WH Architects

Energy and Sustainability Statement

Ref: 21133 – Proposed conversion development @ 888 Chasefield House, Fishponds, BS16 3XB

04 May 2023

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Issue Control

Director	[redacted]

First Issue Date	Revision Issue Date	Issue Revision	Issued By
August 31st, 2021	-	-	[redacted]
	04 May. 23	*A*	[redacted]

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1 Executive Summary

This Energy and Sustainability Statement has been prepared by Watt Energy on behalf of WH Architects to support a planning application for the development of Chasefield House. The statement specifically addresses the following Bristol City Council planning policies, as stipulated in the Bristol City Council's Development Framework Core Strategy 2011:

- BCS13 – Mitigating and Adapting to Climate Change
- BCS14 – Renewable and Low-Carbon Sources of Energy
- BCS15 – Sustainable Design and Construction

The statement details how the development will incorporate sustainable design and resource efficiency in line with the Energy Hierarchy, so to meet the policy requirements and council targets whilst reducing its overall environmental impact.

In relation to the planning documents and policies outlined above, the development is required to achieve a 20% reduction in carbon emissions over the residual emissions, calculated at the Be Lean stage of the Energy Hierarchy, solely through the implementation of renewable and low/zero carbon technologies.

To achieve this compliance, the development has been designed with a holistic low energy design concept involving a fabric first approach and utilising system gas boilers and hot water cylinders to satisfy the space heating and hot water requirements. The U-values, design air permeability and ventilation targets all aspire to achieve and exceed Part L 2013 standards along with the consideration and application of low zero carbon renewable technologies.

Following the LZC feasibility assessment, it is proposed that the development will benefit from ASHP Heating and Hot Water.

As a result of the above the predicted site wide reduction in CO_2 over Part L 2013 of the Building Regulations can be summarised as:

- 25.92% with SAP 9 carbon factors (current Building Regulations)

This statement also examines how the design, specification and characteristics of the proposal will contribute to sustainability and meet the relevant objectives outlined within the National Planning Policy Framework (NPPF) 2019, in addition to the Bristol City Council approved climate change action plans and core strategy planning policies outlined above. The sustainability measures assessed included:

- Flood Risk Zone
- Green and Blue Infrastructure
- Sustainable Drainage Systems (SUDs)
- Biodiversity / Ecology

- Internal Water Efficiency
- Waste Management
- Materials
- Pollution Control
- Health and Wellbeing
- Sustainable Transport

The development therefore complies with all Bristol City Council's current and future policy requirements relating to creating a sustainable development.

2 Planning Statement

The following statement relates to the proposed development at Chasefield House, BS16 3XB.

2.1 The Site and Proposed Development

The proposal is for the conversion of an existing building to create 2no 10 bed houses of multiple occupancy (HMOs).

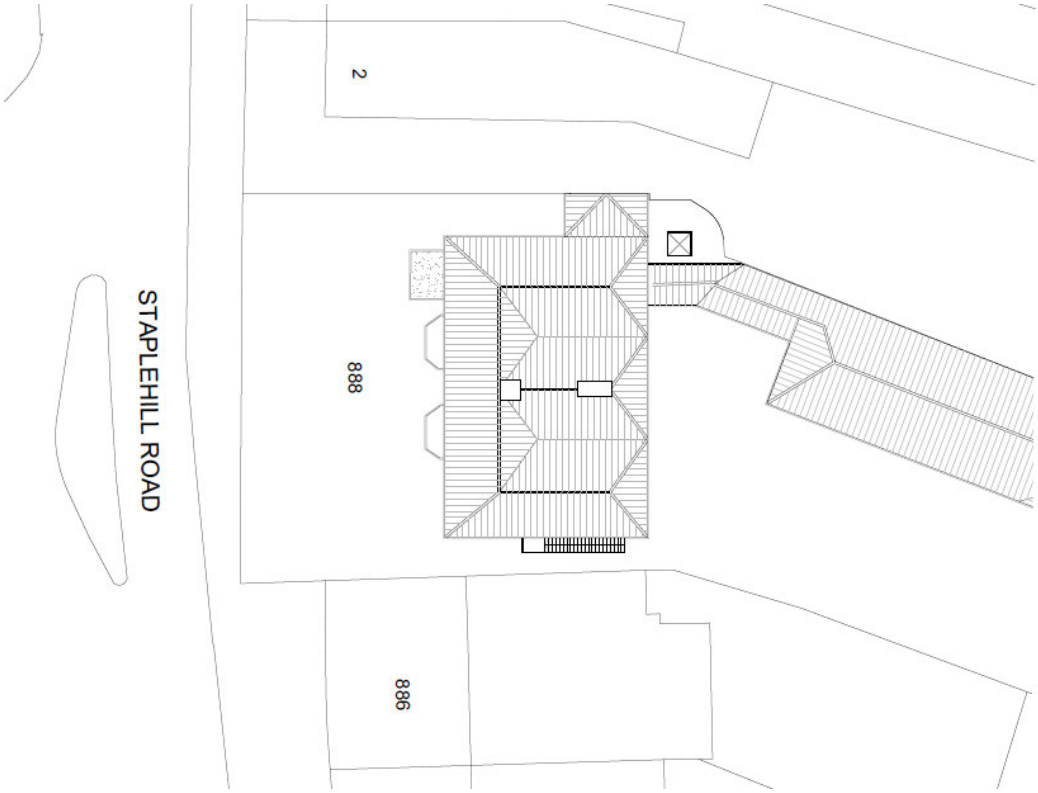

Figure 1: Site Plan

2.2 Relevant Policies and Guidance

2.2.1 Local Planning Policy

2.2.1.1 Bristol Core Strategy

This report is a resultant production in response to Bristol City Council's Development Framework Core Strategy 2011, and specifically deals with planning policies BCS13, BCS14 and BCS15, covering Climate Change and Sustainability.

BCS13

Policy BCS13

Development should contribute to both mitigating and adapting to climate change, and to meeting targets to reduce carbon dioxide emissions.

Development should mitigate climate change through measures including:

- High standards of energy efficiency including optimal levels of thermal insulation, passive ventilation and cooling, passive solar design, and the efficient use of natural resources in new buildings.
- The use of decentralised, renewable and low-carbon energy supply systems.
- Patterns of development which encourage walking, cycling and the use of public transport instead of journeys by private car.

Development should adapt to climate change through measures including:

- Site layouts and approaches to design and construction which provide resilience to climate change.
- Measures to conserve water supplies and minimise the risk and impact of flooding.
- The use of green infrastructure to minimise and mitigate the heating of the urban environment.
- Avoiding responses to climate impacts which lead to increases in energy use and carbon dioxide emissions.

These measures should be integrated into the design of new development.

New development should demonstrate through Sustainability Statements how it would contribute to mitigating and adapting to climate change and to meeting targets to reduce carbon dioxide emissions by means of the above measures.

BCS14

Policy BCS14

Proposals for the utilisation, distribution and development of renewable and low-carbon sources of energy, including large-scale freestanding installations, will be encouraged. In assessing such proposals the environmental and economic benefits of the proposed development will be afforded significant weight, alongside considerations of public health and safety and impacts on biodiversity, landscape character, the historic environment and the residential amenity of the surrounding area.

Development in Bristol should include measures to reduce carbon dioxide emissions from energy use in accordance with the following energy hierarchy:

1. Minimising energy requirements;
2. Incorporating renewable energy sources;
3. Incorporating low-carbon energy sources.

Consistent with stage two of the above energy hierarchy, development will be expected to provide sufficient renewable energy generation to reduce carbon dioxide emissions from residual energy use in the buildings by at least 20%. An exception will only be made in the case where a development is appropriate and necessary but where it is demonstrated that meeting the required standard would not be feasible or viable.

The use of combined heat and power (CHP), combined cooling, heat and power (CCHP) and district heating will be encouraged. Within Heat Priority Areas, major development will be expected to incorporate, where feasible, infrastructure for district heating, and will be expected to connect to existing systems where available.

New development will be expected to demonstrate that the heating and cooling systems have been selected according to the following heat hierarchy:

1. Connection to existing CHP/CCHP distribution networks
2. Site-wide renewable CHP/CCHP
3. Site-wide gas-fired CHP/CCHP
4. Site-wide renewable community heating/cooling
5. Site-wide gas-fired community heating/cooling
6. Individual building renewable heating

BCS15

Policy BCS15

Sustainable design and construction will be integral to new development in Bristol. In delivering sustainable design and construction, development should address the following key issues:

- Maximising energy efficiency and integrating the use of renewable and low-carbon energy;
- Waste and recycling during construction and in operation;
- Conserving water resources and minimising vulnerability to flooding;
- The type, life cycle and source of materials to be used;
- Flexibility and adaptability, allowing future modification of use or layout, facilitating future refurbishment and retrofitting;
- Opportunities to incorporate measures which enhance the biodiversity value of development, such as green roofs.

New development will be required to demonstrate as part of the Sustainability Statement submitted with the planning application how the above issues have been addressed. For major development and development for health or education uses, the Sustainability Statement should include a BREEAM and/or Code for Sustainable Homes assessment. Additionally, in the case of a super-major development, a BREEAM for Communities assessment will be required.

From 2016 residential development will be expected to meet Level 6 of the Code for Sustainable Homes. For non-residential development, also from 2016, a BREEAM "Excellent" rating will be expected.

All new development will be required to provide satisfactory arrangements for the storage of refuse and recyclable materials as an integral part of its design. Major developments should include communal facilities for waste collection and recycling where appropriate.

New homes and workplaces should include the provision of high-speed broadband access and enable provision of Next Generation broadband.

2.2.2 National Planning Policy

The NPPF (February 2019) sets out the Government's planning policies for England and how these are expected to be applied. The overall emphasis of the NPPF is to reiterate the Government's key objectives, including securing sustainable development.

The NPPF defines the purpose of the planning system as being to contribute to the achievement of sustainable development. It explains at Paragraph 8 that there are three dimensions to sustainable development. These are economic, social and environmental and should be pursued simultaneously through the planning system.

Paragraph 10 states that at the heart of the Framework is a presumption in favour of sustainable development.

2.3 Sustainable Design Strategy

2.3.1 Energy and Carbon Emissions

Building Services Strategy

In response to the policy requirements and climate change plan targets set out in section 2.2, developments should aim to assist and achieve the following carbon reduction targets:

1. Achieve a minimum of 20% CO2 reduction over the Part L 2013 residual emissions, solely through renewable/ LZC technologies

To achieve the most accurate calculations and estimates, the proposed units have been modelled using *SAP 2012* the governments Standard Assessment Procedure for residential dwellings.

The proposed strategy for minimising energy use and carbon emissions is based on the energy hierarchy described in CIBSE Guide F 2012 (Energy efficiency in buildings). The energy hierarchy has been adopted for the development to ensure that the correct approach to design is taken to promote an energy-efficient low carbon solution (see figure 2). This has ensured that the benefits of effective methods of energy use reduction have been maximised first. The approach adopted is as follows:

Fig 2: Energy Hierarchy

Minimise energy demand – Implement passive design measures and optimise the building envelope in terms of orientation, air tightness, and insulation. For example, the proposal is targeting a low carbon classification through a holistic low energy design concept as it will be designed with a fabric first approach.

Meet demands efficiently – Specification of energy efficient decentralised plant, heating, ventilation, lighting, and system controls to facilitate efficient operation. For example, each dwelling will include highly efficient gas boilers to provide the main heating and hot water requirements.

Additional Renewable Energy Measures

Opportunities for incorporating low and zero carbon technologies (LZCT) have been considered for this development. The viability of several separate technologies was examined in a LZCT study (see section 3) which helped to identify potential opportunities for the inclusion of ASHP Heating and Hot Water.

Efficient and Sustainable Design Measures

In line with the above Sustainable Design Strategy, the following Energy Efficient design measures are specified.

- High levels of insulation throughout with minimal thermal bridges
- Passive solar gains and internal heat sources
- Excellent level of airtightness
- Good indoor air quality by openable windows

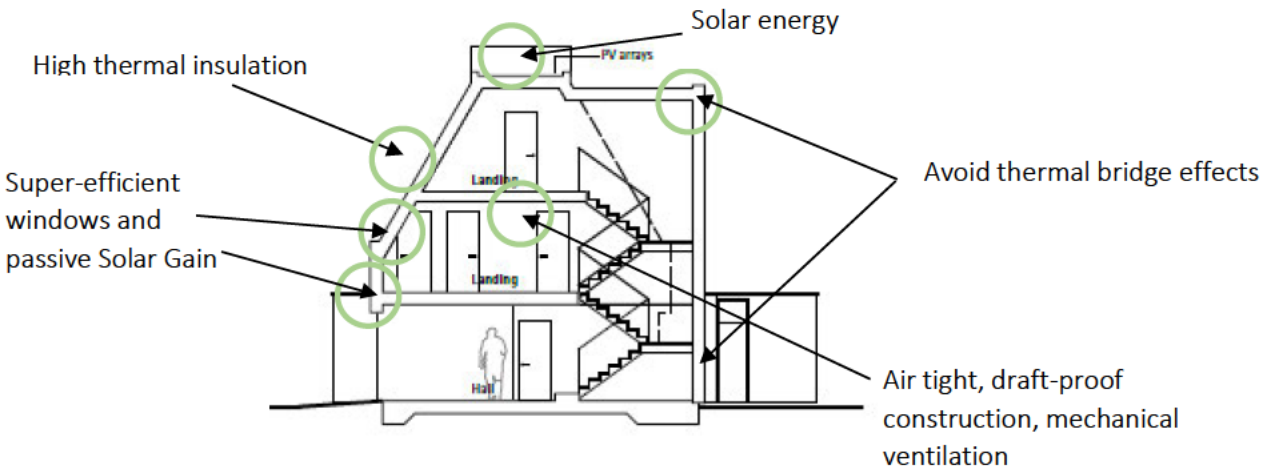

Fig 3. Efficient Design Measure examples

The Proposed specifications and key energy efficient design measures are as follows:

Residential Units:

- Upgraded External Wall U-values of 0.30 W/m²K
- Upgraded Pitched Roof U-values of 0.16 W/m²K
- Low Secondary Glazed Window U-values of 2.4 W/m²K
- 100% low energy lighting throughout
- ASHP Heating and Hot Water
- Minimum 300L hot water cylinders to each house

2.3.2 Choice and Impact of Renewable Technology

All reasonable technologies were investigated for their suitability to the site and development; please refer to section 3 for details.

In addition to energy efficiency measures, it is proposed that the development will feature the following Low/Zero carbon Technologies:

- ASHP Heating and Hot Water

The above LZC contribution has provided an **25.92%** reduction in CO2 following Energy Efficiency Measures.

- Energy Saving from onsite LZC Technologies = **4318.1 kWh/Yr**
- CO2 Saving from onsite LZC Technologies = **2241.1 kgCO2/Yr**

2.3.3 Energy and CO_2 Reduction Summary

A summary of all stages of the energy demand assessment from baseline figures to final carbon reduction are shown in Figures 1 & 2 below:

Carbon Factors (Gas / Electric)	**0.216 / 0.519**
Baseline emissions	26970.5
Improved emissions (after application of energy efficiency measures) - residual emissions	26970.5
Improved emissions (after incorporation of renewable energy technology) % CO2 displaced in total	19981.0
% CO2 displaced in total	25.9%
% CO2 displaced by energy efficiency measures	0.0%
% CO2 displaced by renewable energy	25.92%

Table 1: Summary of CO2 Reductions

	SAP 9.0	SAP 10.0	SAP 10.1
Summary of CO2 Emission Reductions	**Total CO2 emissions (kgCO2/year)**		
Carbon Factors (Gas / Electric)	**0.216 / 0.519**	**0.210 / 0.233**	**0.210 / 0.136**
Baseline emissions	26970.5	16715.3	16503.9
Improved emissions (after application of energy efficiency measures) - residual emissions	26970.5	16715.3	16503.9
Improved emissions (after incorporation of renewable energy technology) % CO2 displaced in total	19981.0	8970.3	5235.9
% CO2 displaced in total	25.9%	46.3%	68.3%
% CO2 displaced by energy efficiency measures	0.0%	0.0%	0.0%
% CO2 displaced by renewable energy	25.92%	46.33%	68.27%

Table 2. Total Energy and Carbon Emissions Savings Based on SAP 9.0 Carbon Factors

For a full Breakdown of the figures and calculations please see Appendix A – Energy Demand Assessment Spreadsheet.

Baseline energy demand

'Standard Assessment Procedure - SAP 2012' was used to produce example SAP reports to generate the figures used within the calculations.

Baseline energy demand (kWh pa)	79358.0
Regulated emissions (kg pa)	26970.5

Be Lean stage

The following table demonstrates how the development achieves the reduction in carbon dioxide emissions from energy efficiency measures.

Energy savings from energy efficiency measures (kWh pa)	-
Emission savings from energy efficiency measures (kg pa)	-
Total regulated emissions after CHP savings and energy efficiency measures (kg pa) ("residual emissions")	-

Be Clean stage

The heating and cooling hierarchy has been applied to the design process of the development. It has resulted in large focus on energy efficiency measures and as can be seen in Figure 1.

Energy savings from the use of CHP systems (kWh pa)	-
Emission savings from the use of CHP systems (kg pa)	-
Total regulated emissions after CHP savings (kg pa)	-

On-site renewables

The following table demonstrates how the development achieves the reduction in carbon dioxide emissions from LZC technologies.

Energy saving from the use of renewables (kWh)	**40859.0**
Saving on residual emissions from the use of renewables (kg)	**6989.5**
Saving on residual emissions from the use of renewables (%)	**25.92%**

2.4 Adaptation to Climate Change

In addition to the primary building design and fabric, many other issues that will influence creating a Sustainable Development, including flood prevention, material use, waste minimisation and transport.

All the sections of creating a sustainable development should be taken into consideration from the start of the development and promoted throughout the building construction on site in order to maximise their benefits. Additionally, features which enable more efficient usage should also be specified to encourage the building users to maintain efficient use once construction has been completed.

2.4.1 Flood Risk Zone

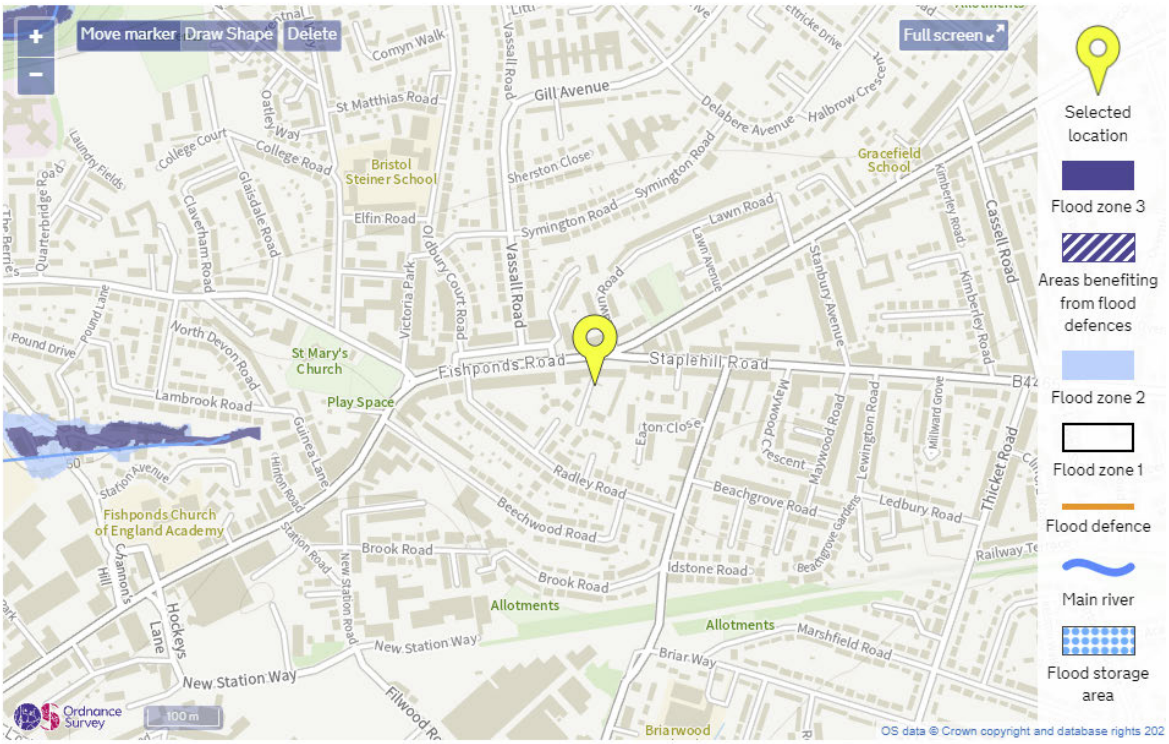

Fig 4: Flood Risk Map

The above map and snippet have been taken from a Government licences flood risk map for Bristol. It can be seen that the site is just located within flood risk zone 1 and therefore has minimal to no risk of flooding.

2.4.2 Green Blue Infrastructure

2.4.2.1 Sustainable Drainage Systems (SUDs)

Even though it has been shown that the proposed scheme is located on a site with a low to zero flood risk, it is adjacent to the canal and therefore it should be ensured that the levels of surface water run-off do not increase from the existing development to the proposed, especially due to the new scheme having a different footprint and potentially resulting in new areas of impermeable surfacing. Therefore, a drainage strategy assessment should be undertaken, by a suitably qualified professional, to assess the feasibility of introducing on-site SUDs measures, that will reduce surface water run-off and any flood risks associated.

2.4.2.2 Biodiversity

Similarly, to the previous section on SUDs, the nature of the proposal: including the demolishing of an existing building and potential change in area of impermeable surface, there could be adverse impacts on the surrounding ecology as well potential for the enhancement. Therefore, an ecology report should be produced, by a suitably qualified professional, in order to ensure that any existing ecology on or near the site is adequately protected and to determine the possibility of new habitat creation, planting schemes, green wall areas.

2.4.3 Internal Water Efficiency

Part G of the Building Regulations requires all new dwellings to have an internal water consumption of no greater than 110 litres / person / day, unless specified to be less. Therefore, fittings proposed should have low flow rates, capacities, effective flush volumes etc. Example targets for these to achieve the required internal consumption are as follows:

Appliance	Unit of measure	Amount (litres)
WC (Dual flush)	Full flush volume	**4**
WC (Dual flush)	Part flush volume	**2.6**
Taps (excluding kitchen)	Flow rate l/min	**5**
Kitchen taps	Flow rate l/min	**6**
Bath	Capacity to Overflow	**170**
Shower	Flow rate l/min	**8**
Washing Machine	Litres / kg dry load	**8.17**
Dishwasher	Litres / place setting	**1.25**

Table 4. Internal Water Efficiency Flow Rates

The above rates will achieve a total internal water consumption of 106.31 with a bath present and 98.25 with only a shower present.

The specifying of 'A' rated appliances should be prioritised where possible.

2.4.4 Waste Management

2.4.4.1 Occupational Waste

Bristol City Council encourages all new developments to incorporate a waste management strategy into the build at the earliest stage possible.

2.4.4.2 Construction Waste

A target of at least 90% of waste generated on site, throughout the construction stage of the development, to be diverted from landfill' will be included as part of a Construction Environmental Management Plan (CEMP) to be agreed with MCC.

The proposal will also endeavour to maximise the use of recycled materials on site, whereby further promoting the minimising of waste production.

2.4.5 Materials

The construction of new buildings and building elements has a large environmental impact in terms of both, energy, and embodied carbon of new materials. Therefore, Bristol City Council promote the prioritising of environmentally friendly materials, where possible, and encourages the use of recycled building materials. This information should also be incorporated into the SWMP mentioned in the previous subsection (Waste Management) as a means of promoting the re-using and recycling of materials.

Where new materials are to be used, careful consideration of their environmental impact should be taken. This can be achieved by ensuring that only materials that score well under The Green Guide to Specification. This useful online tool can be used as a reference that provides guidance on the relative environmental impacts for a wide range of different building specifications. The BRE's Environmental Profile Methodology determines the Life Cycle Assessment (LCA) of materials, which is what the Guide's specifications are based on.

In order to take full advantage of low impact materials, elements key to the scheme should be specified to achieve ratings of between A+ and C under The Green Guide's ratings. Insulation materials that are specified will also have a global warming potential (GWP) of 5 or less, with an ODP of 0. Additionally, 100% of all timber used as part of the scheme will be responsibly sourced from suppliers that are either Forest Stewardship Council (FSC) accredited, Programme for the Endorsement of Forestry Certification accredited, or a similar recognised accreditation body.

To further promote embodied energy and carbon savings, the scheme will first prioritise the reusing of any demolished materials within the site, however if this is not possible secondary priority must be given to the redirecting from landfill, in line with the waste hierarchy.

Finally, in addition to the above policy points, the development is also recommended to register with the Considerate Constructors Scheme, or a similar approved scheme.

2.4.6 Pollution Control

To reduce emissions of gases with high global warming potential (GWP) and nitrogen oxide (NOx) into the atmosphere, new buildings will be specified with insulating materials that have a GWP of less than 5. This will follow throughout the development to reduce the impact that the construction phase has upon climate change.

Additionally, the following measures will be implemented:

- Pollution Prevention Guidance will be adhered to in respects of air (dust) and water (ground and surface) pollution during the demolition and construction phase.
- External light fittings will be controlled through a time switch, or daylight sensor, to prevent operation during daylight hours to limit the impact of artificial lighting for the development's residents and surrounding environment.
- Dust suppression measures will also be put in place as part of the Main Contractor's Environmental Management Plan, this will reduce the potential risk to local watercourses (River Irk) and neighbouring properties.

Sound insulation will be specified to achieve Building Regulation Part E compliance standard (this will be verified by pre-completion testing) in addition to meeting the requirements of the council. This will reduce the impact of sound pollution for the occupants within adjoining dwellings.

2.4.7 Health and Wellbeing

A full daylight and sunlight analysis assessment should be carried out for the proposed development to ensure that compliant levels of vertical sky component (VSC), no sky line (NSL) and annual probabal sunlight hours (APSH) are achieved.

In addition to having this assessment completed, the following measures will also be incorporated:

- Enhancing the green infrastructure of the site by introducing planting wherever possible, therefore improving the physical and mental wellbeing of residents, visitors, and workers.
- Secure by Design accreditation will be sought which will incorporate the adoption of crime prevention measures to further prevent crime and promote a safe environment.

The above findings and technology will all help to promote healthy housing for residents which has been identified by the World Health Organisation (WHO) as an increasingly important factor in increasing quality of life, preventing disease and illness, and mitigating climate change.

3 Feasibility Assessment of Renewable Energy and Low Carbon Technologies

Solar Hot Water (Thermal)

Solar water heating systems are one of the more familiar renewable technologies used at the moment. They use the energy from the sun to heat water, most commonly for hot water needs. Solar heating systems use a heat collector that is usually mounted on a roof in which the sun heats a fluid. This fluid is used to heat water that is stored in either a separate hot water cylinder or in a twin-coil hot water cylinder (the second coil is used to provide additional heating from a boiler or other heat source).

Solar hot water panels could be used however with ASHP being selected they are not required on the development.

Renewable Technology Not Chosen.

Photovoltaic Panels (PV)

Photovoltaic modules convert sunlight directly to DC electricity. The solar cells consist of a thin piece of semiconductor material, in most cases of silicon. Through a process called doping, very small amounts of impurities are added to the semiconductor, which creates two different layers called n-type and p-type layers.

Certain wavelengths of light are able to ionize the silicon atoms, which separates some of the positive charges (holes) from the negative charges (electrons). The holes move into the positive or p-layer and the electrons into the negative or n-layer. These opposite charges are attracted to each other, but most of them can only re-combine by the electrons passing through an external circuit, due to an internal potential energy barrier. This flow of electrons produces a DC current.

PV panels could be used however with ASHP being selected they are not required on the development.

Renewable Technology Not Chosen.

Ground Source Heat pumps

A heat pump is a device that takes up heat at a certain temperature and releases it at a higher temperature. The essential components of a heat pump are heat exchangers (through which energy is extracted and emitted) and a means of pumping heat between the exchangers. The effectiveness of the heat pump is measured by the ratio of the heating capacity to the effective power input, usually known as the coefficient of performance (COP). Ground-source heat pumps (GSHP) extract heat from the ground. They are classified as either water-to-air or water-to-water units depending on whether the heat distribution system in the building uses air or water. Ground source heat pumps either use long shallow trenches or deep vertical boreholes to take low grade heat from the ground and then compress it to create higher temperatures.

Ground source heat pumps would not be suitable due to the lack of land space around the properties and the associated costs.

Renewable Technology Not Viable

Air Source Heat pumps

Air source heat pumps absorb heat from the outside air. This is usually used to heat radiators, underfloor heating systems, or warm air convectors and hot water in your home. An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside.

The system performs down to air temperatures of -20°c which means that they are more than suitable for installations within the UK. Hot water and Heating can be provided 365 days a year. The hot water is produced without the aid of electrical immersions and at 55°c is more than hot enough for baths and showers.

There are two main types of air source heat pump system:

- An air-to-water system distributes heat via your wet central heating system. Heat pumps work much more efficiently at a lower temperature than a standard boiler system would. So they are more suitable for under-floor heating systems or larger radiators, which give out heat at lower temperatures over longer periods of time.
- An air-to-air system produces warm air which is circulated by fans to heat your home. They are unlikely to provide you with hot water as well.

Air Source heat pumps are a good option and has been selected for the proposed development.

Renewable Technology Chosen

Biomass Heating

Biomass is any plant-derived organic material that renews itself over a short period.

Biomass energy systems are based on either the direct or indirect combustion of fuels derived from those plant sources. The most common form of biomass is the direct combustion of wood in treated or untreated forms. The use of biomass is becoming increasingly common in some European countries.

The environmental benefits relate to the significantly lower amounts of energy used in biomass production and processing compared to the energy released when they are burnt. This can range from a four-fold return for biodiesel to an approximate 20-fold energy return for woody biomass. Biomass-fuels can be used to produce energy on a continuous basis (unlike renewables such as wind or solar energy) and it can be an economic alternative to fossil fuels as it is a potential source of both heat and electricity.

However, Biomass systems have particular design management and maintenance requirements associated with sourcing, transportation and storage and are therefore more commonly used in commercial developments rather than domestic installations. It can be less convenient to operate than mains-supplied fuels such as natural gas and are more management intensive and require expertise in facilities management. Sources of biomass can also fluctuate, so boilers should be specified to operate on a variety of fuels without risk of overheating or tripping out.

A communal biomass system would not be feasible for this development due to the expense associated with the necessary output to heat all dwellings on the site.

Renewable Technology Not Chosen

Wind

Wind turbines convert the kinetic energy in wind into mechanical energy that is then converted to electricity. Turbines are available in a range of sizes and designs and can either be free-standing, mounted on a building or integrated into a building structure.

The wind speed in the area is under the advised minimum and the built-up area means that a wind turbine wouldn’t be feasible.

Renewable Technology Not Viable

4 Conclusion

This statement has assessed the proposed development at the Chasefield House site against the relevant climate change and sustainability policies and targets, as outlined within: the Bristol City Council Core Strategy (2011), through the following of the energy hierarchy, the modelling of the HMO's in the FSAP 2012 software and addressing all aspects of a sustainable development. In addition, the proposal has been assessed against national sustainable design definitions to determine how it can be classified.

As part of this process, the development was designed with a fabric first approach; with U-values, design air permeability and ventilation targets all aspiring to exceeding Building Regulations Part L 2013 standards. This approach demonstrates a holistic low energy design concept, involving very low limiting values and thus led to high-energy performance targets.

Furthermore, an LZC feasibility assessment was carried out, with all suitable technologies investigated for their suitability to the site and development. The assessment determined that ASHP Heating and Hot Water can be proposed at this stage which would generate a **25.92%** carbon reduction when using SAP 9.0 carbon factors.

In addition to the following of the energy hierarchy through the efficient design and renewable technology measures mentioned and meeting all relevant Bristol City Council carbon targets the proposal will include a large number of sustainability measures throughout construction and once completed, which will contribute heavily to the development's sustainability performance and accord with the requirements of the NPPF. The key measures to be included and therefore can be taken from this report include:

- The proposal sits within Flood Risk Zone 1 and therefore has minimal to no risk of flooding.
- A SUDs strategy will be produced to outline all measures to be incorporated that will ensure any additional surface water is collected, treated and removed.
- The development will incorporate green infrastructure in the form of extensive planting involving hedges, trees, sedum/green roofs and ornamental planting that will instil a sense of wellbeing whilst also assisting with offsetting carbon dioxide and balancing local temperatures through evapotranspiration.
- Internal water efficiency will be prioritised by ensuring that efficient water fixtures are proposed so that each dwelling achieves less than 110L per person per day and 'A' rated appliances will be specified where possible.
- Waste minimisation will be targeted from throughout construction and occupational phase. It is targeted that at least 90% of construction waste will be diverted from landfill. Whilst tri-separator refuse shoots will be installed on each floor to promote recycling.
- In addition to targeting Secure by Design accreditation through adoption crime prevention measures, the site layout promotes busy spaces and routes.

- Prioritising reusing existing materials and locally sourced materials for construction to reduce waste and transportation to landfill in addition and promote a low embodied carbon development.
- When new materials are specified that are not locally attainable then only those that score well on the BRE: The Green Guide to Specification are to be used; to further encourage the use of sustainable materials and reductions in embodied carbon.
- The buildings will have a daylight and sunlight analysis carried out and will aim to achieve high pass rates.

As a result of all the above, the proposed sustainable design and energy strategy allows the development to comply with Bristol City Council's planning policy requirement and is in line with all targets put forward in their planning documents.

	House Type/Name	House 1	House 2	TOTAL (kWh/yr)		TOTAL (kgCO2/yr)	SAP 10.0	TOTAL (kgCO2/yr)	SAP 10.1	TOTAL (kgCO2/yr)
	Frequency	2	1	3						
BASELINE	BASELINE Dwelling Emission Rate (DER)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)
	Main Heating Fuel Requirement (DER)	22938.05	22549.75	68425.9	0.216	22909.0	0.210	14369.4	0.210	14369.4
	Secondary Main Heating Fuel Requirement (DER)	0	0	0.0	0.519	0.0	0.233	0.0	0.136	0.0
	Secondary Heating Fuel Requirement (DER)	0	0	0.0	0.216	0.0	0.210	0.0	0.136	0.0
	Water Fuel Requirement (DER)	2922.06	2908.6	8752.7	0.216	2930.4	0.210	1838.1	0.210	1838.1
	Electricity Pumps Fans Requirement (DER)	120	120	360.0	0.519	186.8	0.233	83.9	0.136	49.0
	Electricity Lighting Requirement (DER)	620.85	577.73	1819.4	0.519	944.3	0.233	423.9	0.136	247.4
	TOTAL PER DEVELOPMENT			79358.0		26970.5		16715.3		16503.9
BE LEAN	AFTER ENERGY SAVING MEASURES Dwelling Emission Rate (DER)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)
	Main Heating Fuel Requirement (DER)	22938.05	22549.75	68425.9	0.216	22909.0	0.210	14369.4	0.210	14369.4
	Secondary Main Heating Fuel Requirement (DER)	0	0	0.0	0.519	0.0	0.233	0.0	0.136	0.0
	Secondary Heating Fuel Requirement (DER)	0	0	0.0	0.519	0.0	0.233	0.0	0.136	0.0
	Water Fuel Requirement (DER)	2922.06	2908.6	8752.7	0.216	2930.4	0.210	1838.1	0.210	1838.1
	Electricity Pumps Fans Requirement (DER)	120	120	360.0	0.519	186.8	0.233	83.9	0.136	49.0
	Electricity Lighting Requirement (DER)	620.85	577.73	1819.4	0.519	944.3	0.233	423.9	0.136	247.4
	TOTAL PER DEVELOPMENT			79358.0		26970.5		16715.3		16503.9
BE GREEN	FINAL Dwelling Emission Rate (DER)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)
	Main Heating Fuel Requirement (DER)	10813.52	10718.55	32345.6	0.519	16787.4	0.233	7536.5	0.136	4399.0
	Secondary Main Heating Fuel Requirement (DER)	0	0	0.0	0.519	0.0	0.233	0.0	0.136	0.0
	Secondary Heating Fuel Requirement (DER)	0	0	0.0	0.519	0.0	0.233	0.0	0.136	0.0
	Water Fuel Requirement (DER)	1406.6	1399.74	4212.9	0.519	2186.5	0.233	981.6	0.136	573.0
	Electricity Pumps Fans Requirement (DER)	30	30	90.0	0.519	46.7	0.233	21.0	0.136	12.2
	Electricity Lighting Requirement (DER)	632.94	584.62	1850.5	0.519	960.4	0.233	431.2	0.136	251.7
	TOTAL PER DEVELOPMENT			38499.0		19981.0		8970.3		5235.9
BE GREEN	PV Energy Produced (DER)			0.0	0.519	0.0	0.233	0.0	0.136	0.0
	TOTAL PER DEVELOPMENT			38499.0		19981.0		8970.3		5235.9

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