTS

MAX FORDHAM

EXECUTIVE SUMMARY

The aim of the project is to create an exemplar office development that showcases the merits of the existing structure, improves the overall energy performance, and at the same time delivers this at a lower embodied carbon over its lifecycle. The project is not GLA referrable but aims to apply the principles where possible and practicable.

The adopted overall design approach is based on a comprehensive review of the constraints of the existing structure against the project brief. The proposed massing, structure and services strategy is inherently built on circular economy and embodied carbon thinking as outlined below:

- Retain as much of the existing structure as possible;
    - 100% of the existing substructure retained and reused, reducing demolition carbon and concrete demand.
    - Retention of 90% of the superstructure
- Replace all of the existing façade with high performing glazing and solid area with a solid to glazing ratio in the region of 40%. Reducing the amount of glazing replacement required over the life of the scheme;
- Lower embodied carbon-led services strategy.

Embodied carbon

In response to London Plan Policy SI2 'Minimising Greenhouse Gas Emissions', an embodied carbon study was undertaken as per the RICS Whole life carbon assessment for the built environment 1st edition. The results have been benchmarked against the targets set by the GLA, LETI and RIBA.

	Upfront Carbon A1-A5 *$kgCO_2e/m^2$*
GLA Benchmark - *office*	<950
GLA Aspirational Target - *office*	<600
LETI Band C – 2020 Target - *office*	<600
LETI Band A – 2030 Target - *office*	<350
151 Shaftesbury Ave. - Baseline *(RIBA stage 2)*	312

	Embodied Carbon A1-C4 (excl. B6/B7) *$kgCO_2e/m^2$*
GLA Benchmark - *office*	<1400
GLA Aspirational Target - *office*	<970
RIBA 2030 - *office*	<750
151 Shaftesbury Ave - Baseline *(RIBA stage 2)*	653

Massing and structure

An assessment of various structural options for the extension were developed and reviewed during the early parts of Stage 2. A combination of CLT slabs, and Timber joist infills, on a steel frame was chosen in preference to the aesthetically consistent option, but much higher carbon, of a slim floor composite steel system.

Building services

MEP services to be designed in a flexible way to minimise equipment redundancy throughout replacement/removal by future tenants during fit-out. As part of a BREEAM Mat 01 Life Cycle Carbon Analysis, embodied carbon optioneering was carried out to inform a lower embodied carbon services strategy.

As a part of this process, an extensive optioneering exercise was undertaken on the Heat Pumps to find the best performing solution to balance:

- Minimising embodied carbon by balancing Upfront emission of the units themselves with the refrigerant leakage of various types of refrigerants.
- Balance the above with the space constraints of the roof.

Similarly, broader understanding of the embodied carbon impacts of various services elements informed the design development since early stage. The current services strategy is as follows:

- Decentralised AHU
- Air supplied by on-floor Mechanical Ventilation with Heat Recovery (MVHR) units (6No.).
- Distributed point of use hot water services generally instead of central hot water solutions.

Façade

All the of the existing façade is being replaced with high performing glazing and solid area with approximately 40:60 split between windows and walls, aiming to balance the embodied carbon strategy with thermal performances, solar gain, views and wellness.

The façade design of the proposed scheme is combination of various solid materials:

- Precast Concrete with Textured Brick Slips, and precast GRC lintels from ground level up to Level 7.
- GRC Cladding on Levels 8 and 9.
- Metal mesh for the plant enclosure at Level 9 – subject to change.

Further façade proposals for the development are currently being explored in detail by a newly appointed façade consultant.

Circular economy

The following circular economy principles have been applied to help minimise waste as well as reduce embodied carbon:

- Maximise the residual value of the existing building by cataloguing and analysing the existing materials and setting performance targets for diversion of landfill waste and reuse on site.
- Maximise the lifetime value of new build and fit-out via optimising the extension structural design, minimising the waste during construction and making use of recycled or reclaimed materials.
- Maximise future benefits by developing design that facilitate future re-use, reclamation and recycling.

Existing building and fit-out

The proposed scheme aims to achieve the following policy targets (GLA Policy SI7):

- Zero biodegradable or recyclable waste to landfill by 2026;
- 95% of construction and demolition waste reused/recycled/recovered;
- 95% of excavation waste put to beneficial use.

The estimated demolition waste is 687 tonnes of which the project will aim to recycle, and or reuse, 98% of this waste stream. This shows that in terms of material arising, the most significant elements are internal walls (32%), floors (26%) and façade (24%).

- Concrete - Most of the concrete is unsuitable for reuse, but should be separated on site or at a local waste facility for use as an aggregate
- Timber - solid timber should be recycled into chipboard, and some timber fit-out elements are available for reuse.
- Glass - Any clear float glass in the scheme will be segregated separately and sent through closed loop recycling to float glass manufacturers such as Saint Gobain, Pilkington or Guardian glass.
- Glass partitions - Where reuse cannot be found, opportunities to recycle into other elements such as desktops/worktops will be explored. Take back schemes by suppliers such as Optima.
- Gypsum A strong focus on segregation and monitoring record of recycling of gypsum materials will be implemented.

As highlighted by the pre-demolition audit, subject to feasibility, the project targets a diversion of waste from landfill target of 95% (by weight) is recommended. The main contractor will be required to assess the following reuse potential items and develop an approach:

- Fixtures and Fittings
    - LED lighting to be stripped and sent to remanufacturing facility for future reuse.
    - Kitchen equipment, cabinets, granite worktops and other loose furniture to be appraised for resale/ donation to community organisations.

- Floor finishes
    - Carpet tiles (4189m^2)
    - Stone flooring (100m^2, 50% suitable for reuse) - subject to recoverability.

Managing construction impacts
The contractor will follow responsible construction practices in reducing construction impact on the neighbours as well as the environment, by following the Considerate Construction Scheme and aspire for a 4 star or above rating.

Recycled content by value

The London Plan Guidance suggests schemes meet a minimum target of 20% recycled or reused content, by value of a scheme. The following element specification would have to be reviewed at stage 3 and cost plan to report the additional costs involved:

- Recycled content of structural steel members
- Façade aluminium glazing to incorporate specification for higher recycled content aluminium frames e.g., Hydro CIRCAL
- Glazing specification to incorporate glass with >30-40% recycled content.

INTRODUCTION

This report describes our understanding of the brief and presents the current proposals for the embodied carbon and circular economy for 151 Shaftesbury Avenue.

1.1 LOCATION AND EXISTING BUILDING

151 Shaftesbury Avenue is situated on the corner of Shaftesbury Avenue and St Giles Passage, on a key pedestrian route connecting St Giles in the Fields with Seven Dials. The plot is predominantly trapezoidal in shape with a 44m long elevation on Shaftesbury Avenue, a 21m long elevation on St Giles Passage and a 39m long elevation on New Compton Street. To the North, 151 Shaftesbury Avenue shares a party wall boundary with 177 Shaftesbury Avenue, with a listed Odeon cinema building across St Giles Passage to the South.

151 Shaftesbury Avenue's existing building was constructed in 1996 with retail at ground floor and offices above.

The existing structure is believed to comprise of:

- Reinforced Concrete (RC) substructure
- RC Core Walls
- Steel Framed superstructure
- Composite concrete and steel floor. Deep trough profiled decking
- Highly glazed façade with terracotta-coloured precast concrete panels

1.2 PROPOSED SCHEME

The proposed scheme for 151 Shaftesbury Avenue functions as office space from first to ninth floor with retail units on ground and lower ground levels.

The 'refined' deep retrofit strategy proposed for Stage 3 involves the construction of:

- a new steel/timber frame for the extension from level 7 to roof level,
- a new envelope from ground floor to roof level,
- and new internal partitions, finishes, fittings, fixtures and services throughout

The proposed floor area for each use is reported in Table 1.

Table 1 - Proposed Gross Internal Area (m2) by use class.

Usage type	Gross Internal Area (m²)	Percentage
Office	6873	85%
Retail	309	4%
Club Lounge/Cafe	151	2%
Domestic	531	6.5%
Total	8,054	-

1.3 WHOLE LIFE CARBON

Whole Life Carbon (WLC) emissions are those associated with the building materials and products including production, construction, replacement, demolition, disposal and in-use energy consumption. Whole Life Carbon comprises of the lifecycle assessment (LCA) components as shown in Figure 1.

- Upfront Carbon (A1-A5) – Carbon emissions associated with the construction of a building. These are the carbon emissions that a project team can most directly control through modelling the upfront carbon and choosing low-carbon construction materials and processes coupled with leaner material use.
- Embodied Carbon (A1-C4, excl. B6-7 & D) – Carbon emissions associated with the construction, maintenance, repair and end-of-life of a building. Considering embodied carbon, in addition to Upfront Carbon, allows the project team to identify material choices that have a low upfront carbon cost, but avoid high ongoing carbon emissions associated with maintenance and repair.
- Whole Life Carbon (A1-C4, incl. D) – As above, but including the carbon emissions associated with the operational energy expenditure of the building and water usage. Additionally, this metric also reports Module D benefits - i.e. benefits beyond the scope of the building's lifetime such as reuse potential, recovery and recycling.

This report presents the strategies and options reviewed for minimising upfront carbon emissions (A1-A5) and the overall embodied carbon emissions (A1-C4) at RIBA stage 2 and 3.

1.4 CIRCULAR ECONOMY

A Circular Economy is one where building 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.

This means the assets are designed so that whole buildings, and materials, components and parts can be continually and easily recycled.

Through optimising material use embodied carbon can be significantly reduced, supporting the delivery of net zero carbon developments.

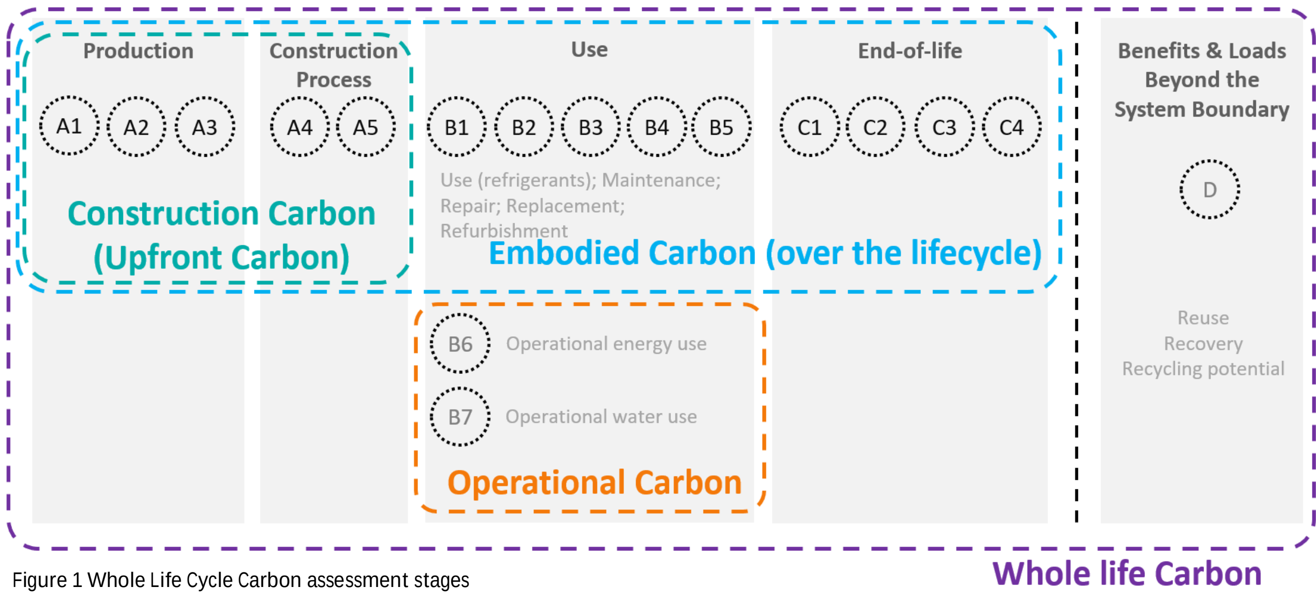


Figure 1 Whole Life Cycle Carbon assessment stages

1.5 INDUSTRY BENCHMARKS

Several industry Embodied Carbon targets exist for Office projects, with LETI, RIBA and the GLA being the most recognised. Each of these have differing target based on the level of sustainable aspiration a project may have, or year of targeted completion

Upfront Carbon (A1-A5)
LETI provide the following banded targets for the upfront construction (A1-A5) embodied carbon stages (excl. sequestration).

- LETI Band C – 2020 Target – RLAM Target – 600 $kgCO_2e/m^2$
- LETI Band A – 2030 Target – 350 $kgCO_2e/m^2$

The GLA provide the following upfront targets depending on level of aspiration.

- GLA Benchmark – “Business-as-usual” – 950 $kgCO_2e/m^2$
- GLA Aspirational – 600 $kgCO_2e/m^2$

Embodied Carbon (A1-C4, excl. B6,B7)
The RIBA Climate Challenge provides a life-cycle embodied carbon target (A1-C4, excl. B6,B7 i.e. operational carbon) of:

- RIBA 2030 - 750 kgCO2e/m² of GIA (A1-C4, excl. B6,B7)

The GLA provide the following upfront targets depending on level of aspiration.

- Benchmark – “Business-as-usual” – 1400 $kgCO_2e/m^2$
- GLA Aspirational – 970 $kgCO_2e/m^2$

1.6 PROPOSED SCHEME EMBODIED CARBON

The table below outlines the embodied carbon of the proposed scheme at Stage 2. The figures below include a buffer of 15% in-line with latest industry guidance. The results below exclude: External Works, FF&E and PVs in order to be comparable to LETI and RIBA targets.

	151 Shaftesbury Avenue Stage 2
Upfront Carbon A1-A5 *($kgCO_2e/m^2$)*	312
Embodied Carbon A1-C4 (excl. B6 & B7) *($kgCO_2e/m^2$)*	653

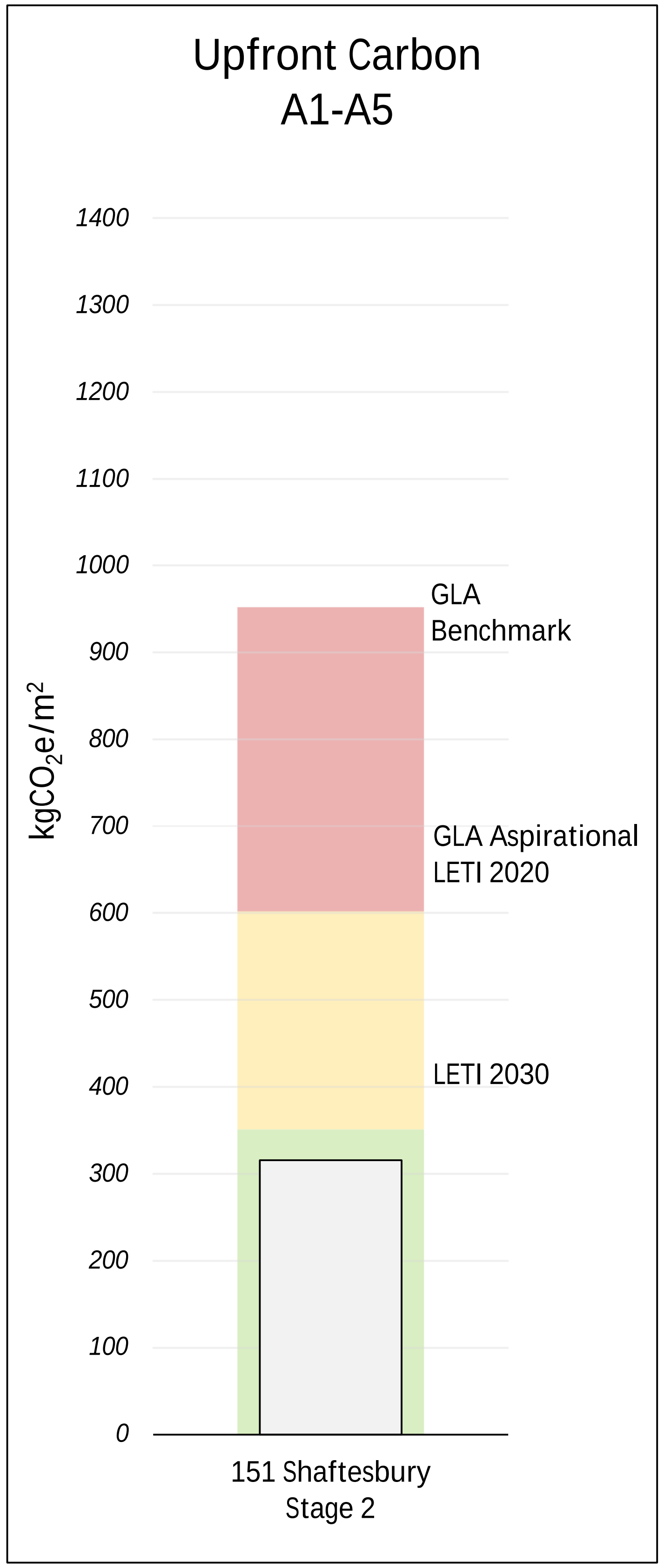
The graphs across demonstrate the projects performance as compared to various industry targets.

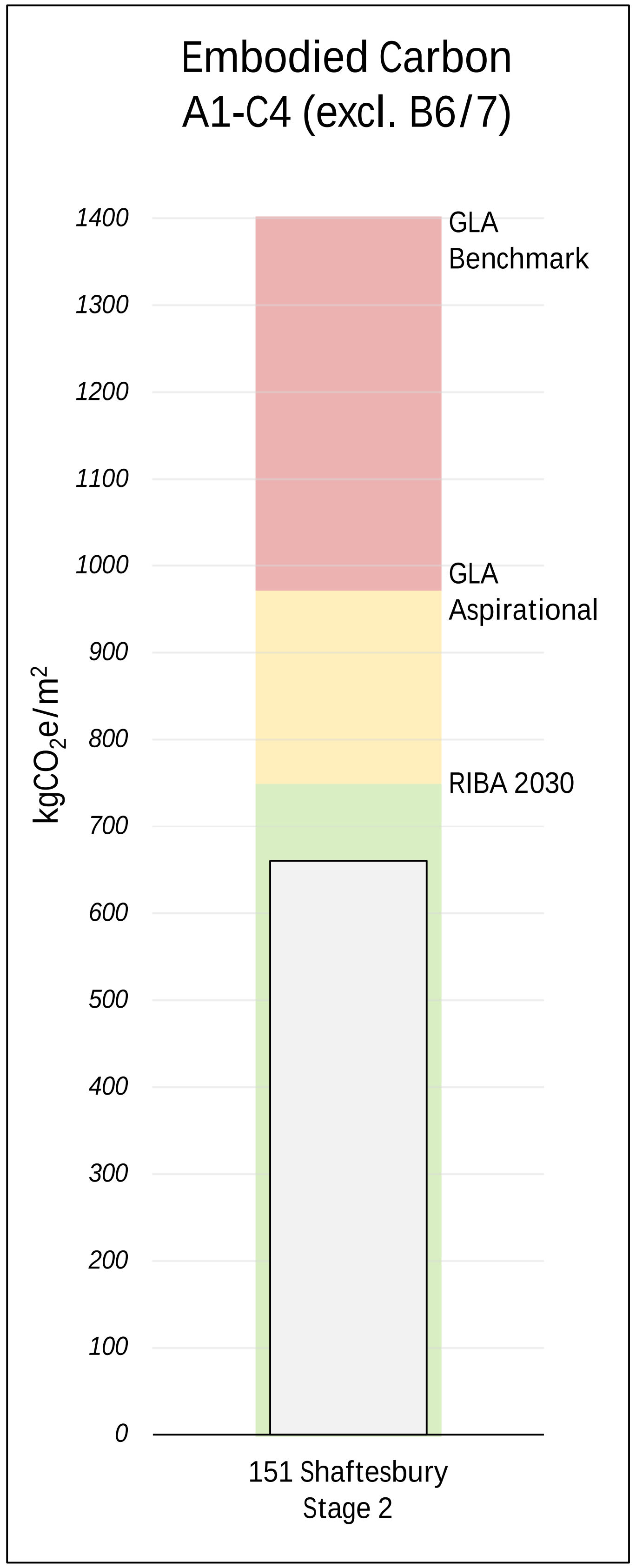
This is based on a GIA of 8,054m².

Net-Zero Construction
The project aligns with the UKGBC Net Zero carbon construction framework due to:

- Comprehensive carbon reduction measures taken during stage 2 – see Mat01 report.
- These actions resulting a minimised upfront carbon.

It is anticipated that the project will align with the new UKGBC Net Zero Carbon Building Standard when released.





1.7 PLANNING POLICY AND GUIDANCE – GLA WLC & CE

2.1 LONDON PLAN (2021)
The London Plan published in March 2021, forms the statutory development plan for Greater London over the next 20-25 years. A number of policies directly related to material resource efficiency, embodied carbon and circular economy within buildings and sites form an integral part of the London Plan.

London Plan Policy SI 2 Minimising Green House Gas Emissions
The policy sets out a requirement for development proposals to calculate and reduce WLC emissions as part of a WLC assessment. A supporting assessment guidance and a WLC assessment template has been produced by the GLA, formally adopted in March 2022. Applicants are required to report whole life embodied carbon by each life cycle stage at planning and post-construction. Local authorities are encouraged to secure the post-construction stage WLC assessment through a planning condition with the applicant.

London Plan Guidance: Whole Life Cycle Assessments (March 2022)
Requirements for office buildings are reported in Table 2.

Table 2 – GLA Office Benchmarks, from Whole Life Cycle Carbon Assessments - London Plan Guidance

	GLA Benchmark ($kgCO_2e/m^2$ GIA)	Aspirational Benchmark ($kgCO_2e/m^2$ GIA)
Upfront Carbon (A1-A5, excl. sequestration)	<950	<600
In-use and End of Life Carbon (B-C, excl. B6, B7)	<450	<370
Whole Life Carbon (A-C excl. B6, B7, incl. sequestration)	<1400	<970

London Plan Policy SI7 - Reducing Waste and Supporting the Circular Economy
Resource conservation, waste reduction, increases in material re-use and recycling, and reductions in waste going to disposal shall be achieved. Referable applications should promote circular economy outcomes and aim to be net zero-waste. Some key overarching targets set out in this policy are as follows:

- Zero biodegradable or recyclable waste to landfill by 2026;
- 65% of municipal waste recycled by 2030;
- 95% of construction and demolition waste reused/recycled/recovered;
- 95% of excavation waste put to beneficial use;

London Plan Guidance: Circular Economy Statement Guidance & Primer (March 2022)
In support of Policy SI7, projects shall demonstrate how their development, including any public realm and supporting infrastructure, will incorporate circular economy measures into all aspects of the design, construction and operation process. Projects shall ensure that their designs:

- Consider strategies to facilitate the transition towards a circular built environment;
- Recognise opportunities to benefit from greater efficiencies that can help to save resources, materials and money;
- Report against targets that will facilitate monitoring of waste and recycling.

London Plan Policy SI 8 Waste capacity and net waste self-sufficiency
In order to manage London's waste sustainably, the policy requires an equivalent of 100 per cent of London's waste to be managed within London (i.e. net self-sufficiency) by 2026. The Mayor is committed to sending zero biodegradable or recyclable waste to landfill by 2026.

London Plan Policy SI 10 Aggregates
The policy aims to achieve an adequate supply of aggregates to support construction in London by:

1) encouraging reuse and recycling of construction, demolition and excavation waste within London (incl. on-site)
2) extracting land-won aggregates within London
3) importing aggregates to London by sustainable transport modes.

2.2. Camden Local Plan (2017) and Energy Efficiency and Adaptation CPG (2021)
Camden Council's Local Plan sets out the following relevant policies relating to sustainability and climate change, in particular with respect to embodied carbon and circular economy.

CC1 Climate change mitigation
The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation.

All developments to optimise resource efficiency by:

- reducing waste;
- reducing energy and water use during construction;
- minimising materials required;
- using materials with low embodied carbon content; and
- enabling low energy and water demands once the building is in use.

All developments involving five or more dwellings and/or more than 500 sqm gross internal floor space are encouraged to assess the embodied carbon emissions associated with the development

CC2 Adapting to climate change
All developments should adopt appropriate climate change adaptation measures, such as:

a. the protection of existing green spaces and promoting new appropriate green infrastructure;
b. not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems;
c. incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and
d. measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

Non-domestic developments of 500 sqm of floorspace or above to achieve "excellent" in BREEAM assessments and encouraging zero carbon in new development from 2019. All new developments will be expected to submit a statement demonstrating how the London Plan's 'cooling hierarchy' has informed the building design.

CC4 Air Quality
Air Quality Assessments (AQAs) are required where development is likely to expose residents to high levels of air pollution. Development that involves significant demolition, construction or earthworks will also be required to assess the risk of dust and emissions impacts in an AQA and include appropriate mitigation measures to be secured in a Construction Management Plan.

CC5 Waste
Developments should include facilities for the storage and collection of waste and recycling. The Council will encourage the submission of a site waste management plan prior to construction.

Energy efficiency and adaptation CPG (2021)

- Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies
- Energy statements should demonstrate how a development has been designed following the steps in the energy hierarchy
- Condition and feasibility study, and options appraisal. (applies to major redevelopment applications, any development proposing substantial demolition)
- Whole Life Carbon assessment and pre-demolition audit. (All applications where the option is substantial demolition)
- Resource efficiency plan. (All major applications, and new buildings)

MAX FORDHAM

1.8 WHOLE LIFE CARBON DESIGN PRINCIPLES

WLC reduction principles	Key benefits	WLC reduction principles applied in the scheme
Reuse and retrofit of existing buildings	Significant retention and reuse of structures is carbon efficient and reduces construction costs.	Options for retaining existing buildings and structures have been fully explored, as a result: • 100% of existing foundations to be reused. • Over 90% of existing superstructure to be retained
		• A pre-refurbishment/strip-out materials audit has been carried out. A survey of opportunities for on-site/off-site reuse of existing internal and external elements has been identified. • Carbon emissions associated with pre-construction demolition has been accounted within the whole life carbon assessment
		The proposed development is considering reuse of existing internal fit-out materials on-site/off-site, subject to feasibility/deliverability: • Fixtures and Fittings o LED lighting to be stripped and sent to remanufacturing facility for future reuse; • Raised access floor o 4600m^2 of Raised Access Flooring in-situ
Use repurposed or recycled materials	Reduces waste and carbon emissions.	As part of design development the project aims to specify: • Options for specifying refurbished/recertified light fittings will be explored by the main contractor. • Recycled content within internal fit out elements (e.g. plasterboard, carpets) to be reviewed at the detailed design stage.
Material selection	Appropriate material choices are key to carbon reduction. Ensuring that materials are selected with consideration of the planned life expectancy of the building reduces waste, the need for replacements and the in-use costs.	Steel frame with either Timber Joist Infills, or CLT slabs, have been chosen to both minimise embodied carbon and maximise end-of-life recovery in a high-value state. Both the steel and timber elements are all designed for simple, non-destructive, disassembly. Off-site manufactured, thin GRC panels has been chosen for the façade spandrels, as a way to minimise embodied carbon and on-site waste. Heat pump refrigerant optioneered to find the right balance between performance, embodied carbon and size.
Minimise operational energy use	A 'fabric first' approach should be prioritised to minimise energy demand and reduce carbon and in-use costs.	The proposed development has set a target rating within a range of NABERS 5-5.5 stars. This requires efficient services and controls strategy in-use to achieve the level of in-use operational energy use.
Minimise the carbon emissions associated with operational water use	Choice of materials and durability of systems, which help to avoid leakage and subsequent building damage, contribute to reducing the carbon emissions of water use.	The development is aiming to minimise on-site water use with low flow rate fittings specified.
Disassembly and reuse	Designing for future disassembly ensures that products do not become future waste and that they maintain their environmental and economic value.	Steel structural framing solution in the extension will enable deconstruction and reuse in future.

Building shape and form	Compact efficient shapes help minimise both operational and embodied carbon emissions from repair and replacement for a given floor area. This leads to a more efficient building overall resulting in lower construction and in use costs.	Proposed external façade and the extensions improve the form of the existing building, reduce the heat loss and therefore, in-use costs as well as carbon emissions associated with operational energy.
Regenerative design	Removing carbon emissions from the atmosphere through materials and systems absorbing it makes a direct contribution to carbon reduction.	N/A.
Designing for durability and flexibility	Durability means that repair and replacement is reduced which in turn helps reduce life-time building costs. A building designed for flexibility can respond with minimum environmental impact to future changing requirements and a changing climate, thus avoiding obsolescence which also underwrites future building value.	Accessible and flexible services allowing tenant fit-out and change of use in future.
Optimisation of the relationship between operational and embodied carbon	Optimising the relationship between operational and embodied carbon contributes directly to resource efficiency and overall cost reduction.	Glazing proportion has been drastically reduced from the existing rate to around 40%. The careful façade material choices, coupled with the large increase in solid façade, is targeting large operational carbon reductions with minimised embodied carbon emissions.
Building life expectancy	Defining building life expectancy gives guidance to project teams as to the most efficient choices for materials and products. This aids overall resource efficiency, including cost efficiency and helps future proof asset value.	The service life of the proposed scheme is 50 years as per the Eurocodes. However, the selection of material choices would mean the building will continue to meet the longer term operational needs.
Local sourcing	Sourcing local materials reduces transport distances and supply chain lengths and has associated local social and economic benefits.	At procurement stage options for distance and mode of transport involved in sourcing various elements will be considered. For the purpose of embodied carbon estimates RICS whole life carbon guidance recommended distance have been assumed. • Locally manufactured e.g. concrete, aggregate, earth - 50km by road • Nationally manufactured e.g. plasterboard, blockwork, insulation - 300km by road • European manufactured e.g. CLT, façade modules, carpet - 1,500 km by road • Globally manufactured e.g. specialist stone cladding - 200 km by road, 10,000km by sea
Minimising waste	Waste represents unnecessary and avoidable carbon emissions. Buildings should be designed to minimise construction waste, and to ease repair and replacement with minimum waste, which helps reduce initial and in-use costs.	Steel and CLT frame eliminates the need for wet-work (i.e. concrete pours) and minimises the amount of material wasted on-site. Elements of the façade are considered for off-site manufacture to minimise wate and increase speed of erection. Windows are detailed to avoid covering and allowing glass to be replaced at end-of-life.
Efficient construction	Efficient construction methods (e.g. modular systems, precision manufacturing and modern methods of construction) can contribute to better build quality, reduce construction phase waste and reduce the need for repairs in the post completion and the defects period (snagging).	As above
Lightweight construction	Lightweight construction uses less material which reduces the carbon emissions of the building as there is less material to source, fabricate and deliver to site.	Steel and CLT, or Steel and Timber Joists, represented the lightest structural solutions, thus minimising the amount of strengthening works required. The façade has also been optioneered with minimal mass routes identified.
Circular economy	The circular economy principle focusses on a more efficient use of materials which in turn leads to carbon and financial efficiencies.	The proposed scheme has carefully considered the options for redeveloping the existing buildings. However, a level of demolition is required to deliver a viable and functional scheme. Within these constraints, all of the 6 key CE design principles have been embedded into the design.

CIRCULAR ECONOMY STRATEGIES

1.9 PROJECT APPROACH

The project aim is to showcase a circular approach to demolition by adopting a proactive strategy following the waste preference hierarchy:

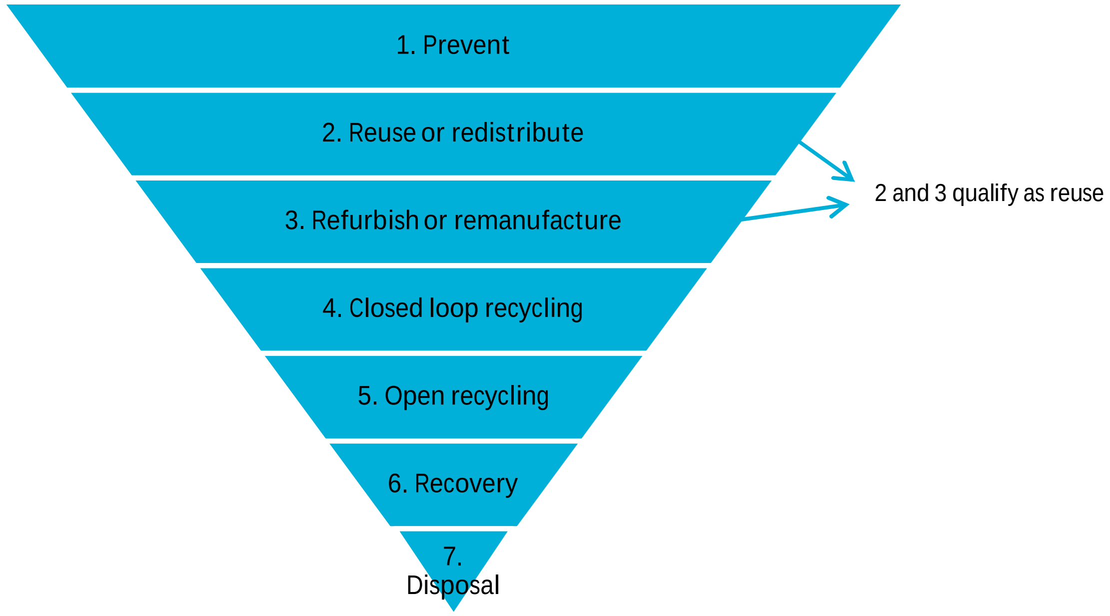


Figure 2 Waste Hierarchy

Prevent
Massing studies and development options have established whether existing buildings, structures and materials can be retained, refurbished, or incorporated into the new development. This included robust analysis that fully explores options for retaining existing structures, materials and the fabric of existing buildings into the new development; and the potential to refurbish buildings before considering substantial demolition.

What counts as reuse? [1]
It's important to understand that recycling is not reuse. Reuse of materials keeps the material in high grade form. Any processing required doesn't reduce the material to a significantly lower grade of material.

- Reuse or redistribute: Products that are in technically good condition, that can be removed and reused multiple times, either on site or redistributed to new users in their original form with little enhancement or change.
- Refurbish or remanufacture: This is when a product is refurbished, its condition is improved – potentially to as-new e.g. Lighting. This can include disassembly and rebuild, replacing components where necessary, updating specifications, and improving cosmetic appearance. When a component is remanufactured, it is re-engineered to as-new condition with the same warranty as a new component.

<u>Examples of reuse include the following:</u>

- reusing steel beams as steel beams at an equivalent or lower structural strength class;
- reuse of raised access floor and pedestals;
- refurbishing M&E items such as light fittings or distribution panels for future use;
- re-purposing metal electrical trunking as a raw material to make furniture or other items;
- reusing cut reinforced concrete elements for reuse elsewhere.

Note that selling or donating materials and products to buyers/beneficiaries who have the intention of putting the items to re-use would be classed as re-use for the project, so long as the buyer/beneficiary can provide some credible evidence that re-use is their primary aim (for example an established business website or a letter of intent).

For example, selling or donating items to an established architectural salvage company who has a track record of stocking items for reuse would qualify as reuse. Selling or donating items to organisations or individuals (such as charities or businesses) would qualify if they provide written confirmation that they intend to reuse/re-purpose (and not recycle or otherwise dispose of) the items.

What counts as recycling? [3]
Recycling reduces a product or a material to its granular level to be reprocessed and made into new products, components or materials.

<u>Examples of closed-loop recycling</u>

- Take-back schemes by manufacturers where they recycle into new product: vinyl, plasterboard;
- Float glass recycling schemes into cullets by manufacturers;
- Aluminium take-back schemes by manufacturers.

<u>Examples of open recycling</u>

- Recycling of glass into crushed aggregates for roads
- selling/donating items to a scrap metal dealer whose primary activity is to serve the recycling industry.
- crushing concrete and using it as Recycled Aggregate (RA)2 in new concrete or Recycled Concrete Aggregate (RCA) or road base.

Waste to energy (e.g. incarnation CHP) is classed as recycling, however it is the least desirable form of recycling as energy is considered a lower grade product than an object or material that can be put to use. Where possible the Contractor is to prioritise material recycling in preference to waste to energy recycling pathways.

[1] Circulytics-definitions-list.pdf (ellenmacarthurfoundation.org)

[2] End of life recycling (concretecentre.com)

1.10 EXISTING BUILDINGS AND FIT OUT

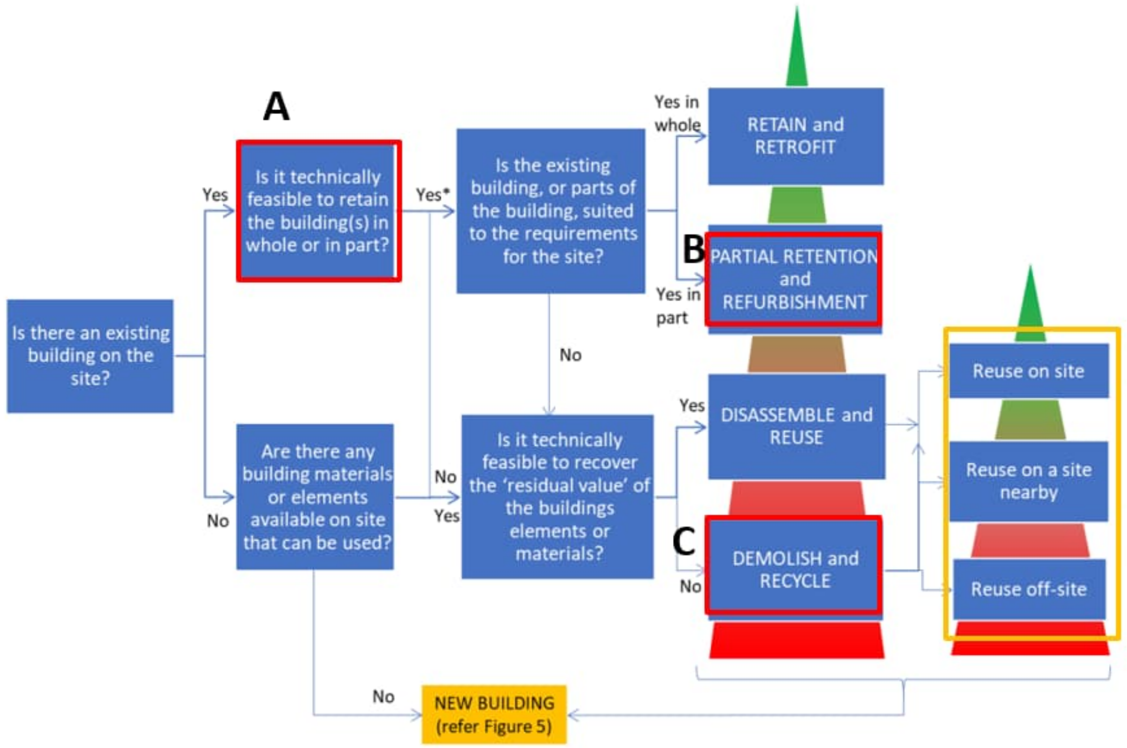


Figure 3 GLA CE Guidance – Decision making tree for design approaches to existing buildings. London Plan

Circular Economy guidance requires project teams to use the flow chart in Figure 3 to demonstrate how the proposed scheme has considered the options for retaining the existing built structures totally or partially before considering substantial demolition. The project development approach to the existing is outlined below:

- Stage A - Retention of the existing building is feasible. However, retention of the building as a whole would not meet the requirements of the development. The proposal is for an energy efficient, optimised building which would not be possible with the existing façade build up and glazing ratio. Those requirements could not be met by a development that would involve retention of the whole building. This is because retaining and extending the existing building in its entirety would perpetuate existing defects of the building, including compromised roof accommodation and inefficient internal layouts. Furthermore, replacing some areas of existing glazing with new façade elements would not allow for as efficient a building as replacing the full envelope.

- Stage B - The Applicant team therefore concluded retention of the entire building was not practical and considered an alternative approach. This partial retention option involves retaining the basements and structural grid away from the façade, along with a new façade. This approach, whilst prioritising the retention of the existing structure, is capable of delivering the development of the site which is supported by planning policy whilst providing a building of an appropriately high standard. In part, this is because the existing compromised roof structure would be removed and the existing structure provides the structural capacity needed to extend the building, without the intrusive and highly inefficient works that would otherwise be required, and which would compromise the quality of the building.

- Stage C - The partial retention design was developed into the proposed development forming this application. Overall, it is estimated that around 90% of the existing structure will be retained. This fully complies with the objectives of the London Plan Policy SI7 and the GLA supplementary guidance. In addition, as described in the previous section, the project team has considered the whole life carbon impacts alongside technical and commercial implications of various development options.

1.11 EXISTING MATERIAL REUSE

The project team have identified a list of potential items for reuse on-site, off-site, closed-loop recycling.

See *Appendix I Pre-Refurbishment audit* which highlights the potential items for reuse.

1.12 PRE-REFURBISHMENT AUDIT

A Pre-demolition audit (defined as 'Pre-Refurbishment Audit' specifically for this project) is a non-intrusive audit capturing a detailed inventory of the materials in the building that will become waste and requires managing during strip out and demolition.

The proposed scheme is aiming for BREEAM Outstanding rating. A Pre-demolition audit is also required for meeting BREEAM Wst 01 credit requirements and to satisfy the London Plan.
See Appendix A Pre-Refurbishment audit for detailed waste arising and opportunities for reuse.

The total estimated waste arisings (Key Demolition Products) are 2,339 tonnes, equivalent to a volume of 1,467m3. The tonnes waste arising per m2 GIA is 0.592.

Having assessed the material arising from strip-out and demolition the report recommends the following targets:

- A diversion of waste from landfill target of 95% (by weight).
- A material reuse target of 1% (by weight).

1.13 DESIGN PRINCIPLES WITHIN THE PROPOSED SCHEME

The London Plan Circular Economy guidance requires the project teams to use the flow chart in Figure 3 GLA CE Guidance – Decision making tree for design approaches to existing buildings. and illustrate how the proposed scheme has embedded CE design approaches. The following also satisfy BREEAM 'Mat 06 Material efficiency' and 'Wst 06 Design for disassembly' credit requirements.

Design out waste
Steel and CLT frame eliminate the need for wet-work (i.e. concrete pours) and minimises the amount of material wasted on-site. A potential off-site route for the façade has been identified using pre-cast concrete with brick slips and GRC spandrels.

Moderating the scale of extensions to situate within the capacity of the existing structure eliminates the need for large amounts of new structure and associated waste.

Designing for Longevity
- The design has been developed with a solid to void ratio around 40%. Limiting the amount of glazing will reduce the need to replace glazing as it reaches the end of its serviceable life.
- All new structure designed for at least 60 years. The timber joists and tilted CLT solutions allow for early detection of any compromised water protection and reduce the risks of early replacements.
- The Design Team will aspire to provide bike parking in excess of the London Plan to ensure the building is future proofed as active modes of travel become further incentivised.
- Robust finishes will be chosen both internally and externally and thoughtful maintenance strategies will be prepared for the building management teams.

Designing for adaptability or flexibility
- No load bearing internal partition wall allowing greater flexibility;
- All distribution pipework and drainage will have a valving arrangement within the risers to allow for easy adaptability by incoming tenants;
- Core risers extend down to basement to allow for future change in use;

- Long form core designed to be compact to maximise flexibility on floorplate;
- Several apertures connecting to the street allow for future additional entrances/exits;
- Wireless lighting controls are being explored.

Designing for disassembly

- Steel columns will have mechanical fixings allowing for future reuse;

Using systems, elements or materials that can be re-used and recycled

- The building has been designed to circular economy principles and these will be conveyed to the building management team upon completion.
- The Design Team are endeavouring to specify high-quality, recyclable materials, including GRC, brick, and CLT. Specifications to be developed at stages 3 and 4.
- At procurement stage, the project team will be engaging met with several demolition and recycling contractors to discuss the feasibility meeting the reuse aspirations for the project.

1.14 CIRCULAR ECONOMY TARGETS

The stage 3 report will capture the reuse strategy and employers' requirements to realise the targets set for the scheme. A summary has been outlined below:

Waste diversion from landfill
Minimum policy target is 95% diversion of construction, demolition and excavation waste from landfill.

Estimated demolition waste is 687 tonnes of which the project will aim to recycle, and or reuse, 98% of this waste stream. This shows that in terms of material arising, the most significant elements are internal walls and partitions (29%), external walls (25%) and floors (19%).

- Concrete - concrete is to be crushed and segregated either on site or at a nearby waste facility as space is limited, to be used as a recycled aggregate;
- Timber - solid timber is to be recycled into chipboard, some timber fit-out elements such as doors and cupboards are suitable for reuse;
- Glass - Any clear float glass in the scheme will be segregated separately and sent through closed loop recycling to float glass manufacturers such as Saint Gobain, Pilkington or Guardian glass;
- Glass partitions - Where reuse cannot be found, opportunities to recycle into other elements such as desktops/worktops will be explored. Take back schemes by suppliers such as Optima.
- Gypsum - A strong focus on segregation and monitoring record of recycling of gypsum materials will be implemented.

The demolition and main contractor will be required to monitor waste generation and destinations, and report percentages to reuse/recycling/landfill in each report, producing a summary report at the end.

Reuse of on-site materials
We would recommend targeting between 15-20% by weight of demolished and strip-out materials to be reused either on-site and/or off-site. Appendix A (Pre-Refurbishment Audit) to be reviewed and actions to be implemented by the project team at before the end of RIBA Stage 3.

Some of the key items identified by the project team are as follows:

- Fixtures and Fittings
  - LED lighting to be stripped and sent to remanufacturing facility for future reuse.
  - Kitchen equipment, cabinets, granite worktops and other loose furniture to be donated to community organisations.
- Floor finishes
  - Carpet tiles (4189m^2) – min. 70% fit for re-use.
  - Raised Access Floor (approx. 4600m^2).
  - Stone flooring (199m^2, 50% recoverable) - subject to recoverability.

Managing the construction impacts
The main contractor will be contractually required to deliver responsible construction and reduce environmental impacts during construction. This will be implemented by main build contractors, such as registering the scheme with Considerate Construction Scheme, aiming for a 4 star or above rating, adopting responsible Construction Practices. This to be delivered in line with the BREEAM Man 03 'Responsible Construction Practices'.

Recycled content

The London Plan requires schemes to meet a minimum target of 20% recycled or reused content, by value of a scheme. This will be a challenging target for CLT and glulam schemes. The following element specification would have to be reviewed at stage 3 and cost plan to report the additional costs involved:

- Concrete specification to incorporate a minimum of 20% recycled aggregates and lower carbon cement specification (as informed by embodied carbon model) to enable higher recycled content by value.
- Façade aluminium glazing to incorporate specification for higher recycled content aluminium frames e.g., Hydro CIRCAL.
- Glazing specification to incorporate glass with up to 40% recycled content.

APPENDIX I PRE-REFURBISHMENT AUDIT

Report From:

Katherine Adams and Gilli Hobbs
Circular Economy and Waste Specialists
Reusefully Ltd

Report Prepared For:

Avison Young

Pre-demolition/refurbishment audit report 151 Shaftesbury Avenue, London

17th August 2022

Contents

Executive Summary

The pre-refurbishment audit was undertaken on the 13th of July 2022 by Katherine Adams and Toby Balson of Reusefully Ltd. A visual survey of the building, combined with analysis of the plans provided, was used to calculate the Key Demolition Products (KDP). The audit has investigated the key materials which are likely to rise from the proposed refurbishment scheme and the other materials present on the floors to aid with the decision making for the proposed development during RIBA Stage 2. The quantities are as follows:

	Weight	**Volume**	**EWC**
Concrete	226.5	133.6	17 01 01
Timber	135.8	201.9	17 02 01
Glass	112.2	45.6	17 02 02
Metals	82.3	11.3	17 04 05
Gypsum	73.93	96.09	17 08 02
Carpet	22	26	20 01 11
Ceramic	16	7	17 01 03
Insulation	10	201	17 06 04
Stone	4	2	01 04 08
Plastics	4	4	17 02 03
WEEE	-	-	16 02 14
Totals	**687**	**728**	

The estimated Key Demolition Products (KDP) by weight are Concrete (33%), Timber (20%), Glass (16%), Metals (12%), and Gypsum (11%), with smaller amounts of Carpet, Ceramic, Insulation and Stone. Parameters have been provided for key products to assist with reuse in this development and others (this will be presented separately in the PowerPoint presentation). This equates to approximately 375 tonnes of embodied carbon.

An estimated 98% of materials could be diverted from landfill. Around 277 tonnes (approximately 40% by tonnage) may be suitable for reuse; a conservative target for reuse would be 20%.

1. The Requirement

Avison Young have engaged Reusefully Ltd to carry out a pre-refurbishment audit of the office building at 151 Shaftesbury Avenue, London. Whilst the scheme is not preferable to the GLA, we understand that the client, Royal London Asset Management, would like the audit to follow the principles in line with the GLA's circular economy statement recommendations as these are well established and will support their circular economy aspirations. The audit also meets the requirements of BREEAM New Construction, Wst 01.

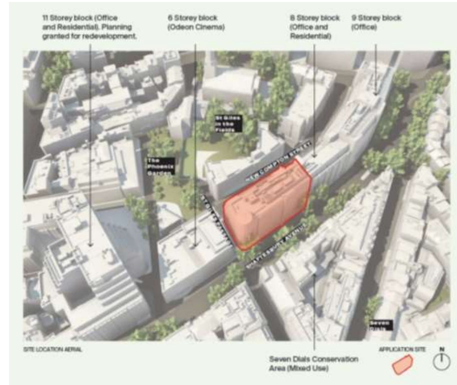
The aim of the audit is:

- To provide an understanding of the types and amounts of products and materials arising during the demolition/deconstruction including dimensions for key products such as door and internal glazing/partitioning to enable reuse in the refurbishment and/or elsewhere
- To optimise the management of products and materials and provide recommendations to the design team and demolition contractor in line with the waste hierarchy i.e. maximise reuse and recycling and minimise waste to landfill
- To provide technical advice on the reuse of products and recycling of material on and off site
- To facilitate better links and communication within the supply chain and provide details of local charities, organisations and companies who may be able to deal with the reuse and higher value recycling of products and materials arising
- To provide data to help with populating the Resource Management Plan and in support of any assessment
- To advise on targets for reuse and recycling for products and materials
- Provide embodied carbon information for the materials and products to be removed.
- Mitigation of negative effects from demolition

2. Site details

151 Shaftesbury Avenue is located centrally in London's West End, with Fitzrovia to the north, Soho to the west, Leicester Square and Covent Garden to the south, and Holborn to the east. The main entrance to the site is located on Shaftesbury Avenue, with a retail unit to the right. The back of the building on New Compton Street is much quieter, with service entrances, as well as the main entrance for the residential units. Its is an 8-storey building (including the roof as the rood terrace with a meeting room) servicing as offices, with part of the ground floor as a retail unit. The lower ground floor contains an office unit with no daylight, car park and plant. The basement level comprises of plant areas only. The residential part of the building is in the North-East corner with one flat per floor for 1st to 4th floors. The building is steel framed with concrete slabs and stairs, and red concrete cladding. The lower ground floors are unoccupied, however some of the upper floors are tenanted and the residential units are in use. The site details and existing building are shown below.

South elevation (Birdseye view)



As proposed in the pre-application report, the proposed refurbishment works include:

- Replacement of facades – the glass and cladding. The reuse of the precast concrete panels is being investigated.
- The refurbishment of the lower ground and ground floors to including partial removal of floor slab in the ground,
- Infills to existing floors, 5, 6, 7 and 8 to allow for a better utilisation of space for tenants.
- Replacement of M&E

The existing floor plans and the proposed floor plans can be seen in Appendix A. Note this pre-demolition audit covers the proposed works for the lower ground and ground floor, as well as for the façade. The other floors are included in the audit in terms of internal finishes and their quantities, including the flats, though it is noted that the flats are not likely to change and the general floor plate will remain the same.

3. The Pre-Demolition Audit

The pre-demolition audit was undertaken on the 13th of July consisting of a non-invasive visual survey of the buildings. Most areas were accessible (the restaurant was not); however some were occupied so time was limited in these areas. Some construction details and materials have been inferred based on typical practice. Survey notes and photographs were taken, and plans of the buildings were supplied with scaled floor layouts and demolition plans based on the information from the pre-application report . A walk round had also been undertaken prior to the audit by Max Fordham identifying potential items suitable for reuse.

On the basis of information gathered and provided, an analysis of materials arising from refurbishment with results reported in both weight and volume. The weight has been calculated using standard density figures for the materials identified. For waste Electrical and Electronic Equipment (WEEE) weight/volume figures are not included, however WEEE items observed on site have been logged and relevant reuse options are suggested within the report.

A separate presentation is being issued which details key products and components for reuse.

4. Overall Materials Arising

Overall, the estimated Key Demolition Products (KDP) by weight are The estimated Key Demolition Products (KDP) by weight are Concrete (33%), Timber (20%), Glass (16%), Metals (12%), and Gypsum (11%), with smaller amounts of Carpet, Ceramic, Insulation and Stone as shown by Figure 1 and Table 1. This amounts to **687 tonnes of material arising** from the refurbishment works. The largest KDPs by volume are Timber (28%), Insulation (28%), Concrete (18%), Gypsum (13%), and Glass (6%), with smaller amounts of Carpet, Metals, Ceramic and Plastics as shown by Figure 2. This amounts to **728 m^3 of material arising** from the refurbishment works. This is for all of the floors. Each of these KDP's has its own section later in the report detailing their arising and management options.

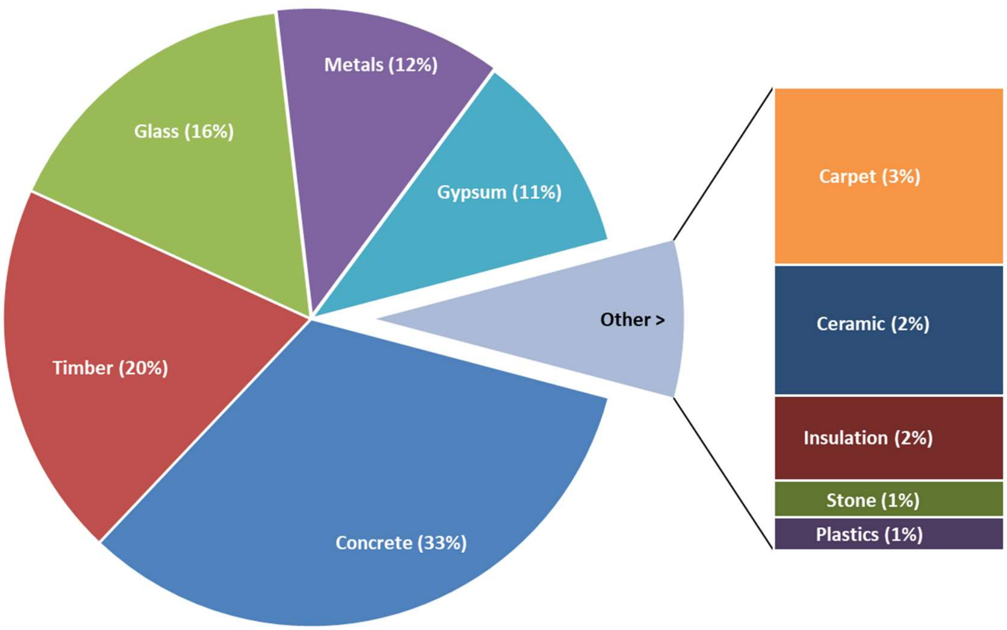


Figure 1: Material Results - KDP's by weight (tonnes)

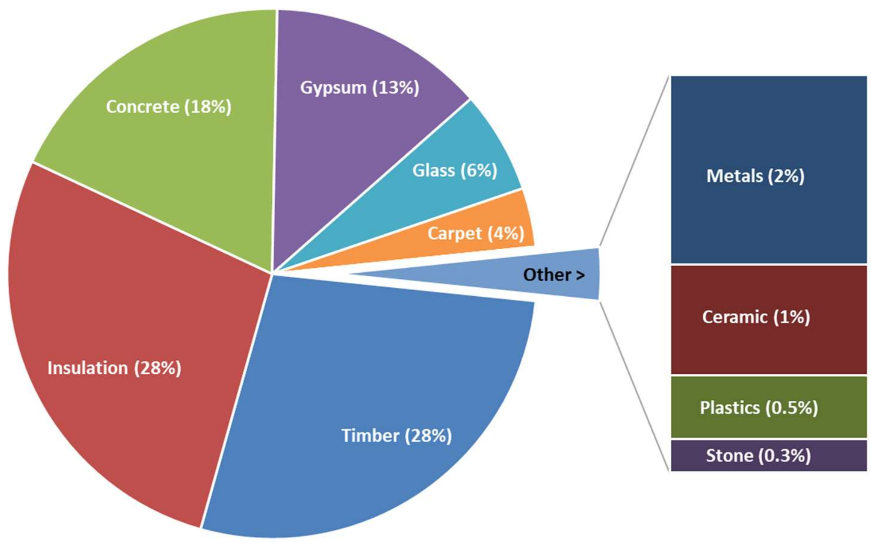


Figure 2: Material Results - KDP's by volume (m^3)

Table 1 provides the weight (tonnes), volume (m^3) and European Waste Codes for each KDP.

	Weight	**Volume**	**EWC**
Concrete	226.5	133.6	17 01 01
Timber	135.8	201.9	17 02 01
Glass	112.2	45.6	17 02 02
Metals	82.3	11.3	17 04 05
Gypsum	73.93	96.09	17 08 02
Carpet	22	26	20 01 11
Ceramic	16	7	17 01 03
Insulation	10	201	17 06 04
Stone	4	2	01 04 08
Plastics	4	4	17 02 03
WEEE	-	-	16 02 14
Totals	**687**	**728**	

Table 1: Material Results - KDP's by tonnage and volume (m^3)

5. Material arising by element

Figure 3 and Table 2 shows the materials arising by each element. The internal walls have the greatest amount of material arising by weight, at 32%, followed by, floors at 26% and the façade at 24%. The remaining elements (Ceiling finishes, services, roof, doors, fixtures and fittings) account for the remaining 18% by weight.

The breakdown of materials per element is shown in tabular form in Appendix B.

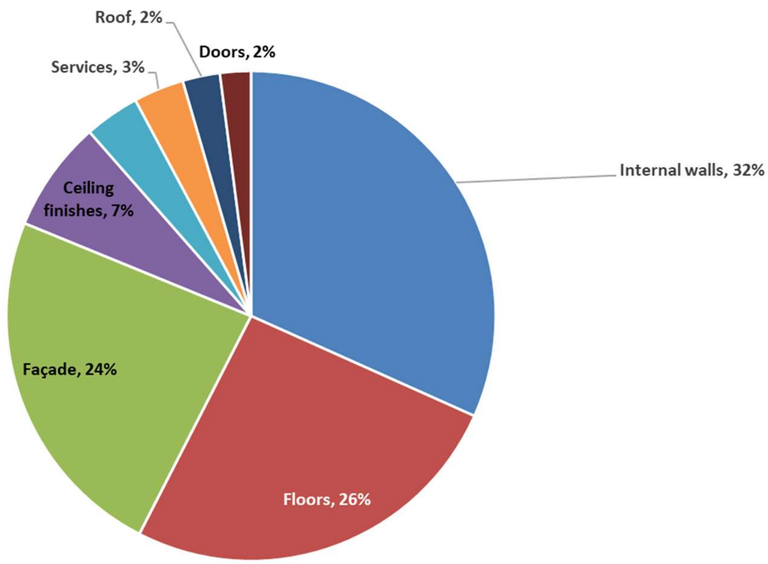


Figure 3: Material Results - by element (%)

Element	Tonnes	Volume	% weight
Internal walls	218	330	32%
Floors	178	188	26%
Façade	162	67	24%
Ceiling finishes	50	77	7%
Fixtures and fittings	25	25	4%
Services	23	4	3%
Roof	17	13	2%
Doors	14	24	2%
Total	687	728	

Table 2: Material Results – by element tonnage and volume (m^3)

The results are also shown by Floors, as per Table 3. From the proposed works (ground, lower ground and the façade), the total amount of materials is estimated to be 249 tonnes (178m^3).

Location	Tonnes	Volume
Façade	162	67
Ground and Lower Ground	87	111
Flats	24	49
Upper floors	414	501
Total	**687**	**728**

Table 3: Material Results – by location tonnage and volume (m^3)

6. Embodied carbon

The embodied carbon of the materials present has been estimated, as shown by Table 4 and Figure 4, totalling 376 tonnes of CO_2e. Nearly half is attributable to the glass present at 187 tonnes/CO_2e; mild steel accounts for 146 tonnes/CO_2e (39%) and steel, 535 tonnes/CO_2e (19%). The source of the embodied carbon figures is shown in Appendix C. Timber and timber products include the sequestered carbon.

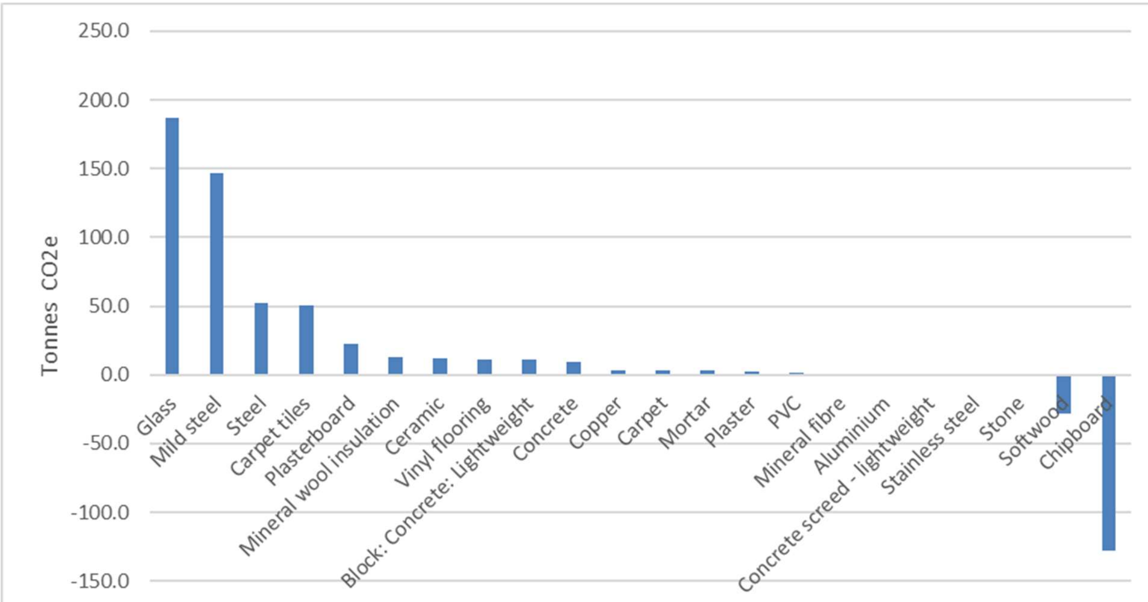


Figure 4: Estimated embodied carbon amounts per material arising

	Tonnes	kg/CO2e	Tonnes/CO2e	%
Glass	112.2	186616.7	186.6	49.7
Mild steel	53.1	146476.6	146.5	39.0
Steel	26.4	52559.6	52.6	14.0
Carpet tiles	20.8	50871.2	50.9	13.5
Plasterboard	58.1	22666.2	22.7	6.0
Mineral wool insulation	10.0	12808.1	12.8	3.4
Ceramic	15.9	12416.6	12.4	3.3
Vinyl flooring	3.6	11347.6	11.3	3.0
Block: Concrete: Lightweight	117.4	10921.6	10.9	2.9
Concrete	88.6	9124.0	9.1	2.4
Copper	1.3	3530.7	3.5	0.9
Carpet	0.9	3422.3	3.4	0.9
Mortar	16.1	3221.9	3.2	0.9
Plaster	15.8	2055.7	2.1	0.5
PVC	0.5	1571.8	1.6	0.4
Mineral fibre	0.4	490.3	0.5	0.1
Aluminium	0.1	485.7	0.5	0.1
Concrete screed - lightweight	4.3	447.4	0.4	0.1
Stainless steel	0.1	248.4	0.2	0.1
Stone	2.5	193.6	0.2	0.1
Softwood	21.8	-28106.5	-28.1	-7.5
Chipboard	114.0	-127652.4	-127.7	-34.0
Total	**683.8**	**375717.2**	**375.7**	

Table 4: Estimated embodied carbon in the materials arising

Embodied carbon is also shown by element type, which is summarised in Table 5 and Figure 5 (note the figures are slightly different to the above figures) as smaller amounts of materials are included in this calculation. By element, the largest proportion is from the facade at 164 tonnes/CO_2e (65%), followed by walls at 85 tonnes/CO_2e (34%).

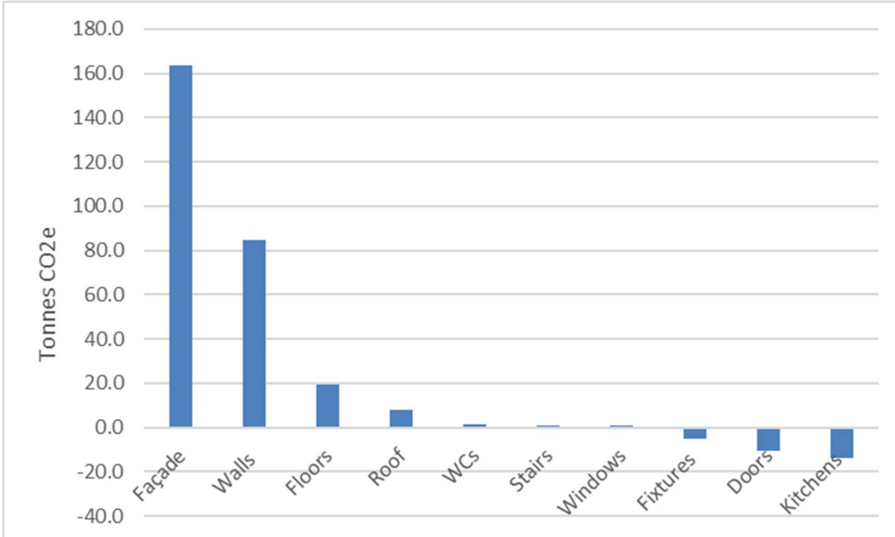


Figure 5: Estimated embodied carbon amounts by element (%)

	Tonnes	kg/CO2e	tonnes/CO2e	%
Façade	162.0	163466.7	163.5	65.4
Walls	217.8	84716.4	84.7	33.9
Floors	177.7	19511.4	19.5	7.8
Roof	16.9	8086.1	8.1	3.2
WCs	7.2	1473.6	1.5	0.6
Stairs	7.3	973.7	1.0	0.4
Windows	0.4	1048.4	1.0	0.4
Fixtures	4.3	-4936.9	-4.9	-2.0
Doors	14.0	-10743.2	-10.7	-4.3
Kitchens	6.5	-13843.5	-13.8	-5.5
Total	**614.1**	**249752.7**	**249.8**	

Table 5: Estimated embodied carbon by element

7. Concrete

Concrete accounts for an estimated 227 tonnes, 33% of total waste arisings by weight and 23 tonnes/CO_2e; sources can be seen in Table 6. This is from a number of sources, the most from the blockwork in the internal walls (all floors), (83 tonnes), the precast panels on the façade (28 tonnes) , the mortar in the block walls and floor (16 tonnes) and ground floor slab removal (4 tonnes). the roof slab (158 tonnes), the staircases (73 tonnes) and the internal walls (concrete blocks) at 67 tonnes. Most of the concrete is unsuitable for reuse, except for some of the precast panels (dependent upon fixings) and he paving slabs on the roof.

Concrete is in theory 100% recyclable. It can be segregated and crushed for reuse as hard core, fill or in landscaping or used as recycled aggregate in new concrete. Although recycled and secondary aggregates can be used in some concrete applications, other lower grade end uses (e.g. in unbound materials as fill and hardcore) may sometimes be more resource efficient due to reduced processing demands and transportation. Often such waste does not even leave the demolition site, being used for the site's redevelopment, as shown by the National Federation of Demolition Contractor (NFDC) figures with nearly half of inert waste (over 9 million tonnes) treated this way. Otherwise it is used on other sites as fill to offset the need for primary raw materials. Very little concrete waste therefore tends to go to landfill.

It is recommended that the concrete should be segregated either onsite (space is limited on site) or at a waste facility and crushed to produce recycled concrete aggregate (RCA)[1] in accordance with the WRAP Quality Protocol for aggregates[2] from inert waste. Ideally, this should be used back in concrete.

The concrete also be used for lower value applications such as for piling mats and temporary/ permanent fill (infilling). If reprocessed, stored and/or used onsite then appropriate permits[3] or exemptions will be required for these operations (though it is unlikely on this project).

RCA is of a higher quality than recycled aggregate (RA) due to the limit of masonry in the aggregate (maximum of 5%). The performance characteristics of RCA are better than RA and therefore there are fewer restrictions on the use of RCA in concrete. Items where the concrete is most likely to be suitable for the higher quality RCA are the floor and roof slabs, external and internal walls and the staircases; ideally this should be segregated either on or offsite from the other inert materials. The use of RCA in concrete is given in BS 8500-2[4]. Various options are available to utilise RCA as listed below.

Recycled concrete aggregates can be used in:

1. Bitumen bound materials – Recycled concrete aggregate can be used may be used in a variety of base course and binder course mixtures.

2. Concrete – Recycled concrete aggregate is permitted for use in certain grades of concrete. It is generally acknowledged that RCA can potentially be used to replace 20% of the coarse aggregate in concrete up to Grade 50.

3. Pipe bedding – suitably graded recycled concrete aggregate is used in pipe bedding.

4. Hydraulically bound mixtures (HBM) for subbase and base – recycled concrete aggregate can be suitable for use in HBMs. These can be used in the construction of car parks, estate/minor roads and hard standing.

5. Unbound mixtures for subbase – suitably graded recycled concrete aggregate is used as subbase.

6. Capping – Recycled concrete aggregate is suitable for capping applications.

---

[1] Recycled concrete aggregate is aggregate resulting from the processing of inorganic material previously used in construction and principally comprising crushed concrete [BS 8500-1: 2002].

[2] https://www.gov.uk/government/publications/quality-protocol-production-of-aggregates-from-inert-waste

[3] https://www.gov.uk/guidance/waste-environmental-permits

[4] https://shop.bsigroup.com/products/concrete-complementary-british-standard-to-bs-en-206-specification-for-constituent-materials-and-concrete/standard

Examples of structural concrete that have been used as RCA include the London Olympics 2012 http://www.klhsustainability.com/assets/Uploads/a0e1e6c7e1/Case-Study-201110-The-Procurement-and-Use-of-Sustainable-Concrete.pdf and Building B16 at BRE; https://www.icevirtuallibrary.com/doi/abs/10.1680/icetra.64638.447

Ideally, concrete waste could be sent to a local concrete producer, to be used as RCA for the new parts of the building or others nearby, following the inert waste Quality Protocol (https://www.gov.uk/government/publications/quality-protocol-production-of-aggregates-from-inert-waste). RCA could be specified in the new concrete.

Local waste management companies that could manage the concrete waste include:

- Powerday, https://www.powerday.co.uk/ T: 020 3858 0504
- RTS Waste, www.rtswaste.co.uk T: 020 7232 1711
- Days Group, http://www.daygroup.co.uk/. T: 0845 065 4655

Alternatively, licensed waste management contractors or demolition contractors should be able to reprocess concrete waste into aggregates.

Higher value opportunities

- There is opportunity to reuse the cladding panels and concrete slabs. There is an example of reuse of precast panels through a new EU Project: https://recreate-project.eu/ and the SuperLocal project https://www.superlocal.eu/sce-en/ . Examples of where bolted connections have been used include https://www.peikko.com/blog/new-white-paper-dismount-and-reuse-of-precast-concrete-structures/
- There are examples of higher value recycling technology where the constituents parts of concrete are removed separately https://www.slimbreker.nl/why-smartcrushers.html (note not in the UK as yet).
- Inert waste can also be used for making bricks e.g. the K-Briq (in Scotland) https://kenoteq.com/ and StoneCycle https://www.stonecycling.com/ .
- Concrete waste can also be used for blocks and paving. For example, Blocks (Aircrete) can be up to 70%; other blocks average 24%; https://www.cba-blocks.org.uk/wp-content/uploads/2018/03/CBA-2pp-Aggregate-Block-datasheet-rnd2.pdf ; but can vary considerably e.g. 74%; https://sheehancontractors.co.uk/eco-friendly-construction-solutions-concrete-blocks/

Item	Volume	Tonnes
Walls (blockwork)	83.88	117.44
Façade (precast panels)	28.28	67.87
Mortar (walls and floor)	8.48	16.11
Ground floor slab	4.43	10.64
Stairs	3.00	7.20
Concrete screed roof	3.45	3.45
Roof	1.20	2.87
Concrete screed ground floor	0.89	0.89
Total	**133.62**	**226.47**

Table 6: Estimated concrete arisings

8. Timber

As shown by Table 7, there is an estimated 136 tonnes (146m^3) of timber arising. Of this, nearly 114 tonnes is chipboard, with 105 tonnes of this from the core of the raised access flooring covering nearly 4600m^2 (around 900m^2 for lower ground and ground floors). RMF will take back this for remanufacture https://www.rmf-services.co.uk/news/135/rmf_launch_total_take_back_scheme
The laminate work tops and kitchen cabinets (around 236) are mostly in good condition and if dismantled appropriately could be reused (at least 50%).

For softwood, amounting to approximately 22 tonnes, many of the doors are in good condition and should be reusable. This includes around 50% of the timber solid doors (around 177 in total) and at least 50% of the timber solid door with vision panels (around 100 in total). Some of the timber cupboards are suitable for reuse (estimated to be around 75% with an estimated 55 in total). Doors should be kept with their frame to aid reuse and warranties/certificates maybe needed. The timber decking is also suitable for reuse which is used on the roof.

Most of the solid timber can be recycled, usually into chipboard. Due to the age of the building, some of the timber maybe hazardous due to the coatings and preservatives used. Guidance has been issued for this[5]. Where reclamation is not possible the timber should be segregated on site if space permits, or offsite and sent to a licensed waste management contractor for recycling.

For chipboard, It is also difficult to recycle due to the length of the fibres and the glues, so the most appropriate route is likely to be energy from waste. There is a company, MDF Recovery that is starting to recycle MDF http://www.mdfrecovery.co.uk/ .

Higher value opportunities

- It is recommended that a local wood recycling organization is contacted (Community Wood Recycling, www.communitywoodrecycling.org.uk) to see what timber items are suitable for reclamation and reuse.
- There are also examples of reuse of doors https://www.nweurope.eu/projects/project-search/fcrbe-facilitating-the-circulation-of-reclaimed-building-elements-in-northwestern-europe/news/reuse-toolkit-material-sheets/.
- A specialist reuse organisation, maybe interested in the kitchen cabinets and laminate worktops as well as the decking.

[5] https://condemwaste.org/wp-content/uploads/2021/07/CIWM-CD-Waste-Wood-Guide-v1.0.pdf

Item	Volume	Tonnes
Chipboard		
Raised access flooring - core	145.73	104.92
Kitchen cabinets	6.80	4.89
Cubicle walls	3.47	2.50
Laminate worktops	2.09	1.51
Freestanding shelves - timber	0.21	0.15
Softwood		
Timber solid door	12.74	6.37
Timber decking	6.72	3.36
Timber door frame	6.40	3.20
Timber solid door with vision panel	5.40	2.70
Timber skirting board	5.33	2.67
Timber cupboards	4.95	2.48
Timber cupboard doors	1.53	0.77
Timber battens	0.50	0.25
Total	**201.87**	**135.76**

Table 7: Estimated timber arisings

9. Glass

Glass is estimated to be 112 tonnes (46m^3) as shown by Table 8. The greatest amount of glass is from the façade, estimated to be 94 tonnes, covering an area of 1663m^2. It is unlikely that they meet today's energy requirements, so the best route is likely to be recycling if it can be separated. Some of the glass panels (partitions) could be reused as they are in good condition, these cover an area of around 600m^2. For glass to be reused it needs to be collected on specialist steel A frame stillages, handled and stored carefully. The doors can also be reused (around 33 in total). Glass can be collected in skips and containers for recycling. The quality of the glass in the skips will be dependent upon the awareness and training of those working on site and appropriate site management is required along with clear signage. They also need to be close to the workplace due health and safety risks from transporting glass.

A few glass manufacturers run their own cullet recycling scheme when they will collect cullet from processors or of older glass where they will be returned to the float line. The UK has three flat glass manufacturers, all operating float lines: Guardian Glass UK, Pilkington UK Ltd and Saint-Gobain Building Glass which are all based in the North of England. One of the limiting factors in the use of post-consumer flat glass as cullet back into the float glass manufacturing process is the availability of it in the right quality and chemical compatibility as the manufacturing process is sensitive to low levels of contamination. Most of post-consumer flat glass waste produced does not go back into glass and will be used as aggregate or landfilled. For demolition, common practice is more likely for it to be crushed into aggregate with other inert waste.

There is a health and safety consideration for the workforce if it is to be segregated onsite. As the cost of logistics is high, large volumes of waste are preferred when collecting. The quality of the glass waste is important with minimal contamination requiring the effective separation and segregation on site, which in turn requires education and training for those working on site. UKGBC have an example of glass being recycled into new glass (https://ukgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2018/09/05151714/VerdeSW1CaseStudy_FINALISSUE1.pdf). Other markets include the use of glass in glass wool insulation, container glass and ballotini products (glass beads). Guidance is available here: https://www.britglass.org.uk/our-work/recycling/windows. The glass recycling industry has developed grades of glass cullet:

- Class C – which is contaminated and not suitable for re-melting back into glass. Contamination can include ceramic frit, putty, lead beading and space bars. This will be used as aggregate and road paint.
- Class B – this is called 'mixed cullet' and may have some contamination such as laminated glass, which is suitable for glass wool insulation and container glass.
- Class A – clean clear glass cullet with no contamination which can be used back in the floating by re-melting. This is currently mostly from pre-consumer glass. Demand for this outstrips supply.

Glass recyclers are:

- Berryman Glass Recycling (www.berrymanglassrecycling.com E: info@berryman-uk.co.uk
- May Glass Recycling (http://www.mayglassrecycling.co.uk/) ; may only take new glass
- Viridor https://www.viridor.co.uk/siteassets/document-repository/brochures/glass-recycling-ukviridor-low-res.pdf.
- British Glass has a guide https://www.britglass.org.uk/our-work/recycling/windows

If glass waste is sent to landfill and not mixed with other types of non-inert waste, it will attract the lower rate of tax, currently at £3.10/tonne. There are economic opportunities with a market price of £50/tonne for recycled glass compared to £90/tonne for virgin material. For flat glass, one tonne of recycled material results in savings of 1200 kg of virgin material and 300kg of CO_2 emissions directly linked to the melting process[6].

<u>Higher value opportunities</u>

- The highest value opportunity would be to reuse the glass partitions as glass partitions- this unfortunately rarely happens due to the nature of refurbishment. For this to happen it would need to be dismantled, handled carefully and stored on A frame stillages for further reuse. It is better to keep it in its frame if possible, so as not to require any resealing.

Item	Tonnes	Volume
Glazing panels (façade)	38.25	94.09
Glass partition- s/g	3.40	8.36
Glass partition- d/g	2.23	5.49
Glass door	0.74	1.83
Glass blocks	0.53	1.30
Glass - 6mm (fixtures)	0.27	0.66
Window glass - double (flats)	0.14	0.34
Glass - 10mm (within doors)	0.06	0.15
Total	**45.62**	**112.22**

Table 8: Estimated glass arisings

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52014DC0445&from=EN

10. Metals

Steel

Steel accounts for neatly 80 tonnes (10m^3) of materials arising from as shown by Table 9 and 10. This comes from a variety of sources, but the majority is from the mild steel covering for the raised access floor (17 tonnes) and perforated ceiling metal panels (13 tonnes) and steel pipework (25 tonnes). The ceiling panels and RAF are suitable for reuse. Other items which may have some potential for reuse are metal railings on the roof, and handrails, on the staircases, cable trays (estimated to be 850m) and plant enclosures on the roof and sinks and radiators (most on the lower ground – around 5). Some of the ductwork and steel piping could also be suitable for reuse.

If any structural steel is suitable for reuse, then the SCI has produced a protocol for its reuse[7] including how to test for recertification.

For recycling, steel should be segregated on site. It is common practice for demolition contractors to reduce their contract value by allowing for the income from the recycling of metals during demolition. Standard skip hire companies are likely to charge for haulage costs only and may give back a small rebate on the metals. Once segregated it is usually sent to a metal scrap merchants (recyclers). At these, the metals will be sorted, sheared (cutting large pieces), shredded, graded, and baled. The steel will be then sent to smelters to be re-melted as ingots (which are usually downcycles material), and then sent to steel furnaces. Much of this maybe abroad - depending on the price per tonnes the scrap merchant can obtain (currently it is around £265/tonne). The UK does not use all the scrap metal it produces with around 80% exported to countries such as China and Turkey.

Higher value opportunities

- Best practice for steel is for it to be reused; recycling is the business as usual model. Companies such as Cleveland Steel and Tubes will buy structural steel for reuse https://cleveland-steel.com/
- Cesla Steel (https://www.celsagroup.com/en/sustainability/circular-economy-and-recycling/) are introducing a scheme where steel can be bought by them and recycled in their furnace and a voucher provided for new high recycled content steel (around 98%) (mainly rebar). They are looking for companies to pilot this with.

Item	Volume	Tonnes
Steel pipework - 50mm	1.60	12.47
Raised access flooring - pedestals	1.24	9.66
Metal railings (roof)	0.46	3.59
Steel rebar	0.07	0.52
Metal handrail (stairs)	0.02	0.12
Metal handrail (reception)	0.00	0.03
Glass railing fixings (reception)	0.00	0.03
Total	**3.40**	**26.41**

Table 9: Estimated steel arisings

[7] https://steel-sci.com/assets/downloads/steel-reuse-protocol-v06.pdf

Item	Volume	Tonnes
Raised access flooring - surface	2.36	16.50
Perforated metal panels	1.90	13.27
Ceiling tile grid - linear metal	0.70	4.93
Metal studwork – joists	0.62	4.35
Metal ductwork	0.53	3.73
Cable tray	0.48	3.34
Plasterboard suspended ceiling frame	0.39	2.76
Metal studwork - top/base channels	0.34	2.37
Plant enclosures	0.24	1.67
Radiator - pressed steel	0.02	0.16
Stainless steel sinks	0.01	0.09
Total	**7.59**	**53.16**

Table 10: Estimated mild steel arisings

Aluminium

There is estimated to be a very low amount of aluminium at 0.07 tonnes (0.03 m^3) originating the window frames in the flats. It has been assumed that the frames for the ceiling panels and glazed partitions are steel (not aluminium). Aluminium has high recycling rates, which can be between 92% and 98% for architectural aluminium and there is a highly established aluminium recycling market. Around 75% of all aluminium ever produced is still in productive use. Recycling uses only 5% of the original energy used to produce primary Aluminium and water. Some aluminium can be up to 75% recycled content (postconsumer); about half of the aluminium produced in Europe originates from recycled materials. The same local waste management contractors for steel can reprocess aluminium.

Higher value opportunities

- The Council for Aluminium in Building has recently launched a closed loop recycling scheme for its members https://c-a-b.org.uk/closed-loop-recycling/ .

Copper

An estimated 1.3 tonnes (0.15m^3) of copper pipe which is estimated to arise related to the hot and cold-water systems (note this is hidden, so pipe length runs are assumed). Whilst in theory it may be possible to reuse these pipes; this does not happen. There may also be opportunities to do some more innovative reuse of these. Copper is a high value scrap material, at £6,000/tonne for heavy copper and as such will be segregated onsite for recycling.

11. Gypsum

There is an estimated 74 tonnes (96m^3) of plaster and plasterboard arising as shown by Table 11. 50 tonnes is from plasterboard (around 7 tonnes from lower ground and ground floors), the remainder is plaster skim which has been used on the internal block walls and the ceiling.

Plasterboard should if possible be segregated on site or if room does not permit then segregated at a waste transfer station. The plaster maybe difficult to remove from the brickwork/blockwork, and as such it can be treated with concrete blocks as recycled aggregate, if it is in low quantities. There are a number of companies within the London area that offer recycling services, as long as the plasterboard is relatively free from contamination. Some of the recycling routes can include being used in the plasterboard manufacturing process (check with the waste/recycling company for their recycling routes). Note, a lot of plasterboard is sent for land treatment – it would be better if possible, to recycle back into plasterboard, though most companies do not accept plasterboard from demolition/refurbishment to be then put back into the product. If it is sent to disposal, then it should be landfilled in a monocell (i.e. landfilled separately from the other waste).

Local waste management companies

Local waste management options include:

- Powerday, https://www.powerday.co.uk/ T: 020 3858 0504
- Plasterboard Recycling Solutions http://www.plasterboardrecyclingsolutions.co.uk/ T: 0780 118 6380
- Hintons Waste, https://www.hintonswaste.co.uk/recycling-facilities/plasterboard-recycling/ T:020 3322 3476
- Hippo Waste (collect in bags), https://www.hippowaste.co.uk/blog/plasterboard-recycling-removal/ T: 0333 9990 999
- RTS Waste Management, https://www.rtswaste.co.uk/plasterboard-mobile-compaction-service/ T: 020 7232 1711

Item	**Volume**	**Tonnes**
Plasterboard - walls	47.89	35.91
Plasterboard - ceilings	29.61	22.20
Plaster skim - walls	12.68	10.78
Plaster skim - ceilings	5.92	5.03
	96.09	73.93
Plasterboard - walls	47.89	35.91
Total	**93.6**	**117.3**

Table 11: Estimated plaster and plasterboard arisings

12. Carpet

Carpet tiles accounts or an estimated 21 tonnes and 26m^3, covering an area of 4189m^2. Around 2.5 tonnes if from the lower ground and ground floors (nearly 500m^2). There is also carpet in the residential flats, estimated to be 0.8 tonnes, covering 45m^2. The majority of the carpet tiles (minimum 70%) suitable for reuse as they are in a good condition and easily uplifted. Carpet tiles can potentially be reused/recycled via:

- Carpet Tile Recycling; http://www.carpettilerecycling.co.uk; 01115 940 4454 (these need to be stacked on a pallet)
- Envirocycle; http://envirocyclelondon.com/recycle-office-carpet-tiles/; 07549448123 (these will also offer a removal service)
- Used Carpet Tiles, offer a pick up service; https://www.usedcarpettiles.com/; T: 0800 014 8591

Some manufacturers also offer a reuse/recycling service:

- Interface works with ReEntry Partners (social enterprise); https://www.interface.com/EU/en-GB/campaign/reentry/reentry-en_GB
- Millken; https://floors.milliken.com/floors/sustainability/end-of-life; t: 01942 612777

Potential recycling routes can also be searched at: https://carpetrecyclinguk.com/find-a-recycler/. If it is not suitable for recycling it can be sent for energy recovery via a waste transfer station.

13. Ceramics

There is an estimated 16 tonnes (7m^3) of ceramic materials arisings. This is estimated to be from around 67 toilets (2.34 tonnes) and a similar number of basins (1.36 tonnes). There are also 11 Belfast sinks, suitable for reuse. However, the most is from the ceramic tiles on the walls and the floors at 11.5 tonnes and around 918m^2. It will be difficult to remove these tiles intact for reuse without damage and their monetary value is relatively low. There is a factsheet produced by the FCRBE project which discusses the requirements for reuse; see https://www.nweurope.eu/projects/project-search/fcrbe-facilitating-the-circulation-of-reclaimed-building-elements-in-northwestern-europe/news/reuse-toolkit-material-sheets/ . However, for this project, it is recommended that these are either crushed with the inert waste on site or sent off site to produce recycled aggregate (RA). Finished recycled aggregates should not contain more than 1% (by weight of clay, soil, metals, wood, plastic, rubber and gypsum plaster), in line with the limits set within the aggregates standards. It is recommended that they are processed where possible into recycled aggregates (RA). The Quality Protocol for inert materials (https://www.gov.uk/government/publications/quality-protocol-production-of-aggregates-from-inert-waste) should be followed. It is unlikely that the WCs could be reused due to hygienic reasons.

14. Insulation

Insulation accounts for Insulation accounts for an estimated 10 tonnes (100m^3) arising. This is assumed to be mineral wool and present in the internal stud walls (around 8 tonnes of which 1.66 tonnes is from the lower ground and ground floor) and the remained mineral wall baffle in the ceilings. From a visual inspection it is difficult to ascertain the type of insulation used and the extent of it. There may be more present within the external walls and no insulation has been included which may have been used for pipes or within the roof. Recovery of insulation material is unlikely to be possible if it is bonded to the substrate. Insulation is usually disposed of to landfill via a licensed waste management contractor or could be sent for energy recovery if foam-based insulants can be successfully disaggregated. There is a pilot project looking at the recycling of insulation including from Knauf: https://www.knaufinsulation.com/news/knauf-insulations-new-customer-waste-take-back-scheme-good-for-environment-and-business-0 and Rockwool offer a recycling scheme: https://www.rockwool.co.uk/about/sustainability/recycling/. Care should be taken to ensure that any foam-based insulation that may contain ozone-depleting substances are removed and handled carefully.

Mineral ceiling tiles

Mineral ceiling tiles are used in the ceiling are also included at an estimated 0.4 tonnes (0.9m^3) on the second floor, covering 65m2; some of these (around 25%) may be reusable, though most are of not good quality. There was a recycling programme for ceiling tiles, run by Zenith (Armstrong Ceiling Tiles), which requires the ceiling tiles to be stacked on pallets; however this is currently on hold. Rockfon have a recycling scheme but they will only recycle their own tiles https://www.rockfon.co.uk/sustainability/our-sustainability-services/recycling-service/ They may have to be dated after January 2000 (it is assumed that these are due to their condition (the date should be stamped on the back of the tiles). Other routes include as fuel (e.g. cement kilns).

15. Stone

There is an estimated 4 tonnes of stone arising; which is stone tiling on the lower ground and ground floors, covering around 100m^2. About 50% of these could be suitable for reuse, if removed intact.. Reuse routes for undamaged stone material include:

- Authentic Reclamation: https://authentic-reclamation.co.uk/stock-categories/
- Lassco: https://www.lassco.co.uk/
- V&V Reclamation: https://www.vandv.co.uk/
- The Reclaim and Salvage Company: http://www.reclaimandsalvage.co.uk/sell-to-us
- Contact Salvo https://www.salvoweb.com/main/contact or 01227 500485. The items could also be listed as upcoming 'demolition' on their website. Please note some of the reclamation companies will dismantle.
- Contact the British Stone Federation, to see if any of their members would take reclaimed stone. http://www.stonefed.org.uk/ .

16. Plastic

There is an estimated 4 tonnes (2m^3) of plastic arising, mostly from the vinyl flooring (at 3.55 tonnes), covering 1318m^2. There is a small amount of PVC (assumed) (0.5 tonnes) from pipework The best route for this vinyl is either recycling or energy recovery. Schemes exist to recycle old vinyl flooring, depending on the quality and amount of screed attached. This can either be dropped off at specific locations or collected. See https://www.recofloor.org/contractors-how-it-works/ and http://www.recofloor.org/about-us/#specifications for more details. Tarkett also has a program, called ReStart program, where old vinyl flooring can be reused in new flooring: https://professionals.tarkett.co.uk/en_GB/node/restart-10623. If the product does not meet the specification for recycling, then it is likely to be sent for energy recovery. Any uPVC may be collected through the Recovinyl scheme for recycling: https://axiongroup.co.uk/wp-content/uploads/2021/07/Recovinyl-Recyclers-2021.pdf . It should be noted that there is likely to be more plastic arising than estimated from hidden components such as cabling.

17. Other materials

WEEE

There are a number of Waste Electrical and Electronic Waste Equipment (WEEE) which were identified; as shown by Table 13. Note, these are assumed in terms of the type and number per building. Some of the lighting may be suitable for reuse in another project or via the community. Any fluorescent lighting should be segregated onsite, collected and disposed by a licensed hazardous waste carrier. Alternatively, schemes such as Recolight, https://www.recolight.co.uk/ offer collection and drop off services. The metal fittings, if not suitable for reuse should be segregated with the other metal for recycling. There are also companies that will remanufacture lighting, including: Egg Lighting (www.egglighting.com/egg-circular) and Whitecroft Lighting – Vitality (www.whitecroftlighting.com/whitecroft-vitality) .

Any waste electrical and electronic equipment should be separated on site and sent to a specialist recycling facility, such as the following: www.wasteserviceslondon.co.uk/weee_recycling.htm ;

www.pureplanetrecycling.co.uk/weee-recycling-london .If items are in good condition, then they could be given to the local charities or advertised for resale. The company Envirocycle; https://envirocyclelondon.com/ will buy air conditioning units, Note, there are likely to be more items of WEEE that were not visible when undertaking the survey.

Item	Quantity	Reusable
Pendant lights	99 no.	75% reuse - most are pretty nice feature lights.
Car lift	1 no.	Not working
Electric panel heaters	25 no.	100% reuse - 25 in the flats; https://rointe.com/uk/kyros-radiators/
Recessed/spot lights - LED	275 no.	90% reuse
Recessed/spot lights - fluorescent	25 no.	0% reuse
Suspended ceiling lights - fluorescent	180 no.	25% reuse
Suspended ceiling lights - LED	545 no.	90% reuse
Fan coil units	106 no.	50% reuse, assuming they can be tested/certified etc.
Hand dryers	61 no.	100% reuse
Fridges (some commercial)	10 no.	50% reuse, possibly higher - assume there are more expensive commercial units in the restaurant
Dishwashers (some commercial)	7 no.	100% reuse - all Miele/Siemens or commercial in the restaurant.
Ovens (some commercial)	8 no.	50% reuse - will be some commercial units in the restaurant.
Extract hoods	5 no.	0% reuse (too dirty)
Freezers (some commercial)	2 no.	50% reuse - will be some commercial units in the restaurant.
Microwaves	5 no.	25% reuse
The reusability column is provided for indicative guidance only; these items should be suitable for reuse, provided all required performance characteristics can be verified and no insurance/warranty clauses are breached.		

Table 12: Estimated WEEE arisings

Hazardous materials

Some materials may be hazardous is nature. This could include materials contaminated with oil, treated timber, bitumen and asbestos. It is recommended that the demolition contractor undertakes appropriate testing to determine the hazardousness of materials and how they should be managed. This may affect some of the recycling opportunities presented.

18. Maximising Reuse and Best Practice

It is advised that a long lead-in time as possible and maximum exposure are required to enable the reuse of products and components. The best chances for reuse, with the associated environmental and economic benefits, are as near to site as possible:

- Used by the same client locally
- Sold or given away locally

Table 13 shows the items that maybe suitable for reuse. The following recommendations may assist in maximising the reclamation potential of the items identified:

- Consult the client on the findings of this report and consider any options for closed-loop re-use in a similar project (or within the hospital)
- Consider setting aside storage on site for segregation of salvage items.

There are a few organisations that may be able to assist with the reuse of items, which are listed below in London:

- Reyooz: http://www.reyooz.com/about/clients. Offer a service to collect surplus and distribute to charities, schools and small businesses.
- Globechain: https://globechain.com/; a reuse marketplace that donates to charities, schools and small businesses
- Reuse Network: https://reuse-network.org.uk/donate-items/#/
- Collecteco: https://www.collecteco.co.uk/; donation of furniture and equipment to charities, schools and small businesses.
- London Reuse Network - http://lcrn.org.uk/projects-services/london-re-use-network/
- Scrapstores: https://www.workandplayscrapstore.org.uk/ and Reuseful UK https://www.reusefuluk.org/

There is also an interactive map available from the Supply Chain Sustainability School, which shows geographically the different platforms available for material exchange.
https://www.supplychainschool.co.uk/school-launches-new-mep-mapping-tool/

For items that may have some architectural salvage value, specific salvage items can be advertised for free on www.salvo.co.uk or low value materials on www.salvomie.co.uk. Salvo also operate a demolition/refurbishment alert service on their website which serves to bring forthcoming demolition products to the attention of potential buyers or users. Local architectural salvage merchants about specific items can also be contacted. Salvo publishes a directory on their website. Ensure that salvaged items are removed and stored in such a way that all components remain together, e.g. doors in their frames.

Table 14 summarises the products that are likely to be more suitable for reuse. Note some images can be seen in Appendix D.

Facade	• Precast concrete panels
Floors	• Raised access flooring • Carpet tiles • Vinyl flooring • Stone flooring (reception)
Roof	• Metal railings • Timber decking • Concrete paving slabs • Shingle • Plant enclosures
Doors	• Timber solid doors (177 no.) • Timber solid doors with vision panel (100 no.) • Glass door (30 no.)
Internal walls	• Glass partitions (single and double) • Glass blocks (ground floor)
Ceiling	• Mineral fibre tiles • Metal ceiling tiles • Ceiling tile grid • Mineral wool baffles
Fixtures and fittings	• Kitchen cabinets • Basins • Kitchen sinks • Belfast sinks • Built in cupboards • Laminate worktops • Timber cupboard • Freestanding shelves
M&E (services)	• Cable tray • Metal ductwork • Radiators • Copper pipework • Steel pipework

Table 13: materials and components recommended for reuse

Table 14 summarises the standard and best practice opportunities for each of the KPDs identified on this project.

	Opportunities	
	Standard practice	**Best practice**
Concrete	Crushed as RA for fill on/offsite	Crushed for RCA back into concrete Reuse of precast cladding panels Reuse of concrete paving
Steel	Recycled as scrap on the global market	Reuse; closed loop recycling as scrap
Glass	Crushed and used for RA for fill on/offsite	Reuse; closed loop recycling
Gypsum	Sent to cement kilns; or spread on land	Closed loop recycling (opportunities limited)
Softwood	Sent for energy recovery	Reuse; recycled into panelboard and animal bedding
Stone	Recycled as RA for fill on/offsite	Reuse; recycle into higher value products
Ceramic	Recycled as RA for fill on/offsite	Higher value recycling e.g into tiles
Chipboard	Sent for energy recovery	Reuse; sent for energy recovery (opportunities limited)
Insulation	Sent for energy recovery/ landfill	Closed loop recycling
Vinyl	Sent for energy recovery/ landfill	Closed loop recycling
Carpet	Sent for energy recovery/ landfill; reuse of carpet tiles	Reuse of carpet tiles; recycling of carpet

Table 14: Standard and best practice opportunities for the KPDs

19. Targets and Costs

It is highly recommended that to maximise the reuse and recycling of the KDP's that the following materials are segregated on site, if space permits

- concrete
- glass
- steel
- stone
- timber (softwood)
- doors
- raised access flooring
- plasterboard
- carpet tiles
- copper
- vinyl

- ceiling tiles (metal)
- any hazardous waste

Potential targets for materials are shown in Table 15.

An estimated 98% of materials could be diverted from landfill. Around 277 tonnes (approximately 40% by tonnage) may be suitable for reuse; a conservative target for reuse would be 20%. This equates to an embodied carbon of 88 tonnes.

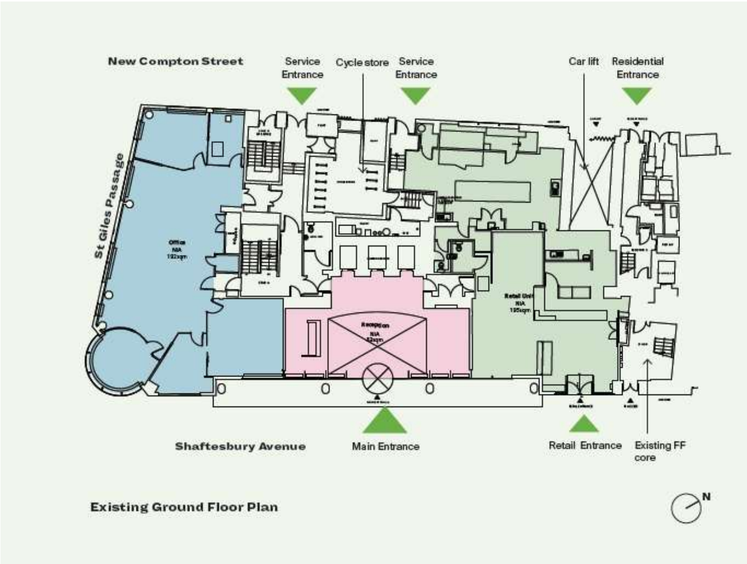
	Reuse	**Recycling**
Concrete	0%	98%
Steel	5%	95%
Brick	15%	83%
Glass	25%	75%
Gypsum	0%	50%
Softwood	30%	70%
Hardwood	75%	25%
Ceramic	5%	98%
Chipboard	50%	0%
Stone	75%	25%
Insulation	0%	25%
Carpet	30%	20%
Vinyl	0%	50%
Asphalt	0%	80%

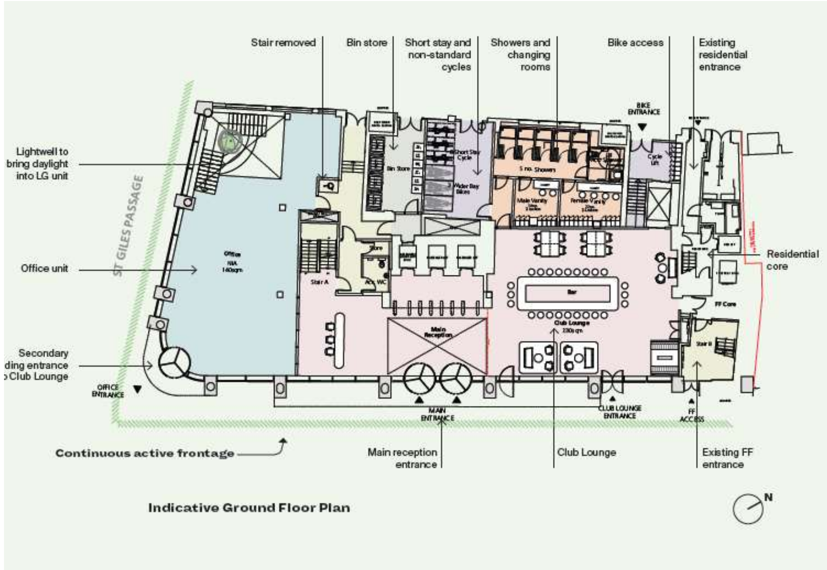
Table 15: Recommended targets per material

During the refurbishment details of the actual materials arisings and the waste management methods used should be recorded to compare actual with forecast and to assess performance against the targets set. Following completion of the project, any barriers to achieving the targets should be reviewed to ensure that in future projects these barriers can be overcome.

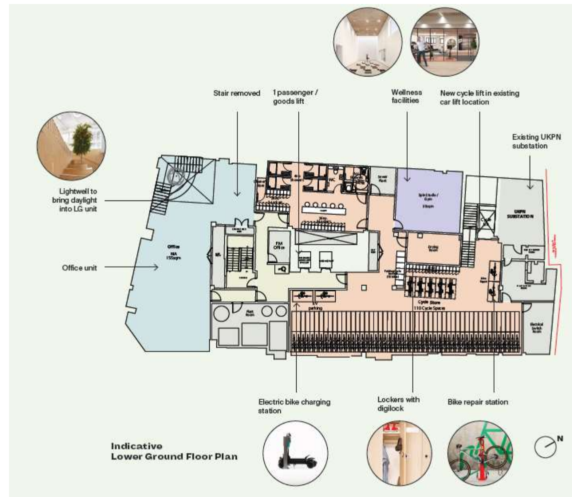
Appendix A

Existing and proposed (indicative) floor plans from the pre-app report






New Compton Street
Car lift
Existing substation
No natural daylight to unit
End of trip facilities
Car park
Existing
Lower Ground Floor Plan
N


Stair removed
1 passenger / goods lift
Wellness facilities
New cycle lift in existing car lift location
Existing UKPN substation
Lightwell to bring daylight into LG unit
Office unit
UKPN SUBSTATION
WC
FM Office
Cycle Store
110 Cycle Spaces
Electric bike charging station
Lockers with digilock
Bike repair station
Indicative
Lower Ground Floor Plan
N

Appendix B

Material quantities by element type

Façade

Material	Description	Tonnes	Volume
Glass	Glazing panels	94.09	38.25
Concrete	Concrete cladding panels	67.87	28.28
Glass	Window glass	0.34	0.14
Metal	Aluminium window frames	0.07	0.03
	Total	**162.4**	**66.7**

Floors

Material	Description	Tonnes	Volume
Timber	Raised access flooring - core	104.92	145.73
Carpet	Carpet tiles	20.76	25.95
Metal	Raised access flooring - surface	16.50	2.36
Concrete	Concrete floor slab	10.64	4.43
Metal	Raised access flooring - pedestals	9.66	1.24
Ceramic	Ceramic tiles	4.86	2.02
Plastic	Vinyl flooring	3.56	2.64
Stone	Stone tiles	2.45	0.98
Concrete	Grout	2.04	1.07
Concrete	Screed	0.89	0.89
Carpet	Carpet	0.88	0.23
Metal	Steel rebar	0.52	0.07
	Total	**162.38**	**66.69**

Roof

Material	Description	Tonnes	Volume
Metal	Metal railings	3.59	0.46
Concrete	Screed	3.45	3.45
Timber	Timber decking	3.36	6.72
Concrete	Concrete paving slabs	2.87	1.20
Stone	Shingle	2.00	1.03
Metal	Plant enclosures	1.67	0.24
	Total	**177.68**	**187.61**

Doors

Material	Description	Tonnes	Volume
Timber	Timber solid door	6.37	12.74
Timber	Timber solid door with vision panel	2.70	5.40
Timber	Timber door frame	2.47	4.93
Glass	Glass door	1.83	0.74
Glass	Door glazing	0.66	0.27
	Total	**14.03**	**24.09**

Internal walls

Material	Description	Tonnes	Volume
Concrete	Block walls	117.44	83.88
Gypsum	Plasterboard	35.91	47.89
Concrete	Mortar	11.26	5.93
Gypsum	Wet Plaster	10.78	12.68
Glass	Glazed wall panel - single glazed	8.36	3.40
Insulation	Mineral wool insulation	8.12	162.32
Metal	Metal studwork	6.72	0.96
Ceramic	Ceramic tiles	6.68	2.78
Glass	Glazed wall panel - double glazed	5.49	2.23
Concrete	Grout	2.81	1.48
Timber	Timber skirting board	2.67	5.33
Glass	Glass blocks	1.30	0.53
Timber	Timber battens	0.25	0.50
	Total	**217.78**	**329.91**

Ceiling finishes

Material	Description	Tonnes	Volume
Gypsum	Plasterboard	22.20	29.61
Gypsum	Wet plaster	5.03	5.92
Metal	Steel framing	2.76	0.39
Insulation	Mineral fibre tiles	0.38	0.85
Metal	Ceiling tile grid	4.93	0.70
Metal	Metal ceiling tiles	13.27	1.90
Insulation	Mineral wool baffles	1.89	37.81
	Total	**50.47**	**77.18**

Fixtures and Fittings

Material	Description	Tonnes	Volume
Concrete	Concrete stairs	7.20	3.00
Timber	Kitchen cabinets	4.89	6.80
Ceramic	WCs/basins/urinals/shower trays	4.38	1.83

Timber	WC fit out	2.50	3.47
Timber	Built in cupboards	2.48	4.95
Timber	Miscellaneous fixtures	1.65	3.21
Timber	Laminate worktops	1.51	2.09
Glass	Miscellaneous items	0.15	0.06
Metal	Metal handrails	0.12	0.02
Metal	Sinks	0.09	0.01
Metal	Miscellaneous fixings	0.06	0.01
	Total	**25.01**	**25.44**

Services

Material	**Description**	**Tonnes**	**Volume**
Metal	Cable tray	3.34	0.48
Metal	Metal ductwork	3.73	0.53
Metal	Radiators	0.16	0.02
Metal	Copper pipework	1.30	0.15
Metal	Steel pipework	13.84	1.78
Plastic	Plastic pipework	0.51	1.19
WEEE	Pendant lights	99 no.	-
WEEE	Car lift	1 no.	-
WEEE	Electric panel heaters	25 no.	-
WEEE	Recessed/spot lights - LED	275 no.	-
WEEE	Recessed/spot lights - fluorescent	25 no.	-
WEEE	Suspended ceiling lights - fluorescent	180 no.	-
WEEE	Suspended ceiling lights - LED	545 no.	-
WEEE	Fan coil units	106 no.	-
WEEE	Hand dryers	61 no.	-
WEEE	Fridges (some commercial)	10 no.	
WEEE	Dishwashers (some commercial)	7 no.	
WEEE	Ovens (some commercial)	8 no.	

Appendix C

The embodied carbon figures have been taken from the freely available ICE Inventory of Carbon and Energy V3 -10th November 2019. This can be downloaded at: https://circularecology.com/embodied-carbon-footprint-database.html. It should be noted that as the original material is not known in detail (in terms of its composition, source etc), then the figures used for CO_2e must be treated with some caution).

Material	**Kg/kgCO2e**	**Assumption**
Aluminium	6.67	Aluminium General, European Mix, Inc Imports
Block: Concrete: Lightweight	0.093	Concrete block, medium density solid, average strength, per kg
Carpet	3.9	General; CO_2 only
Carpet tiles	2.45	Carpet tiles, nylon (Polyamide), pile weight 500 g/m2; note: 10.7 (GWP) per sqm
Cast Iron	2.03	Iron, general
Ceramic	0.780	General
Chipboard	-1.120	Chipboard - including carbon storage
Concrete	0.103	General
Copper	2.71	EU Tube and Sheet
Glass	1.663	Glass glazing (double)
Mineral wool insulation	1.280	Mineral wool
Mortar	0.200	Mortar (1:3 cement:sand mix)
Plaster	0.130	General, gypsum
Plasterboard	0.390	Plasterboard
PVC	3.10	General
Softwood	-1.290	Softwood - including carbon storage
Steel (rebar)	1.990	Steel Rebar
Steel (hot galavanised)	2.760	Steel hot galvanised)
Stone	0.079	General
Vinyl flooring	3.19	General

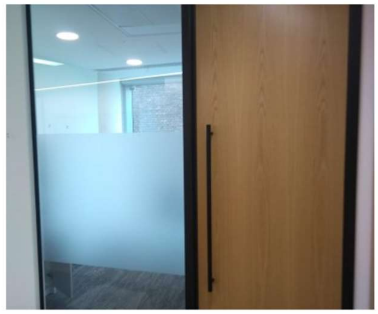
Appendix D

Items potentially suitable for reuse

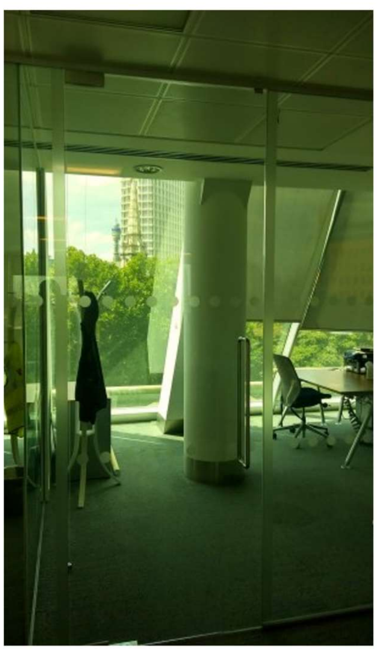
<u>Facade</u>

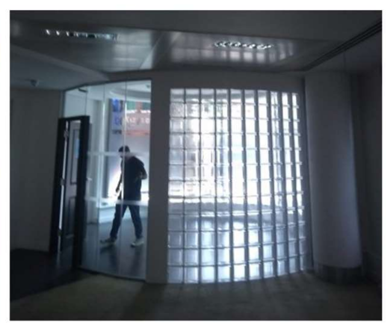
<u>Roof</u>

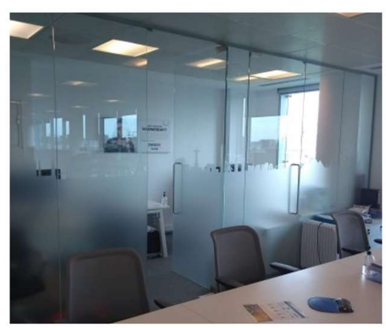
Doors


Internal walls





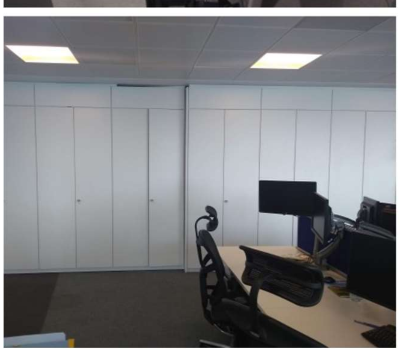
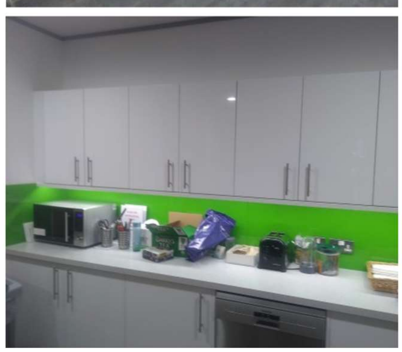


Ceiling



Fixture and fittings




Lighting

APPENDIX II RE-USE TRACKER

J7173 151 Shaftesbury Avenue

Reuse Tracker

Rev	A	06/07/2022	KB
Rev	B	26/09/2023	MF

Discipline	Who	Category	Item	Reuse potential for 151SA	Survey?	Impact on Upfront Carbon	Next steps	Final reuse strategy	Discipline Comment	Cost	Notes
MEP	HM	Electrical installations	Electrical cables	Low	No	Med/High	Obtain condition survey of this element	Recycle	Expected lifetime comes to end	To be confirmed at stage 2	Many challenges: cables must be right size, designed to latest regs,
MEP	HM		Rising busbar	Medium	No		Obtain condition survey of this element	Recycle	Expected lifetime comes to end		Could be reused subject to survey
MEP	HM		Electrical distribution trays and uni struts	High	No		Obtain condition survey of this element	Recycle	Expected lifetime comes to end		
MEP	HM		Illuminated escape signs	Medium	No		HM to Check O&M for product data	Recycle			Need to be LEDs, compliant with standards, compatoble witj comtrols
MEP	HM		Fire detection and alarm	Low	No		NA	Recycle			Can't compromise life safety
MEP	HM		Power sockets and control switches		No		Obtain condition survey of this element	Recycle	Expected lifetime comes to end		Could be resused subject to condition and survey
MEP	HM		Electrack underfloor busbar	High	No		Obtain condition survey of this element	Recycle	Expected lifetime comes to end		Could keep and see if tenant wants to use? Could be easy win
MEP	HM		Tenant lighting - newer floors	High	No		Obtain condition survey of this element	Recycle			Could reuse these in back of house areas. May compromise operational energy
MEP	HM		Tenant lighting - older floors	Medium	Yes		Obtain condition survey of this element	Reuse	Could be used in other building		Could reuse these in back of house areas. May compromise operational energy
MEP	HM	Space heating and airconditioning	Expansion vessels	Medium	No	High	Obtain condition survey of this element	Recycle	Not suitable for low temperature heating system		
MEP	HM		Heating Pipework	Medium	No		HM to Confirm extent of pipework to be surveyed	Recycle	Expected lifetime comes to end		To agree a timeline
MEP	HM		Heating Pumps	Low	No		HM to produce design and confirm feasibility	Recycle	Expected lifetime comes to end		Pumps are all constant speed - not suitable for reuse
MEP	HM		Tenant DX units	Low	No		HM to contact manufacturer about takeback scheme	Manufacturer takeback	Mitsubishi Electric have worked with Environcom Recycling to develop an end of life recycling system for air conditioning units.		
MEP	HM		Refrigerant pipework	Low	No		NA	Recycle			
MEP	HM		Fan coil units - central cooling	Medium	No		Obtain condition survey of this element	Recycle	Wrong size		Efficiency and control challenges
MEP	HM		Fan coil units - 4 pipe	Low	No		HM to contact manufacturer about takeback scheme	Recycle	Wrong size		Not suitable due to not pursuing a 4-pipe system
MEP	HM	Water installations	Steel CHW pipework	Medium	No	Medium	HM to confirm extent of pipework to be surveyed	Recycle	Expected lifetime comes to end		to agree a timeline
MEP	HM		Sump pumps	Low	Yes		HM to Check O&M for product data	Await design	Could be resused subject to condition and survey		Sump pits should eb able to be retained
MEP	HM		Domestic water tank	Low	No		HM to Check O&M for product data	Recycle	Wrong size		wrong shape - complications with sectional tanks
MEP	HM		Sprinkler tank	Low	No		NA	Recycle	Wrong size		Too small
MEP	HM		Water pipework	Medium	No		HM to confirm extent of pipework to be surveyed	Recycle	Expected lifetime comes to end		
MEP	HM		CHW pumps	Low	No		HM to Check O&M for product data	Recycle	Expected lifetime comes to end		likely to be old tech
MEP	HM	Ventilation systems	Office AHUs	Low	No	Medium	HM to Check O&M for product data	Recycle	Not suitable for decentralised system		Space efficiency and design efficiency is a problem
MEP	HM		Existing ductwork	Medium	Yes		Obtain condition survey of this element	Await design	Could be resused subject to condition and survey		Could be resused subject to design, condition and survey
MEP	HM		Internal ventilation grilles	Medium	No		Obtain condition survey of this element	Recycle	Not suitable for open ceiling design		Could be resused subject to condition and survey
MEP	HM	Disposal installations	Vertical drainage stacks	Medium	Yes	Medium	Obtain condition survey of this element	Await design	Could be resused subject to condition and survey		Could be resused subject to condition and survey
MEP	HM		Drainage branches	Low	No		NA	Recycle			Plastic pipe becomes brittle and decays with age
MEP	HM	Lifts/conveyor system installations	Lifts	Low	TBC	Low	Further briefing discussions required	Await design			Discuss manufacturer takeback, discuss RLAM briefing. Possible contractor input could help?
Architecture	BGY	Concrete	Façade	Medium	Yes	High	Further briefing discussions required				Some internal investigations have taken place. Opportunities may include internal finishes, roof terrace flooring, roof terrace planters?
Architecture	BGY		Blockwork walls	Medium	No		Discuss with contractor when on board	Recycle			
Architecture	BGY	Fit-out	Chipboard Cabinets	Medium	TBC	Low	Investigate storing in building material bank				Needs further discussion with RLAM
Architecture	BGY		Cubicle walls	Medium	TBC		Investigate storing in building material bank				
Architecture	BGY		Carpet tiles	High	TBC		Investigate storing in building material bank				
Architecture	BGY		Sanitaryware	Low	TBC		Investigate storing in building material bank				
Architecture	BGY	Interior elements	Cupboards/doors	Medium	TBC	Med/High	Investigate storing in building material bank				
Architecture	BGY		Solid doors & frames	Medium	TBC		Investigate storing in building material bank				
Architecture	BGY		RAF pedestals	Low	TBC		Invesitgate refurbishing route				
Architecture	BGY		RAF tiles	High	TBC		Invesitgate refurbishing route				
Architecture	BGY		Plasterboard	Low	TBC		Investigate storing in building material bank	Recycle			
Architecture	BGY	Glass	Glazing panels	Low	TBC	High	Investigate storing in building material bank				
Structures	HTS	Superstucture	Columns	?	Yes	High	Final strategy and extent of retention TBC	Majority to be retained			
Structures	HTS		Beams	?	Yes		Final strategy and extent of retention TBC	Majority to be retained			
Structures	HTS		RC Slab	?	Yes		Further briefing discussions required				

MAX FORDHAM

APPENDIX III BREEAM MAT 06 AND WST 06

151 SHAFTESBURY AVENUE
BREEAM MAT O6 AND WST 06 STAGE 2 WORKSHOP

Time	Thursday 17th August 2023 10:00-11:30		
Location	Online		
Chair	Chris Price, Senior Sustainability Consultant		
Attendees	Thomas Quinton	Buckley Gray Yeoman	Architect
	Zakariya Ganghish	Heyne Tillet Steel	Structures
	Patryk Zduniak	Hilson Moran	M&E
	Mari Ferguson	Max Fordham LLP	BREEAM

1 Project Introduction

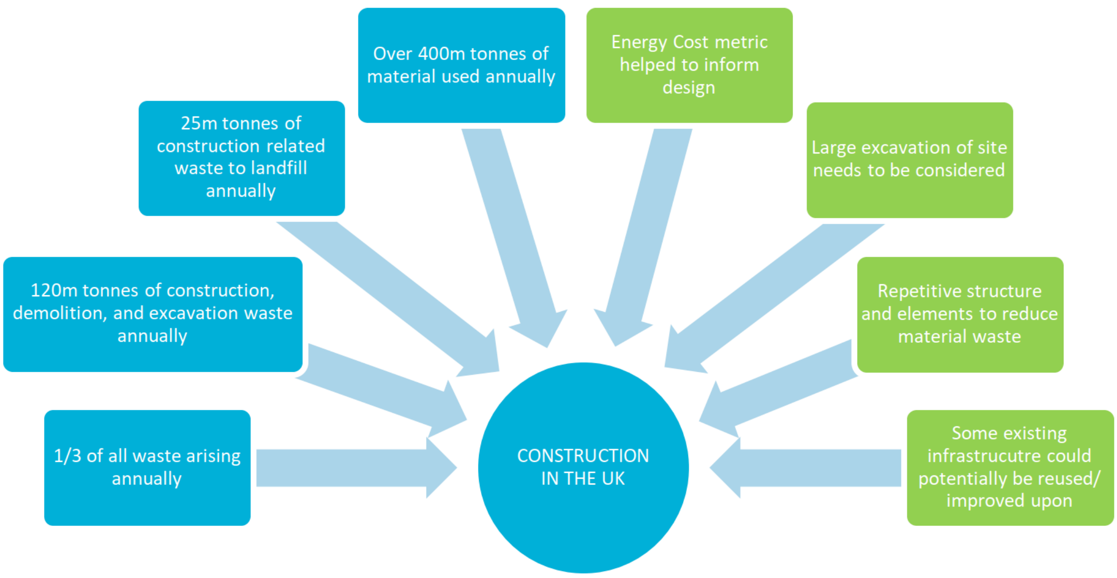
The proposal is to extend and refurbish the existing building. Two floors will be added to the building, and the existing office space is to be optimised. The lower ground and ground floors will have space for various retail and amenity uses such as a bar and a wellness studio. The main aim of the project is to create high-quality contemporary workspaces, with improved sustainability credentials.

2 Purpose

The purpose of this workshop was to achieve the RIBA Stage 1/2 requirements of BREEAM issue Mat 06 Material Efficiency and Wst06 Design for Disassembly and Adaptability which have the following aims:

"To recognise and encourage measures to optimise material efficiency in order to minimise environmental impact of material use and waste."

The use of materials over the life cycle of the building has become a significant issue in the UK's building industry, as represented by the following figure:



To achieve the material efficiency credit, opportunities must be identified, and appropriate measures investigated and implemented in order to optimise the use of materials in building design, procurement, construction, maintenance, and end of life. This must be reviewed in the following stages:

- Preparation and Brief (RIBA Stage 1)
- Concept Design (RIBA Stage 2)
- Developed Design (RIBA Stage 3)
- Technical Design (RIBA Stage 4)
- Construction (RIBA Stage 5)

3 Format

The format of the workshop was interactive and informal, with participants encouraged to discuss and write any and all ideas on "post-its" on a collaborative "Miro" white board. Participants were prompted by Chris Price (Senior Sustainability Consultant), which resulted in idea sharing and generation, as well as thoughtful conversations about the various topics. The following Key was set for post-its too be distinguishable between disciplines:

- Architecture: Blue Post-its
- Structures: Green Post-its
- MEP: Orange Post-its

4 Wst 06 Designing for Disassembly and Functional Adaptability

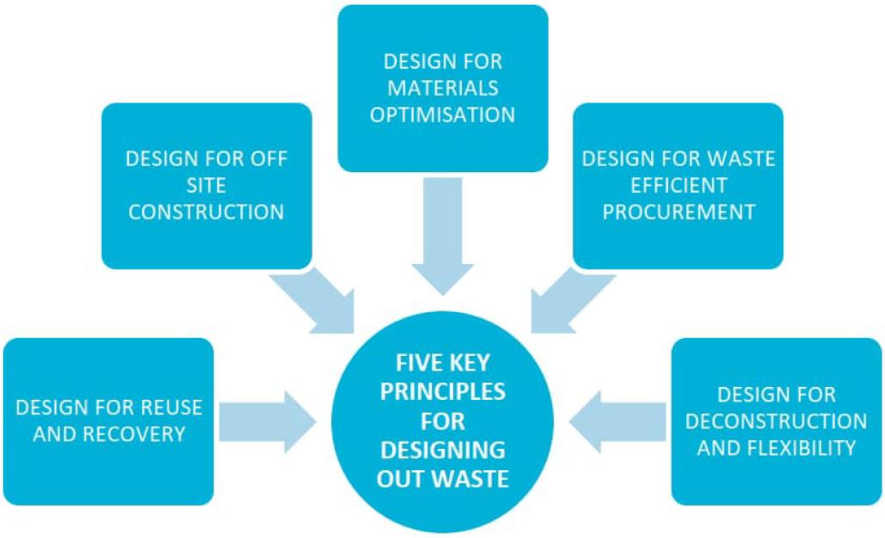
Wst 06 Design for Disassembly and Adaptability seeks "to recognise and encourage measures taken to accommodate future changes of use to the building over its lifespan." This section will cover key considerations that form a Design for Disassembly and Functional Adaptability Study. The content of this study is taken from the workshop that was held in Stage 2.

The design has been developed during both RIBA Stages 1 & 2 and will continue to be developed into detailed development stages to be a resourceful design that makes preference for strategic and efficient construction. With this in mind, the design team were asked to identify opportunities and investigate appropriate measures for implementation of adaptability solutions within the building design, and end of life. Such considerations will be carried forward by the design team in consultation with the relevant parties beyond RIBA Stage 2, particularly at RIBA Stage 4.

The identified opportunities and measures that the design team discussed in the workshop are recorded in the tables in the following sections.

5 Mat 06 Material Efficiency

The team were reminded of the five key principles of designing out waste, as shown in Figure 2. Each principle was discussed separately, with the team generating ideas for each principle using the following structure:



- Advantages
- Disadvantages
- Impact on cost and design

Comments made by the team are presented in the following tables. There is much overlap with the ideas generated under each of the five principles, showing that all of the principles share synergies and rely on one another to optimise material efficiency.

6 Workshop Outputs

7 Summary

The summary highlights some of the key decisions that the design team has taken in Stage 1/2. The overall takeaways were that the workshop was a positive process and fits the project brief. Design for Disassembly and Functional Adaptability and Material Efficiency will be revisited at RIBA Stage 4 to ensure these ideas are effectively carried forward.

Items to be implemented:

- Lightweight GRC façade
- CLT fixed to steel beams using screws
- Limited use of refrigerants
- High modularity for maintenance and replacement
- Accessible plant

Items to be explored during the next stage of works:

- Flexible and adaptable structure and floorspace
- CLT and Timber Joist floor options
- Exposed services
- Stone Cycling brick

Next Steps
The next step is to incorporate some of the ideas that were generated in the workshop in Stage 2 into the design and procurement processes. Identified opportunities for material reuse from the existing building will be tracked through the design stage.

APPENDIX IV BREEAM MAT 01 REPORT

151 Shaftesbury Avenue

BREEAM Mat 01 Life Cycle Carbon Assessment

P01

15th December 2023

MAX FORDHAM

MAX FORDHAM

Max Fordham LLP
Max Fordham LLP
Exchange Place 3
3 Semple Street
Edinburgh

T +44 (0)131 476 6001

maxfordham.com

ISSUE HISTORY

Issue	Date	Description
P01	15.12.23	First Issue

MAX FORDHAM LLP TEAM CONTRIBUTORS

Engineer (Initials)	Role
MF	Graduate Sustainability Consultant
CP	Senior Sustainability Consultant

CONTENTS

1.0 INTRODUCTION

A considerable percentage of a building's whole life carbon emissions are related to the materials specified. For a typical office development, the embodied carbon of the construction materials alone can be as much as 45%, even excluding the impact of transportation, maintenance, repair and replacement. Life Cycle Carbon Analysis (LCA) aims to help us understand a building material's life cycle carbon impact on an element-by-element basis using this knowledge to:

- Help project teams to understand the overall environmental impact of the building design.
- Ensure that all life cycle greenhouse gas emissions are taken into account in the design, not just operational emissions.
- Reduce the impact of the construction industry and construction product industries.
- Assess the environmental impacts at the building level to provide flexibility when specifying construction products, to take into account project-specific conditions and priorities.
- Allow optimal solutions to be identified and adopted to reduce overall environmental impacts arising from construction product use.

A LCA study was undertaken for the 151 Shaftesbury Avenue during RIBA Stage 2, exploring the associated carbon emissions from building materials over the course of the development's design life.

The proposed development is the refurbishment and expansion of an eight-storey office building in London. The existing floors will be stripped out, retaining the existing structure, and an extension will be added on the 6th, 7th, and 8th floors, with a new 9th floor to be added.

The tool used for the calculation is One Click LCA, a web-based tool linked to a large database of generic and proprietary construction materials. The software has been verified to be IMPACT equivalent by BRE.

The primary environmental impact reported in this study is the carbon dioxide equivalent emissions (kgCOe$_2$), also referred as Global Warming Potential (GWP).

The scope of the Mat 01 LCA reflected the credits targeted below as part of the '*BREEAM Refurbishment and Fit-Out 2014 – Office'* assessment and covers both the building superstructure, substructure, hard landscaping and core building services.

Figure 1 Concept Elevation (courtesy of Buckley Gray Yeoman)

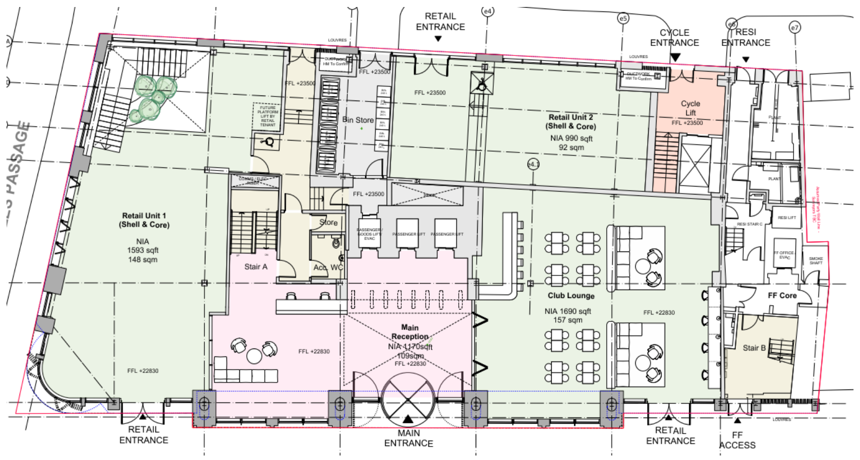


Figure 2 Ground Floor Plan (courtesy of Buckley Gray Yeoman)

1.1 BREEAM Credits Targeted

Depending upon the scope of the project the number of options appraised will vary as will the number of credits the process can contribute towards BREEAM. However as a minimum the following number of options must be considered:

Superstructure - Up to 6 credits

- RIBA Stage 2:
  Options appraisal, comparison of 2 to 4 (including the 'base case') significantly different superstructure design options
- RIBA Stage 4:
  Options appraisal, comparison of 2 to 4 (including the 'RIBA Stage 2 chosen solution) significantly different superstructure design options.

The comparison with the BREEAM LCA benchmark during Stage 2 and 4, where credits are awarded based on a reduction in life cycle carbon when compared to a BREEAM benchmark for a similar type building, is required for office, industrial and retail buildings only, therefore not currently in the scope for this assessment.

Substructure and Hard Landscaping - 1 credit

- RIBA Stage 2:
  Options appraisal, comparison of at least 6 (including the 'base case') significantly different substructure and Hard Landscaping options.

Core Building Services - 1 exemplary credit

- RIBA Stage 2:
  Options appraisal, comparison of at least 3 (including the 'base case') significantly different core building services design options.

Third Party Verification - 1 credit

- RIBA Stage 2 and 4:
  As per our targeted BREEAM credits, a suitably qualified third party will verify the work undertaken. This will achieve an additional credit, and it requires RIBA Stage 4 update to be completed.

One Click LCA has also been third party verified by ITB for compliancy with the following LCA standards: EN 15978, ISO 21931–1 and ISO 21929, and data requirements of ISO 14040 and EN 15804. The letter of compliance can be found here.

1.2 Methodology

As mentioned, the life cycle assessment calculation was undertake using One Click LCA which is officially approved for the BREEAM UK Mat 01 credit by BRE. In order to identify potential reductions in life cycle carbon a 'base case' was developed within the tool. The methodology undertaken at each stage of the design is shown in Figure 4.

A Mat01 optioneering workshop was held in July 2023 to discuss the general design principles and which elements would be most impactful and poignant to develop options for.

A Mat 01 Option Proforma was issued to all relevant Design Team members to collect information on the preferred material strategy. Further conversations to develop the final Mat 01 optioneering strategy were held with the relevant team members and various material alternatives were discussed.

Finally, the LCA model was developed through exploring the available materials on the One Click LCA database, in accordance with what agreed with the Design Team. It has been assured that all design options assessed fulfil the same functional requirements and all statutory requirements (to ensure functional equivalency).

Where exact material selections were not determined, the closest equivalent available within the One Click data base was selected. A full break down of input material quantities into the LCA One Click software corresponding to the results presented can be found in Appendix B.

The results represent the total life cycle impact for 60 year service life according to BS EN 15978:2011 for the proposed design.

The life cycle stages considered in this study are also compliant with BS EN 15978:2011 and includes the embodied impacts, transport to site (typical figures are used), construction and installation impacts, refurbishment and replacement, de-construction and disposal as set out in Figure 3.

This study must be BREEAM compliant and therefore the building elements modelled are in line with the BREEAM New Construction 2018 Manual - '*In Scope Elements'* - as set out under the Mat 01 issue. The full list of building elements and sub-elements assessed and out of the scope can be found in Appendix A.

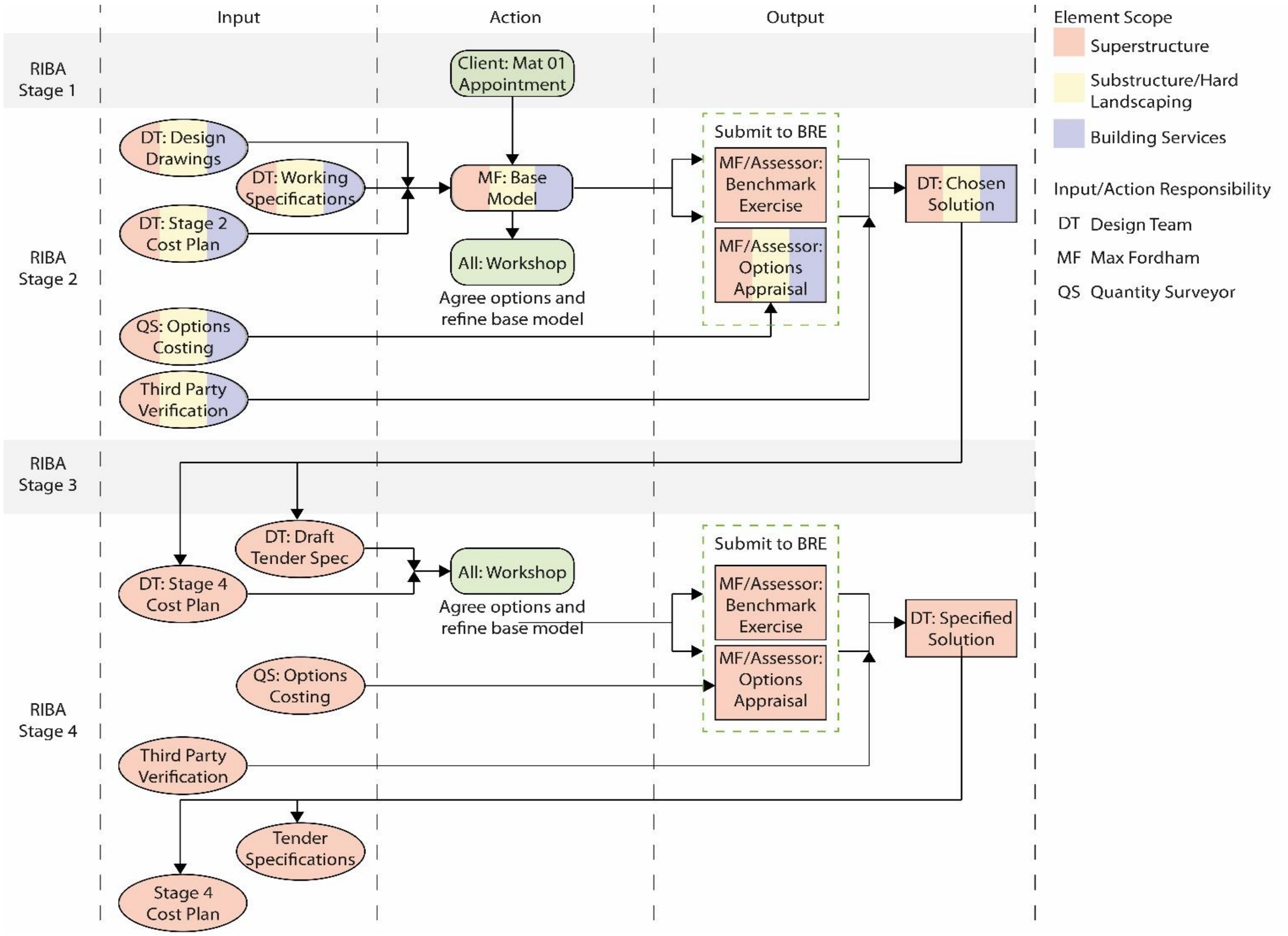


Figure 4 Overarching Methodology for Mat 01 LCA Study

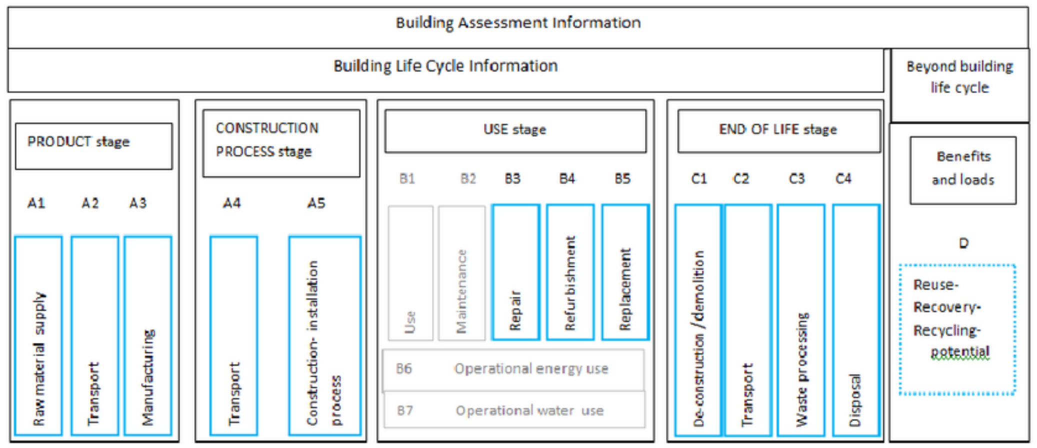


Figure 3 Life Cycle Stages from BS EN 15978:2011

MAX FORDHAM

1.3 Summary of Design Options

The design options agreed with the Design Team are summarised below, the significantly different alternatives considered are highlighted in grey.

SUPERSTRUCTURE OPTIONS				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Frame *- Steel frames* *- Space decks* *- Concrete casings to steel frames* *- Concrete frames* *- Timber frames* *- Other frame systems*	Top: D/S Steel + Columns Rear: D/S Steel + Columns. Timer Joist Infill	Top: D/S Steel + Columns Rear: SlimFlor Composite Beams	Top: D/S Steel + Columns Rear: D/S Composite Steel	Top: D/S Steel + Columns. Timer Joist Infill Rear: D/S Steel + Columns. Timer Joist Infill
External walls *- External enclosing walls above ground floor level* *- External enclosing walls below ground level* *- Solar or rain screening*	Main Façade: Brick Faced GRC Feature: GRC Scalloped Panels/Lintels Ground Floor: Reconstituted Stone Panels	Main Façade: Brick Faced GRC (K-Briq) Feature: GRC Scalloped Panels/Lintels Ground Floor: Reconstituted Stone Panels	Main Façade: Handset Brick Feature: GRC Scalloped Panels/Lintels Ground Floor: Reconstituted Stone Panels	Retained Façade
Upper floors	OSB	Ribdeck	ComFlor	OSB
Roof *- Roof structure* *- Roof coverings* *- Specialist roof systems* *- Rooflights, skylights and openings*	Structure: CLT Main covering: Green roof Terrace: Porcelain Flags on pedestals	Structure: CLT Main covering: Green roof Terrace: Stone Flags on pedestals	Structure: CLT Main covering: Green roof Terrace: Timber Decking on pedestals	Structure: OSB Main covering: Green roof Terrace: Stone Flags on pedestals
Stairs and ramps *- Stair or ramp structures*	Pre-cast Concrete Staircases	Steel Staircases	Pre-cast Concrete Staircases	Steel Staircases
Windows and external doors *- External windows*	Double glazed, aluminium frame	Double glazed, timber composite frame	Double glazed, aluminium frame	Double glazed, timber composite frame

Table 1 Summary of the Superstructure Options

Table 3 - Summary of Building Services Options

BUILDING SERVICES OPTIONS					
	Option 1	**Option 2**	**Option 3**	**Option 4 (extra)**	**Option 5 (extra)**
Space Heating and Air Conditioning	ASHP 4-pipe (R513A) ASHP 2-pipe (R32) Fan Coil Units	VRF System (R32) Indoor VRF Units	Hybrid VRF System (R32) Indoor VRF Units	ASHP 4-pipe (R290) Fan Coil Units	ASHP 4-pipe (R454B & R290) Fan Coil Units
Ventilation	Decentralised MVHR	Decentralised MVHR	Centralised AHUs	Decentralised MVHR	Centralised AHUs

MAX FORDHAM

2.0 SUPERSTRUCTURE ANALYSIS

2.1 Options Appraised

For the superstructure appraisal, four different options have been proposed as follows:

Option 1 – Steel Frame with Timber Floors & CLT Roof
Mat01_CD_SuperS_Opt1

- **External Walls and Façade:** Majority Brick Faced GRC slabs, with the Ground Floor being Reconstituted Stone Panels and the Upper Floors and Corner detail being GRC Scalloped Panels/Lintels.
- **Columns and Load-bearing Vertical Structures:** Steel frame with S355 Steel – Average UK consumed
- **Horizontal structures, floors and roof:** CLT 160mm floor on roof slab. Timber Joist floors on rear extension.
- **Roof Coverings:** Green roof, with Porcelain (Porcelnosa) tiles on pedestals over the terrace area.
- **Stairs and Ramps:** Pre-cast concrete staircases.
- **Windows and Doors:** Aluminium, double glazed system.

Option 2 – Steel Frame with SlimFlor Floors & CLT Roof
Mat01_CD_SuperS_Opt2

- **External Walls and Façade:** Majority K-Briq Faced GRC slabs, with the Ground Floor being Reconstituted Stone Panels and the Upper Floors and Corner detail being GRC Scalloped Panels/Lintels.
- **Columns and Load-bearing Vertical Structures:** As per Option 1.
- **Horizontal structures, floors and roof:** CLT 160mm floor on roof slab. SlimFlor slabs with 1.2mm steel deck and ready mix concrete C32/40 with cement replacements approximating the theoretical carbon reduction of 25% GGBS content on rear extension.
- **Roof Coverings:** Green roof, with Stone tiles on pedestals over the terrace area.
- **Stairs and Ramps:** Steel staircases.
- **Windows and Doors:** Timber composite, double glazed system.

Option 3 – Steel Frame with ComFlor Floors & CLT Roof
Mat01_CD_SuperS_Opt3

- **External Walls and Façade:** Majority Handset Brick, with the Ground Floor being Reconstituted Stone Panels and the Upper Floors and Corner detail being GRC Scalloped Panels/Lintels.
- **Columns and Load-bearing Vertical Structures:** As per Option 1.
- **Horizontal structures, floors and roof:** CLT 160mm floor on roof slab. Composite (ComFlor) slabs with 1.2mm steel deck and ready mix concrete C32/40 with cement replacements approximating the theoretical carbon reduction of 25% GGBS content on rear extension.
- **Roof Coverings:** As per Option 1.
- **Stairs and Ramps:** As per Option 1
- **Windows and Doors:** As per Option 1.

Option 4 – Steel Frame with Timber Floors & Timber Roof
Mat01_CD_SuperS_Opt4

- **External Walls and Façade:** Existing façade retained.
- **Columns and Load-bearing Vertical Structures:** Steel frame with S355 Steel – Average UK consumed
- **Horizontal structures, floors and roof:** As per Option 1 for rear extension. Timber Joist infill at roof level.
- **Roof Coverings:** As per Option 2.
- **Stairs and Ramps:** As per Option 2.
- **Windows and Doors:** As per Option 2.

2.2 Results

The graph in Figure 5 presents a summary of the kg CO_2e/m^2 over the 60-year study period (design life of the building).

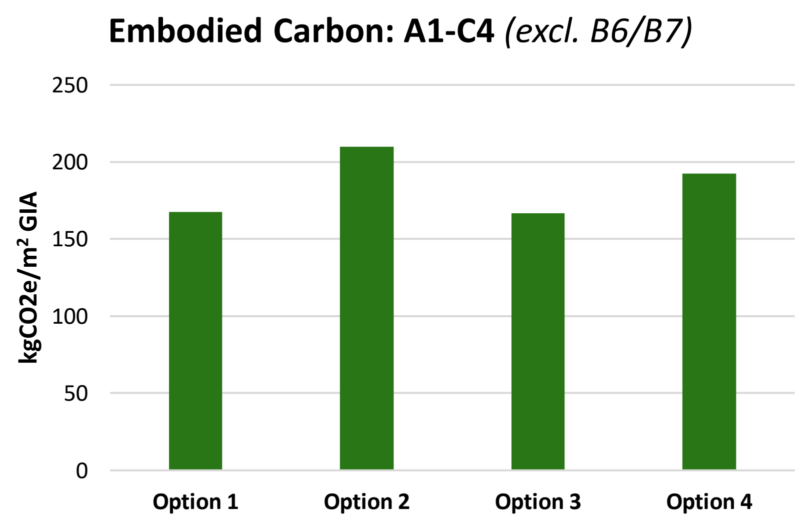


Figure 5 Superstructure Life Cycle Carbon Impact ($kgCO_2e/m^2$ GIA)

The results shown that Options 1 & 3 have the lowest embodied carbon out of all the options assessed, achieving an approximate reduction of 42.5 $kgCO_2e/m^2$ that is roughly 20% lower than Option 3. This is driven mostly by the avoidance of concrete within the floor plates and the heavy steel penalty the slimfor option entails.

Option 4 reduces the embodied carbon by approximately 17 $kgCO_2e/m^2$, roughly 8% lower than Option 3. This is mainly due to the retained façade.

The graph in Figure 6 presents a summary of the $kgCO_2e$ over the 60-year study period (design life of the building) associated with the life cycle stages of the materials. The materials (A1-A3) make the largest carbon contribution across all design Options.

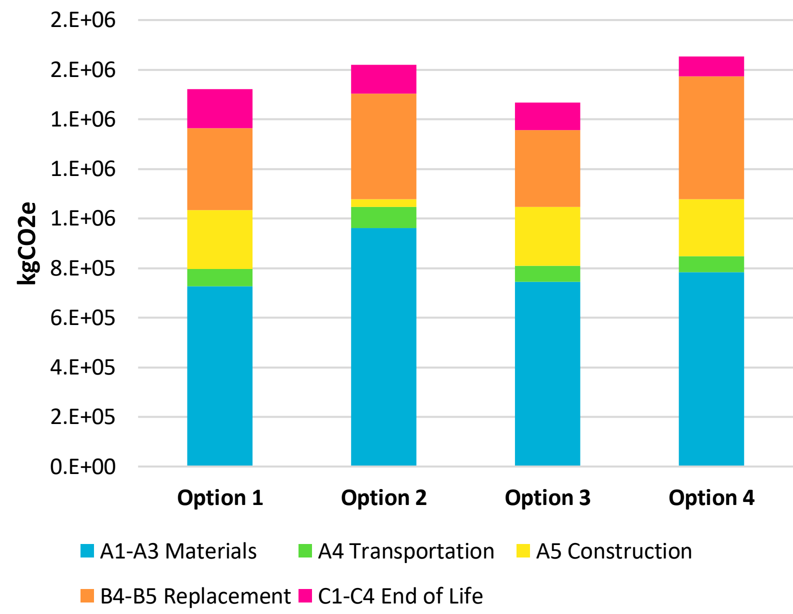


Figure 6 Superstructure Global Warming Potential ($kgCO_2e$) by Stage

Structural Comparison
A number of studies were pulled from the overall analysis to give a clearer picture of the impact of the different options considered. The first of these was a Structural Comparison looking solely at the optioneering done for this. The results of this can be seen below.

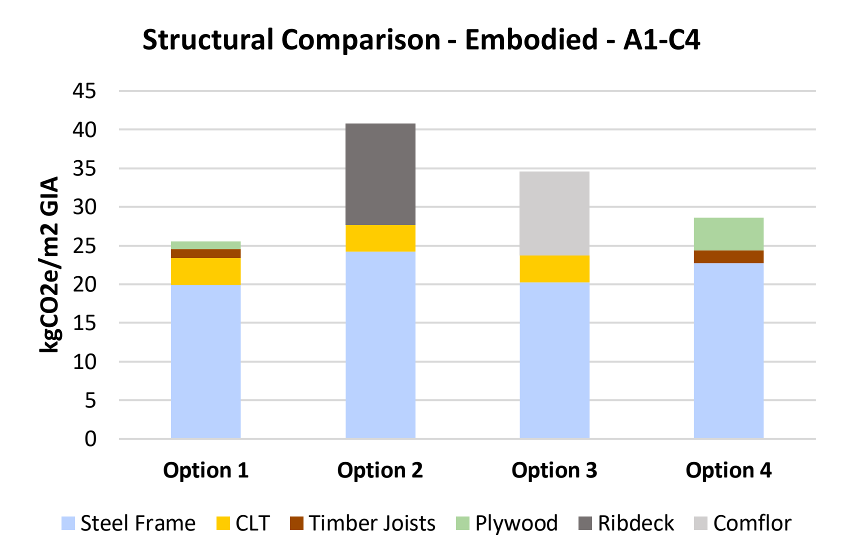


Figure 7 Structural Comparison (kgCO₂e/m²)

These results show that the RibDeck used in Option 2 has the highest impact, due to the large increase in steel tonnage required to facilitate a shallow beam system. Option 1 has the lowest impact, with Option 4 not being significantly higher. At this stage we would not be declarative about the difference between these two options.

Façade Comparison
The second comparison pulled out was the façade build-ups for each option. The results of this can be seen below.

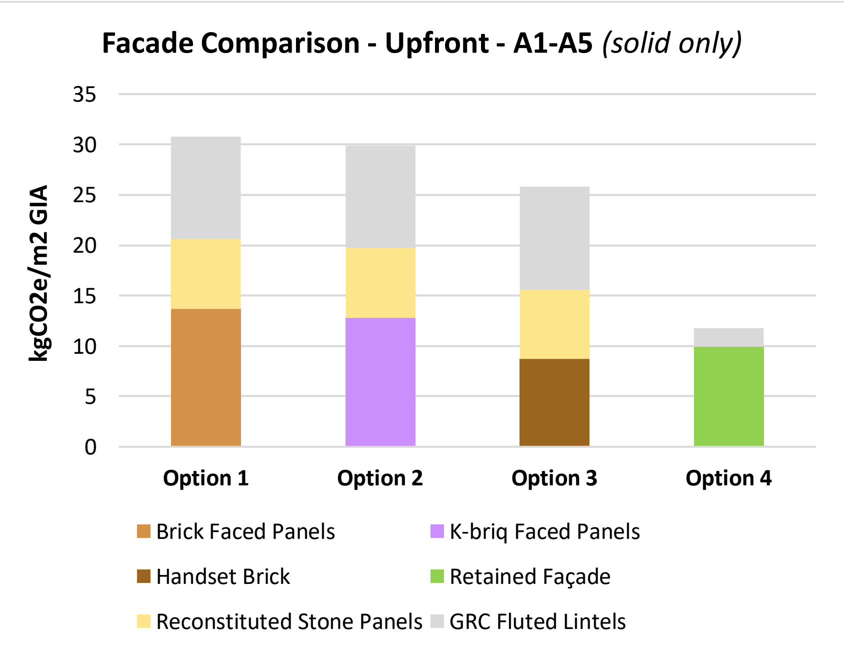


Figure 8 Facade Comparison (kgCO₂e/m²)

Thes results show that Option 1 – Retained façade has a significant reduction when compared to the other three. It should be noted that this relates to the solid area only. Given the larger quantity of glazing within the existing building, replacing that outweighs the benefits of retaining the solid areas.

The handset brick modelled in Option 3 also gives a reasonable reduction in embodied carbon when compared to the brick faced panelling used in the first two options.

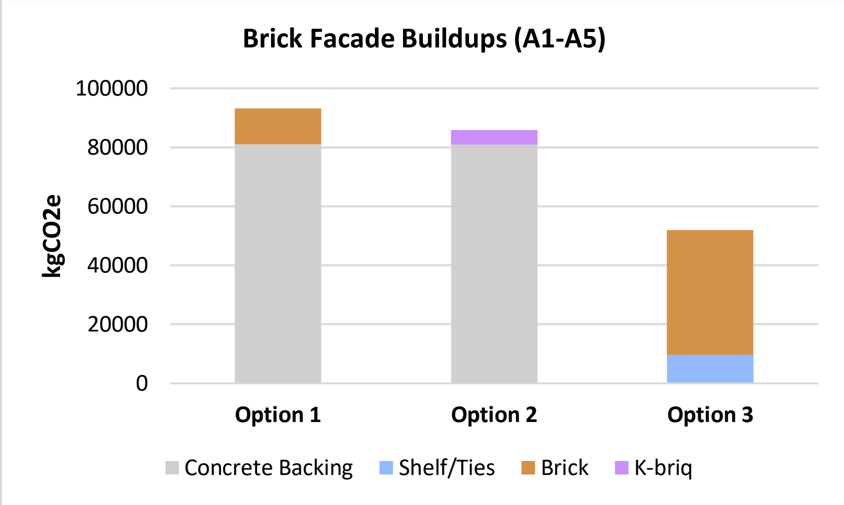


Figure 9 Brick Facade Build-up Comparison (kgCO₂e)

This observation was investigated further by separating out just the facing and handset brick for Options 1-3. This highlights that although K-briq gives a significant reduction over traditional brick, the concrete backing impact is so dominant that it becomes less noticeable.

Rooftop Paving Comparison
The results of a comparison of the paving used on the roof terraces can be seen below.

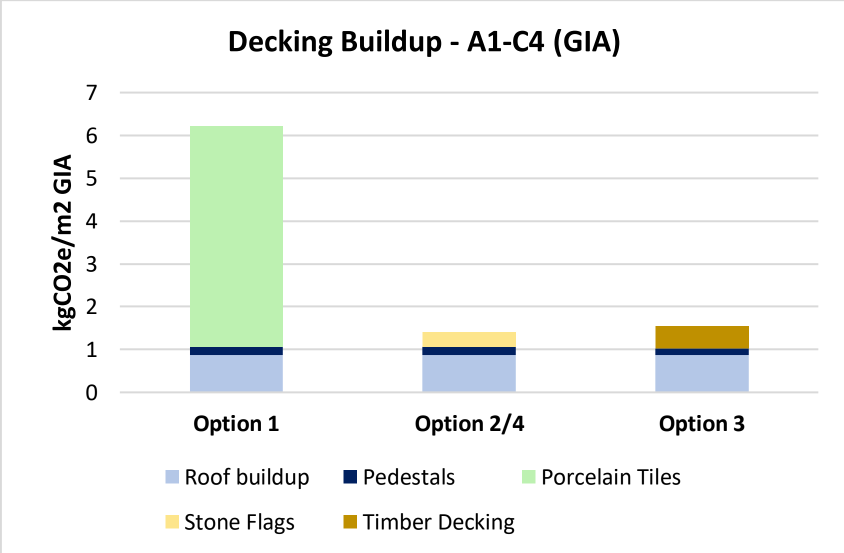


Figure 10 Rooftop Paving Comparison (kgCO₂e/m²)

This comparison shows that porcelain tiles have a significant increase in carbon when compared to the other two options. This is largely due to the manufacturing processes required.

Window Comparison
A study was done looking into the carbon savings from using timber composite windows. The study is based off of the CWCT methodology, using average quantity information form a variety of appropriate EPDs.

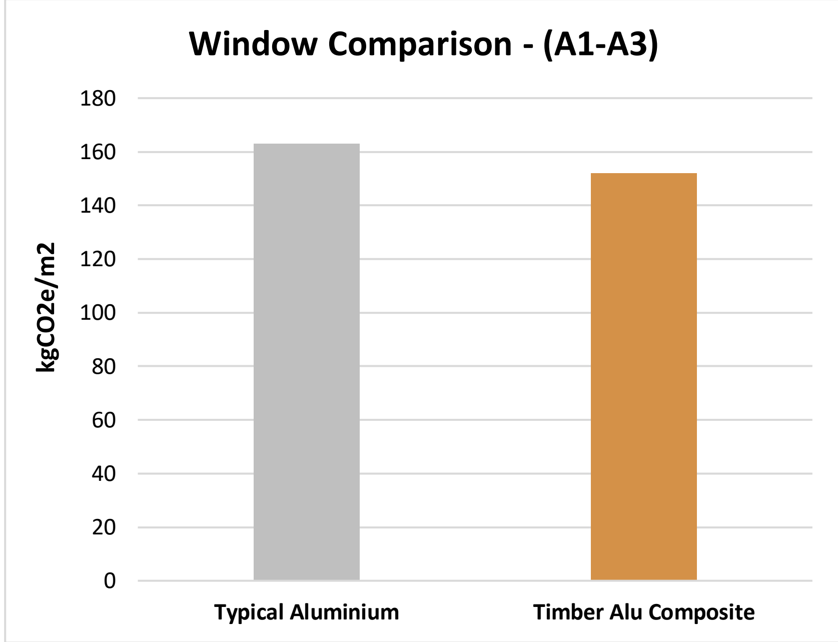


Figure 11 Window Comparison (kgCO2e/m2)

The results show a slight reduction in carbon for the timber composite windows. A large proportion of the emissions from the windows is the glass itself when dealing with double-leaf safety glass (laminated), so there is a more significant reduction when comparing just the frame elements.

2.3 Proposed Superstructure Option

Based on discussions with Design Team members, results of the life cycle carbon analysis and our considerations, Option 1 (Steel Frame with Timber Floors & CLT Roof) is the preferred option. Elements from other options to further reduce the Embodied Carbon will be considered in Stage 3.

3.0 CORE BUILDING SERVICES ANALYSIS

3.1 Options Appraised

For the core building services, three different core building services configurations have been proposed as below.

Option 1 – ASHP with R513A and R32
Mat01_CD_BDServ_Opt1

- **Heat source**
  - 4-pipe Air Source Heat Pump with R513A
  - 2-pip Air Source Heat Pump with R32
- **Space heating and air-conditioning**
  - Fan Coil Units
- **Ventilation**
  - Decentralised Mechanical Ventilation with Heat Recovery on each floor

Option 2 – VRF with R32
Mat01_CD_BDServ_Opt2

- **Heat source**
  - Variable Refrigerant Flow system using R32.
- **Space heating and air-conditioning**
  - Indoor VRF units
- **Ventilation**
  - Decentralised Mechanical Ventilation with Heat Recovery on each floor

Option 3 – Hybrid VRF with R32
Mat01_CD_BDServ_Opt3

- **Heat source**
  - Hybrid Variable Refrigerant Flow system with R32 – Water based up the risers, refrigerant based on the floor plate
- **Space heating and air-conditioning**
  - Indoor VRF units
- **Ventilation**
  - Centralised Mechanical Ventilation with Heat Recovery on each floor

Option 4 (extra) – ASHP with Very Low GWP
Mat01_CD_BDServ_Opt4

- **Heat source**
  - 4-pipe Air Source Heat Pump with R290.
- **Space heating and air-conditioning**
  - Fan Coil Units
- **Ventilation**
  - Decentralised Mechanical Ventilation with Heat Recovery on each floor

Option 5 (extra) – ASHP with Low/Very Low GWP
Mat01_CD_BDServ_Opt5

- **Heat source**
  - Air Source Heat Pump with R290
  - Air Source Heat Pump with R454B
- **Space heating and air-conditioning**
  - Fan Coil Units
- **Ventilation**
  - Centralised Mechanical Ventilation with Heat Recovery on each floor

3.2 Results

The graph in **Error! Reference source not found.** presents a summary of the comparative embodied emissions over the 60 year study period (design life of the building) for each of the options.

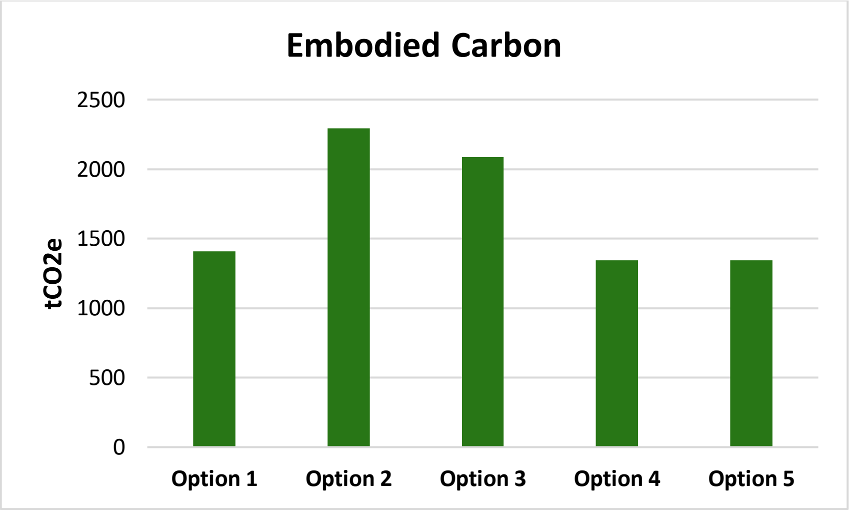


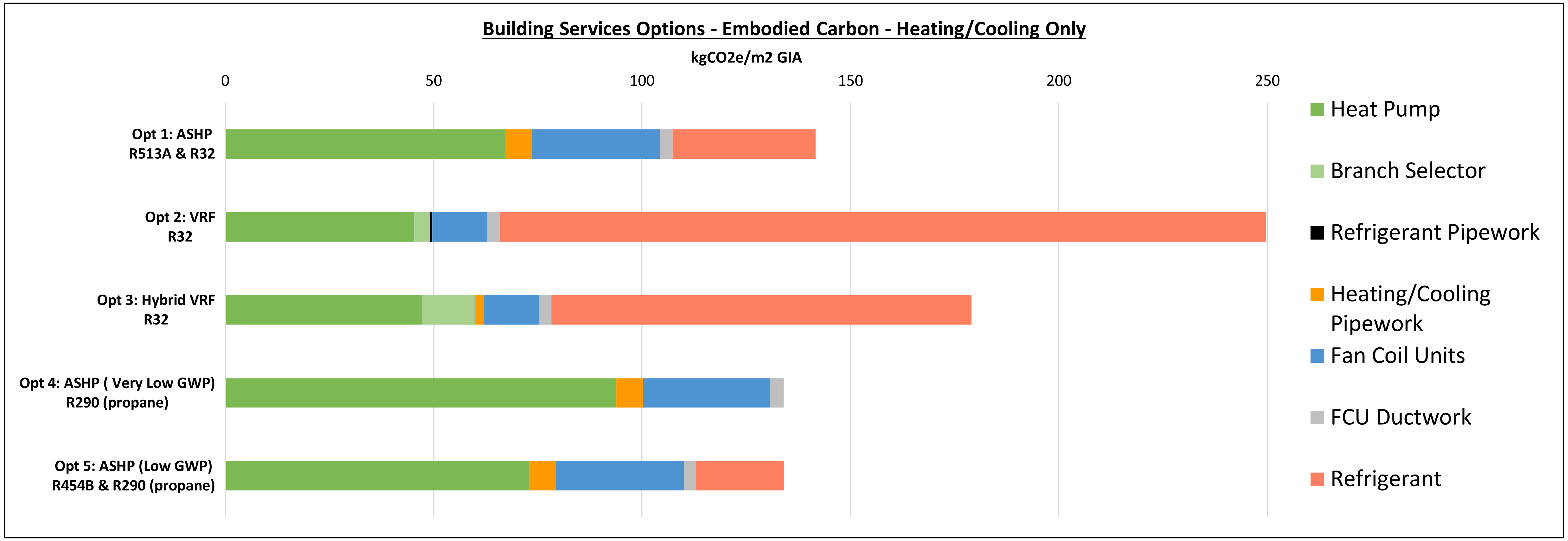
Figure 12 - Core Building Services Life Cycle Carbon Impact (tCO2e)

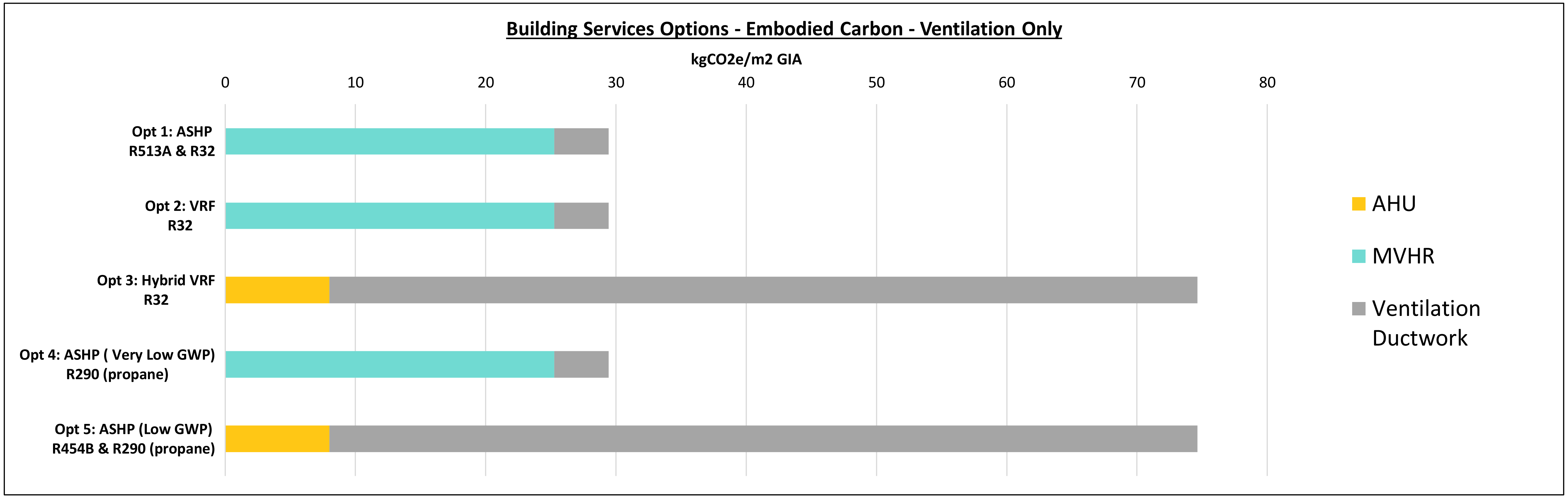
The graph on the next page outlines the Heating & Cooling comparison between options. VRF and Hybrid VRF perform relatively poorly, this is due to the higher emissions from refrigerant leakage – both in quantity and GWP - that outweigh their well performing upfront carbon emissions from the equipment itself. Option 1,2 & 5 are too close to be declarative about in this stage, but what is apparent is that low GWP units that can satisfy the schemes energy demands are likely to be larger and heavier, thus requiring more material and with larger upfront carbon emissions. Option 1 sits well in terms on low upfront carbon and refrigerant emissions that don't completely undo the upfront benefits.

3.3 Proposed Core Building Services Option

Based on discussions with Design Team members and the results of the study, Option 1 has been chosen as the preferred option. This is mainly due to:

- Good performance balance between upfront carbon and ongoing refrigerant leakage emissions
- Lower risk supply chain. R290 units, for example, are newer to market and may narrow down the options for supply
- Decentralised ventilation satisfies the wider energy design while also presenting as the lowet embodied carbon option


Building Services Options - Embodied Carbon - Heating/Cooling Only
kgCO2e/m2 GIA
0
50
100
150
200
250
Opt 1: ASHP R513A & R32
Opt 2: VRF R32
Opt 3: Hybrid VRF R32
Opt 4: ASHP (Very Low GWP) R290 (propane)
Opt 5: ASHP (Low GWP) R454B & R290 (propane)
Heat Pump
Branch Selector
Refrigerant Pipework
Heating/Cooling Pipework
Fan Coil Units
FCU Ductwork
Refrigerant


Building Services Options - Embodied Carbon - Ventilation Only
kgCO2e/m2 GIA
0
10
20
30
40
50
60
70
80
Opt 1: ASHP R513A & R32
Opt 2: VRF R32
Opt 3: Hybrid VRF R32
Opt 4: ASHP (Very Low GWP) R290 (propane)
Opt 5: ASHP (Low GWP) R454B & R290 (propane)
AHU
MVHR
Ventilation Ductwork

4.0 BREEAM CREDITS ACHIEVED

The Shaftesbury Avenue project is on track to achieve all the available credits under '*Mat 01 Environmental impacts from construction products - Building life cycle assessment (LCA)*'

The BREEAM Mat 01 reporting and scoring tool has been prepared and submitted to the BRE.

Superstructure - Up to 6 credits

- RIBA Stage 2:
  With the option appraisal undertaken in this report at concept design stage, 4 credits have been achieved.
- RIBA Stage 4:
  An update will be carried out at technical design stage to achieve the remaining 2 credits.

Substructure and Hard Landscaping - 1 credit

- No significant Hard-landscaping or Sub-structure works proposed. BRE have agreed this is thee case after presenting evidence.

Core Building Services - 1 exemplary credit

- RIBA Stage 2:
  With the option appraisal undertaken in this report at concept design stage, 1 exemplary credit has been achieved.

5.0 APPENDIX A – MAT 01 LCA SCOPE OF ASSESSMENT

The following table presents a list of the building elements and sub-elements included or excluded from the scope of the building LCA Mat 01 Assessment.

In addition, the table shows classification codes based on the RICS New Rules of Measurement (NRM) classification system.

Key
In scope elements
Out of scope elements

Element Group		Building Element	Building Sub-element
	Demolition	01 - Toxic/hazardous/contaminated material treatment	
		02 - Major demolition works	
0	Facilitating works	03, 05 - Temporary/enabling works	
		04 - Specialist groundworks	
1	Substructure	1.1 - Substructure	1.1.1 - Standard foundations 1.1.2 - Specialist foundation systems 1.2.3 - Lowest floor construction 1.2.4 - Basement excavation 1.2.5 - Basement retaining walls
2	Superstructure	2.1 - Frame	2.1.1 - Steel frames 2.1.2 - Space decks 2.1.3 - Concrete casings to steel frame 2.1.4 - Concrete frames 2.1.5 - Timber frames 2.1.6 - Other frame systems
		2.2 - Upper floors	2.2.1 - Floors 2.2.2 - Balconies 2.2.3 - Drainage to balconies
		2.3 - Roof	2.3.1 - Roof structure 2.3.2 - Roof coverings 2.3.3 - Specialist roof systems 2.3.4 - Roof drainage 2.3.5 - Rooflights, skylights and openings 2.3.6 - Roof features
		2.4 - Stairs and ramps	2.4.1 - Stair or ramp structures 2.4.2 - Stair or ramp finishes 2.4.3 - Stair or ramp balustrades and handrails 2.4.4 - Ladders, chutes, slides
		2.5 - External walls	2.5.1 - External enclosing walls above ground floor level 2.5.2 - External enclosing walls below ground level 2.5.3 - Solar or rain screening 2.5.4 - External soffits 2.5.5 - Subsidiary walls, balustrades, handrails, railings and proprietary balconies 2.5.6 - Façade access or cleaning systems
		2.6 - Windows and External doors	2.6.1 - External windows 2.6.2 - External doors

MAX FORDHAM

	Element Group	Building Element	Building Sub-element
		2.7 - Internal walls and partitions	2.7.1 - Walls and partitions (Education assessments only) 2.7.2 - Balustrades and handrails 2.7.3 - Moveable room dividers 2.7.4 - Cubicles
		2.8 - Internal doors	2.8.1 - Internal doors
3	Internal Finishes	3.1 - Wall finishes	3.1.1 - Finishes to walls
		3.2 - Floor finishes	3.2.1 - Finishes to floors 3.2.2 - Raised access floors
		3.3 - Ceiling finishes	3.3.1 - Finishes to ceilings 3.3.2 - False ceilings 3.3.3 - Demountable suspended ceilings
4	Fittings, furnishings and equipment (FF&E)	4.1 - Fittings, furnishings and equipment including building-related* and non-building-related**	4.1.1 - General fittings, furnishes and equipment 4.1.2 - Domestic kitchen fittings and equipment 4.1.3 - Special purpose fittings, furnishings and equipment 4.1.4 - Signs or notices 4.1.5 - Works of art 4.1.7 - Internal planting 4.1.8 - Bird and vermin control
5	Building services/MEP	5.1 - Sanitary installations	5.1.1 - Sanitary appliances 5.1.2 - Sanitary ancillaries 5.1.3 - Pods
		5.2 - Services equipment	5.2.1 - Services equipment
		5.3 - Disposal installations	5.3.1 - Foul drainage above ground 5.3.2 - Chemical, toxic and industrial liquid waste drainage 5.3.3 - Refuse disposal
		5.4 - Water installations	5.4.1 - Mains water supply 5.4.2 - Cold water distribution 5.4.3 - Hot water distribution 5.4.4 - Local hot water 5.4.5 - Steam and condensate distribution
		5.5 - Heat source	5.5.1 - Heat source
		5.6 - Space heating and air-conditioning	5.6.1 - Central heating 5.6.2 - Local heating 5.6.3 - Central cooling 5.6.4 - Local cooling 5.6.5 - Central heating and cooling 5.6.6 - Local heating and cooling 5.6.7 - Central air-conditioning 5.6.8 - Local air-conditioning
		5.7 - Ventilation	5.7.1 - Central ventilation 5.7.2 - Local ventilation 5.7.3 - Smoke extract and control 5.7.4 - Specialist ventilation
		5.8 - Electrical installations	5.8.1 - Electrical mains and sub-mains distribution

	Element Group	Building Element	Building Sub-element
			5.8.2 - Power installations 5.8.3 - Lighting installations 5.8.4 - Specialist lighting installations 5.8.5 - Local electricity generation systems 5.8.6 - Earthing and bonding systems
		5.9 - Fuel installations and systems	5.9.1 - Fuel storage 5.9.2 - Fuel distribution systems
		5.10 - Lift and conveyor installations or systems	
		5.11 - Fire and lighting protection	
		5.12 - Communication, security and control systems	
		5.13 - Special installations or systems	
		5.14 - Builder's work in connection with services	
6	Prefabricated buildings and building units	6.1 - Prefabricated buildings and building units	
7	Works to existing building	7.1 - Minor demolition and alteration works	
8	External works	8.1 - Site preparation works	
		8.2 - Roads, paths, paving and surfacing	8.2.1 - Roads, paths and paving 8.2.2 - Special surfacing and paving
		8.3 - Soft landscaping, planting and irrigation systems	
		8.4 - Fencing, railings and walls	
		8.5 - External fixtures	
		8.6 - External drainage	
		8.7 - External services	
		8.8 - Minor building works and ancillary buildings	