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Graham Construction

Meadow School, Northwood Road

260386

Post Construction
Whole Life-Cycle Carbon Assessment
(WLCA)

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1.0 Introduction

This Whole Life-Cycle Carbon Assessment (WLCA) has been prepared by CPW on behalf of Graham Construction, in order to discharge the relevant planning condition for the Meadow School development. The school forms part of the Harefield academy and is a local authority-maintained community school, which has a designation for Complex and Moderate Learning Difficulties. The development includes the erection of a new academic building (Use Class F1), ancillary structures including heat pumps, a multi-games area, revised vehicular access and associated external works.

This exercise has been undertaken at Stage 6 and provides an as-built update to the planning stage assessment undertaken previously. This report outlines the scope and methodology of the assessment undertaken, in accordance with the London Plan Guidance (2022). The total estimated embodied (A1-C4) and upfront (A1-A5) carbon emissions are reported with respect to the Greater London Authority (GLA) benchmarks.

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2.0 Relevant Policy and Guidance

2.1 Greater London Authority

This assessment has been undertaken in order to satisfy Policy SI 2 F of the London Plan 2021, which states the following with reference to WLCAs:

E. Development proposals referable to the Mayor should calculate whole lifecycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

The emissions reported in this document were calculated in accordance with the guidance and methodology set out in London Plan Guidance (LPG) for WLCAs (March 2022), specifically section 3.3, which stipulates that a post-construction assessment shall be submitted to the local council. The LPG WLCA reporting template has also been completed with the results of the exercise and submitted as a separate document.

2.2 Industry Guidance

There are a number of industry standards which outline methodology and reporting requirements for Embodied and WLCAs, most notably the Royal Institute of Chartered Surveyors (RICS) Whole Life Carbon Assessment for the built environment. With regards to the RICS guidance, the GLA states the following:

The RICS WLC methodology's second edition came into effect on 1 July 2024. The GLA WLC guidance document (including benchmarks) and template are underpinned by first edition methodology, so referable applications should provide assessment in accordance with this guidance.

On this basis the assessment has been carried out in accordance with the RICS 1st Edition guidance (November 2017).

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3.0 Scope

3.1 Spatial Boundaries

A Life Cycle Assessment has been undertaken for the Proposed Development to provide a representative embodied carbon figure for the site. A full list of elements included in the assessment is provided in Section 4.2.1 (Table 1). The proposed site plan is shown in Figure 1, the site boundary shown below indicates the works that have been included within this investigation.

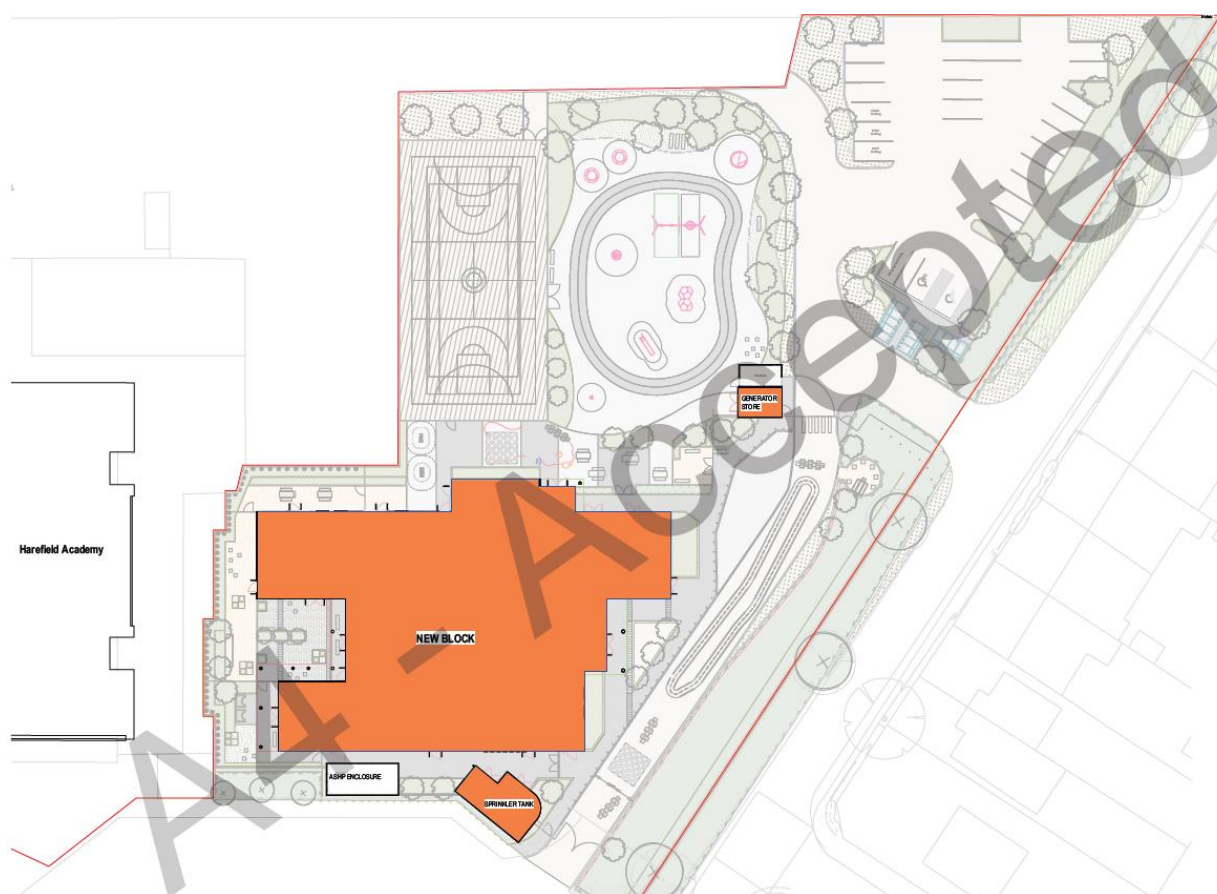


Figure 1: Site plan, Noviun drawing ref TVC0024-NOV-V1-00-DR-A-0200. The red line boundary indicates the scope of this assessment.

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3.2 Life Cycle Stages

In the UK, the framework for appraising the environmental impacts of the built environment is provided by BS EN 15978: 2011: (Sustainability of construction works — Assessment of environmental performance of buildings – Calculation method). It sets out the principles and calculation method for whole life assessment of the environmental impacts from built projects based on life-cycle assessment.

In terms of establishing the carbon footprint, the study follows the ‘module approach’ as shown below for the Building Life-Cycle Assessment ‘Cradle-to-Grave’ over a 60-year life cycle.

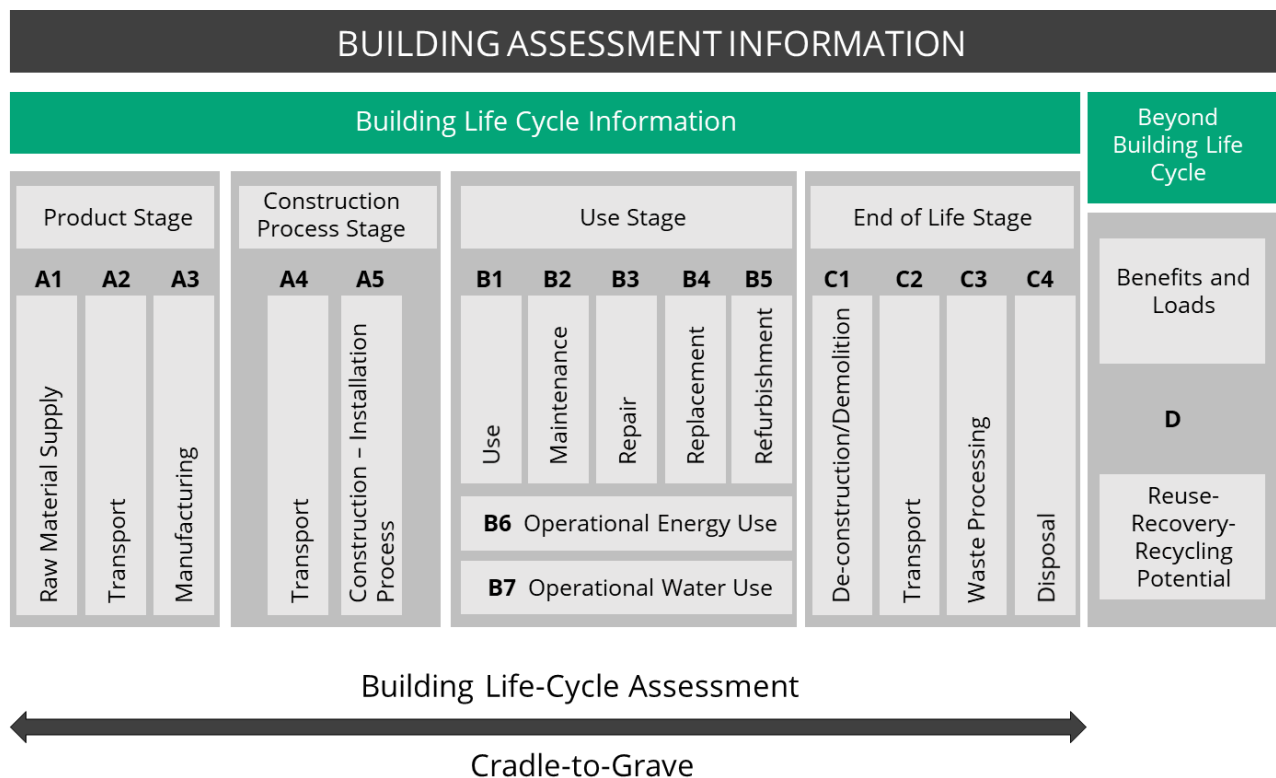


Figure 2: Life Cycle Stages in accordance with by BS EN 15978: 2011.

The WLCA undertaken for the development, includes emissions for the following:

- **A1-A5 (Upfront Carbon):** Includes raw material extraction & supply (A1), transport to manufacturing plant (A2), manufacturing & fabrication (A3) and transport to project site (A4).
- **B1-B4 (Use stage):** Includes refrigerant leakage (B1), as well as maintenance (B2), repair (B3) and replacement (B4) of materials and products that are anticipated over the 60-year life cycle.
- **B6-B7 (Operational):** Includes energy (B6) and water consumption (B7) during the building's operation.
- **C1-C4 (End of Life Stage):** Includes deconstruction & demolition (C1), transport to disposal facility (C2), waste processing for reuse, recovery, or recycling (C3) and disposal (C4).

It is also noted that emissions savings associated with module D, have been calculated, but are excluded from the final results, due to the uncertainty surrounding anticipated End-of-Life scenarios.

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4.0 Methodology

One Click LCA modelling software was used in this study. The software utilises a database of thousands of Environmental Product Declarations (EPDs) to determine the embodied carbon footprint of a built asset. The independently verified EPDs, based on ISO 14025 and EN 15804, communicate transparent and comparable information about the life-cycle environmental impact of chosen products. The software follows the RICS and BS EN 15978 naming conventions to describe the physical characteristics of the building.

The modelling was undertaken by Morgan Layton (CPW) and verified by Michelle Ward (CPW). The Reference Study Period (RSP) for this exercise is 60 years and the functional unit for the assessment is kgCO_{2e}.

4.1 Data Collection

The assessment has primarily been based on Graham Construction's final Bill of Quantities, with further details taken from as-built drawings and the Operation & Maintenance manuals where required. The assessment therefore represents the 'as-built' materials quantities used in construction. The building elements that are included and excluded within the exercise are detailed in Table 1 below.

Table 1: Summary of inclusions and exclusions by building element.

Building Group	Building Element	Included (Yes/No)
Demolition	Toxic/Hazardous/Contaminated Material Treatment	N/A
	Major Demolition Works	Yes*
Facilitating Works	Temporary Enabling Works	No
	Specialist Groundworks	N/A
Substructure	Foundations	Yes
	Ground Floor Construction	Yes
Superstructure	Frame	Yes
	Upper Floors	Yes
	Roof	Yes
	Stairs and Ramps	Yes
	External Walls	Yes
	Windows and External Doors	Yes
	Internal Walls and Partitions	Yes
	Internal Doors	Yes

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Building Group	Building Element	Included (Yes/No)
Finishes	Wall Finishes	Yes
	Ceiling Finishes	Yes
	Floor Finishes	Yes
Fittings, Furnishings and Equipment (FF&E)	Sanitaryware	Yes
	Fittings	Yes
	Furniture	No
	Plug-in Equipment e.g., Computers	No
Building Services	Electrical Installations	Yes
	Space Heating and Air Treatment	Yes
	Water Installations	Yes
	Lift Systems	Yes
	Solar PV Panels	Yes
	Fire Detection and Alarm System	Yes
	Sprinkler System	Yes
	Drainage	Yes
	Lighting Distribution	Yes
External Works	Roads/Car Park/Service Yard	Yes
	Footpaths/Pavement	Yes
	Protective Installations	Yes
	External Fixtures	Yes

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4.2 Life Cycle Stages

The below table outlines how emissions have been calculated for each life cycle stage, including any assumptions or omissions, in accordance with the life cycle stages from BS EN 15978: 2011.

Table 2: Summary of data sources and assumptions for all life cycle stages.

A1-A3 Construction Materials	Where available, product specific EPDs were used, and a full list of EPDs is provided in the GLA reporting spreadsheet. Where specific data was not available, the closest alternate product was selected the first instance. If no suitable alternative was available, then regional generic information was used.
A4 Transportation to site	Transportation impacts are based on the measured distance from the factory addresses to the site location.
A5 Construction/installation process	As demolition records are not available, the impact of demolition of the existing building has been assumed at the GLA default assumption of 50kgCO ₂ e/m ² GIA. Emissions associated with site operations have been estimated based on Graham Construction's final site records for energy, water and fuel.
B1 Use	Refrigerant leakage was estimated based on the installed VRF system with R32 refrigerant. Annual and end-of-life leakage rates were assumed as 1%, in accordance with CIBSE TM65 guidance.
B2 – B3 Maintenance and repair	In lieu of any relevant maintenance scenarios, B2 emissions have been calculated based on RICS and GLA guidance, which advise an average rate of 10 kgCO ₂ e/m ² GIA. B3 emissions are estimated as 25% of B2 emissions.
B4 Replacement	At this stage One Click default values for service life have been used, which represent typical replacement periods depending on the material type.
B6 Energy use – B7 Water Use	Operational energy emissions are based on the as-built TM54 assessment. The results of which are detailed in a separate report. Water use has been estimated based on the installed sanitaryware specification, and the BREEAM Wat 01 calculator tool.
C1-C4 Deconstruction	The C1 emissions have been calculated based on RICS and GLA guidance, which advise an average rate of 3.4 kgCO ₂ e per m ² GIA. C2-C4 emissions are estimated via One Click calculations, based on Market-based End-of-Life scenarios, which come from DGNB International (German Sustainable Building Council).
D External impacts/end-of-life benefits	This module covers the potential carbon benefits beyond the system boundary arising from reuse, recycling, and energy recovery at End-of-Life. Benefits are estimated from Market-based End-of-Life scenarios as above.

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5.0 Results

5.1 Embodied Carbon

5.1.1 Performance and Benchmarks

The total estimated embodied carbon (A1–C4, Excluding B6 & B7) for the Proposed Development is **1,892,924kgCO₂e**, which is equivalent to **832kgCO₂e/m²**. The upfront (A1-A5) emissions are estimated as **557kgCO₂e/m²**.

The London Plan Guidance for WLCAs includes embodied carbon benchmarks for a variety of building types. While there is no strict requirement to meet the benchmarks, paragraph A2.1.2 of the LPG states they should be used as a guide for all developments. The results are reported below and compared to the GLA benchmarks for education buildings. The development is currently performing positively, with both the upfront and embodied carbon showing an improvement compared the benchmark, of 25% and 17% respectively.

Table 3: Embodied and Upfront Carbon, compared to GLA benchmarks for Education buildings.

	(kg CO ₂ e/ m ² GIA)	
	Upfront Embodied Carbon (A1-A5)	Embodied Carbon (A – C) Excluding B6 & B7
GLA Benchmark – Education	<750	<1,000
Meadow School	557	832
GLA Aspirational Benchmark – Education	<500	<675

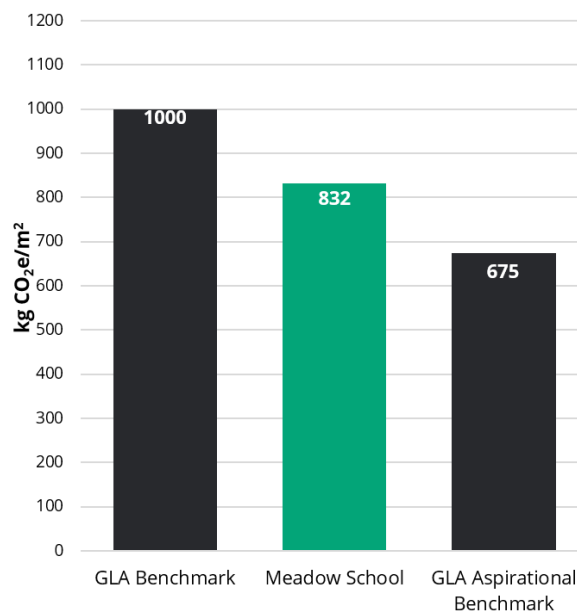


Figure 3: Embodied Carbon (A-C) of the development, compared to GLA benchmarks for education buildings.

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5.1.2 Carbon Reduction Measures

The LPG requires a summary and quantification of key actions taken to reduce whole life carbon emissions of the development. The following measures have been adopted, and the associated carbon reduction is reported below.

Table 4: Summary of alternative options considered, and the associated carbon savings compared to the final design.

Adopted measures	Carbon Savings	
	kg CO ₂ e/ m ² GIA	%
Construction site activities supplied by renewable electricity and biodiesel	48	5.78
Traditional brickwork in lieu of prefabricated brick slips	7	0.84
Total savings	55	6.62

All measures lead to a carbon reduction estimated to be 55kg CO₂e/m², which equates to 6.62% of the total embodied carbon.

5.1.3 Carbon Intensive Elements and Stages

Pie charts illustrating the breakdown of carbon in terms of life cycle stages and building elements are provided below and overleaf. In terms of significant building elements, upper floors account for 24.8% of total embodied carbon, followed by services (MEP) (15.6%) and substructure (standard foundations) (10.7%). In terms of life cycle stages, most carbon can be attributed to the A1-A3 Product Stages (65.3%), followed by B1-B4 stage (20.0%). The split of emissions across life cycle stages shows no significant deviations from what would be expected for this building type.

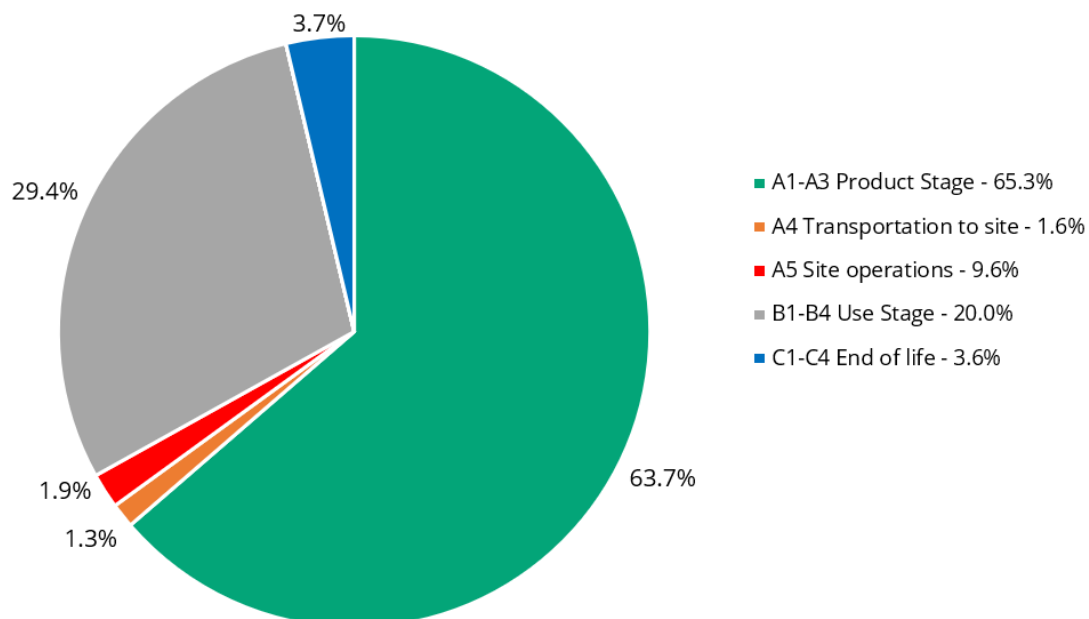


Figure 4: Total kg CO₂e for the development split by lifecycle stage.

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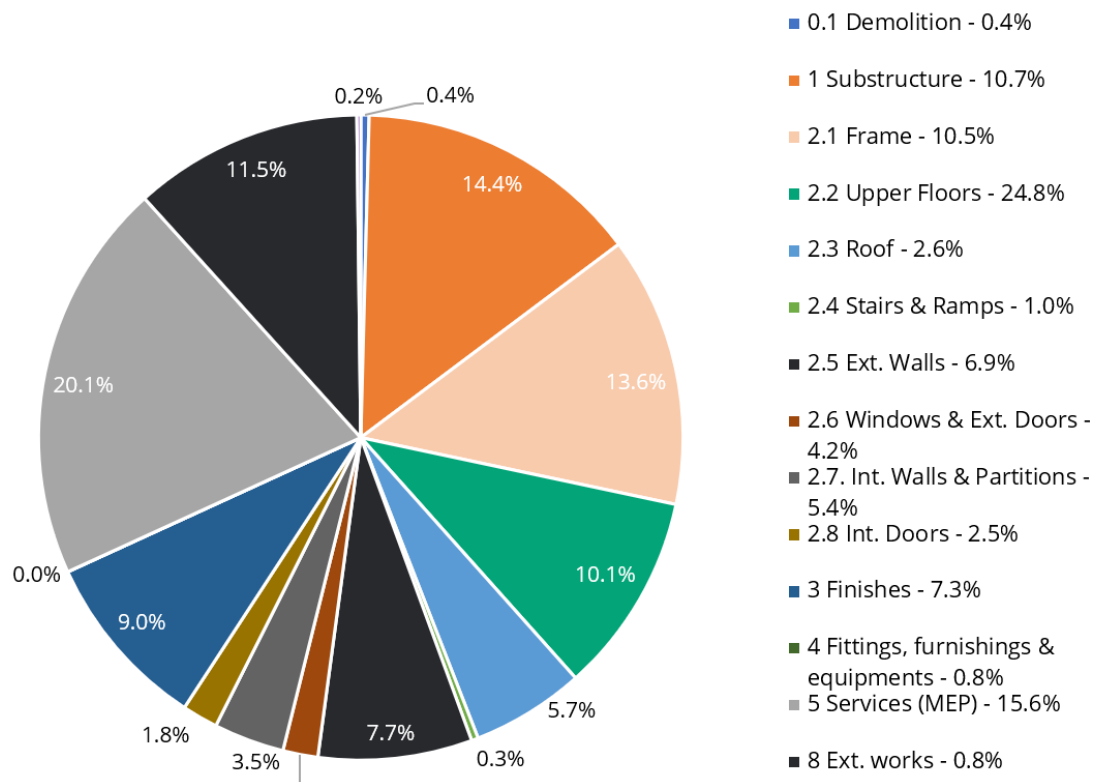


Figure 5: Total kg CO₂e for the development split by RICS category.

5.1.4 Baseline results comparison

At the detailed planning stage, a Whole life assessment was undertaken for the development by another consultant. The total embodied carbon (A1-C4, Excluding B6 & B7) was an estimated as **2,204,967kgCO₂e**, equivalent to **969kgCO₂e/m²** alongside the upfront (A1-A5) emissions **713kgCO₂e/m²**. At post construction the development is performing positively, with both the upfront and embodied carbon showing an improvement upon the detailed planning stage model by **22%** and **14%**.

Carbon reduction measures have been considered at post construction to promote reduced carbon emissions, such as construction site activities being supplied by renewable energy and fuel, resulting in lower carbon emissions associated with the product and construction stages (A1-A5). The structural framework has also been rationalised, which has resulted in a lower total mass of material used and therefore lower carbon emissions compared to the detailed planning stage results. The steel staircases have also been replaced with precast concrete as specified in the detailed planning stage assessment as a further opportunity to reduce whole life carbon emissions which has also contributed to great reductions in carbon at stages A1-A5. Furthermore, traditional brickwork was installed in lieu of the prefabricated brick slips modelled at Stage 2, resulting in lower emissions. These examples provide some detail into the reduction in A1-A5 embodied carbon results from the detailed planning stage to the final, as-built stage.

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Table 5: Embodied and Upfront Carbon, compared to Detailed Planning Stage.

	(kg CO ₂ e/ m ² GIA)	
	Upfront Embodied Carbon (A1-A5)	Embodied Carbon (A – C) Excluding B6 & B7
Meadow School – Detailed Planning Stage	713	969
Meadow School – Post Construction	557	832

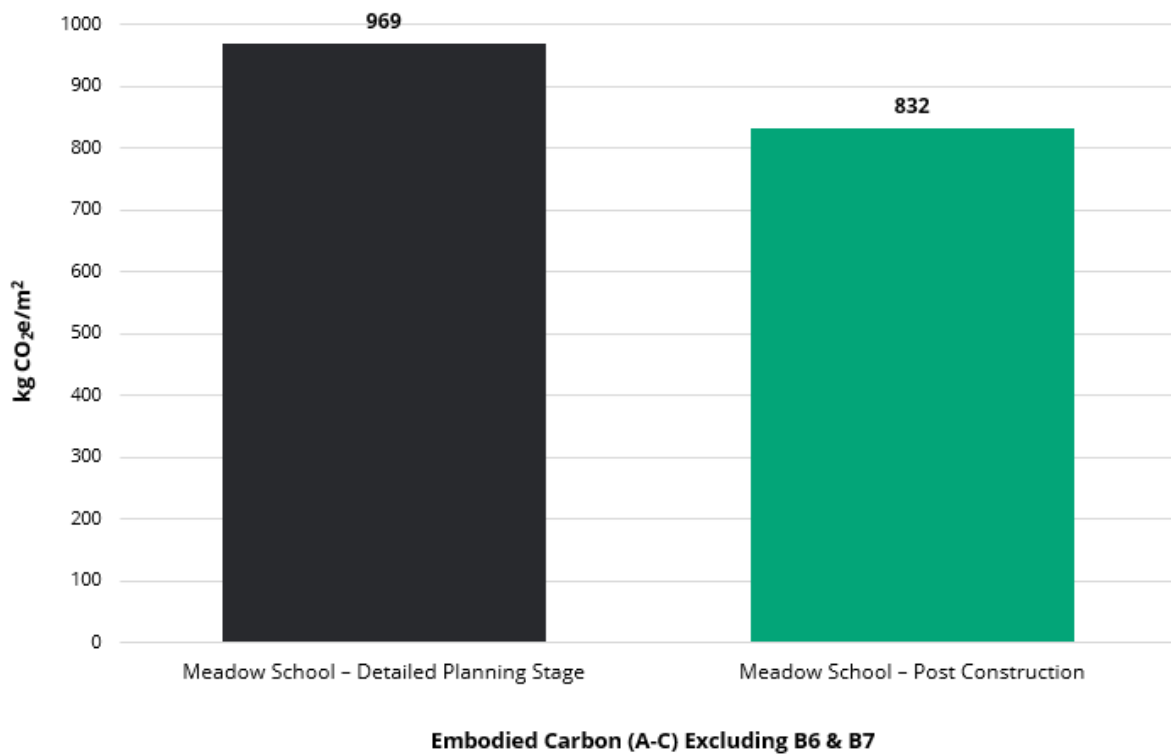


Figure 6: Embodied Carbon (A-C) of the development, compared to Detailed Planning Stage.

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5.2 Detailed Results Breakdown

RICS Building Element	Product	Construction		Use						End of Life	Total kg CO ₂ e (Excl B6-B7)	Total kg CO ₂ e /m ² (Excl B6-B7)	Beyond Life (D)
	A1-A3	A4	A5	B1	B2	B3	B4	B6	B7	C1-C4			
0.1 Demolition	-	-	-	-	-	-	-	-	-	7,738	7,738	3.40	-
1. Substructure	240,733	7,113	10,707	-	-	-	-	-	-	9,517	268,070	117.78	-79,705
2.1 Frame	242,897	1,834	2,505	-	-	-	-	-	-	5,787	253,023	111.17	-166,214
2.2 Upper floors	180,926	1,502	1,860	-	-	-	-	-	-	3,559	187,846	82.53	-117,494
2.3 Roof	63,341	458	2,854	-	-	-	26,477	-	-	13,046	106,176	46.65	-20,032
2.4 Stairs & ramps	6,002	94	72	-	-	-	-	-	-	134	6,302	2.77	-1,736
2.5 External walls	106,732	1,329	5,664	-	-	-	26,242	-	-	4,196	144,162	63.34	-13,616
2.6 Windows & external doors	31,854	127	237	-	-	-	-	-	-	557	32,775	14.40	-187
2.7 Int. Walls & Partitions	36,284	725	1,248	-	-	-	25,390	-	-	2,450	66,098	29.04	-4,820
2.8 Int. Doors	16,588	48	0	-	-	-	16,748	-	-	112	33,496	14.72	0
3. Finishes	41,877	123	2,906	-	-	-	106,794	-	-	15,430	167,129	73.43	-50,516
5. Services	126,838	1,512	1,765	46,243	-	-	195,022	1,406,172	2,544	1,654	373,034	163.89	-95,703
8. External works	110,948	10,470	3,012	-	-	-	84,563	-	-	5,999	214,991	94.46	-50,525
Site wide impacts	-	-	3,633	-	22,760	5,690	-	-	-	0	32,083	14.10	-
Total kg CO ₂ e	1,205,020	25,335	36,463	46,243	22,760	5,690	481,235	1,406,172	2,544	70,178	1,892,924	831.68	-600,547
Total kg CO ₂ e / m ²	529.45	11.13	16.02	20.32	10.00	2.50	211.44	617.83	1.12	31.00	831.68		-263.86

Table 6: Whole Life Carbon (kgCO₂e) split by building element and life cycle stage. Beyond life values (Module D) are reported in negative carbon emissions and represent savings delivered by reusing or recycling materials post demolition. They are calculated based on likely EOL scenarios; however, they are not deducted from the total figures.

6.0 Summary

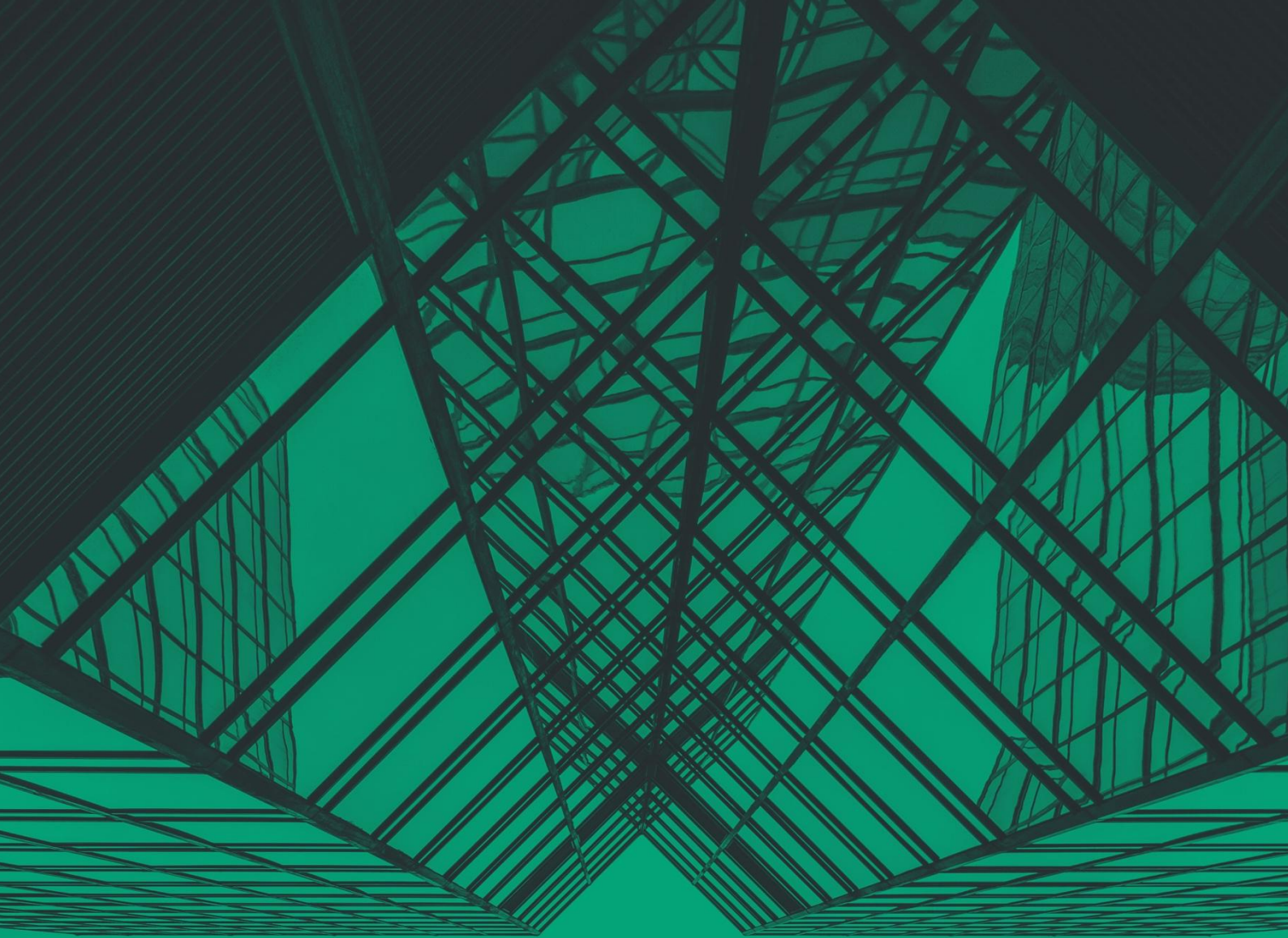
A Whole Life-Cycle Carbon Assessment has been carried out for the Meadow School at Stage 6, in accordance with the requirements set out in Section 3.3 of the London Plan Guidance (March 2022). The assessment has been undertaken based on 'as-built' information and monitored site records, and as such represents the final development at the time of handover.

The estimated embodied carbon (A-C) for the development is **832kgCO₂e/m²**. This is a **17%** improvement compared to the GLA benchmarks for education buildings.

Key measures taken to reduce the embodied carbon have been reported on and equate to **6.62%** of total embodied emissions.

Combining operational (B6 and B7) and embodied (A-C) carbon, the development's total estimated emissions over 60 years are:

$$619 + 832 = \mathbf{1,451kgCO_2e/m^2}$$



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