PASSIVHAUS PILOT STUDY

Initial Report

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1. Executive Summary

1.1. Passivhaus is a voluntary standard for extremely high levels of energy efficiency in a building. The standard is administered in the UK by the Passivhaus Institute (PHI).

1.1. The Cambridge Investment Partnership (CIP) decided to undertake a Passivhaus Pilot Study including 35 homes across five small sites. Three sites targeted Passivhaus certification (21 homes) and two sites include Passivhaus principles (14 homes).

1.2. The objective of the study is to compare 'Passivhaus certified' properties against homes built to 'Passivhaus principles' - exploring specification, cost and energy use differences.

1.3. The number of properties in the Study manages risks associated with 'doing something for the first time' and includes comparable similar sized terrace houses.

1.4. The three Passivhaus certified sites have been completed and the two Passivhaus principles sites are due to complete by the end of 2024.

1.5. This **Initial Report** focuses on the completed certified schemes at Fen Road (Five Trees Court), Ditton (Wadloes Road) and Borrowdale (30A-C) highlighting the certification results, key challenges and a revised performance specification to achieve sustainability costs effectively.

1.6. A **Completion Report** in spring 2025 will compare the certified properties with those constructed to Passivhaus principles.

1.7. A **Final Report** will assess the impact on tenants heating bills following a suitable period of occupation and comparison to design stage modelling.

1.8. The Final Report will facilitate a comprehensive update of the SHDG - linking to three of the Councils four key priorities for 2022 to 2027, including:

- Priority 1: Leading Cambridge's response to the climate change and biodiversity emergencies

- Priority 2: Tackling poverty and inequality and helping people in the greatest need

- Priority 3: Building a new generation of council and affordable homes and reducing homelessness

1.9. The 21 Passivhaus certified homes were completed in February 2024. We have received the certification results (see Appendix A).

1.10. We can confirm that **13 homes** (62%) achieved the Passivhaus Institute (PHI) **'Classic'** building standard. This is a great achievement and demonstrates the Council's commitment to delivering sustainable homes in accordance with the Sustainable Housing Design Guide (SHDG).

1.11. There is a PHI Low Energy Building (LEB) Standard which is suitable for buildings which, for a variety of reasons, may not quite reach the stringent Passivhaus 'classic' criteria. We can confirm that **8 homes** (38%) have been certified to the **LEB Standard**.

1.12. The requirements for energy demand, airtight-ness and comfort are lower for the LEB Standard compared to Passivhaus Classic. However, the documentation is the same ensuring that certification provides an accurate assessment of the building's energy demand.

1.13. Achieving Passivhaus certification is not cost effective or practicable on all sites. A sustainability performance specification has been developed called CamStandard, as an alternative to Passivhaus. This proposal is based on the cost implications of certification and the most cost-effective route to ensuring high sustainability standards.

1.14. CamStandard includes a more flexible option whilst still striving for the highest possible levels of sustainability. This aligns to approaches being adopted by other organisations who recognise the challenges of achieving Passivhaus certification across a range of sites with different characteristics, constraints and requirements.

1.15. The Cambridge City Council Sustainable Housing Design Guide (SHDG) will be updated to include the CamStandard via an Addendum (see Appendix B).

1.16. The update to the SHDG ensures that ongoing schemes in the new build programme capture the learnings from the pilot programme and strive to achieve the best cost-effective sustainability levels appropriate for each site.

2. Background Information

2.1. Passivhaus is a voluntary standard for extremely high levels of energy efficiency in a building. It originated in the late 1980s, based on pioneering work on low-energy buildings in North America and northern Europe. The standard is administered in the UK by the Passivhaus Institute (PHI).

2.2. The Passivhaus pilot study being delivered by the Cambridge Investment Partnership (CIP) includes 35 homes across five small sites. Three sites targeted Passivhaus certification (21 homes) and two sites incorporate Passivhaus principles (14 homes).

2.3. The objective was to compare Passivhaus certified properties against homes built to Passivhaus principles - exploring specification, cost, and energy use differences.

2.4. The number of properties selected managed the cost, quality and time risks associated with 'doing something for the first time' and provides comparable similar sized terrace houses.

2.5. The certified schemes include Fen Road, Ditton and Borrowdale which started on site between August and October 2022, and all completed in February 2024 (c. 16 to 18 month builds).

2.6. The certified properties include:

- Three homes at Borrowdale with postal addresses 30A, 30B and 30C Borrowdale, Cambridge, CB4 3HU.
- Six homes at Ditton with postal addresses 143, 145, 147, 149, 151 and 153 Wadloes Road, Cambridge, CB5 8PF.
- 12 homes at Fen Road with postal addresses 1 to 10 Five Trees Court, Fen Road, Cambridge, CB4 1UT.

2.7. The Passivhaus principles sites at Aragon and Sackville Close started on site in April 2023, following the resolution of significant archeological findings, and are due to complete by the end of 2024 (estimated c. 18 to 19 month build).

2.8. The Passivhaus principles sites include:

- Seven homes at Aragon Close, 1 to 7 Aragon Terrace, Cambridge (postal addresses to be registered).

- Seven homes Sackville Close, 1 to 7 Sackville Terrace, Cambridge (postal addresses to be registered).

2.9. The Cambridge Investment Partnership (CIP) is an equal partnership between Cambridge City Council and Hill Investment Partnerships. The partnership was established in 2017 to address the housing shortage across Cambridge by providing high-quality new council homes and market sale homes, commercial and community facilities.

2.10. One of the significant benefits of the Joint Venture (JV) partnership is the flexibility to embark upon a pilot study, trailing something for the first time, based on shared risks and collaborative working.

2.11. Three reports will be prepared as part of the pilot study, these are as follows:

- The **Initial Report** focuses on the completed certified schemes at Fen Road (Five Trees Court), Ditton (Wadloes Road) and Borrowdale (30A-C) highlighting the certification results, key challenges and a revised performance specification to achieve sustainability costs effectively.

- A **Completion Report** in spring 2025 will compare certified properties with those constructed to Passivhaus principles.

- A **Final Report** will assess the impact on tenants heating bills following a suitable period of occupation and comparison to design stage modelling. The Final Report will also facilitate a comprehensive update of the SHDG.

2.12. The Sustainable Housing Design Guide (SHDG) 2021 provides a summary of the council's expectations for sustainable design and placemaking for council homes.

2.13. From 2021 designs for all council homes were required to **target Passivhaus certification** and the sustainability targets outlined in the Four Steps to Zero Carbon Report, prepared by Buro Happold.

2.14. From 2030 all council homes will be expected to target Net Zero Carbon.

2.15. The SHDG and Zero Carbon Report provide technical and placemaking principles beyond baseline planning and Building Regulations that work together to give measurable outcomes.

2.16. Where there are financial viability and/or technical constraints in meeting Passivhaus certification, or other sustainability targets, design teams are expected to **justify** why targets cannot be met and provide alternative sustainable design approaches.

2.17. The key performance criteria included in the SHDG is included in the table below.

Key Performance Criteria	Compliance Level
Building specification	
Energy use (kWh)	Mandatory
Address fuel poverty (by reducing bills)	Mandatory
Low form factor to reduce heat loss (via building design)	Mandatory
Solar control (preventing heat entering building)	Mandatory
Insulation levels (via building fabric)	Mandatory
Indoor air quality (via MVHR)	Mandatory
Mechanical ventilation (via MVHR)	Mandatory
Internal temperature control (via controls)	Mandatory
Avoid overheating (via TM59 assessments)	Mandatory
General design	
Carbon reduction	Mandatory
Water use no more than 90l/ppd	Mandatory
20% improvement in biodiversity	Recommended
Max. parking ratio of 0.5 spaces/home	Mandatory
EV charging capacity for all parking spaces	Mandatory

NDSS space standards	Mandatory
Prioritise dual aspect (for passive ventilation)	Mandatory
Modern Methods of Construction (known as MMC)	Recommended
Post Occupancy Evaluations (POE) 5yrs	Mandatory
Performance of renewable energy	Mandatory
Resident feedback	Recommended

2.18. The SHDG has been updated to reflect the emerging trends included in this Initial Report via an Addendum, which is included at Appendix B of this report. This will include the CamStandard described in detail at section 8 of this report.

2.19. The SHDG Addendum ensures that ongoing schemes in the programme capture the learnings to date and strive to achieve the best cost-effective sustainability levels appropriate to each scheme.

3. Passivhaus

3.1. Passivhaus buildings are characterised by particularly high levels of comfort with very low energy consumption.

3.2. Passivhaus is achieved by imposing very strict requirements on a building's airtightness and its use of energy for cooling, space and water heating.

3.3. From the outside, Passivhaus buildings do not differ from conventional buildings, because Passivhaus means a **standard** and not a particular type of construction.

3.4. Passivhaus provides:

- Excellent levels of comfort
- Consistent fresh air all throughout the building
- Structurally sound and durable construction
- Extremely low energy costs

3.5. The five key principles of Passivhaus buildings include:

- High **quality fenestration**. Tripple or advanced double glazing and insulated window frames ensure heat gains in winter.

- A **ventilation strategy**. Passivhaus buildings are supplied with consistent fresh air via the ventilation system. A heat exchanger ensures that air is supplied to rooms at nearly room temperature without the need for additional heating meaning cold and heat remain outside.

- High **thermal insulation**. A well-insulated building keeps warmth in during winter and heat out during summer.

- **Airtightness**. Passivhaus buildings have a continuous air-tight outer shell. This protects the building structure, prevents energy losses, and improves comfort.

- No **thermal bridges**. Passivhaus buildings are designed and constructed without thermal bridges. This ensures lower heating costs and prevents condensation damage to the fabric.

4. Passivhaus Certification

4.1. Certification is verified through an energy balance calculation using the Passivhaus Planning Package (PHPP).

4.2. Not all Passivhaus projects are created equal. The options include:

- Premium (requires renewable energy generation)

- Plus (requires renewable energy generation)

- **Classic**

- **Low Energy Building (LEB)** Standard

4.3. The pilot study aimed for Passivhaus Classic certification - but acknowledged that the existing site constraints and the challenges associated with doing something for the first time, could result in a near miss (the Low Energy Building (LEB) standard).

4.4. To achieve Passivhaus Classic the performance requirements in the table below must be achieved:

Passivhaus Classic Requirements	Limiting Value
Annual space heating demand	≤ 15 kWh/(m^2.a) or peak heating load of 10 W/m2
Annual space cooling demand	≤ 15 kWh/(m^2.a) or peak cooling load of 10 W/m2
Primary energy renewable (PER) demand	≤ 60 kWh/m^2a (up to 75 kWh/m^2a with PVs)
Airtightness	≤ 0.6 Air Changes per Hour @50Pa
Overheating	< 10% occupied hours above 25°C
Design temperature (winter)	20°C
Design temperature (summer)	25°C
Window installed U-value	≤ 0.85 W/(m^2K)
MVHR efficiency	>=75% (unit to be certified by the PHI)
MVHR Specific Fan Power (SFP)	≤ 0.45 Wh/m^3 (1.62 W/l/s)
Evidence	Certificates, delivery notes, photographs, confirmation of performance specification, declarations
Passivhaus Consultant	Applicable
Passivhaus Certifier	Applicable
Passivhaus Institute (PHI) Assessment	Applicable

4.5. The PHI Low Energy Building Standard can be awarded where a building aiming for the Passivhaus standard does not satisfy the targets. For example, this could be a near miss of the space heat demand, peak load or air tightness targets.

4.6. It is not the intention that projects should start out aiming for the PHI Low Energy Building Standard, instead the Passivhaus classic should be used, which is the approach that CIP have adopted.

4.7. The LEB requirements for energy demand, airtight-ness and comfort are lower than Classic. However, the required documentation is the same facilitating an accurate assessment of the building's energy demand.

5. Certification Results

5.1. All 21 properties following the certification route have been certified by the Passivhaus Institute (PHI). The certificates are included at Appendix A.

5.2. Qoda Consulting acted as the Passivhaus Consultant and the Warm Low Energy Building Practice were the accredited Passivhaus Certifier. Both parties collectively provided details to the Passivhaus Institute for assessment.

5.3. Certification can only be achieved once all the design and construction evidence has been provided and checked.

5.4. **13 properties** (62%) have been certified as Passivhaus **Classic** buildings.

5.5. The Passivhaus Classic homes include:

- Fen Road – 6 to 8 Five Trees Court (3 homes)
- Fen Road – 9 to 12 Five Trees Court (4 homes)
- Ditton – 143, 145, 147, 149, 151 & 153 Wadloes Road (6 homes)

5.6. **8 homes** (38%) have been awarded the **Low Energy Building** (LEB) Standard.

5.7. The LEB standard homes include:

- Fen Road – 1 to 2 Five Trees Court (2 homes)
- Fen Road – 3 to 5 Five Trees Court (3 homes)
- Borrowdale - 30A, 30B and 30C Borrowdale (3 homes)

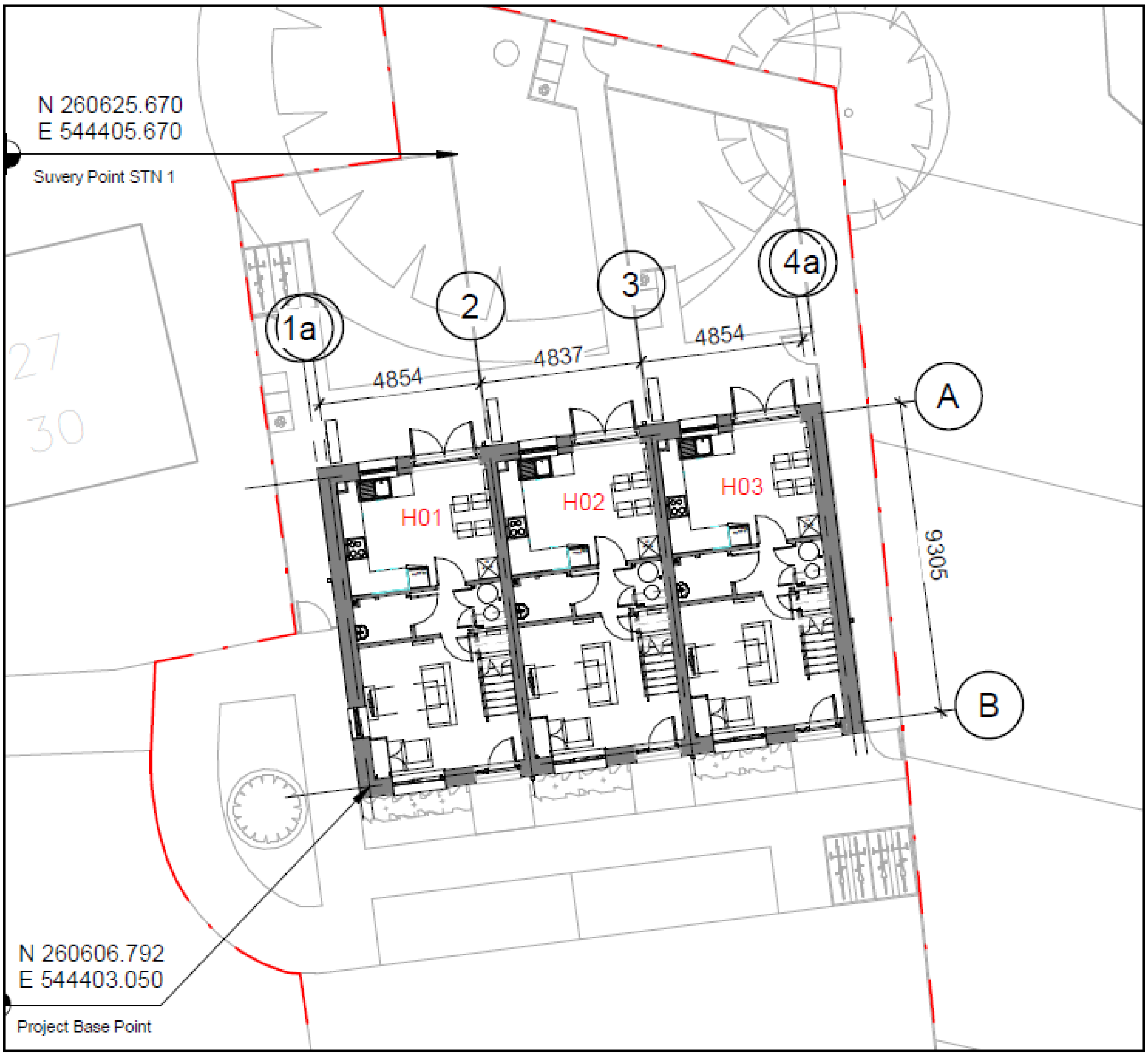
5.8. The certificates are included in Appendix A.

5.9. A performance assessment has been undertaken to review the factors that have resulted in a mix of Passivhaus Classic and LEB standard dwellings. The findings are included in Section 6 below.

6. Performance Assessment

6.1. The tables below benchmark the performance of each block against the Passivhaus ‘Classic’ targets. Blocks that did not achieve all the classic targets have defaulted to a LEB certification (near miss).

Borrowdale

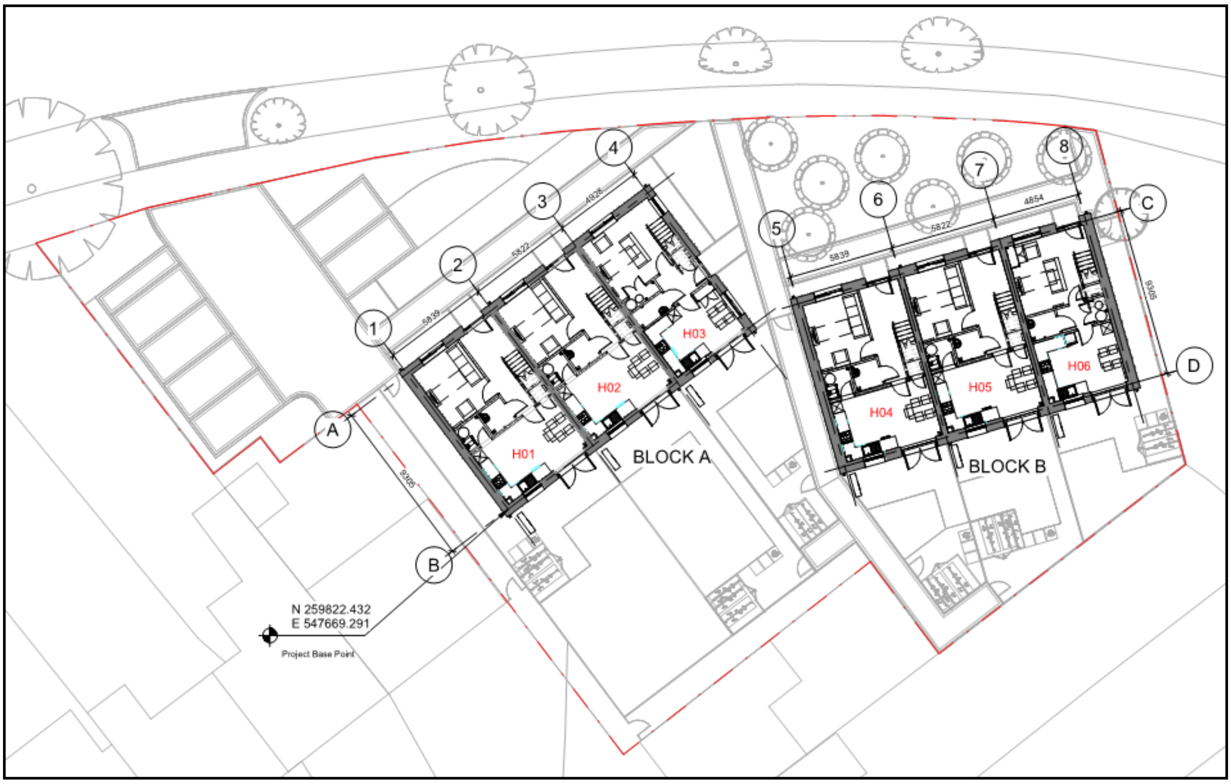


Key Achieved / Not achieved

Criteria	Borrowdale		
	30A Borrowdale	**30B Borrowdale**	**30C Borrowdale**
	Plot 1	Plot 2	Plot 3
Orientation			
Shape / size			
Space heating			
Space cooling			
Hot water			
Ventilation			
Airtightness			
Product verification			
Thermal detailing			
Primary Energy Renewable			

This block achieved Low Energy Building certification

Ditton Fields



<u>Block A</u>

Key

Achieved
Not achieved

Criteria	**Ditton Fields**		
	143 Wadloes Rd	**145 Wadloes Rd**	**147 Wadloes Rd**
	Plot 6	Plot 5	Plot 4
Orientation			
Shape / size			
Space heating			
Space cooling			
Hot water			
Ventilation			
Airtightness			
Product verification			
Thermal detailing			
Primary Energy Renewable			

This block achieved Passivhaus Classic certification

<u>Block B</u>

Key

Achieved
Not achieved

Criteria	**Ditton Fields**		
	149 Wadloes Rd	**151 Wadloes Rd**	**153 Wadloes Rd**
	Plot 3	Plot 2	Plot 1
Orientation			
Shape / size			
Space heating			
Space cooling			
Hot water			
Ventilation			
Airtightness			
Product verification			
Thermal detailing			
Primary Renewable Demand			

This block achieved Passivhaus Classic certification

Fen Road

<u>Block A</u>

Key

Achieved	
Not achieved	

Criteria	Fen Road		
	3 Five Trees Ct	**4 Five Trees Ct**	**5 Five Trees Ct**
	Plot 10	Plot 9	Plot 8
Orientation			
Shape / size			
Space heating			
Space cooling			
Hot water			
Ventilation			
Airtightness			
Product verification			
Thermal detailing			
Primary Energy Renewable			

This block achieved Low Energy Building certification

Block B

Key	
	Achieved
	Not achieved

Criteria	**Fen Road**	
	1 Five Tress Ct	**2 Five Trees Ct**
	Plot 12	Plot 11
Orientation	Not achieved	Not achieved
Shape / size	Not achieved	Not achieved
Space heating	Not achieved	Not achieved
Space cooling	Achieved	Achieved
Hot water	Achieved	Achieved
Ventilation	Achieved	Achieved
Airtightness	Not achieved	Not achieved
Product verification	Achieved	Achieved
Thermal detailing	Achieved	Achieved
Primary Renewable Demand	Achieved	Achieved

This block achieved Low Energy Building certification

Block C

Key	
	Achieved
	Not achieved

Criteria	**Fen Road**		
	6 Five Trees Ct	**7 Five Trees Ct**	**8 Five Trees Ct**
	Plot 7	Plot 6	Plot 5
Orientation	Achieved	Achieved	Achieved
Shape / size	Achieved	Achieved	Achieved
Space heating	Achieved	Achieved	Achieved
Space cooling	Achieved	Achieved	Achieved
Hot water	Achieved	Achieved	Achieved
Ventilation	Achieved	Achieved	Achieved
Airtightness	Achieved	Achieved	Achieved
Product verification	Achieved	Achieved	Achieved
Thermal detailing	Achieved	Achieved	Achieved
Primary Energy Renewable	Achieved	Achieved	Achieved

This block achieved Passivhaus Classic certification

Block D

Key	
	Achieved
	Not achieved

Criteria	Fen Road			
	9 Five Trees Ct	**10 Five Trees Ct**	**11 Five Trees Ct**	**12 Five Trees Ct**
	Plot 4	Plot 3	Plot 2	Plot 1
Orientation				
Shape / size				
Space heating				
Space cooling				
Hot water				
Ventilation				
Airtightness				
Product verification				
Thermal detailing				
Primary Energy Renewable				

This block achieved Passivhaus Classic certification

7. Key Challenges

7.1. The performance tables in Section 6 highlight four challenges relating to:

- Airtightness
- Orientation
- Shape/size
- Space heating

7.2. Airtightness was difficult to achieve for several reasons including:

- Upskilling & training sub-contractors on appropriate working practices
- Sub-contractors not reporting breaches of the airtight barrier
- Continuous sub-contractor management in every plot
- Movement due to the timber frame construction

7.3. Orientation proved challenging for several reasons including:

- Unable to optimise building orientation due to planning considerations
- Making best use of site to meet housing need and ensure viability
- Existing site constraints

The ideal situation is a north-south orientation with daylight optimised glazing on the north façade and 15-25% glazing on the south façade.

7.4. The ideal shape/size was difficult to achieve due to:
- Not being able to design high buildings on these sites
- Form factor (heat loss area of envelope) of buildings being poor due to site and planning constraints

7.5. Space heating challenges arose due to:
- Achieving the right balance between heat losses, solar gains and internal heat gains
- Solar gain links to building orientation and the challenges listed above

Over-heating is specifically assessed as part of the PHPP energy modelling process to mitigate associated risks.

General challenges

7.6. Generally, earlier consultant involvement is required to bring forward elements of detailed design. This includes architectural, mechanical, electrical, and plumbing services.

7.7. Delivering Passivhaus requires additional time on site for the bespoke sequencing of specific tasks, such as forming the airtight barriers to all relevant construction details. Co-ordinating the certification inspections also impacts on programme.

7.8. Additional site management time is required to provide the necessary level of quality management on site.

7.9. Reviewing Passivhaus construction elements with warranty providers and building control needs to be accommodated as designs develop.

7.10. Integrating Passivhaus specifications with traditional components is a key task. For example, insulated ductwork being too large to fit through standard floor joists and items of plant being larger than standard cupboards sizes. These clashes need to be identified and resolved as early as possible to avoid delays to works on site and additional preliminaries costs.

7.11. Sub-contractors needing Passivhaus training and specialist supply chains need to be available.

7.12. Changing the cultures adopted by on site trades is necessary relating to mistakes and oversights, they must feel comfortable and be encouraged to admit mistakes to prevent airtightness issues arising during later stages of the build.

7.13. Ensuring key contractual and specification requirements are clear to all sub-contractors and suppliers is a specific requirement.

7.14. Out of sequence working allowances need to be built into the on-site construction programmes and be included within tender packages for pricing purposes.

8. Passivhaus Principles & CamStandard

8.1. The Council are aware of the misconceptions and legal implications associated with reference to Passivhaus principles/standards.

8.2. The sites at Aragon and Sackville Close are being constructed to Passivhaus principles as documented in planning condition 20 as follows:

(20) Passivhaus principles

The development hereby permitted shall be designed in accordance with Passivhaus principles, as set out in the Land at Aragon Close, Cambridge, Sustainability Report, January 2022 Pollard Thomas Edwards Rev P02. The renewable and/or low carbon technologies shall thereafter be retained and remain fully operational in accordance with a maintenance programme, which shall be submitted to and approved in writing by the Local Planning Authority before the development is first occupied.

Reason: In the interests of reducing carbon dioxide emissions and promoting principles of sustainable construction and efficient use of buildings (Cambridge Local Plan Policy 29 and Greater Cambridge Sustainable Design and Construction SPD 2020).

8.3. The Sustainability Report referenced in the condition wording confirms that the homes will target Passivhaus standards using the following fabric and services approach:

- Highly insulated walls, floors and roof
- High performance triple glazing
- Air tightness of <1.0 m3/m2/hr @ 50Pa
- Air Source Heat Pumps (ASHP)
- 100% energy efficient lighting
- Minimal thermal bridging
- Highly efficient Mechanical Ventilation Heat Recovery (MVHR) units
- Heat recovery 89%
- Specific fan power <1.3 w/l/s.

8.4. All Passivhaus buildings have basic physical characteristics in common, for example a high-performance thermal envelope which relates to the climate zone where it is located. To deliver the performance in-use, they are also required to follow the principle of quality assurance, for example, accurate modelling in PHPP, air tests, commissioning of ventilation systems etc.

8.5. The Passivhaus community and the Passivhaus Trust does not support the use of the term '**Passivhaus principles**', as this is widely misused in the UK as it commonly refers to projects which do not meet all the quality assurance requirements established by the Passivhaus standard. The uninformed individual incorrectly discusses **characteristics** when they should be discussing the principle of **quality assurance**

8.6. The Consumer Protection from Unfair Trading Regulations 2008 (CPRs), specifically; Banned Practices (Schedule 1), Professional Diligence (Regulation 2), and Misleading Practices (Regulations 5 & 6); protect the customer against false claims and misrepresentations that a building meets the Passivhaus standard.

8.7. Claims relating to the use of so-called Passivhaus principles could be considered misleading and therefore illegal so the Council must move away from using this terminology.

8.8. The alternative descriptor **CamStandard** is to be used in conjunction with Passivhaus /Feasibility Studies undertaken at RIBA Stage 1. The Feasibility Study may highlight significant challenges in achieving Passivhaus certification. Sites may not offer the required degree of flexibility to secure ideal orientation, or planning constraints may restrict form factor, for example. These criteria then increase the pressure on other performance criteria.

8.9. Adopting the proposed CamStandard helps when financial viability is under pressure and the additional costs associated with Passivhaus certification cannot be accommodated. Rising build costs and inflation during the pilot study have also contributed to challenging financial viability.

8.10. The CamStandard incorporates all elements of architectural, mechanical, electrical & plumbing (MEP) design. Sustainability will be optimised whilst maximising options for cost saving and providing some flexibility to cater for site and/or scheme specific constraints and requirements.

8.11. The CamStandard will be a careful collaboration between The Council, Hill and QODA as MEP/Passivhaus consultant.

8.12. The buildings will deliver very low running costs, considerable health and wellbeing advantages, excellent air quality and daylight, and a high degree of climate resilience.

8.13. CamStandard is proposed to be a practical alternative in terms of environmental building with a focus on benefits to tenants.

8.14. The contractor, subcontractors, suppliers, and manufacturers will be required to participate towards the achievement of CamStandard.

8.15. The performance specification in the table below highlights the differences between Passivhaus Certified targets and the proposed CamStandard. Passivhaus principles will be replaced by the CamStandard.

Performance Specification Table

REQUIREMENT	**Passivhaus certified**	**CamStandard**
	Limiting Value	**Limiting Value**
Annual space heating demand	≤ 15 kWh/(m^2.a) or peak heating load of 10 W/m2	**Up to 40 kWh/(m^2.a)**
Annual space cooling demand	≤ 15 kWh/(m^2.a)	**≤ 15 kWh/(m^2.a)**
Primary energy renewable (PER) demand	≤ 60 kWh/m^{2}a (up to 75 kWh/m^{2}a with PVs)	**60 to 75 kWh/m^{2}a (up to 75 kWh/m^{2}a with PVs); or a project specific PER calculated using the**

		PHPP for high occupancy density buildings
Airtightness	≤ 0.6 Air Changes per Hour @50Pa	**Up to 1.0 Air Changes per Hour @50Pa**
Overheating	< 10% occupied hours above 25°C	**< 10% occupied hours above 25°C**
Design temperature (winter)	20°C	**20°C**
Design temperature (summer)	25°C	**25°C in conjunction with Building Regulations Part O assessment for residential buildings**
Window installed U-value	≤ 0.85 $W/(m^2K)$	**≤ 0.85 $W/(m^2K)$**
MVHR efficiency	>=75% (unit to be certified by the PHI)	**>=75%**
MVHR Specific Fan Power (SFP)	≤ 0.45 Wh/m^3 (1.62 W/l/s)	**≤ 0.45 Wh/m^3 (1.62 W/l/s)**
Passivhaus Consultant	Applicable	**Passivhaus or AECB Consultant**
Passivhaus Certifier	Applicable	**Not applicable**
Passivhaus Institute (PHI) Assessment	Applicable	**Not applicable**
QUALITY ASSURANCE		
PHPP Model	Required for all schemes	**Required for all schemes**
Evidence	Certificates, delivery notes, photographs, confirmation of performance specification, declarations	Certificates, delivery notes, photographs, confirmation of performance specification, declarations
Independent Certification	Applicable	Not applicable

9. Indicative Costs

9.1. Detailed costs cannot be reviewed until the final accounts for the sub-contract packages for the certified schemes are finalized and agreed.

9.2. Final outturn costs will exceed the original contract value for the certified schemes, based on current valuations and estimates relating to final work packages.

9.3. The table below highlights some of the additional costs to deliver Passivhaus certified homes compared against a standard build, and the proposed CamStandard (formally Passivhaus principles).

Key	
Green	No or minimal additional costs (less 5%)
Amber	Some additional costs (+6% to 25%)
Red	Significant additional costs (+26%)

Criteria	**Build Type**		
	Standard Build	**Passivhaus Certified**	**Camhaus / Cam Standard**
Time:			
Air testing	Green	Red	Amber
Labor re-scheduling	Green	Red	Amber
Re-modelling PHPP	Green	Red	Amber
Approval periods	Green	Amber	Green
Fees:			
Planning fees	Green	Red	Red
PH Consultant	Green	Red	Red
PH Certifier	Green	Red	Green
PH Champion	Green	Amber	Amber
Certified Products:			
Windows & doors	Green	Red	Red
Insulation	Green	Red	Red
ASHP	Green	Amber	Amber
MVHR	Green	Red	Red
Wall system	Green	Red	Red
Airtight barrier	Green	Red	Red

9.4. Passivhaus design, specification and certification needs to be viable otherwise the Council/CIP cannot progress schemes.

9.5. Additional costs arising from targeting Passivhaus Classic criteria include:

- General inflexible design, specification and procurement
- Local planning authority requirements
- Pricing increased risk

- Supply chain availability and capability
- Extended project programmes with higher preliminary costs
- Quality assurance of installations
- Cost per metre square for basic substructure and superstructure are more expensive than traditional builds
- Costs of insulation are increasing

10. Next Steps

10.1. This Initial Report on the Passivhaus pilot certified schemes has highlighted the requirement to refine the Sustainable Housing Design Guide (SHDG). This should clarify the standard that is being achieved avoiding any legal issues and also create a transparent regime to ensure high levels of sustainability. This will enable the learning from the pilot scheme and future schemes to be captured.

10.2. Interim updating of the SHDG will be via the Addendum included at Appendix B of this report.

10.3. The preparation of a Completion Report once the remaining homes forming part of the pilot study are constructed is appropriate to facilitate a comparable analysis of the Passivhaus certified specification and Passivhaus principles/CamStandard, to carefully balance cost and viability with sustainability targets.

10.4. A Final Report following a suitable period of occupation in both the certified and Passivhaus principles homes will provide data that can be analysed to review the modelled and actual impact on tenants heating bills and operational carbon.

10.5. The Final report will form the basis of a comprehensive update of the SHDG which is expected late 2025 - early 2026.

10.6. The Final Report will also include practical steps required to achieve Net Zero by 2030.

Appendix A

Passivhaus Certification

Certificate

Certified PHI Low Energy Building

WARM

Authorised by:

Passive House Institute

Dr. Wolfgang Feist
64283 Darmstadt
Germany

30 A,B,C
Borrowdale, CB4 3HU Cambridge, United Kingdom

PHI **Low Energy** Building

Client	CIP - Hill Duxford Road CB10 1SX Cambridge, United Kingdom
Architect	aPLB 50 Southwark Street SE1 1UN London, United Kingdom
Building Services	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom
Energy Consultant	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom

The characteristic energy values of buildings certified according to the PHI Low Energy Building Standard are verified as thoroughly as for Passive House certification. However, due to various reasons PHI Low Energy Buildings have a somewhat higher energy demand (criteria: see www.passivehouse.com).

The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the PHI Low Energy Building Standard:

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	21	≤	30	
Cooling					
Frequency of overheating (> 25 °C)	[%]	0	≤	10	
Airtightness					
Pressurization test result (n_{50})	[1/h]	0.7	≤	1.0	
Renewable primary energy (PER)					
PER-demand	[kWh/(m²a)]	67	≤	75	75
Generation (reference to ground area)	[kWh/(m²a)]	29	≥	-	-

The associated certification booklet contains more characteristic values for this building.

Plymouth
18/04/2024

Certifier: Sally Godber, WARM

Certificate

Certified Passive House Classic

WARM
NO.3 ADMIRALS HARD, PLYMOUTH, PL1 3RJ UK

Authorised by:

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

149, 151, 153
Wadloes Road, CB5 8PF Cambridge, United Kingdom

Certified Passivhaus
Passivhaus Institut
| classic | plus | premium |

Client	CIP - Hill Duxford Road CB10 1SX Cambridge, United Kingdom
Architect	aPLB 50 Southwark Street SE1 1UN London, United Kingdom
Building Services	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom
Energy Consultant	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom

Passive House buildings offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

The design of the above-mentioned building meets the criteria defined by

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	19	≤	15	-
Heating load	[W/m²]	10	≤	-	10
Cooling					
Frequency of overheating (> 25 °C)	[%]	2	≤	10	
Airtightness					
Pressurization test result (n_{50})	[1/h]	0.5	≤	0.6	
Renewable primary energy (PER)					
PER-demand	[kWh/(m²a)]	64	≤	60	64
Generation (reference to ground area)	[kWh/(m²a)]	44	≥	-	6

The associated certification booklet contains more characteristic values for this building.

Plymouth, 18 April 2024
Certifier: Sally Godber, WARM

Certificate

Certified Passive House Classic

WARM
NO.3 ADMIRALS HARD, PLYMOUTH, PL1 3RJ UK

Authorised by:

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

143, 145, 147
Wadloes Road, CB5 8PF Cambridge, United Kingdom

Certified Passivhaus
Passivhaus Institut
classic | plus | premium

Client	CIP - Hill Duxford Road CB10 1SX Cambridge, United Kingdom
Architect	aPLB 50 Southwark Street SE1 1UN London, United Kingdom
Building Services	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom
Energy Consultant	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom

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The design of the above-mentioned building meets the criteria defined by

Building quality			This building		Criteria	Alternative criteria
Heating						
Heating demand		[kWh/(m²a)]	19	≤	15	-
Heating load		[W/m²]	10	≤	-	10
Cooling						
Frequency of overheating (> 25 °C)		[%]	1	≤	10	
Airtightness						
Pressurization test result	(n_{50})	[1/h]	0.5	≤	0.6	
Renewable primary energy (PER)						
PER-demand		[kWh/(m²a)]	65	≤	60	65
Generation (reference to ground area)		[kWh/(m²a)]	40	≥	-	8

The associated certification booklet contains more characteristic values for this building.

Plymouth, 18 April 2024
Certifier: Sally Godber, WARM

Certificate

Certified PHI Low Energy Building

WARM

Authorised by:

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

1-2 Five Trees Court
Fen Road, CB4 1UN Cambridge, United Kingdom

PHI Low Energy Building

Client	CIP - Hill Duxford Road CB10 1SX Cambridge, United Kingdom
Architect	aPLB 50 Southwark Street SE1 1UN London, United Kingdom
Building Services	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom
Energy Consultant	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom

The characteristic energy values of buildings certified according to the PHI Low Energy Building Standard are verified as thoroughly as for Passive House certification. However, due to various reasons PHI Low Energy Buildings have a somewhat higher energy demand (criteria: see www.passivehouse.com).

The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the PHI Low Energy Building Standard:

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	20	≤	30	
Cooling					
Frequency of overheating (> 25 °C)	[%]	1	≤	10	
Airtightness					
Pressurization test result (n_{50})	[1/h]	0.7	≤	1.0	
Renewable primary energy (PER)					
PER-demand	[kWh/(m²a)]	64	≤	75	75
Generation (reference to ground area)	[kWh/(m²a)]	38	≥	-	-

The associated certification booklet contains more characteristic values for this building.

Plymouth
18/04/2024

Certifier: Sally Godber, WARM

Certificate

Certified PHI Low Energy Building

WARM

Authorised by:

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

3-5 Five Trees Court
Fen Road, CB4 1UT Cambridge, United Kingdom

PHI **Low Energy** Building

Client	CIP - Hill Duxford Road CB10 1SX Cambridge, United Kingdom
Architect	aPLB 50 Southwark Street SE1 1UN London, United Kingdom
Building Services	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom
Energy Consultant	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom

The characteristic energy values of buildings certified according to the PHI Low Energy Building Standard are verified as thoroughly as for Passive House certification. However, due to various reasons PHI Low Energy Buildings have a somewhat higher energy demand (criteria: see www.passivehouse.com).

The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the PHI Low Energy Building Standard:

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	19	≤	30	
Cooling					
Frequency of overheating (> 25 °C)	[%]	1	≤	10	
Airtightness					
Pressurization test result (n_{50})	[1/h]	0.9	≤	1.0	
Renewable primary energy (PER)					
PER-demand	[kWh/(m²a)]	64	≤	75	75
Generation (reference to ground area)	[kWh/(m²a)]	34	≥	-	-

The associated certification booklet contains more characteristic values for this building.

Plymouth
18/04/2024

Certifier: Sally Godber , WARM

Certificate

Certified Passive House Classic

WARM

NO.3 ADMIRALS HARD, PLYMOUTH, PL1 3RJ UK

Authorised by:

Passive House Institute

Dr. Wolfgang Feist
64283 Darmstadt
Germany

6-8 Five Trees Court
Fen Road, CB4 1UT Cambridge, United Kingdom

Certified Passivhaus
Passivhaus Institut
| classic | plus | premium |

Client	CIP - Hill Duxford Road CB10 1SX Cambridge, United Kingdom
Architect	aPLB 50 Southwark Street SE1 1UN London, United Kingdom
Building Services	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom
Energy Consultant	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom

Passive House buildings offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

The design of the above-mentioned building meets the criteria defined by

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	18	≤	15	-
Heating load	[W/m²]	10	≤	-	10
Cooling					
Frequency of overheating (> 25 °C)	[%]	4	≤	10	
Airtightness					
Pressurization test result (n_{50})	[1/h]	0.6	≤	0.6	
Renewable primary energy (PER)					
PER-demand	[kWh/(m²a)]	66	≤	60	66
Generation (reference to ground area)	[kWh/(m²a)]	29	≥	-	9

The associated certification booklet contains more characteristic values for this building.

Plymouth, 18 April 2024

Certifier: Sally Godber, WARM

Certificate

Certified Passive House Classic

WARM

NO.3 ADMIRALS HARD, PLYMOUTH, PL1 3RJ UK

Authorised by:

Passive House Institute

Dr. Wolfgang Feist
64283 Darmstadt
Germany

9-12 Five Trees Court
Fen Road, CB4 1UT Cambridge, United Kingdom

Certified
Passivhaus
Passivhaus Institut
| **classic** | plus | premium |

Client	CIP - Hill Duxford Road CB10 1SX Cambridge, United Kingdom
Architect	aPLB 50 Southwark Street SE1 1UN London, United Kingdom
Building Services	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom
Energy Consultant	QODA Consulting 5 Upper St Martins Lane WC2H 9EA London, United Kingdom

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The design of the above-mentioned building meets the criteria defined by

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	17	≤	15	-
Heating load	[W/m²]	10	≤	-	10
Cooling					
Frequency of overheating (> 25 °C)	[%]	1	≤	10	
Airtightness					
Pressurization test result (n_{50})	[1/h]	0.5	≤	0.6	
Renewable primary energy (PER)					
PER-demand	[kWh/(m²a)]	67	≤	60	67
Generation (reference to ground area)	[kWh/(m²a)]	31	≥	-	11

The associated certification booklet contains more characteristic values for this building.

Plymouth, 18 April 2024
Certifier: Sally Godber, WARM

Appendix B

Sustainable Housing Design Guide

Addendum

TO FOLLOW

Being prepared by Architects

Polard Thomas Edwards