Energy Statement

Hayes Park South & Central, Hemel Hempstead

Prepared on behalf of:
Prospero Projects

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Executive Summary

This report has been produced on behalf of Prospero Projects to demonstrate how the application for the conversion of an existing listed buildings to a multi domestic use scheme at Hayes Park South & Central, Hemel Hempstead can address the carbon reduction and sustainability requirements set by the Greater London Authority (GLA) and The London Borough of Hillingdon. The energy assessment has been prepared in accordance with 'Energy Planning – Greater London Authority guidance on preparing energy assessments' and local guidance documents from The London Borough of Hillingdon.

About the development

The proposed development aims to refurbish the existing Grade II office buildings to provide 124 residential dwellings. For the Central building 49 residential dwellings are proposed measuring a floor area of approximately 4359m^2, for the South building 75 residential dwellings are proposed measuring a floor area of approximately 7325m^2.

Figure 1: Site plan of the Central and South buildings (Courtesy of Studio Egret West 2023)

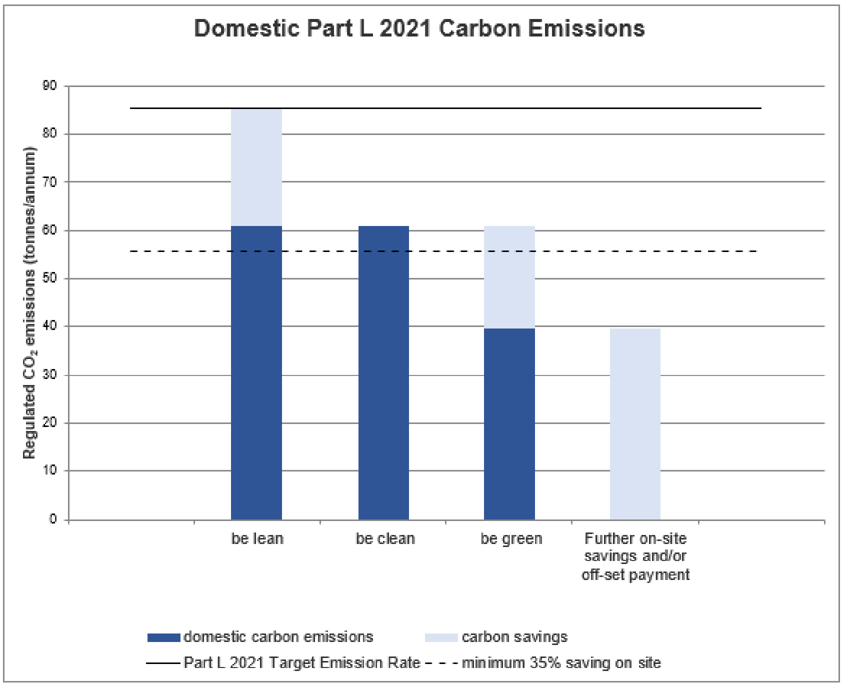
Key measures and CO_2 reductions

The report demonstrates that the given design and specification achieves a reduction of **54.00%** in on-site regulated emissions, meeting the target of 35.00% beyond Building Regulations requirements. This can be achieved by following the Energy Hierarchy:

- Demand reduction measures have been investigated including improved U-values, construction methods for the avoidance of thermal bridging and the improvement of air tightness, more efficient controls, and heat recovery technology.
- The energy systems for use at the development have been considered and selected in accordance with the order of preference described by the GLA.
- After full consideration of the suitability of renewable generation, air source heat pump technology has been incorporated into the design.

All results and strategies are directly affected by the inputs listed in this document; any deviation from these is certain to output different results. Enforcement bodies must ensure that they are satisfied that the below inputs are an accurate reflection of the final building before using this reporting to demonstrate compliance.

The carbon savings achieved by the proposed development are shown at each stage of the Energy Hierarchy in the figures below. These have been calculated and presented in accordance with the guidance set by the GLA.



Summary of Targets

The following reduction targets for regulated operational carbon emissions are applicable to the proposed development at Hayes Park South & Central, Hemel Hempstead.

Targets set Nationally

Part L of the Building Regulations sets requirements for the conservation of fuel and power in buildings within England and Wales. Among other requirements, new buildings are expected to meet or exceed a TER (Target Emission Rate), a maximum level of regulated emissions expressed in kg of CO_2 per m^2 per year. There is no TER for buildings created from refurbishment or change of use.

Targets set by the GLA (Greater London Authority)

For major developments, the GLA sets targets for reduction in carbon dioxide (CO_2) emissions beyond those required by Part L of the Building Regulations. A major development is defined in The Town and Country Planning (Development Management Procedure) (England) Order 2010 as one meeting any one of the following criteria:

- The number of dwellings provided is ten or more
- The floor space to be created by the development is 1,000 m^2 or more
- The development is carried out on a site having an area of 1 hectare or more

Since 2016, the target set by the GLA for new build dwellings within major developments is Zero Carbon (100% over Part L1A of the Building Regulations). Since 2021, this target is applicable to major non-domestic schemes also.

A minimum on site saving of 35% beyond the Building Regulations is required. Residential development should achieve 10%, and non-residential development should achieve 15% through energy efficiency measures ("Be Lean") alone. When the zero-carbon target cannot be fully achieved on-site, any shortfall must be provided through a cash in lieu contribution to the borough's carbon offset fund, or through certain off-site solutions in agreement with the borough.

There are no fixed targets for developments created through change of use, however applicants are still expected to demonstrate how individual elements of the Energy Hierarchy have been implemented, and how reductions in regulated CO_2 emissions have been achieved. The GLA states within their guidance on preparing energy assessments that *"…It is generally acknowledged that the level of carbon savings that can be achieved through a refurbishment can vary considerably, however every effort should be made to improve the energy performance of the building in line with London Plan carbon targets and to follow the energy hierarchy.".*

Certain additional criteria apply to developments which are referred to the Mayor. To be referable an application must meet one of three criteria outlined with the Mayor of London Order (2008):

- Include 150 domestic units or more.
- Be over 30 metres in height if outside of The City of London.
- Be on Green Belt or Metropolitan Open Land

Hillingdon Local Plan

The London Borough of Hillingdon adopted the Development management policies as part of the Local Plan Part 2 in January 2020. The following policy DMEI2 primary related to the results of this report:

> *Policy DMEI 2: Reducing Carbon Emissions:*
>
> A. All developments are required to make the fullest contribution to minimising carbon dioxide emissions in accordance with London Plan targets.
> B. All major development proposal must be accompanied by an energy assessment showing how these reductions will be achieved.
> C. Proposals that fail to take reasonable steps to achieve the required savings will be resisted. However, where it is clearly demonstrated that the targets for carbon emission cannot be met onsite, the Council may approve the application and seek an off-site contribution to make up the shortfall.

Targets Applicable to Hayes Park South & Central

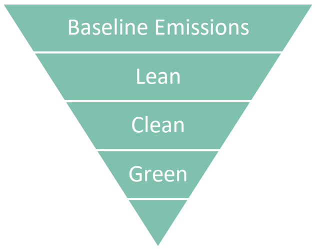
The proposed Hayes Park South & Central scheme is defined as a change of use development under the criteria described above, and so targets set by the GLA and The London Borough of Hillingdon apply. As such there is a **35.00%** target reduction in CO_2 emissions over Part L of the Building Regulations through on-site solutions following the Energy Hierarchy.

Establishing CO_2 Emissions

This assessment seeks to identify the carbon footprint of the development after each stage of the Energy Hierarchy. This includes regulated emissions and, separately, those emissions associated with uses not covered by Building Regulations i.e. unregulated emissions. The methodologies for calculating emissions in this report have been taken from the relevant guidance on preparing energy assessments.

The Energy Hierarchy can be described as follows:

- Baseline Emissions: Compliance with the relevant Part L 2021 Building Regulations only
- Be Lean: Use less energy
- Be Clean: Supply energy efficiently
- Be Green: Use renewable energy
- Be Seen: Ongoing monitoring post completion.



The carbon footprint of Hayes Park South & Central at each stage of the Energy Hierarchy is demonstrated in the tables below:

Carbon dioxide emissions after each stage of the Energy Hierarchy for domestic buildings created from refurbishment or change of use	**Carbon dioxide emissions for domestic buildings (tonnes CO_2 / annum)**	
	Regulated	**Unregulated**
Baseline: Part L 2021 of the Building Regulations compliant development	85.50	0.00
After energy demand reduction	61.10	0.00
After heat network / CHP	61.10	0.00
After renewable energy	39.70	0.00

Regulated carbon dioxide savings from each stage of the Energy Hierarchy for domestic buildings created from refurbishment or change of use	**Regulated carbon dioxide savings**	
	(Tonnes CO_2 / annum)	**(%)**
Be lean: Savings from energy demand reduction	24.40	29%
Be clean: Savings from heat network	0.00	0
Be green: Savings from renewable energy	21.40	25%
Cumulative on-site savings	45.80	54%
Carbon shortfall	39.70	
	(Tonnes CO_2)	
Cumulative savings for offset payment	1,1910	
Cash-in-lieu contribution	£95.00 per tonne	
Offset price per tonne:	*£113,172*	

Carbon Offsetting

This report demonstrates that it is possible to reduce the regulated on-site carbon dioxide emissions of the proposed Hayes Park South & Central development by 54.00% over Part L of the Building Regulations with the specification described, based on the modelling undertaken.

The total tonnes of CO_2 predicted to be produced by the new dwellings over a 30-year period are demonstrated above. These have been calculated using the tables and methodologies required by the GLA. It is not necessary to multiply this figure by an assumed lifecycle as this has already taken place.

To calculate the required offset payment this figure must be multiplied by the boroughs preferred price per tonne. The Mayor's Housing Standard's Viability Assessment assumes a carbon offset price of £95 per tonne of carbon dioxide.

Calculating Regulated CO_2 Emissions

At each stage of the assessment, regulated emissions have been calculated using Building Regulations approved compliance software. This is SAP 10 for dwellings. A representative sample of 13 dwellings, a 10% sample estimated to represent 35% of the developments apartment typologies, have been assessed and area weighted to calculate the site wide emission rate and fabric energy efficiency. The assessment has been undertaken using approved Elmhurst Design SAP 10.2 software version. The results are based on the parameters for building fabric and services outlined within this report.

The GLA have provided additional guidance for projects where an existing building or group of buildings is refurbished. Here it is still expected that developers provide an energy assessment demonstrating how the individual elements of the Energy Hierarchy have been implemented and how reductions in regulated CO_2 emissions have been achieved. The DER of the refurbished building should also be determined at each stage of the energy hierarchy using building regulations compliance software.

Under Part L of the Building Regulations, new build homes are expected to be designed such that the DER falls below the TER. There are no such requirements for refurbishments or properties created by change of use, and as such there is no TER or baseline for regulated emissions.

Instead, the baseline performance is calculated using either the 'Notional specification for existing buildings" given within Appendix 4 of the GLA's 'Energy Assessment Guidance', or existing performance, whichever is greater. This is to provide a consistent baseline across all refurbishments and clearly distinguish the improvements in CO_2 emissions that are over and above what would ordinarily be undertaken through meeting Building Regulation requirements. The specification modelled at this stage is shown below. This baseline DER is substituted for the TER described above.

Specification at 'Baseline' Stage for Domestic Units in Existing Buildings

Elements	Specification
Building Fabric - U-Values (W/m²K)	
Walls	0.55
Floors	0.55
Roofs	0.18
External opaque doors (whole frame)	1.6
Glazing (glazed doors, windows & rooflights (whole frame)	1.6 (G-value 0.63)
Building Fabric - Other	
Air Permeability (m^3/hm^2)	Default of 15
Thermal Bridging	Default values
Services	
Ventilation	MVHR
Efficiency	89%
SFP	0.73
Low Energy Lighting	75% of fittings

The baseline emissions for the project are shown below:

Baseline emissions	(Tonnes CO_2 / year)			
	Baseline	Be lean	Be clean	Be green
Domestic from refurbishment or change of use	85.50	-	-	-

Demand Reduction (Be Lean)

The following section of the report outlines measures which have been taken to reduce the energy demand of the proposal. This includes both architectural and building fabric measures (passive design) and energy efficient services (active design), considered at the earliest design stage.

Demonstrating CO_2 Savings from Demand Reduction Measures

According to the guidance from the GLA, passive design measures, including optimising orientation and site layout, natural ventilation and lighting, thermal mass and solar shading must be set out in the Design and Access statement. The impact of these factors is also accounted for within the energy calculations.

Active design measures to reduce energy can include high efficiency lighting and ventilation. Other possible measures include enhanced U-values, air tightness improvement and the development's approach to limiting thermal bridges. The specification for these items as proposed for the project is outlined below:

Specification at 'Be Lean' Stage

Demand Reduction Measures	**Specification**
Building Fabric - U-Values (W/m²K)	
Existing Walls	0.32
New External Walls	0.15
Floors	0.25
Roofs	0.16
External opaque doors (whole frame)	1.4
Glazing (glazed doors, windows & rooflights (whole frame)	1.4 with g-value of 0.40
Building Fabric - Other	
Air Permeability (m^3/hm^2)	4.0
Services	
Ventilation	MVHR
Efficiency	89%
SFP	0.73
Low Energy Lighting	100% of fittings

The glazing areas of the project are shown within the energy modelling documents which are included within the appendices of this report.

For the purposes of demonstrating CO_2 emission improvements in the 'be lean' stage of the energy hierarchy, the notional building system type and performance values are specified in the Part L 2021 baseline as determined by the final proposed building specification. In this way CO_2 emission improvements from the proposed space heating and hot water demand reduction measures can be compared against the Part L 2021 baseline, for example through improvements in performance of building fabric, heat recovery or water efficient fittings.

The notional values used are as follows:

Notional specification at 'Be Lean' Stage	
Item	**Specification**
Air Source Heat Pump	170%
Light fittings*	75lm/cw

The GLA sets the following energy efficiency targets in the London Plan with the 'be seen' stage of the hierarchy:

- Residential developments should achieve at least a 10 per cent improvement on Building Regulations from energy efficiency measures alone.
- Non-residential developments should achieve at least a 15 per cent improvement on Building Regulations from energy efficiency measures alone.

The carbon produced and reductions achieved by the project when the above specification is applied are shown below.

Cumulative savings after 'be lean'	(Tonnes CO_2 / year)				Cumulative Improvement (%)
	Baseline	**Be lean**	**Be clean**	**Be green**	
Domestic from refurbishment or change of use	85.5	61.10	-	-	29%

Reporting Energy Use Intensity (EUI) and space heating demand

Energy Use Intensity (EUI) is a measure of the total energy consumed in a building annually. It includes both regulated (fixed systems for lighting, heating, hot water, air conditioning and mechanical ventilation) and unregulated (cooking and all electrical appliances, and other small power) energy. It does not include energy use from electric vehicle charging or any reduction in EUI due to renewable energy generation on-site.

Within 'Energy Assessment Guidance…' the GLA states that applicants should report the EUI and space heating demand of the development, as well as aiming to achieve and exceed as far as possible the values given below. These values are taken from the LETI Climate Emergency Design Guide and are supported by RIBA, UKGBC and CIBSE. The Committee on Climate Change has also recommended the residential space heating demand values, whilst the recommended value for hotels is taken from the Greater Cambridge Local Plan Net Zero Carbon evidence base:

Energy Use Intensity (EUI) and Space Heating Demand

Building Type	EUI (kWh/m²/year)	Space heating demand (kWh/m²/year)
Residential	35	15
School	65	15
Office	55	15
Hotel	55	15
All other non-residential	55	15

The predicted EUI and space heating demand for Hayes Park South & Central are shown below:

Energy Use Intensity (EUI) and Space Heating Demand

Building Type	EUI (kWh/m^2/year, excluding renewable energy)	Space heating demand (kWh/m^2/year, excluding renewable energy)	Methodology used.
Residential	38.18	5.014	SAP10

Heating Infrastructure (Be Clean)

The Future Homes Standard

Under the government's current plans, gas and oil boilers will be banned in newbuild homes from 2025. The government has stated that "… a low carbon heating system will be integral to the specification of the Future Homes Standard and we anticipate that heat pumps will become the primary heating technology for new homes"

The Heating Hierarchy

The energy systems for use at the development have been considered and selected in accordance with the order of preference within 'Energy Assessment Guidance Greater London Authority guidance on preparing energy assessments as part of planning applications. The hierarchy is as follows:

- **Connection to an area wide heat network**. Where proposed developments are located near to existing or planned networks, connection must be prioritised.
- **Communal heating system**
    - **Site-wide heat network**. Where proposed developments are located in areas of decentralised energy potential, but no heat networks currently exist or are planned, developers should provide a site-wide heat network served by a single energy centre to future proof the development for easy connection to a wider heat network in the future.
    - **Building-level heating system**. Appropriate for single building applications or low density developments with domestic blocks, where no district heating networks are planned or feasible.
- **Individual heating system**. Appropriate for low density individual housing, where no district heating networks are planned or feasible, and where evidence is provided that a site-wide heat network is uneconomic.

Connection to Area Wide Low Carbon Heat Distribution Networks

Using the London Heat Map as a guide, there are no existing or planned heat networks near the development and the scheme is outside of the London Heat Map's areas of 'Heat Mapping Decentralised Energy Potential'. The screenshot below shows the location of the development.

Figure 2: London heat map for Hayes Park South & Central

Communal Heating Systems

A site-wide heat network is defined in the relevant guidance as "a set of flow and return pipes circulating hot water to the apartment blocks (and apartments contained therein) and non-domestic buildings on a development." This must be explored where "proposed developments are located in areas of decentralised energy potential, but no heat networks currently exist or are planned".

The London Heat Map demonstrates that the proposed development is not within an area of decentralised energy potential and that an area wide heat network is not proposed.

The suitability of Combined Heat and Power (CHP) systems, formally recommended within the relevant guidance, is addressed within Appendix A.

Proposed Heating and Cooling Specification

Individual heating systems have been found to be viable in accordance with the guidance from the GLA and as such form part of the proposed specification.

The proposed system is an individual ASHP (air source heat pump) providing heating and hot water. In accordance with the advice of the GLA, this is considered a renewable technology and modelled under "Be Green". The "Be Clean" model retains the previous HVAC assumptions.

The carbon produced by the project when this specification is applied is shown below.

Cumulative savings after 'be clean'	(Tonnes CO_2 / year)				Cumulative Improvement (%)
	Baseline	Be lean	Be clean	Be green	
Domestic from refurbishment or change of use	85.5	61.10	61.10	-	0%

Renewable Energy (Be Green)

The use of renewable technology in the proposed design of the development has been fully considered as outlined in Appendix A.

Air Source Heat Pump technology has been modelled to provide heating and hot water as follows:

Specification at 'Be Green' Stage (Continued)

Element	Specification
Heating System	
Type	ASHP (Nibe system)
Efficiency	Winter – 263.24% Summer – 303.38%
Controls	Programmer and at least two room thermostats
Hot Water	
Type	From main heating system
Cylinder	201.0 L
Heat Loss	1.61 kWh/day
Ventilation	MVHR (Nibe system)
Efficiency	89%
SFP	0.73

An individual ASHP system has been proposed for the site, that will provide a combined service of heating, hot water and MVHR. The systems will be located externally, due to the conservation status of the external design, the plant may need to be placed on the flat roof and distributed through an ambient loop system. The Nibe system can provide an SCOP of 4.26 at a flow temperature of 45°C.

The proposed system complies with the minimum performance standards as set out in the Enhances Capital Allowances (ECA) product criteria and is listed on the Microgeneration Certification Scheme Heat Pump listing [Product Directory - MCS].

As the proposed specification has already been sufficient to meet and exceed the carbon reduction requirements of both the GLA and the local authority, no further savings through renewable technology are currently proposed, though this option remains open to the developer if necessary in the future.

The carbon produced by the project when this specification is applied is shown below. The results of these improvements show a **54.00%** reduction in emissions over the Part L compliant base case, exceeding the target.

Cumulative final savings	(Tonnes CO_2 / year)				Cumulative Improvement (%)
	Baseline	Be lean	Be clean	Be green	
Domestic from refurbishment or change of use	85.50	61.10	61.10	39.70	54%

Overheating Risk Analysis

All developments are required to undertake a detailed analysis of the risk of overheating as part of the planning application.

Dwellings constructed today may be operating in a substantially different climate over the coming decades, and therefore should be designed to ensure that they are able to adapt and reduce the risk of overheating with potentially higher summer temperatures and longer hot spells.

Key design decisions can affect the potential risk of overheating:

- Poor consideration of orientation of large, glazed facades
- High density development contributing to urban heat island effects
- High glazing ratios contributing to excessive unwanted solar gain
- Inadequate ventilation strategies
- Very high levels of thermal insulation without considering heat build-up

Other factors which additionally contribute to heat build-up within homes and should be addressed where possible include:

- High levels of occupation
- Appliance use contributing to internal gains Cooling hierarchy In common with sustainable heating strategies, it is possible to apply a sustainable 'cooling hierarchy' which sets out the priorities to ensure overheating risk is minimised:
- Minimise internal heat gain
- Manage heat through internal thermal mass and design of spaces
- Passive ventilation strategies
- Mechanical ventilation systems
- Active cooling systems

Addressing overheating risk

The cooling hierarchy described has been considered, with passive measures of reducing overheating risk given priority. Key measures which will be taken within the development include:

- A layout which incorporates significant green space around the site and in rear gardens reducing the potential for heat build-up in enclosed and low albedo external areas such as tarmac and dark roofs.
- Glazing specification which has been considered to balance the requirements for useful solar gain with unwanted summer gain
- Consideration of thermal mass of construction materials to smooth internal temperature profiles, storing excess heat during the day and releasing at night

A overheating assessment has been conducted for the site, the result of which have been issued separately.

Resource Efficiency

This section sets out details of additional resource efficiency and sustainable design principles to be applied at the development.

Materials

The impacts of construction materials range from the depletion of natural resources to the greenhouse gas emissions and water use associated with their manufacture and installation. Within the development choices will be made in order to reduce the consumption of primary resources and using materials with fewer negative impacts on the environment, including but not limited to the following;

- Use fewer resources and less energy through designing buildings more efficiently.
- Specify and select materials and products that strike a responsible balance between social, economic and environmental factors.
- Incorporate recycled content, use resource-efficient products and give due consideration to end-of-life uses.
- Influence, specify and source increasing amounts of materials which can be reused and consider future deconstruction and recovery.

Waste

Sending waste to landfill has various environmental impacts, such as the release of local pollution, ecological degradation and methane emissions, in addition to exacerbating resource depletion. Waste in housing comes from two main streams: construction waste and domestic waste during occupation.

Household Waste

In this respect regard has been given to the policy advice contained in the Council's current strategy in terms of waste and recycling to ensure that the new dwellings are provided with adequate storage facilities for both waste and recyclable materials. Future occupiers of the dwellings will be provided with an information pack detailing the Council's current collection arrangements for waste and recycling and advising of the nearest recycling centres to the Application site.

Construction Waste

The development will additionally be designed to effectively and appropriately monitor and manage construction site waste. Target benchmarks for resource efficiency will be set in accordance with best practice – e.g., 5m3 of waste per 100m2 / tonnes waste per m2. Wherever possible materials will be diverted from landfill through re-use on site, reclamation for re-use, returned to the supplier where a 'take-back' scheme is in place or recovered and recycled using an approved waste management contractor. A target to divert 85% by weight/volume of non-hazardous construction waste will be applied.

Electric Vehicle Charging

It is recognised that there is a need to ensure that the development is adaptable to accommodate a future shift in personal transportation to electric vehicles, to promote sustainable transport and to minimise air pollution. As Electric Vehicle (EV) ownership increases, developers have an increasing responsibility to provide EV charging points for occupants.

Flood Risk and Drainage

A Flood Risk Assessment will be undertaken for the site. The site is at very low risk of groundwater flooding and at high risk of flooding from a surface water. A multifunctional SuDS scheme comprising storage ponds, and (tanked) permeable paving to a limited extent, has been proposed to manage post-development runoff and afford water treatment, amenity and ecological benefits.

Lighting

Light pollution can result from any adverse effect of artificial lighting and includes the following:

- Glare – the uncomfortable brightness of a light source when viewed against a dark sky;
- 'Light trespass' – the spread of light spillage on the boundary of the property on which a light is located; and
- 'Sky glow' – the orange glow seen around urban areas caused by a scattering of artificial light by dust particles and water droplets in the sky.

All external lighting for the site will be designed in line with current British Standards and ILP Guidelines

Biodiversity

The presence of any significant ecological features as defined using guidance from BRE will be noted, and the appropriate measures for protection and conservation undertaken before works begin. Features to promote biodiversity, such as bird and bat boxes, will be incorporated into the design wherever feasible.

Internal Water Use

The following addresses water consumption for the proposed development. The approved document Part G gives two options to demonstrate compliance. These are as follows:

- **Fittings Approach.** Within the approved document, tables 2.1 and 2.2 describe the maximum rates for fittings to achieve 125/p/d or the 'optional' 110 l/p/d. The specifier may choose fittings which do not exceed these limits to attain compliance.

- **The Water Efficiency Calculator.** If any fittings exceed the amounts described within tables 2.1 or 2.2, then the water efficiency calculator must be completed to demonstrate compliance. Similarly, where a shower is not to be provided or where a waste disposal unit, a water softener or water re-use is to be provided the water efficiency calculator must be completed.

The standard required by default is **125 litres/person/day**. The 2015 edition of Approved Document G includes an 'optional' standard of **110 litres/person/day** which may be required by planning permission. This is intended to supersede the ability of planning authorities to require the Code for Sustainable Homes. The optional standard is equivalent to the minimum water use permitted under CSH Level 4.

By following the Government's national calculation methodology for assessing water efficiency in new dwellings for the project as designed, it is possible to achieve a water consumption of less than 110 litres per person per day using the fittings approach. Compliance with Building Regulation 36(1) can therefore be demonstrated.

This is compliant with Policy 5.15 B (Water Use and Supplies) of the London Plan, which states that developers should minimise the use of mains water by:

A. Incorporating water saving measures and equipment.
B. Designing domestic development so that mains water consumption would meet a target of 105 litres or less per head per day (excluding an allowance of 5 litres or less per head per day for external water consumption).

Compliant Design Specification

The fittingss approach can be adopted to demonstrate compliance as follows. Fittings must not exceed the given the rates during design and construction:

Fitting	**Maximum Consumption**
WC flush	4/2.6 litres dual flush
Basin taps (in WCs and bathrooms)	5 l/min
Sink taps (kitchen and utility)	6 l/min
Showers	8 l/min
Baths	170 litres to overflow
Dishwasher	1.25 l/place setting
Washing machine	8.17 l/kilogram
Waste disposal unit	None fitted
Water softener	None fitted
Total consumption:	**110 litres/person/day (105 internal)**

Further Guidance for Specifiers on Achieving the Required Flowrates

Taps and showers will **require flow limiters** to meet these values. Please ensure these are installed along with the tap and shower fittings as these must be checked by Building Control prior to sign off.

Some taps and showers may already have built in limiters. Flow limiters are almost needed to meet the shower and tap values. You could alternatively check the flow rate with the manufacturer. For high pressure water systems (above 1 bar) it's the flow rates measured at 3 bar that is required. If it's a low-pressure water system (less than 0.3 bar), the flow rate at 0.1 bar is required. Tap values should be the maximum flow rate and showers should be the cold flow rate.

What if a waste disposal unit or water softener system is being used? These use additional water so may need to be compensated with lower values elsewhere. Please provide details of the waste disposal and softener systems being used. This report assumes that no such system is present.

What if any values are exceeded? It may be possible to compensate for them by further reducing values elsewhere. If you'd like us to look at this, please let us know. Grey water recycling or rainwater harvesting for internal use can also compensate for exceeding values.

WC Flush and Baths. The flush volume and capacity to overflow is often displayed on the manufacturer website or can be requested from them.

Dishwashers must achieve a water use of 1.25 l/place setting. This can be found by dividing the water consumption of a standard cycle by the number of place settings. If only the annual water consumption is given, divide this by 280 to get the water consumption of a single cycle. Where a dishwasher is not being fitted, 1.25 l/place setting is used as a default.

Washing machines need to achieve a water use of 8.17 l/kg dry load. This can be found by dividing the water consumption of a standard cycle by the dry load capacity in kg. If only the annual water consumption is given, divide this by 220 to get the water consumption of a single cycle. Where a washing machine is not being fitted, 8.17 l/place setting is used as a default.

External Water Use. Both the 125l and 110l target include a 5l allowance for external water use, e.g. to water a garden. This is not influenced by the building specification or fittings. It is common to see these targets described as 120l or 105 targets for internal water use. For example, the Greater London Authority require "mains water consumption would meet a target of 105 litres or less per head per day (excluding an allowance of 5 litres or less per head per day for external water consumption)".

Conclusion

This report outlines how a variety of sustainability criteria have been considered alongside the proposed design. Based on the modelling undertaken, it has been demonstrated that it is possible to reduce regulated on-site carbon dioxide emissions of the proposed Hayes Park South & Central development by **54.00%** beyond the requirements of Part L of the Building Regulations, where the building and services specification described in this report is implemented. This specification is sufficient to meet the target of 35.00%, and is therefore compliant with the carbon reduction policies of The London Borough of Hillingdon.

Appendices

Appendix A – Consideration of Renewable and Alternative Technology

Photovoltaic Solar Panels

Photovoltaic panel systems convert energy from the sun into electricity through semi-conductor cells mounted in collector panels. The panels are connected to an inverter to turn the DC output into AC for use in the building to which they are attached and to be fed back into the grid when not required. Photovoltaic arrays provide a quiet and effective renewable energy source with a relatively low aesthetic impact. The major benefit of PV systems is the significant reductions they can achieve in comparison to other technologies, in terms of CO_2 and energy use.

The PV panels should ideally be orientated between southeast and southwest (optimally south). The optimal tilt angle (inclination of panel from horizontal) should be calculated to ensure the best possible output of the system during the year. In the UK, the angles of most pitched roofs are suitable for mounting PV panels. Panels can also be mounted on A-frames on flat roofed buildings. PV technology comes in a range of forms: PV panels that can be retrofitted to the roof of an existing building or equally, sunk to fit flush with the roof line; PV cells that are 'laminated' between sheets of glass to provide shading in a glazed area, and PV cladding. PV systems are low maintenance as they have no moving parts and panels generally have 25 year warranties, although the lifetime of the panel can be expected to be beyond this time. The PV systems should not be shaded. Shading caused by other buildings, greenery and roof 'furniture' such as chimneys or satellite dishes, even over a small area of the panel, can significantly reduce performance. Excess energy can be exported to the grid. Although the Feed-in Tariffs are generally not high, exporters can negotiate with their utility company. Future consideration may be given to the benefits of battery storage. Payback times for this technology are usually approximately twenty years; but this is reducing year on year as the technology matures and are set to reduce further as fuel prices increase. Integrating PV into a building and replacing other building materials can further offset the cost.

Solar Hot Water Systems

Solar water heating systems use the energy from the sun to heat water stored in a hot water cylinder inside the building. A solar collector comprises a housing that contains piping, through which the carrier fluid circulates, and a glass panel to retain the radiation from the sun. The temperature inside the collector increases and this heat is then transferred to a carrier fluid. In an open loop system, the hot water is heated directly. Solar thermal panels are generally black in appearance for maximising energy absorption and the glass panels have a special coating in order to retain as much heat as possible. Two types of collector exist: flat plate and evacuated tube. Flat plate collectors can be mounted on or flush with the roof. The air in the collection tubes can be evacuated to reduce heat losses within the frame by convection. Evacuated tube collectors need to be re-evacuated every few years. They are more difficult to install but are more efficient and allow higher temperature heating.

Solar thermal collectors offer a good price-performance ratio. Solar hot water systems are best suited to developments with high hot water requirements, such as hotels, care homes and leisure centres. Many systems have been installed in the UK and they work well, even without direct sunlight. Solar thermal systems should be sized to the hot water requirements of the user since any excess heat that is generated cannot be exported elsewhere. The optimal angle for mounting depends on when the water demand is greatest. Ideally, the collectors should be mounted onto a non-shaded, south-facing roof. Solar thermal technology is a cost effective way to reduce carbon emissions, especially if it is replacing electric water heating. Due to limited roof space, solar hot water cannot be used effectively alongside photovoltaic arrays. Accordingly, it is considered preferable to install photovoltaic panels as these represent a greater carbon saving.

Biomass Heating

With the long term availability of fossil fuels such as oil and gas, and the persistent number of price rises of oil and natural gas a growing concern in the UK, alternative heating methods such as wood burning boilers are becoming more popular. Due to technical advances in wood burning technology, and improvements in the preparation of wood fuels, efficiencies of new wood pellet burning boilers have increased to around 90%, with carbon monoxide emissions dropping dramatically. There are three types of wood burning boiler - logs, woodchips and wood pellets. Wood logs are the most readily available, generally produced as a by-product from forestry and woodland from sawmills, tree surgery and wind damage. Wood chips have a high moisture content which tends to restrict their efficiency to only 50% and they tend to suffer from blockages hence we would be cautious about their use on this site. Storage space requirements are also high due to the irregularity of the chips. Wood pellets are made from dry waste wood, such as used pallets and off-cuts/sawdust from furniture manufacturers. The waste wood is compressed into uniform, high density pellets that are easier to transport, handle and store than other forms of wood fuel.

Biomass combustion systems (BCS) are generally more mechanically complex than conventional boiler heating systems, especially when it comes to fuel delivery, storage, handling and combustion. The complexity is necessary because of the different combustion characteristics of biomass as compared to conventional fossil fuels. The increased complexity means higher capital costs than for conventional systems. BCSs typically require more frequent maintenance and greater operator attention than conventional systems. As a result, the degree of operator dedication to the system is critical to its success. They often require special attention to fire insurance premiums, air quality standards, ash disposal options and general safety issues. Domestic scale boilers such as Woodchip-fed systems remain very costly and the requirements for siting both the boiler and the fuel source were considered impractical for this development. There are also some concerns on current availability of suitable fuel within a reasonable distance of the development as well as the additional traffic that would be associated with it. The use of efficient heat pumps is considered more suitable.

Biomass can be burnt directly to provide heat in buildings using wood from forests, urban tree pruning, and farmed coppices or as liquid biofuel, such as bio diesel. In non-domestic applications, biomass boilers replace conventional fossil fuel boilers and come with automated features to enable reduced user intervention. Due to the size of the proposed project, biomass energy has not been considered as an economically suitable technology for this development.

Heat Pumps

Heat pumps transfer heat from a lower temperature source to one of a higher temperature. These are split into three main categories:

- Air source heat pumps operate by converting the energy of the outside air into heat, creating a comfortable temperature inside the building as well as supplying energy for the hot water system. Air-to-water systems provide hot water for direct use or to supply 'wet' heating through underfloor heating or radiators. Air-to-air systems provide hot air, either directly into an internal space, or to be distributed by fans.
- Ground source heat pumps apply the same principle to heat energy stored underground. In this case a circuit of piping is buried horizontally or via a bore hole.
- Water source heat pumps absorb heat from a local water source, such as a lake, river, well, or borehole.

The most prevalent system is an air source heat pump. As with all heat pumps, air source models are most efficient when supplying low temperature systems such as underfloor heating.

An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can extract heat from the air even when the outside temperature is as low as minus 15°C. Cold water or another fluid is circulated through pipes, picking up the ambient temperature and then passing through the heat exchanger (the evaporator) in the heat pump unit. The heat exchanger extracts heat from the fluid, using a refrigerant compression cycle to upgrade the heat to a usable temperature (+55°C). This heat is then transferred to the heating system via another heat exchanger, the condenser of the heat pump.

Accordingly, ASHP heating systems generally run at a lower temperature than conventional heating systems. There are two main types of air source heat pumps. An air-to-water system uses the heat to warm water. Heat pumps heat water to a lower temperature than a standard boiler system would, so they are better suited to underfloor heating systems than radiator systems. An air-to-air system produces warm air, which is circulated by fans to heat the building. Whilst heat pumps are not a wholly renewable energy source due to use of electricity, the renewable component is considered as the heat is extracted from the air. It is measured as the difference between heat outputs, less the primary electrical energy input. Using this heat, for every Watt of electrical energy supplied to the system, 4 Watts or more of heating energy can be supplied to a heating system. This 'Coefficient of Performance' (CoP) of 4 is effectively an 'efficiency' of 400% for the system and compares very favourably with even the best gas condensing boiler's efficiency of around 85%. The smaller the temperature difference between the source and the output temperature of the heat pump (i.e. the temperature of the distribution system) the higher the heat pump's CoP. Unlike boilers, there is no pollution on-site and as the mix of power stations used to supply the electricity grid gets 'cleaner', with more renewable electricity generation being brought on line, so the carbon emissions from the heat pumps system will decrease even further. The key operational benefit of air source heat pumps for the user is the reduction in fuel bills. In addition, space savings can be made over other plant types as an air source heat pump unit is compact, and requires no storage space for fuel.

Since air source heat pumps produce less heat than traditional boilers, it is essential that the building where the air source heat pump is proposed is well insulated and draught proofed for the heating system to be effective. Fans and compressors integral to the air source heat pump unit generate some noise, but this is generally acceptable especially where outdoor units can be located away from windows and adjacent buildings. By selecting a heat pump with an outdoor sound rating of 7.6 dB or lower and mounting the unit on a noise-absorbing base these issues can be resolved for the site. Costs for installing a typical system vary but they are considerably more economical to install than an equivalent capacity ground source heat system and can produce similar levels of energy and carbon savings. Actual running costs and savings for space heating will vary depending on several factors - including the size and use pattern of the building and how well insulated it is.

Combined Heat and Power (CHP)

A Combined Heat and Power system (CHP) or cogeneration is the simultaneous generation of both heat and power (thermal energy and electricity). This is achieved through recovering heat generated in the production of electricity, which can be utilised in providing space heating and hot water. The most common fuel used in the UK to power a CHP engine is natural gas although LPG, biogas, ethanol, methane, hydrogen, biofuel, oil or any fuel that can drive an engine can be used. A CHP operating on fossil fuels, e.g. gas, diesel, is not considered a renewable technology. A biomass CHP, however, is considered to be a renewable energy technology but it is only suitable for developments with larger heat and electricity demands.

A CHP system uses on average 35% less primary energy compared to conventional heat-only boilers and power stations approaching efficiencies as high as 75%. Although not a renewable technology, except if biomass is being used, CHP is considered very efficient, reducing carbon emissions related to a site's energy consumption while providing electricity and heat to occupiers.

The GLA does not recommend CHP for use in developments consisting of 500 units or less, as 'at this scale it is generally not economical'. CHP has also been removed from the GLAs hierarchy for selecting energy systems with the publication of 'Energy Assessment Guidance Greater London Authority guidance on preparing energy assessments as part of planning applications - October 2018'.

CHP installed at the development to meet the base heat load would require the export of electricity to the national grid as it would likely exceed demand. The GLA continues to state that '…the administrative burden of managing CHP electricity sales at this small scale where energy service companies (ESCOs) are generally not active, and the low unit price available for small volumes of exported CHP electricity, means it is generally uneconomic for developers to pursue'.

CHP requires significant infrastructure and a substantial heat demand. In order to obtain maximum efficiency, it is necessary to have an energy demand profile which is evenly spread throughout the day and night. A CHP unit will operate efficiently when running continuously and so requires its energy to be used continuously to avoid wastage.

Appendix B – Glazing Ratios

The glazing areas of the project are shown within the energy modelling documents are as follows:

Hayes South		
Elevation	Glazed area m2	Glazed area %
North	431	55%
East	557	57%
South	460	59%
West	549	56%
Total	1997	56%

Hayes Central		
Elevation	Glazed area m2	Glazed area %
North	410	71%
East	380	87%
South	410	72%
West	392	80%
Total	1592	83%

Appendix C – Energy Model Output Documents

Energy model output documents reflecting each stage of the energy hierarchy accompany this report separately.