3.4 Climate change adaptation

3.4.1 The global climate is changing, with greenhouse gas emissions from human activity the dominant cause. The global increase in temperature of 0.85°C since 1880 is mirrored in the UK climate, with higher average temperatures and some evidence of more extreme weather events.[14]

3.4.2 Climate change adaptation is a term that describes measures that can be put into place to help us adapt the changes in our climate that are now inevitable. These changes range from increased temperatures and drought conditions to extreme weather events such as intense periods of rainfall and subsequent flash flooding.

3.4.5 The NPPF is clear that planning has an important role to play in ensuring that new and existing communities are capable of adapting to our changing climate. It sets out that new development should be planned to avoid increased vulnerability to the range of impacts arising from climate change, taking account the long-term implications of issues such as flood risk, coastal change, water supply, biodiversity and landscapes and the risk of overheating from rising temperatures[15]. This section of the SPD provides further guidance on the range of measures that can be integrated into all scales of development in order to comply with policy requirements.

LOCATION:	Cambridge and South Cambridgeshire
POLICY:	• Cambridge Local Plan (2018) Policy 28: Carbon reduction, community energy networks, sustainable design and construction and water use • South Cambridgeshire Local Plan (2018) Policy CC/1: Mitigation and Adaptation to Climate Change
RELATED POLICIES	Cambridge Local Plan (2018): • Policy 31: Integrated water management and the water cycle • Policy 32: Flooding • Policy 59: Designing landscape and the public realm • Policy 71: Trees South Cambridgeshire Local Plan (2018): • Policy CC/7: Water quality • Policy CC/8: Sustainable Drainage Systems • Policy CC/9: Managing Flood Risk • Policy HQ/1: Design Principles • Policy NH/7: Ancient Woodlands and Veteran Trees
SCALE OF DEVELOPMENT:	All development proposals
TYPE OF DEVELOPMENT:	Residential and Non-residential development
SUBMISSION REQUIREMENTS:	Sustainability Statement and Design and Access Statement

[14] Committee on Climate Change (2016). UK Climate Change Risk Assessment 2017 Synthesis report: priorities for the next five years.
[15] HM Government (2018). National Planning Policy Framework (paragraphs 149 and 150)

	and other documents as relevant to the proposal (e.g. Arboricultural Impact Assessments, Surface Water Drainage Strategy, Site Specific Flood Risk Assessments).
LINK TO THE SUSTAINABILITY CHECKLIST:	Ca.1, Ca.2, Ca.3, Ca.4, Ca.5, Ca.6, Ca.7

Policy overview

3.4.6 Both the 2018 Cambridge and South Cambridgeshire Local Plans require climate change adaptation to be embedded into development proposals. The key principle is to ensure that adaptability is designed into all new developments from the outset, so that residents and building occupiers do not have to rely on complex systems and technologies that are expensive to maintain. It is also important to look to measures beyond buildings themselves, seeking opportunities within the landscape setting of new developments for adaptation. This will often require a multidisciplinary approach to design in order to maximise benefits, recognising the role of all members of the design team in responding to climate change.

3.4.7 Adaptation measures can be implemented at a variety of scales, and consideration should be given to the following measures:

- Taking architectural approaches to design out issues such as overheating;
- The role of green infrastructure;
- Implementing resilient architecture and construction to minimise impacts;
- The role of materials in minimising microclimatic effects;
- The use of Sustainable Drainage Systems (SuDS) and flood resilient architecture (see section 3.7 and the Cambridgeshire Flood and Water SPD).

Submission requirements

3.4.8 Compliance with the policy requirements for both Cambridge and South Cambridgeshire should be demonstrated via the submission of a **Sustainability Statement** alongside other relevant documents, for example Drainage Strategies, Landscape Strategies and Tree Surveys and Arboricultural Impact Assessments. Where appropriate, adaptation measures should also be shown on relevant drawings, for example where external shading is proposed to help reduce the risk of overheating, this shading should be shown on elevations. Further guidance on possible adaptation strategies is provided below.

3.4.9 When considering adaptation measures it will be important to ensure that they are appropriate for the context in which the development sites and that they do not conflict with other strategies. For example, in areas of poor air quality, careful consideration will need to be given to ventilation strategies to ensure that buildings do not overheat and that good levels of indoor air quality and thermal comfort are maintained. In such circumstances, the importance of designing out the risk of overheating, for example through the use of building overhangs or external shading becomes even more important.

Adaptation Strategies – Overheating

3.4.10 The UK's Climate Change Risk Assessment and the evidence underpinning it identifies the risks to health, wellbeing and productivity from high temperatures as one of the six priority risk areas for action, as illustrated in figure 4 below. Overheating in the built environment is already an issue in relatively cool summers, with research indicating that 20% of homes in England already experience overheating. With temperatures set to rise as a result of our changing climate, this risk is likely to increase unless measures are put in place to mitigate the risk of overheating in buildings.

Figure 4: The Adaptation Sub-Committee's assessment of the top six areas of inter-related climate change risks for the UK[16].

3.4.11 Some properties are at a higher risk of overheating than others, for example:

- Flats with south and west facing facades due to excess solar gains;
- Flats on top floors due to heat gain through the walls and roof;
- Single aspect flats as there is no allowance for cross ventilation;
- Properties with district heating or other communal heating systems where excess internal gains arise from poorly placed or poorly insulated pipe work;
- Properties with restricted window openings due to noise and air quality issues.
- Buildings with heat recovery systems that are installed without a summer bypass mode leading to inadvertent excess internal heat gains in the summer and shoulder months.
- Buildings with poorly designed thermal mass coupled with insufficient secure ventilation provision to enable night purge to take place.

In these cases it is important that consideration is given to ways in which to mitigate the potential for overheating early in the design process.

3.4.12 A common approach to overheating in the past has been a reliance on air conditioning. However, this is energy intensive with high associated levels of carbon emissions. It also places a cost burden on residents and building occupiers, not only in terms of energy bills

[16] Image replicated from Committee on Climate Change (2016). *UK Climate Change Risk Assessment 2017 Evidence Report: Synthesis Report*

but also the maintenance of such systems. It is therefore important that the design of all new buildings, and the redevelopment of existing buildings, responds to the issue of overheating by designing out risk as far as possible to reduce the cooling load of buildings. Consideration of overheating should be included in the **Sustainability Statement** and **Design and Access Statement**.

3.4.13 The Councils' preferred approach to overheating is that the design of developments should follow the cooling hierarchy, illustrated in figure 5 below, to ensure that energy use associated with cooling is minimised. The cooling hierarchy takes the following approach:

- **Passive Design:** Minimise internal heat generation through energy efficient design and reduction of the amount of heat entering the building in the summer and shoulder months through consideration of orientation, overhangs and shading, albedo, fenestration, insulation and green roofs. Where heat is to be managed within the building through exposed internal mass and high ceilings, provision must be made for secure night time ventilation to enable night purge to take place;
- **Passive/natural cooling:** use of outside air, where possible pre cooled by soft landscaping, a green roof or by passing it underground to ventilate and cool a building without the use of a powered system. This includes maximising cross ventilation, passive stack and wind-driven ventilation and enabling night purge ventilation. Single aspect dwellings should be avoided for all schemes as effective passive ventilation can be difficult or impossible to achieve. Windows and/or ventilation panels should be designed to allow effective and secure ventilation.
- **Mixed mode cooling:** with local mechanical ventilation/cooling provided where required to supplement the above measures using (in order of preference):
  i) low energy mechanical cooling (e.g. fan powered ventilation with/without evaporative cooling or ground coupled cooling);
  ii) air conditioning – not a preferred approach as these systems are energy intensive;
- **Full building mechanical ventilation/cooling system**, ensuring the lowest carbon/energy options and are only considered after all other elements of the hierarchy have been utilised.

Figure 5: The cooling hierarchy (adapted from Islington Borough Council (2012) Low Energy Cooling. Good Practice Guide 5)

3.4.14 We would recommend that thermal modelling be undertaken to understand the performance of a proposed new development, with buildings designed and built to meet CIBSE's latest overheating standards[17]. As part of this, consideration should also be given to future climate scenarios, for example using CIBSE future weather data. Where officers have concerns about the potential for overheating, a planning condition may be used to secure overheating analysis, for example for a sample of units on a site.

Further guidance

3.4.15 For further detailed guidance on overheating see:

- Good Homes Alliance (2019). Overheating Toolkit for Planners (to be added once available)
- Islington Borough Council (2012) Low Energy Cooling. Good Practice Guide 5. Available online at: https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/planningandbuildingcontrol/publicity/publicconsultation/20122013/20121220goodpracticeguide5lowenergycooling
- CIBSE Guides (note there is a charge to access these documents for non-members):
  - See GVA/15 CIBSE Guide A: Environmental Design (2015). Available online at: https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q20000008I79JAAS
  - CIBSE TM52: The Limits of Thermal Comfort: Avoiding Overheating in European Buildings (2013). Available online at: https://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q20000008I7f5AAC
  - CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes (2017). Available online at: https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q0O000000DVrTdQAL

Adaptation Strategies – The role of green infrastructure

3.4.16 Green Infrastructure is our natural life-support system. It is the network of natural and manmade features such as open spaces, woodlands, landscapes, rights of way, waterways, historic parks and private gardens, which link and serves our communities and countryside. Within an urban context, it includes allotments, cemeteries, and features such as green and brown roofs as well as tree canopy cover. Green infrastructure provides a wide range of social, environmental and economic benefits, including:

- Improving people's mental and physical health;
- Reducing air pollution and improving water quality;
- Protecting against climate change, for example by reducing flood risk, dealing with storm water at source, storing water for times of drought, storing carbon, or preventing soil erosion;

[17] See GVA/15 CIBSE Guide A: Environmental Design (2015), CIBSE TM52: The Limits of Thermal Comfort: Avoiding Overheating in European Buildings (2013) and CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes (2017)

- Providing jobs and contributing to economic competitiveness;
- Increasing biodiversity;
- Encouraging local food growing, healthy eating and healthy food environments;
- Encouraging active travel and safer roads; and
- Using limited land efficiently by providing multiple benefits simultaneously[18].

3.4.17 From an adaptation perspective, green infrastructure has the potential to enhance the adaptive capacity of an area, for example through the integration of sustainable drainage features (blue infrastructure) and through enhancing urban cooling. Green spaces and water bodies help to lower air temperatures and are on average one degree cooler than the surrounding urban area[19]. Modelling carried out in Manchester as part of the SCORCHIO project predicted that increasing the area of green infrastructure in the city by 10% would reduce the maximum surface temperature by 2.2°C compared to no change in green space, with similar results found by modelling projects carried out in Birmingham (BUCCANEER project) and London (LUCID project). In a warming climate, finding ways of providing free cooling will become increasingly important, and all new developments, regardless of scale, can play a role in enhancing adaptive capacity through the provision of green and blue infrastructure.

Enhancing the tree canopy

3.4.18 Trees provide many benefits to the built environment: they sequester carbon, reduce noise, absorb particulate pollution, provide cooling and shade, and reduce surface water runoff. They are also an integral part of the creation of high quality, sustainable development. Trees have psychological benefits in reducing stress and providing spaces for relaxation and contact with nature. From a climate change adaptation perspective it is the role that trees play in shade and cooling through evapotranspiration that is of greatest interest.

3.4.19 Both the 2018 Cambridge and South Cambridgeshire Local Plans include policies to encourage the planting of trees as part of new developments, as well as the retention of existing trees. Increasing tree canopy cover is a cost-effective and sustainable remedy to heat stress, storm water attenuation and air pollution that results in improvements to human well-being, as well as the role that trees play in delivering a wide range of other ecosystem services to the Greater Cambridge area as a whole.

3.4.20 Heat reduction, energy savings, surface water runoff, air quality, environmental justice, social well-being, or some combination of these and other factors will influence how many trees should be added, what kind of trees, and where to situate them. For example, to cut energy use for cooling a building, large trees must be placed close enough to shade the structure, particularly on the west side; to boost economic development, trees can be added to car parks, which invites more leisurely shopping; to capture surface water runoff, engineered tree pits may be most effective.

[18] P Massini and H Smith (December 2018). PERFECT Expert Paper 2. Planning for Green Infrastructure – the green space factor and learning from Europe. Published by the Town and Country Planning Association.
[19] https://www.mui.manchester.ac.uk/cure/research/projects/past-projects/scorchio/

3.4.21 The quality of the trees to be retained and planted on site is an important consideration. Quality covers:

- Tree health – a healthy tree provides more benefits than a tree in poor condition;
- Age and species diversity – provide long-term resilience;
- Mature size - large trees bring more benefits than small trees;
- Location – to avoid future conflicts and;
- Other factors – all intended to maximise the desired ecosystem services.

Retention of existing trees – submission requirements

3.4.22 Planning policy seeks to ensure the retention of existing trees on development sites wherever suitable, unless there are demonstrable public benefits accruing from the proposal which clearly outweigh the current and future amenity value of the trees. When considered early on in the design of new development, significant removal of existing trees can be avoided. Developments should seek to:

a. preserve, protect and enhance existing trees and hedges that have amenity value as perceived from the public realm;

b. provide appropriate replacement planting, where felling is proved necessary; and

c. provide sufficient space for trees and other vegetation to mature.

3.4.23 Where there are trees within an application site, or on land adjacent to it that could influence or be affected by the development, information will be required as to which trees are to be retained/lost, including whether any are ancient or veteran. A Tree Survey should be carried out before any layouts are developed, following the guidance contained within BS 5837: 2012 "Trees in relation to design, demolition and construction – Recommendations". In accordance with the British Standard consideration should also be given to safeguarding space for replacement or new planting. The information from this survey should be used to inform a viable and sustainable layout of the proposed development.

3.4.24 Once layouts are fixed, an **Arboricultural Impact Assessment** should be prepared identifying significant vegetation on and adjacent to the site, the quality and value of that vegetation, the effect that stages of the development could have on individuals, the significance of such impact in landscape terms and any appropriate methods to be adopted in order to mitigate any potentially negative impacts. Depending on the density and complexity of new development it may also be necessary to prepare and submit for approval a methodology for the protection of trees agreed to be retained. This would take the form of an **Arboricultural Method Statement**.

Tree planting in new developments – considerations

3.4.25 It is important to ensure that new development provides sufficient space to accommodate a level of replacement and new tree planting appropriate to the size of the development site and in accordance with the right tree right place principle. At its most basic, this means that appropriate space is made available for species that will contribute most to amenity and that the correct species of tree is chosen for the space made available, with consideration given to the final size of the tree at maturity.

3.4.26 When considering new planting, soil requirements should be assessed. There is a direct relationship between how well a tree can grow above ground and the health and resources of the root system below. Trees need soil in which to grow and that soil needs to provide for the tree for many years if it is to reach its potential. Too often trees are planted in a small pit which is surrounded by compacted inhospitable soil; as a result many trees barely grow in size, die early or break out of the available rooting volume. The volume and quality of soil, and the way it is provided will dictate the size to which a tree can grow and can reduce conflict between tree roots and adjacent light structures. It is often considered that a tree needs approximately $0.6m^3$ of soil for each $1m^2$ of canopy projection.

3.4.27 The first step when planning to plant a tree is identifying the planting location. This will determine what attributes the selected tree must have and influences all subsequent decisions. This decision ultimately determines whether the tree will thrive and fulfil its true potential and provide all its possible benefits. Tree planting locations should always be one of the first and most important decisions when considering space allocation in the built environment.

3.4.28 The urban design of new developments has to take into account many competing constraints, it is imperative that Arboriculturists and Landscape Architects coordinate with Urban Designers from an early stage and throughout the design process to ensure the target can be met in an appropriate manner. Trees are important in streets, gardens, open spaces and other areas. To ensure that their benefits are maximised throughout a development, their distribution must be appropriately balanced, taking account of the effect they can offer in different locations.

Green/brown roofs

3.4.29 At an individual building scale, green infrastructure can take the form of features such as green/brown roofs. For new development in Cambridge, all flat roofs are required to be green or brown roofs in line with the requirements set out in policy 31 of the Cambridge Local Plan (2018). Policy CC/8 of the South Cambridgeshire Local Plan (2018) encourages the use of green roofs. A green roof is created when vegetation is established on a roof structure, and can be established at any scale. There are many types of green roof, but they can broadly be placed into two categories; intensive systems or extensive systems.

3.4.30 An intensive system includes those type of green roof that are used as recreational spaces. These roofs often include features similar to those found within traditional parks and gardens, such as shrubs, trees, paving, lawns, rooftop allotments and even water features.

3.4.31 Extensive green or biodiverse roofs are normally intended to be viewed from another location as visual or ecological features and may not be accessible. However access for maintenance should be incorporated with the introduction of walkways and suitable edge guards. Green roofs using hardy, drought tolerant species of plants such as sedums and wildflowers fall within this category. A brown or biodiverse roof is designed to create a habitat for a specific type of flora or fauna. This may be chosen to replicate or enhance the pre-development surroundings. For instance, particular plant species may be required to attract a specific type of bird, butterfly or insect. Biodiverse roofs in their most extreme scenario, are left without vegetation, with the growing medium selected to allow the indigenous plant species to colonise the area over time.

3.4.32 Green roofs offer multiple benefits including reducing storm water runoff and velocity and volumes, providing evaporative cooling and prolonging the life of the roof by preventing the deteriorating effects of UV. The additional insulation provided by green roofs can also help to reduce the internal cooling loads of buildings by up to 2°C. Contrary to popular belief, green roofs can also be combined with renewable energy systems such as solar panels. Solar panels work more efficiently at a set operating temperature. Once there is a deviation either above or below this level, electricity generation becomes less efficient. As a green roof is more able to maintain a more constant temperature around the panels than a traditional flat roof, their combined use can help to maximise the efficiency and power output of solar panels. Where solar panels are proposed, biosolar roofs should be incorporated under and in-between the panels. An array layout will be required incorporating a minimum of 0.75m between rows of panels for access and to ensure establishment of vegetation.

3.4.33 The maintenance and management of green roofs is also simple and limited. Maintenance is concentrated in the first 5 years of establishment, where bi-monthly checks for unwanted self-seeded species are necessary, with watering also required during establishment at prolonged times of drought. Thereafter, yearly checks are required for unwanted self-seeded species.

Further guidance – green infrastructure

3.4.34 For further guidance on Green Infrastructure, please see:

- Cambridgeshire Green Infrastructure Strategy (2011). Available online at: https://www.cambridge.gov.uk/cambridgeshire-green-infrastructure-strategy
- Planning for Green and Prosperous Places. TCPA (January 2018). Available online at: https://www.tcpa.org.uk/Handlers/Download.ashx?IDMF=db632de1-38cc-468a-9401-0599b0bea52b
- BS 5837:2012 "Trees in relation to design, demolition and construction – Recommendations". In accordance with the British Standard consideration should also be given to safeguarding space for replacement or new planting.
- Benefits of Green Infrastructure - Report by Forest Research. Available online at: https://knowledgebase.permaculture.org.uk/resources/books/benefits-green-infrastructure-report-forest-research

3.4.35 When specifying green roofs, we would recommend that applicants follow the guidance contained within the Green Roof Organisation's (GRO) Green Roof Code (2014) or successor document, available online at: https://livingroofs.org/wp-content/uploads/2016/03/grocode2014.pdf

3.4.36 Further guidance is also available in the Greater London Authority (2008) Living roofs and walls technical report, available online at: https://www.london.gov.uk/sites/default/files/living-roofs.pdf

Adaptation strategies – the role of materials

3.4.37 In addition to the role of green infrastructure in helping to cool our environment, there is also a role for the choice of materials in helping to reduce overheating. Roofs and pavements cover about 60 % of urban surfaces, and absorb more than 80 % of the sunlight that contacts them. This energy is converted to heat, which results in hotter, more polluted cities, and higher energy costs.[20] Consideration should be given to specifying new or replacement roofs and pavements with cool materials that are more reflective to help the built environment both mitigate and adapt to climate change.

3.4.38 The Global Cool Cities Alliance (GCCA)[21] notes that cool materials are measured by how much light they reflect (solar reflectance) and how efficiently they radiate heat (thermal emittance). A cool roofing surface is both highly reflective and highly emissive to minimise the amount of light converted into heat and to maximise the amount of heat that is radiated away. Increasing the reflectance of our buildings and paved surfaces, whether through white surfaces or reflective coloured surfaces can reduce the temperature of the built environment. By way of example:

- Most roofs are dark and reflect no more than 20% of incoming sunlight (i.e., these surfaces have a reflectance of 0.2 or less); while a new white roof reflects about 70 to 80% of sunlight (i.e., these surfaces have a reflectance of 0.7 to 0.8).
- New white roofs are typically 28 to 36 degrees Celsius cooler than dark roofs in afternoon sunshine while aged white roofs are typically 20 to 28 degrees Celsius cooler.[22]

3.4.39 While the choice of material is influenced by a number of factors, applicants are recommended to give consideration to the role of cool materials alongside wider strategies such as green infrastructure, integration of sustainable drainage systems to help cool the built environment and enable new and existing communities to adapt to our changing climate.

Further guidance – cool materials

3.4.40 For further guidance on cool materials, see:

- Global Cool Cities Alliance (January 2012). A Practical Guide to Cool Roofs and Cool Pavements. Available online at: https://www.coolrooftoolkit.org/wp-content/pdfs/CoolRoofToolkit_Full.pdf

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[20] Ibid., and US EPA (October 2008). Reducing urban heat islands: a compendium of strategies.
[21] The Global Cool Cities Alliance (January 2012). A practical guide to cool roofs and cool pavements
[22] Comparing a dark roof with a solar reflectance of 0.2 with a new white roof with a solar reflectance of 0.8 and an aged white roof with a solar reflectance of 0.55.