ELEMENT SUSTAINABILITY

FIRST STREET, MANCHESTER

MAT01 LIFE CYCLE ASSESSMENT

DECEMBER 2024

REF: 2024.118



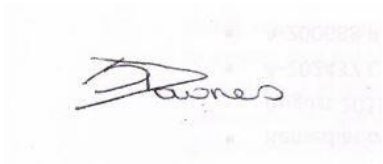
ELEMENT SUSTAINABILITY – ISSUE NOTES

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1. INTRODUCTION

Element Sustainability have been commissioned by Vita Meadows Limited to undertake a Life Cycle Assessment (LCA) of the proposed Plot 9b First Street purpose built student accommodation (PBSA) development.

This analysis is being undertaken in order to assess the embodied carbon levels of the scheme, and to provide details for alternative construction methods which may be used in order to reduce the embodied carbon of the scheme.

The purpose of this assessment is to assess the carbon emissions of the proposed construction methods, to facilitate meaningful carbon comparisons between designs, and to report separately on lifecycle modules A1-A5 (embodied carbon up to practical completion), B1- B5 (use phase), and C1- C4 (end of life).

The primary metric used to analyse the embodied carbon is expressed in terms of carbon dioxide equivalent ($kgCO_2e$), often referred to as carbon emissions. The Whole Life Cycle (WLC) emissions are the carbon emissions resulting from the materials, construction, and the use of a building over its entire life, including its demolition and disposal.

The aim of this report is to align with the **BREEAM MAT 01 (Life Cycle Impacts) criteria** and to achieve the required number of credits, as identified in the pre-assessment study undertaken for this scheme. The credits are to be awarded based on the design options appraised and opportunities identified to reduce the Global Warming Potential (GWP) of the scheme over a sixty-year lifecycle.

In short, the BREEAM credit aims to achieve:

Mat 01 Environmental impacts from construction products - Building life cycle assessment (LCA):

To reduce the burden on the environment from construction products by recognising and encouraging measures to optimise construction product consumption efficiency and the selection of products with a low environmental impact (including embodied carbon), over the life cycle of the building.

The LCA undertaken for this report will cover **RIBA Stage 2** and will assess the following construction categories:

- Superstructure,
- Substructure and hard landscaping, and,
- Building services

However, further assessments at the Technical Design stage (RIBA Stage 4) are advisable for monitoring the carbon emissions as the project develops.

2. PROPOSED DESIGNS

2.1 Development Proposals

Erection of a purpose-built student accommodation (PBSA) building (Sui Generis), alongside ancillary amenity space, landscaping, secure cycle parking and other associated works; and use of Land east of River Street as a construction compound.

Figure 2.1 below presents the site plan for the scheme.

Figure 2.1 – Proposed Site Plan



3. LIFE CYCLE ASSESSMENT

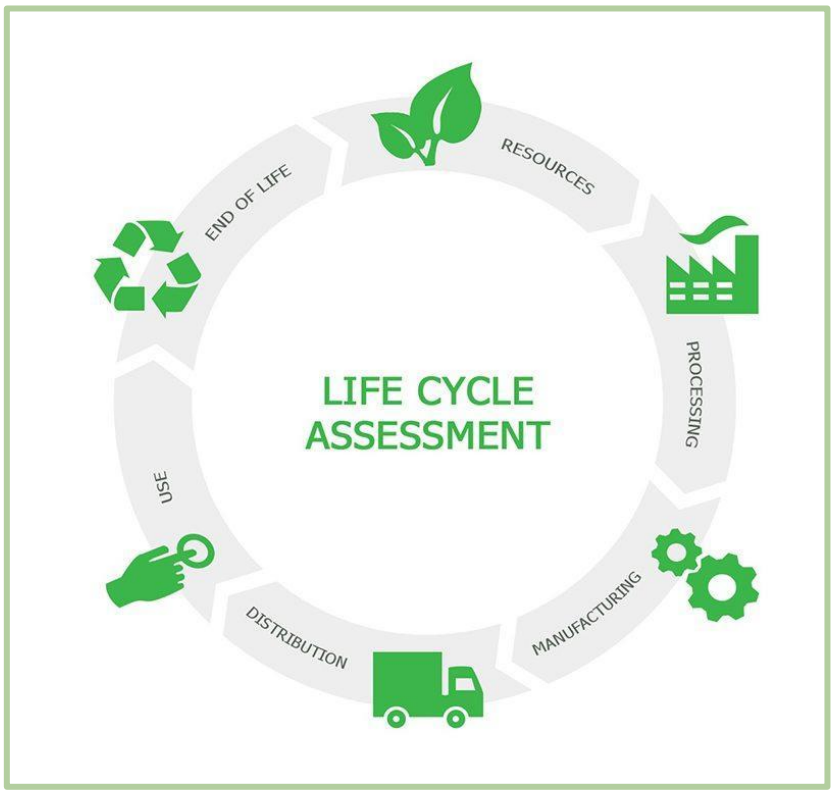
3.1 Definition

Building Life Cycle Assessment (LCA) is a science-based methodology for quantifying the lifetime environmental impacts of a building. It is used to measure and reduce the embodied and whole-life carbon of a building. The embodied carbon refers to the emissions arising from the extraction, manufacture, transportation, installation, maintenance and disposal of all building materials.

Typically, the assessment is used to calculate the overall environmental footprint of a product and then identify design measures to reduce the carbon emissions associated with each stage of the project's lifecycle.

The following image shows a LCA model that would apply to a scheme within the built environment.

Figure 3.1 – Lifecycle Stages of a Building



Source: OneClickLCA

3.2 Scope

The LCA undertaken for this report will assess the concept design proposal for the proposed development, covering RIBA Stage 2. A 'study boundary' has been defined, as per the requirements set out by BREEAM UK New Construction 2018 V6. Therefore, the following elements have been considered:

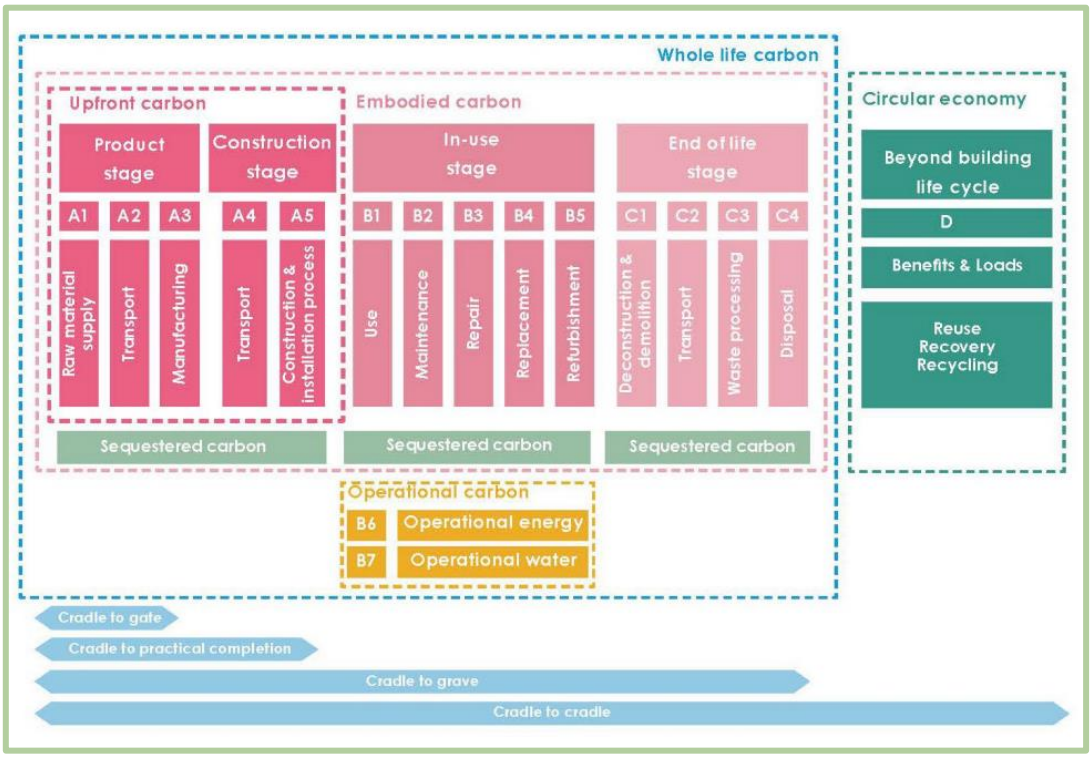
- Superstructure;
- Substructure and hard landscaping; and,
- Building services

The following life stages are considered within this study boundary:

- A1 – A3: Product Stage;
- A4 – A5: Construction Processes;
- B1: Use Phase;
- B4 – B5: Replacement;
- C1 – C4: End of life stage.

Figure 3.2, below, presents the whole life carbon life cycle modules stipulated within the BS EN 15978 standard, which is the framework for appraising the environmental impacts of the built environment. However, whilst the scope for this assessment is reduced from that of the EN 15978 scope, it does represent the design in consideration based on the BREEAM UK New Construction scope. This does not include operational energy and water. Supplementary information beyond the project's lifecycle has also been excluded.

Figure 3.2 – EN 15978 Assessment Scope



Source: LETI, Whole Life carbon

The focus of this assessment is on the environmental impacts of the project, in particular the embodied carbon of the materials sourced, and energy consumed in the manufacturing, transportation, assembly, in use and the end-of-life stages of the scheme.

Supplementary information beyond the project's lifecycle (module D) has not been considered as these impacts fall outside of the project's boundary and influence.

The building elements covered within this study are demonstrated in Table 3.1 below.

Table 3.1 - Building Elements

Element Group	Building Elements
Substructure	Standard Foundations
	Lowest Floor Construction
Superstructure	Frame
	Upper Floors
	Roof Structure
	Stairs & Ramps
	External Walls
	External Windows
External Works	Road, paths and paving's
Services	Heat Source
	Space Heating & Air Conditioning
	Ventilation
	Fuel Installations

3.3 Methodology

A BREEAM assessment is being produced for the proposed scheme and therefore, this LCA is designed to achieve the targeted MAT 01 credits.

One Click LCA Software has been used as an approved BRE IMPACT Compliant Tool to conduct this LCA. This software complies with the following standards:

- BS EN 15978: 2011 – Sustainability of Construction Works – Assessment of Environmental Performance of Buildings - Calculation Method;
- ISO 14040 2006: Environmental Management – Lifecycle Assessment – Principles and Framework; and
- ISO 14044 2006: Environmental Management – Lifecycle Assessment – Requirements and Guidelines.

The construction materials and quantities specified for this model were provided by the design team or extracted from the necessary plans and specification documents provided, as listed below:

- 1207-TGA-MT-01001-MX-P01 Mat 01 Options Appraisal Matrix
- 241029 1207-TGA-MT-01001-MX-P01 Mat 01 Options Appraisal Matrix
- BREEAM NC CD LCA RFI - FUT comments
- TPM Copy of BREEAM NC CD LCA RFI
- Copy of BREEAM NC CD LCA RFI

The templates selected for the baseline design match the materials that were provided by the design team, and where certain material templates were not available, a similar product was selected from those available within the One Click database.

The data sets used to conduct these assessments include:

- BREEAM, UK

The One Click LCA scenarios that were used to facilitate the carbon calculations for this scheme, are set out below:

- Service life values were set to the 'Technical default Service Life';
- Transportation distances for materials were set to reflect UK construction best practice;
- The 'End of Life' calculation method used reflects market scenarios, which utilises the most typical method for that material in the market; and,
- The study period was set at sixty years in line with the methodology outlined in the RICS Professional Statement BREEAM Mat01 requirements.

The LCA undertaken for this report will demonstrate the environmental impact of the proposed developments in terms of its Global Warming Potential (GWP), which represents the impact of all greenhouse gases on a carbon dioxide basis emitted as a direct result of the building.

3.4 BREEAM Credits Targeted

The BREEAM credits targeted for the scheme are outlined in section 3.4.1 to 3.4.3 below.

3.4.1 Option Appraisal during concept design

For option appraisals, the number of credits depends on the number of design options included and they must meet the following criteria:

- Each option should be a significantly different design option, in terms of either the types of, or quantity of, construction products specified for one or more major elemental constructions that are within the scope of the assessment; and,

- Each design option, should fulfil the same functional requirements specified by the client and all statutory requirements.

The necessary option appraisals required for this assessment include:

- Four significantly different superstructure design options;
- Six significantly different substructure/ hard landscaping design options (at least two substructure and two hard landscaping); and,
- Three significantly different core building services design options.

3.4.2 Third Party Verification

MAT 01 Credit: One credit – Third party verification (all building types)

This LCA has been verified by Charles Atkins, who is an experienced LCA practitioner and a specialist user of One Click LCA, who is not professionally connected to a single manufacturer. He has received all the necessary training provided by One Click LCA and has completed over ten LCA's for commercial gain over the past two years.

It can be confirmed that the inputs and templates used are appropriate for the study and all quantities are within ±10% accuracy. Although the LCA's scope is reduced from the EN15978 scope, it does however represent the design in consideration based on the BREEAM NC 2018 V6 criteria, which does not include, finishes, fittings, operational energy and water.

It may add value to the study to add these in and compile an LCA which aligns entirely with EN15978. That way further opportunities for improvement beyond the basic BREEAM scope may be captured and explored.

3.5 Limitations of the Life Cycle Assessment and Assumptions

3.5.1 Limitations

The One Click LCA predictions of embodied impacts conducted in One Click LCA software, by their very nature, cannot be exact. It is not possible to track all the impacts associated with a product or service back through history. One Click LCA software has been built and tested to enable informed decisions when comparing design options. Generic environmental impact coefficients do not necessarily correspond to those of individual brands of the same product or service due to differences within industries and in the way these products and services are delivered.

3.5.2 Assumptions

This assessment is being conducted during RIBA Stage 2 (concept design); therefore, design detail is limited and will be considered further as the scheme progresses through to the Technical Design Stage. A number of assumptions were consequently used in order to complete the baseline assessment. The RICS Professional Statement has provided reasonable assumptions, based on UK average industry standard practice, which must be used during early design phase WLCA's that are to act as baselines for progressive reporting. This data should be refined during later project phases and replaced by more comprehensive and product specific information as it becomes available.

The assumptions used for this assessment are outlined in Table 3.2 below.

Table 3.2 – Assessment Assumptions

Level 1 Group Element	Building Component	Material	Source	Template Selected
Superstructure	Roof – Rigid insulation	Rigid polyurethane (PU) Polyurethane (PU) rigid foam	RICS PS Version 2	PUR (polyurethane foam) insulation panels, unfaced, generic, L
Superstructure	External wall (series core wall)– RC cast in situ	C40/50 concrete with 25% cement replacement	RICS PS Version 2	Ready-mix concrete, generic, C40/50 (5800/7300 PSI), XC1, 25% GGBS in cement, CEM II/B-S portland-slag

				cement, 2391 kg/m3 (One Click LCA (2024))
Superstructure	External wall (series core wall) Concrete reinforcement	concrete reinforcement bars - 96% recycled content in UK	RICS PS Version 2	Reinforcement steel (rebar), generic, 97% recycled content (typical), A615. Assumed 100kg/m^3 as per One Click LCA average quantities of reinforcement quantities
Substructure	Foundations	Ready mix concrete C40/50 with 35% GGBS	ROC Consulting quantities	In the absence of a C40/50 concrete template with 35% GGBS – the following was used instead: Ready-mix concrete, generic, C40/50 (5800/7300 PSI), XC1, 25% GGBS in cement, CEM II/B-S portland-slag cement, 2391 kg/m3 (One Click LCA (2024))
Hard landscaping	Surface Type 1	Yorkstone Flags	TPM Quantities	In the absence of specific yorkstone/ sandstone landscaping templates – the following was used instead: Natural stone slabs (EUROROC)

4. LCA RESULTS

The information presented in this section demonstrates the environmental impact of the proposed scheme.

4.1 Key Project Details

Table 4.1 sets out the key project parameters used for this assessment:

Table 4.1 – Key project Parameters

	Church Street PBSA
Address	Plot 9b, First Street, Manchester, M1 5GG
Date of Assessment	05/11/2024
Project Type	New Construction
Building Type	PBSA
Size (GIA)	27,146.8m^2
Project Design Life	60
Design Stage	Concept Design

4.2 Superstructure

Table 4.2 outlines the total impact of the superstructure elements of the scheme in both absolute (in $kgCO_2e$) and normalised (in $kgCO_2e/ m^2$) terms.

Table 4.2 – Superstructure Environmental Impact

Construction Category	Total $KgCO_2e$	Total $KgCO_2e/m^2$
A1-A5	7,223,138.34	266.08
B1-B5	24,034.38	0.88
C1-C4	184,444.89	6.80
A1-C4	7,431,617.61	273.76

4.3 Substructure & Hard Landscaping

The whole life cycle impact of the proposed substructure design is presented in Table 4.3 below.

Table 4.3 – Substructure & Hard Landscaping Environmental Impact

Construction Category	Total $KgCO_2e$	Total $KgCO_2e/m^2$
A1-A5	721,034.19	26.56
B1-B5	-	-
C1-C4	15,763.69	0.58
A1-C4	736,797.88	27.14

4.4 Building Services

The whole life cycle impact of the proposed building services is presented in Table 4.4 below.

Table 4.4 – Building Services Environmental Impact

Construction Category	Total $KgCO_2e$	Total $KgCO_2e/m^2$
A1-A5	82,475.65	3.03
B1-B5	166,191.81	6.12
C1-C4	620.26	0.02
A1-C4	249,287.72	9.18

4.5 Entire Scheme

The total environmental impact of the scheme is presented below in Table 4.5 below and also expressed per gross internal floor area[1].

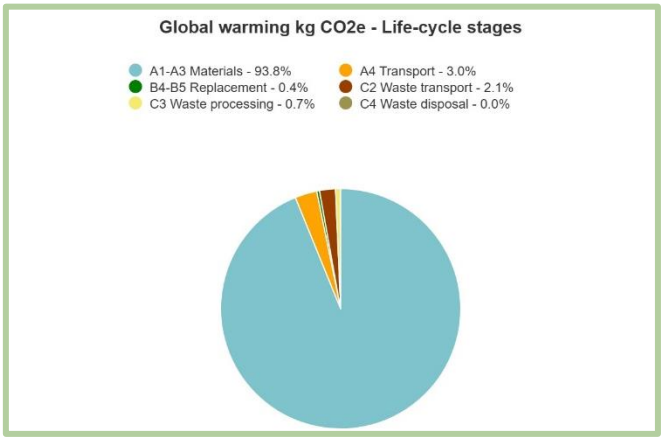
Table 4.5 - GWP Impact by Life Cycle Module

Construction Category	Total $KgCO_2e$	Total $KgCO_2e/m^2$
A1-C4	8,417,703.21	310.08
A1-A5	8,026,648.18	295.67

It is clear that the proposed superstructure elements are likely to have the greatest environmental impact (accounting for approximately 88%) of all emissions.

Figure 4.1 below demonstrates the embodied carbon by life cycle stage for the superstructure components, as these are responsible for the greatest environmental impact across the scheme.

Figure 4.1 – Embodied Carbon by Life Cycle Stage – Superstructure



[1] This assessment is a reduced scope from the EN 15978 scope but is in line with the BRE methodology. Therefore, to calculate an accurate result for the entire scheme, an LCA will need to be conducted in line with the RICS Professional Statement where all aspects of the scheme are assessed using the same dataset.

5. OPTION APPRAISALS

The proposed appraisals derived in this section are based on information provided by the design team and the assessors best judgement. Each design option will fulfil the same functional requirement as set out in the proposed design.

Option appraisals have been conducted for the following categories in order to gain the required BREEAM MAT01 credits as set out in the BREEAM Pre-Assessment and to identify possible opportunities to reduce the GWP of the following aspects of the scheme:

- Superstructure;
- Substructure and Hard Landscaping; and,
- Building Services.

5.1 First Street Option Appraisals

5.1.1 Superstructure Option Appraisal

MAT 01 Credit: Option appraisal during Concept Design (all building types)

Table 5.1 below demonstrates the superstructure options assessed.

Table 5.1: Superstructure Design Options

Design Option	Design options	
Baseline Design/ Option 1 Elements	Unitised Aluminium Cladding, brickwork wall and C50/60 25% GGBS concrete columns	
	Proposed Design	Alternative Option
Option 2	Unitised Aluminium Cladding	Stick curtain wall cladding
Option 3	brickwork wall	Brick slip
Option 4	C50/60 25% GGBS concrete columns	40% GGBS concrete columns

The following tables (Tables 5.2 and 5.3) show the options appraised and their associated changes in GWP for each design option, over the lifetime of the project against the baseline scenario.

Table 5.2: GWP of the Baseline Design

Option	Construction Method	GWP ($kgCO_2e$)
Baseline Model (Option 1)	Unitised Aluminium Cladding, brickwork wall and C50/60 25% GGBS concrete columns	7,431,617.61

Table 5.3: Change in GWP for Each Superstructure Option Appraised

Options	Construction Method	GWP ($KgCO_2e$)	Change in GWP ($kgCO_2e$)
Option 2	Stick curtain wall aluminium cladding	8,143,505.33	+711,887.72

Option 3	Brick slip	7,400,435.89	-31,181.72
Option 4	40% GGBS concrete columns	7,393,452.21	-38,165.40

The results demonstrate that options 3 and 4 will help to reduce the embodied carbon of the scheme when only considering the superstructure components. Option 2 was discounted based upon the fact that this system will have longer lead and construction sequencing times. There is also a preference for off-site prefabricated construction, which is led by the client and design team due to timeline and costs. Option 3, the brick slip railing system was discounted due to the additional complexity to the wall build-up and associated costs and subcontractor co-ordination, especially considering the system is only used on a portion of the external envelope. Option 4 has been discounted at this stage, as the proposed design will already have as a minimum of 25% GGBS, however further investigations will take place during the technical design stage.

Figure 5.1 – Environmental Impact per Superstructure Option



5.1.2 Substructure Option Appraisal

MAT 01 Credit: One credit – Substructure and hard landscaping options appraisal during Concept Design (all building types)

Table 5.4 below demonstrates the substructure options assessed.

Table 5.4: Substructure Design Options

Design Option	Design options	
Baseline Design/ Option 1 and 2 Elements	Substructure – C45/55 ready mix concrete with 30% GGBS (foundations) Hard landscaping - Yorkstone Flags (pathway) and concrete blocks (service road)	
	Proposed Design	Alternative Option
Option 3 (substructure)	C45/55 ready mix concrete with 30% GGBS	C45/C55 concrete with 50% GGBS
Option 4 (substructure)	Reinforcement steel (rebar), B500B, B500C	Rebar - 96% recycled content
Option 5 (hard landscaping)	Yorkstone Flags (pathway)	Precast concrete paving

Option 6 (hard landscaping)	Concrete blocks (service road)	Asphalt

The following tables (Tables 5.5 and 5.6) show the options appraised and their associated changes in GWP for each design option, over the lifetime of the project against the baseline scenario.

Table 5.5: GWP of the Baseline Design

Option	Construction Method	GWP ($kgCO_2e$)
Baseline Model (Option 1 and 2)	Substructure – C40/50 ready mix concrete with 25% GGBS Hard landscaping - Yorkstone Flags (pathway) and concrete blocks (service road)	736,797.88

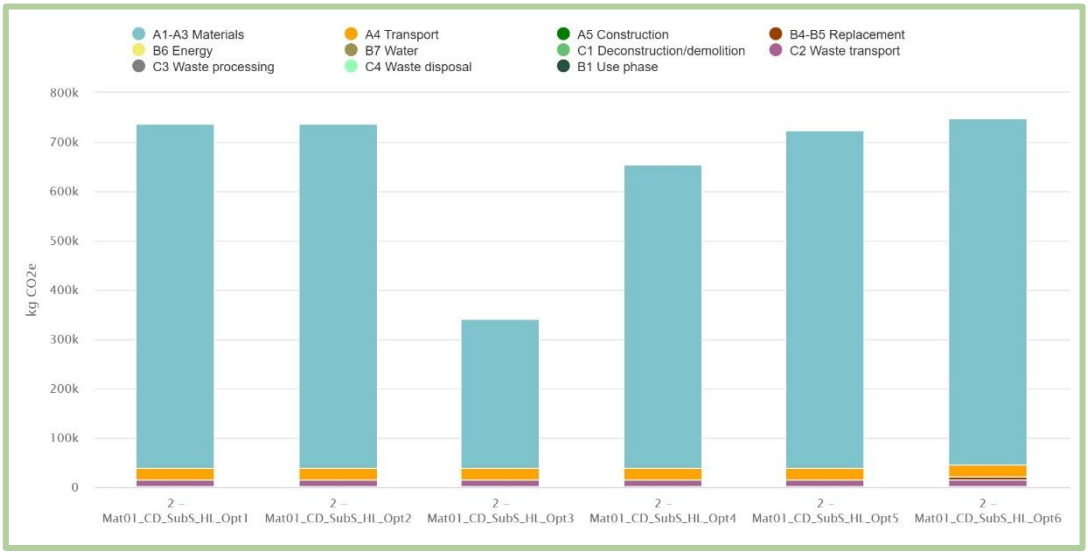
Table 5.6: Change in GWP for Each Substructure Option Appraised

Options	Construction Method	GWP ($KgCO_2e$)	Change in GWP ($kgCO_2e$)
Option 3	C40/C50 concrete with 75% GGBS	341,845.32	-394,952.56
Option 4	Rebar - 97% recycled content	654,692.19	-82,105.68
Option 5	Precast concrete paving	724,031.68	-12,766.20
Option 6	Asphalt	746,790.56	+9,992.68

The results demonstrate that Options 1,2 and 3 will help to reduce the environmental impact of the scheme. However, the alternative substructure Options 3 and 4 were discounted at this stage but will be reviewed further throughout the technical design stage. The alternative hard landscaping options 5 and 6 were discounted as the design team are required to follow the masterplan materials that have already been approved by the LPA under the other phases.

Figure 5.2 below highlights the changes in $KgCO_2e$ between each substructure design option.

Figure 5.2 – Environmental Impact per Design Option – Substructure & Hard landscaping



5.1.3 Building Services Option Appraisals

MAT 01 Credit: One credit– Core building services options appraisal during Concept Design (all building types)

Table 5.7 below demonstrates the building services assessed.

Table 5.7: Building Services Design Options

Design Option	Design options	
Baseline Design/ Option 1	Electric panel heaters and VRF system to amenity zones	
	Proposed Design	Alternative Option
Option 2	Electric panel heaters	ASHP to radiators
Option 3	VRF system	Hybrid VRF system

The following tables (Tables 5.8 and 5.9) show the options appraised and their associated changes in GWP for each design option, over the lifetime of the project against the baseline scenario.

Table 5.8: GWP of the Baseline Design

Option	Construction Method	GWP ($kgCO_2e$)
Baseline Model (Option 1)	Proposed design	249,287.72

Table 5.9: Change in GWP for Each Building Service Option Appraised

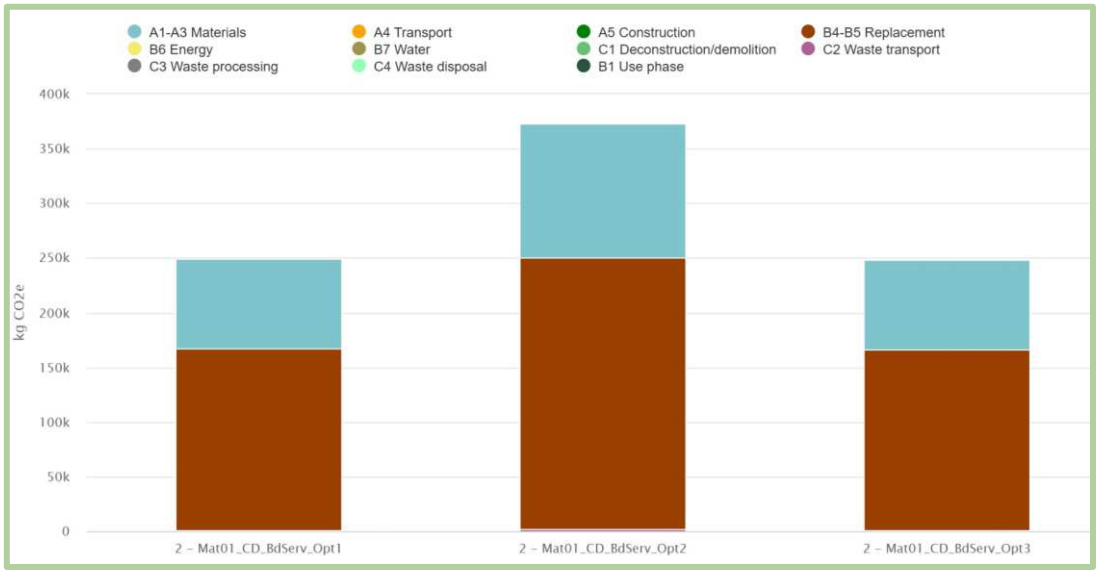
Options	Construction Method	GWP ($KgCO_2e$)	Change in GWP ($kgCO_2e$)
Option 2	ASHP and radiators	373,060.69	+123,772.97
Option 3	Hybrid VRF system	248,322.70	-965.02

The results demonstrate that option 3 have the potential to reduce the environmental impact of the scheme, however further design reviews would be necessary to determine the exact VRF system that will be installed as part of the development. Additionally, pipework has not been included within the assessment as this information was not determined within Stage 2. This would likely increase the impact of both the proposed VRF system and the hybrid VRF system. However, the hybrid version would require both refrigerant and water pipework, leading to more materials being required and is mor complex to install. Therefore Option 3 has been discounted. Option 2 would also cause an increase in the global warming potential and has therefore been discounted, as this would require additional pipework distribution throughout building, radiators, plus a larger plantroom. Consequently, more materials would be used overall.

Conversely, the operational performance of each system will need to be assessed, in order to determine which option performs the best overall, and which also generates the greatest reduction on the environmental impact of the scheme.

Figure 5.3 below highlights the changes in $KgCO_2e$ between each building service design option.

Figure 5.3 – Environmental Impact per Design Option – Building Services



6. CONCLUSION

The purpose of this Life Cycle Assessment is to quantify the environmental impacts of the proposed Plot 9b First Street PBSA development, and to provide recommendations for reducing the global warming potential of the materials and associated construction compositions.

The total global warming potential for the preferred design, split into whole life carbon impact and upfront carbon emissions:

Table 4.5 - GWP Impact by Life Cycle Module

Construction Category	Total $KgCO_2e$	Total $KgCO_2e/m^2$
A1-C4	8,417,703.21	310.08
A1-A5	8,026,648.18	295.67

However, these are calculated from a reduced scope which aligns with the BREEAM NC 2018 V6 requirements (which omits internal partitions, fitting, furnishes and equipment, site preparation works, drainage and operational energy and water from the analysis). A more in-depth Whole Life Cycle Assessment (WLCA) that aligns with the RICS methodology is therefore recommended to allow for accurate comparisons to be made against industry benchmarks.

Having undertaken numerous options appraisals, looking at alternative construction materials and design options for the proposed scheme, we can confirm that the following options would provide the greatest improvements in carbon emissions associated with the buildings' construction, operation and end of life:

Superstructure

- 40% GGBS concrete columns

Substructure & Hard Landscaping

- C40/C50 concrete foundations with 50% GGBS

Building Services

- A hybrid VRF system may have the potential to reduce the overall impact, but further assessments would be required, which also take into account the operational performance of the system

This report demonstrates that the LCA is expected to achieve **5+ Exemplar BREEAM credits.**