7 REDDINGTON GARDENS

WLCA – New Construction Vs Refurbishment Comparison

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Document Information

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Contents

1.0 Executive Summary

Viro Consult have been commissioned by Carnell Warren to calculate the anticipated life cycle embodied and operational carbon impact for two design scenarios – new build and refurbishment. The results will be presented in kgCO2e. The existing scenario has also been modelled as a baseline scenario, where all carbon impacts will result from operational energy.

- ***New build scenario*** - The existing building (including foundations) will be deconstructed, and a new property will be constructed in its place. Although the embodied carbon will likely be higher, the savings made in operational energy consumption may offset this as the U-values are not limited.
- ***Refurbishment scenario*** – Refurbishment of two external wall elevations (retained brickwork, new insulation and external skin) and extension works to the upper floors. The existing structural design, roof, internal floor and wall constructions could not be adapted or strengthened to accommodate the upper floor extension, with new structure and substantial insulation improvements proposed.

The Life Cycle Assessment (LCA) has been calculated using the Whole Life Carbon assessment principles, from the Greater London Authority (GLA), and will quantify the embodied carbon of the new build and refurbishment scenario.

Summary of Results

Existing Scenario

The existing scenario has been modelled as though no work has been done. Therefore, as no new materials are entering the scheme, the embodied carbon of the existing scheme is 0 kgCO2e. The total lifetime carbon impact (60 years) of the existing scenario is **734,765 kgCO2e** (1,493 kgCO2e/m2).

Refurbishment Scenario

The total lifetime carbon impact (60 years) of the refurbishment scenario is **641,110 kgCO2e** (1,303 kgCO2e/m2):

- The operational carbon of the refurbishment scheme is 311,323 kgCO2e
- The embodied carbon of the refurbishment scheme over the study period is 329,787 kgCO2e

New Build Scenario

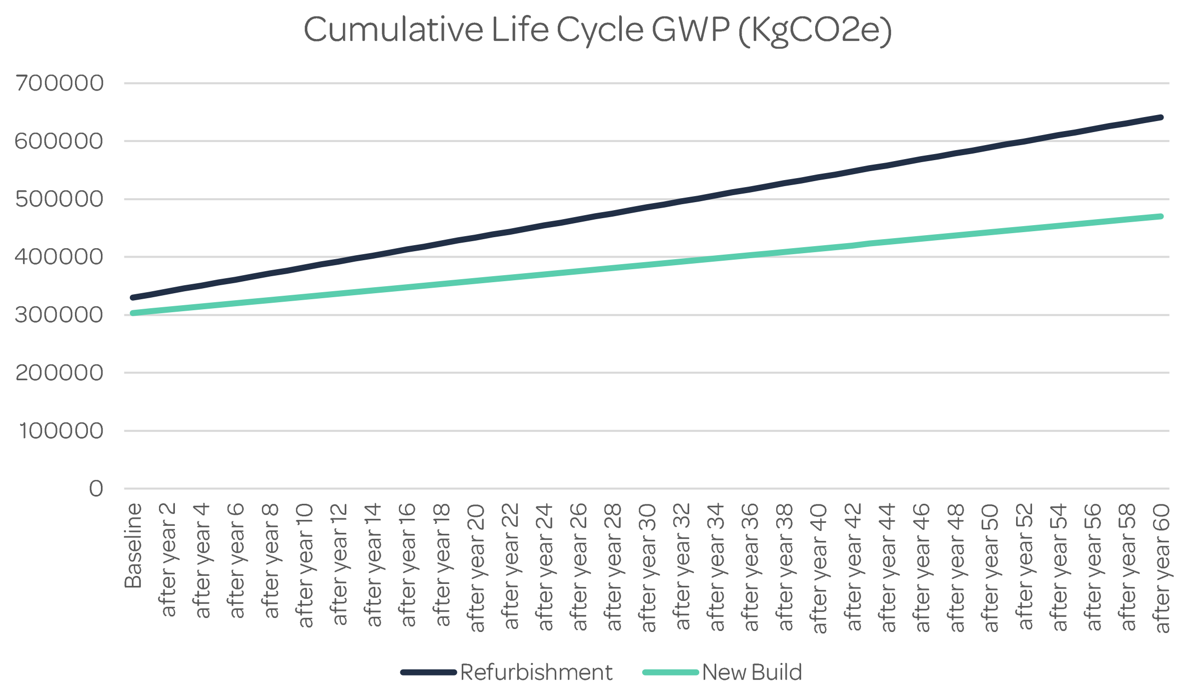
The total lifetime carbon impact (60 years) of the new build scenario is **470,120 kgCO2e** (956 kgCO2e/m2):

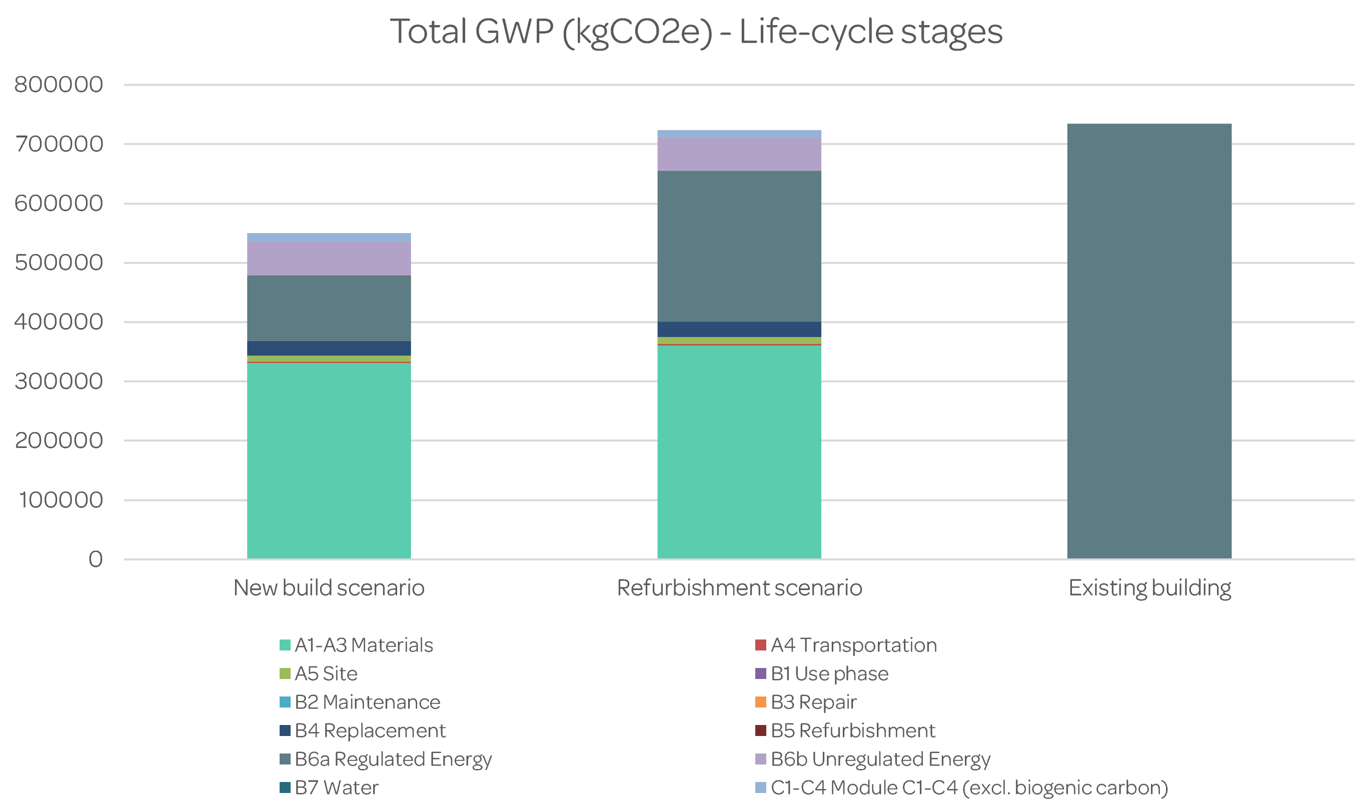
- The operational carbon of the new build scheme is 167,062 kgCO2e
- The embodied carbon of the new build scheme over the study period is 303,058 kgCO2e

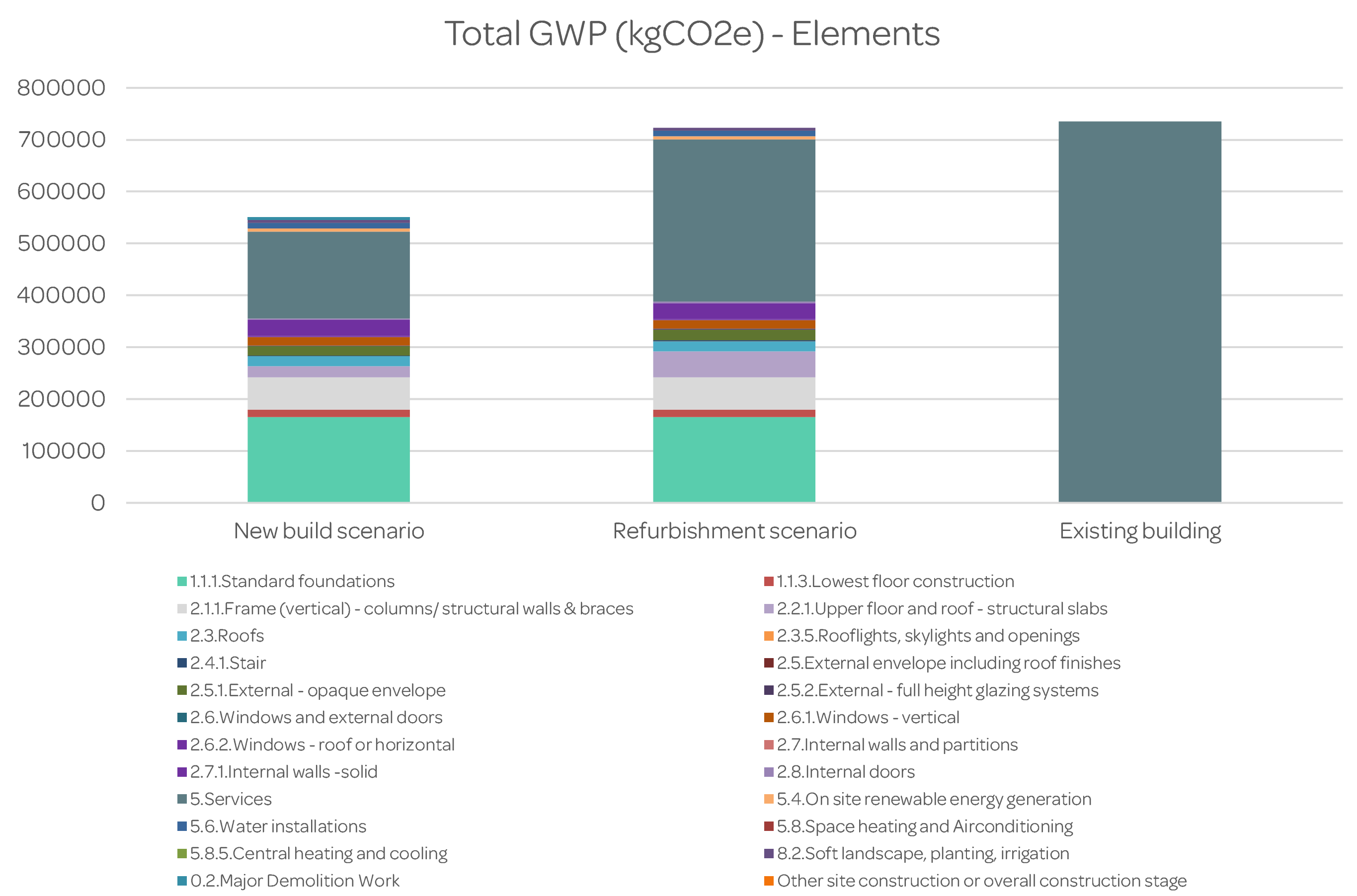
The Energy analysis has been calculated using the Standard Assessment Procedure (SAP) and will evaluate the annual energy consumption of the new build and refurbishment scenario. The energy consumption figures will be converted to operational carbon using the SAP10.2 carbon factors.

Results confirm the new build scenario as the less carbon-intensive option during the calculated 60 year life cycle, with improvements in embodied carbon and operational carbon achieved.

Scenario	Life cycle carbon impact (60 years) kgCO2e		
	Operational	Embodied	Total
Existing build	734,765	0	734,765
Refurbishment	311,323	329,787	641,110
New build	167,062	303,058	470,120




Total GWP (kgCO2e) - Life-cycle stages
800000
700000
600000
500000
400000
300000
200000
100000
0
New build scenario
Refurbishment scenario
Existing building
A1-A3 Materials
A4 Transportation
A5 Site
B1 Use phase
B2 Maintenance
B3 Repair
B4 Replacement
B5 Refurbishment
B6a Regulated Energy
B6b Unregulated Energy
B7 Water
C1-C4 Module C1-C4 (excl. biogenic carbon)


Total GWP (kgCO2e) - Elements
800000
700000
600000
500000
400000
300000
200000
100000
0
New build scenario
Refurbishment scenario
Existing building
1.1.1.Standard foundations
1.1.3.Lowest floor construction
2.1.1.Frame (vertical) - columns/ structural walls & braces
2.2.1.Upper floor and roof - structural slabs
2.3.Roofs
2.3.5.Rooflights, skylights and openings
2.4.1.Stair
2.5.External envelope including roof finishes
2.5.1.External - opaque envelope
2.5.2.External - full height glazing systems
2.6.Windows and external doors
2.6.1.Windows - vertical
2.6.2.Windows - roof or horizontal
2.7.Internal walls and partitions
2.7.1.Internal walls -solid
2.8.Internal doors
5.Services
5.4.On site renewable energy generation
5.6.Water installations
5.8.Space heating and Airconditioning
5.8.5.Central heating and cooling
8.2.Soft landscape, planting, irrigation
0.2.Major Demolition Work
Other site construction or overall construction stage

2.0 Introduction

Viro Consult have been commissioned by Carnell Warren to calculate the anticipated life cycle embodied and operational carbon impact for two design scenarios – new build and refurbishment. The purpose of the assessment is to ensure the demolition and reconstruction proposals provide a more sustainable alternative to the refurbishment and to meet the sustainability requirements of the London Borough of Camden.

Current proposals allow for the construction of a 5-bedroom dwelling designed to have a floor area of 492m^2 located in Hampstead, London.

3.0 Methodology

The aim of the Whole Life-Cycle Carbon Assessment (WLCA) is to compare carbon emissions associated with the two scenarios and continued operation of the existing building. All emissions associated with the proposed materials for the new development were calculated using One Click LCA's 'RICS: Whole life cycle assessment' Tool. Whole life-cycle carbon emissions are the total greenhouse gas emissions arising from a development over its lifetime, from the emissions associated with raw material extraction, the manufacture and transport of building materials, to installation/construction, maintenance, and eventual material disposal.

The WLCA will follow the Greater London Authority's (GLA) 'London Plan Guidance: Whole Life-Cycle Carbon Assessments', reporting on the following parameters:

- any carbon emissions associated with pre-construction demolition.
- any carbon savings associated with the retention, reuse and recycling of existing structures and materials that are already on-site.
- its operational carbon emissions (both regulated and unregulated).
- its embodied carbon emissions.
- any future potential carbon savings post end-of-life, including savings from reuse and recycling of building structures and materials.

The One-Click LCA tool's database allows the materials of a building to be broken down into each applicable building element in accordance with the RICS PS methodology.

A range of generic data sources such as ICE and One-Click datasets have been included within the WLCA calculation. The product service life and transport distances are based on RICS default figures.

Table 1 confirms the life cycle stages assessed in accordance with BS EN 15978 and the building's service life was estimated to be 60 years.

Product				Construction				Use				End of life				Beyond project
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw Material	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Demolition	Transport	Waste Processing	Disposal	Reuse, Recovery, Recycling Potential

Table 1: LCA scope

Internal finishes have been excluded from both assessments as these items are functionally identical between scenarios.

Final life cycle carbon emissions includes operational energy (B6) allowing for a direct comparison between the life cycle emissions for both options.

This is a provisional WLCA conducted to support the project planning application, as such, it is based on design drawings and bill of quantities provided by the design team.

The energy analysis has been calculated using the Standard Assessment Procedures (SAP) and will calculate the annual energy consumption of the new build and refurbishment scenarios.

This report has been checked by Marcus Eves of E&S Bristol who is an On Construction Domestic Energy Assessor (OCDEA).

4.0 Existing Site

The existing site is located in Hampstead, London which falls within the Borough of Camden. It is also situated within the Redington Frognal Conservation Area, within a residential area. The site consists of an existing dwelling built circa 1960s and a large garden. The property has not been extended or comprehensively internally upgraded.

The building is of basic traditional construction with limited insulation, shallow mass concrete strip foundations, and defective unreinforced ground bearing concrete slab without insulation. External walls are brick cavity without insulation and windows are single glazed. There are low ceiling heights, and the roof is a shallow double pitched timber construction with copper panelled coverings without insulation.

Refer to figure 1 on the following page for the existing site 3D model developed by Wolff Architects.

Figure 1: Existing site - 3D model (Source: Wolff Architects)

5.0 Proposed Development – Refurbishment

The alternative design option includes the refurbishment of two external wall elevations (retained brickwork, new insulation and external skin) and extension works to the upper floors to create more internal space and to allow for an internal layout functionally similar to that of the new build scenario. Architectural proposals issued by Wolff Architects confirm location of the retained brickwork and fabric upgrades to the northeast and southeast elevations.

It has been reported by the design team that the existing foundations will not provide adequate support to the additional second floor and would need to be underpinned or replaced with new foundations. For the purpose of the WLCA, new foundations to match the new build specification has been assumed.

The existing ground floor slab will be removed in its entirety and replaced with a new insulated suspended slab on new deeper foundations, with new insulated slab on piled foundations provided to the rear and side extension to match the new build specification.

The existing roof, internal floor and internal wall constructions could not be adapted or strengthened to accommodate the proposed second floor extension. New construction will be proposed to match the new build specification with new structure and substantial insulation improvements provided.

All existing single glazed windows will be replaced with new double glazed timber framed windows with improved thermal efficiency to match the new build specification.

To meet the primary energy target a gas-fired boiler will be required due to the non-MCS certified ASHP specification accounted for within the refurbishment scenario. The remaining mechanical, electrical and plumbing services will be replaced to match the new build specification with energy efficient equipment.

Figure 2: Proposed site (refurbishment) - 3D model (Source: Wolff Architects)

5.1 Retained Brickwork and Fabric Upgrades

Table 2 below details the external wall composition for the retained northeast and southeast elevations, as discussed previously all remaining building fabric elements within scope of the refurbishment WLCA have been selected to match the new build specification.

Building element	Newly specified (Y/N)	Specification
External wall	Y	102.5mm facing brickwork tied to existing masonry
	N	300mm existing cavity wall
	Y	Timber battens to form cavity on DPC
	Y	SuperQuilt insulation
	Y	Timber battens to form cavity
	Y	12mm class 2 plywood
	Y	63mm insulated plasterboard

Table 2: Retained external wall material composition

5.2 Building Service Upgrades

Table 3 below details the building service upgrades required to meet the primary energy target for the refurbishment scenario. As previously discussed, a gas-fired boiler will be required to meet primary energy targets.

Building element	Specification
Services	Gas-fired boiler (Worcester Greenstar 8000)

Table 3: Building service upgrades

6.0 Proposed Development – New Build

The project involves a comprehensive approach to building design and materials, focusing on energy efficiency and sustainability. The existing structure will be deconstructed, using selective techniques to maximize material reuse and minimise waste. New materials brought to the site will be considered for future recycling.

To surpass minimum U-value requirements, the project incorporates super-insulated construction throughout. This includes a new insulated suspended slab with deeper foundations to reduce thermal bridging and enhance airtightness. Structural elements like steel framing and concrete construction, as well as external cavity wall construction with full-fill insulation, further contribute to improved thermal performance.

The roofing system will also feature super-insulated construction, addressing linear thermal bridging and enhancing overall airtightness. Internal elements, such as walls and floors, will be crafted from materials meeting both noise transmission and thermal standards. The internal layout of rooms and facilities is designed to meet modern family living standards.

Notably, the project diverges from constructing a basement, a decision influenced by the aim to reduce the carbon footprint compared to neighbouring properties with basements. This deliberate choice aligns with the broader environmentally conscious approach in the entire construction process.

Figure 3: Proposed site (new build) - 3D model (Source: Wolff Architects)

Table 4 details the materials and building services specifications assessed for the new build WLCA. Specifications were utilised where possible in the WLCA with the closest possible alternative being used where specific products are not present in the database.

Building element	Specification
Foundations	Reinforced concrete piles, concrete ground beams, rebar, cellcore
Lowest floor construction	Beam and block floor, DPM, kingspan kooltherm K103 insulation, polyethene separating layer, screed
Frame	Structural steel frame
Upper floor slabs	Lightweight concrete slab, composite metal deck, polythene foam, extruded polystyrene insulation, screed board
Roof	***Pitched roof –*** Roof rafters, treated battens & counter battens, breather membrane, Kingspan K107 insulation, plywood boarding, clay tiles
	Flat roof – Roof joists, plywood sheet, bauder PIR insulation board, plywood boarding, alwitra roofing system
	Dormer roof – Roof joists, plywood deck, kingspan TP10 insulation board, vapour permeable underlay sheets, kingspan TR26 insulation, breather membrane, plywood, lead coverings
	Roof terrace – Bauder PIR insulation board, alwitra roofing system
Stairs	Pre-cast concrete stairs
External walls (above ground)	***Type 1 –*** Brickwork, kingspan kooltherm K108 insulation, blockwork inner skin, DPC, wall lining system (metal framing), plywood, gypsum sounbloc plasterboard
	Type 2 – Brickwork, rockwool nyrock cavity slab, blockwork inner skin, DPC, wall lining system (metal framing), plywood, gypsum sounbloc plasterboard
	Type 3 – Plywood sheathing, breather membrane, timber studs, kingspan kooltherm K112, VCL
External walls (below ground)	Engineered brickwork, kingspan GG300 cavity insulation, blockwork inner skin, DPC
External windows	Timber frame with double glazing
External doors	Hardwood timber doors (single and double swing), hardwood entrance door, PCC aluminium frame sliding doors
Internal partitions	Gypframe I studs, rockwool flexi acoustic insulation, plywood, gypsum soundbloc plasterboard, wedi board
	Blockwork walls, wall lining system (metal framing), plywood, gypsum sounbloc plasterboard
	Gypframe I studs, isowool insulation, gyproc coreboard, gyproc fireline board, gyproc fireline MR board, plywood, wedi board
Internal doors	Hardwood timber doors
Services	ASHP (MCS certified), air conditioning
External works	Sandstone paving slabs, laying course, aggregate sub-base

Table 4: WLCA – Assessed building elements

7.0 Results

7.1 Existing Building Scenario

The total lifetime carbon impact (60 years) of the existing building scenario is 734,765 kgCO2e (1,493 kgCO2e/m2):

- The operational carbon of the existing building is 734,765 kgCO2e
- The embodied carbon of the existing building over the study period is 0 kgCO2e

Life Stages	GWP (kgCO2e)
A1-A3 Construction materials	0
A4 Transport to site	0
A5 Construction / installation process	0
B4-B5 Material replacement and refurbishment	0
B6 Energy use	734,765
C1Deconstruction / demolition	0
C2 Waste transportation	0
C3 Waste processing	0
C4 Waste disposal	0
D1-D5 Benefits beyond the system boundary	0
Total	**734,765**

Table 5: GWP results (existing building scenario)

7.2 Refurbishment Scenario

The total lifetime carbon impact (60 years) of the refurbishment scenario is 641,110 kgCO2e (1,303 kgCO2e/m2):

- The operational carbon of the refurbishment scheme is 311,323 kgCO2e
- The embodied carbon of the refurbishment scheme over the study period is 329,787 kgCO2e

Life Stages	GWP (kgCO2e)
A1-A3 Construction materials	360,661
A4 Transport to site	2,776
A5 Construction / installation process	11,405
B4-B5 Material replacement and refurbishment	25,711
B6 Energy use	254,844 (regulated)

	56,479 (unregulated)
C1Deconstruction / demolition	4,542
C2 Waste transportation	6,194
C3 Waste processing	39,287
C4 Waste disposal	11
D1-D5 Benefits beyond the system boundary	-120,800
Total	**641,110**

Table 6: GWP results (refurbishment scenario)

7.3 New Build Scenario

The total lifetime carbon impact (60 years) of the new build scenario is 470,120 kgCO2e (956 kgCO2e/m2):

- The operational carbon of the new build scheme is 167,062 kgCO2e
- The embodied carbon of the new build scheme over the study period is 303,058 kgCO2e

Life Stages	GWP (kgCO2e)
A1-A3 Construction materials	330,597
A4 Transport to site	2,699
A5 Construction / installation process	10,208
B4-B5 Material replacement and refurbishment	25,180
B6 Energy use	110,583 (regulated) 56,479 (unregulated)
C1 Deconstruction / demolition	4,794
C2 Waste transportation	5,298
C3 Waste processing	36,324
C4 Waste disposal	11
D1-D5 Benefits beyond the system boundary	-112,053
Total	**470,120**

Table 7: GWP results (new build scenario)

7.4 Greater London Authority Benchmarks

The Greater London Authority (GLA) have published a new set of benchmarks for a Whole Life Carbon assessment, focusing on the embodied carbon of Construction Stage modules (A1-A5) and Use and Deconstruction Stage modules (B-C), excluding operational energy (B6).

Table 8 highlights the standard and aspirational GLA WLC emissions benchmark for residential developments.

GLA's WLCA Benchmarks (kgCO2e/m2) – Residential			
	A1-A5	B-C (excl. B6 & B7)	A-C (excl. B6 & B7)
Standard WLC	<850	<350	<1200
Aspirational WLC	<500	<300	<800

Table 8: GLA WLCA benchmarks

Table 9 summarises performance of the proposed development options against the GLA WLC benchmarks:

Life Stage module	Results (kgCO2e/m2)	Benchmark compliance
Refurbishment scenario		
A1-A5	762	Exceeds standard WLC benchmark
B-C (exc. B6 & B7)	85	Exceeds aspirational WLC benchmark
A-C (exc. B6 & B7)	847	Exceeds standard WLC benchmark
New-build scenario		
A1-A5	698	Exceeds standard WLC benchmark
B-C (exc. B6 & B7)	81	Exceeds aspirational WLC benchmark
A-C (exc. B6 & B7)	779	Exceeds aspirational WLC benchmark

Table 9: WLCA results Vs GLA WLCA benchmarks

8.0 Conclusion

This report summarises the WLCA for the development at 7 Reddington Gardens situated in the London Borough of Camden. The aim of the study is to determine the extent to which the demolition and new construction of the property will provide long term carbon savings when compared to the proposed refurbishment scenario.

All emissions associated with the proposed materials were calculated using One Click LCA's 'RICS: Whole life cycle assessment' Tool. Operational energy emissions were then quantified by using the approved Standard Assessment Procedure for the Energy Rating of Dwellings (SAP).

The results indicate that the total lifetime carbon emissions from the construction of the new development will be **470,120 kgCO2e** during the buildings service life (60 years). Despite retention of the northeast and southeast external cavity wall, the total lifetime emissions for the refurbishment scenario increased by **170,990 kgCO2e** due the following changes:

- **Building fabric upgrades**:
    - Additional facing brickwork, superQuilt insulation and insulated plasterboard specified to achieve the required fabric U-values.
    - SuperQuilt insulation consists of 19 layers of reflective foil, expanded polyethylene & polyester wadding which is highly carbon intensive, increasing embodied carbon emissions by 4.3 tonnes.
- **Building service upgrades:**
    - Specification of a gas-fired boiler in addition to the ASHP specification to meet primary energy targets.
    - Introduction of gas-fired boilers has increased operational carbon emissions due the increased global warming potential in comparison to grid-fired boilers (gas-fired boilers 0.21 kgCO2e/kWh, grid-fired boilers 0.14 kgCO2e/kWh).
    - Additional gas-fired boiler has increased the developments embodied carbon footprint by 0.43 tonnes.

The refurbishment scenario demonstrates a higher operational and embodied carbon footprint than the proposed new build scenario. Therefore, a newly built scheme would be preferred from a WLC perspective.