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Holborn Liveable Neighbourhood

Heat Resilience Study

Final Report
07 April 2025

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HOLBORN LIVEABLE NEIGHBOURHOOD

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The project involves a collaboration between the following organisations.

Shade the UK

Shade the UK is a London-based community interest company adapting the built environment and public spaces to protect the vulnerable against a changing climate.

Shade the UK's mission is to reduce the deaths caused by overheating in the UK to zero, safeguarding the health and wellbeing of vulnerable people during hot weather. We want the UK to become fully adaptable to increasing temperatures through the reimagination of how our cities, buildings and spaces are designed.

Love Design Studio

Love Design Studio is a London-based sustainability consultancy working with teams in the built environment to create sustainable buildings and promote ethical business practices. We are a team of environmental consultants, designers, engineers and technicians to address various aspects of sustainability in our projects.

Love Design Studio aims to inspire businesses across all sectors to adopt a purpose-driven approach to building design and business practices. We aim for a world where economic success and environmental wellbeing coexist, generating a lasting and meaningful positive influence.

Camden Council

Camden Council has a strong track record of reducing greenhouse gas emissions that drive the climate crisis. Since 2005, borough wide emissions have fallen by 48% and, since 2010, emissions across our own estate and operations have reduced by 65%. However, the impacts of the climate crisis are already here and being experienced; flooding across Camden in 2021 affected over 100 homes and businesses, disrupting lives and our local economy, while the July 2022 heatwaves caused significant spikes in respiratory related hospital admissions and damaged infrastructure in Camden. The Council's Climate Adaptation and Resilience Plan 2023-2025 sets out actions that the Council will take to improve resilience and recognises that vulnerable residents will need more support. In 2025, Camden is shaping its next five year Climate Action Plan, with actions to make Camden a zero carbon borough whilst protecting those most vulnerable to climate change impacts.

Holborn Liveable Neighbourhood Project

The Holborn Liveable Neighbourhood (HLN) project is a street and public realm transformation project in the heart of London which aims to support healthier lifestyles, active and sustainable travel choices, and improvements to the safety, air quality and climate resilience of the area. The project is being led by the London Borough of Camden (LBC) with sponsorship from Transport for London (TfL) under its wider Liveable Neighbourhood programme.

Holborn Liveable Neighbourhood

01

Introduction

Shade the UK have been commissioned by Camden Council to undertake a Heat Resilience Study for the Holborn Liveable Neighbourhood (HLN) area. This is because heat risk is the primary climate risk in Holborn, and Camden Council want to ensure HLN proposals respond to, and are resilient to, the impacts of heat - now and in the future.

This chapter introduces the HLN Heat Resilience Study, which assesses heat risk distribution across Holborn by analysing exposure and vulnerability factors.

The study identifies targeted adaptation measures to enhance heat resilience in the public realm, aligning with all five of the HLN project outcomes: Safe, Efficient, Green, Active, and Connected.

Key outputs include: a map of heat exposure across the HLN area; a longlist of 'hot spots'; a vulnerability assessment for the HLN area and hot spots; recommended cooling interventions for three priority hot spots based on heat risk; a Heat Resilience Strategy, a high-level Shade and Cooling Masterplan, and a hierarchy of Thermal Comfort Design Principles for the public realm.

While tailored to Holborn's conditions, characterised by limited green space, low tree canopy cover, and medium-to-high heat risk, the study also considers how these outputs can be applied to other Camden neighbourhoods.

The aim of the HLN Heat Resilience Study is to better understand the spatial distribution of heat risk in Holborn based on an analysis of data and information relating to exposure and vulnerability to heat.

Image 1. Corner of Lambs Conduit Street and Great Ormond Street on a hot and sunny day.

The study has identified appropriate, targeted, and effective, heat adaptation and resilience measures for the public realm in Holborn.

The intended outcomes of the Heat Resilience Study are in line with the five overarching outcomes for the HLN project (Figure 1), with a specific focus on how to ensure these outcomes can be achieved and realised during periods of hot weather.

The main outputs of the Heat Resilience Study are:

- A detailed map of heat exposure across the HLN area and a longlist of 'hot spots'.
- A heat vulnerability assessment for the HLN area and the longlist of hot spots.
- Recommended heat adaptation measures for three priority hot spots (based on heat risk), with an indication of the potential cooling benefits, and wider benefits, of these measures.
- An overarching Heat Resilience Strategy for the HLN area, including a high-level Shade and Cooling Masterplan, and a hierarchy of Thermal Comfort Design Principles for Holborn's public realm.

Whilst these outputs are place- and evidence-based, specific to the context of the HLN area, the study also considers their transferability and replicability to other neighbourhoods within Camden.

The Five HLN Project Outcomes with Heat Resilience Study Focus

01 Safe

Holborn's streets and public realm will be safer for people to use **during hot weather** and people will feel more secure whilst using them.

02 Efficient

Holborn's streets and public realm will enable people and assets to be more energy, water and resource efficient **during hot weather.**

03 Green

Holborn's streets and public realm will celebrate existing trees and green spaces and will integrate more greenery to keep people and assets cool **during hot weather.**

04 Active

Holborn's streets and public realm will enable people to be healthy and active **during hot weather** and to choose active travel as a mode of transport.

05 Connected

Holborn's streets and public realm will be more legible and connected and will enable people to access and use public transport comfortably **during hot weather.**

Figure 1: The five HLN project outcomes highlighting the focus of the Heat Resilience Study.

The study area for the HLN Heat Resilience Study is located within the wider Holborn area, in the south of the London Borough of Camden.

The study area (referred to as 'the HLN area' from here on in) predominantly falls within the ward of Holborn and Covent Garden, with a portion of it falling within the Bloomsbury ward (Figure 2)[1].

The HLN area experiences medium-to-high levels deprivation (Figure 3)[2]. The HLN area has several publicly accessible green spaces, and some notable tree lined streets (Figure 4)[3].

However, there is a deficit of larger green spaces, no water bodies, and overall tree canopy cover in the Holborn and Covent Garden ward is the lowest in the borough.

Based on metrics for heat vulnerability and exposure at the Lower Super Output Area (LSOA) scale, overall heat risk levels across the HLN area have been established as 'Medium' to 'High' prior to this study (Figure 5)[4].

For further detail on the characteristics of the HLN area see **Appendices B** and **C.**

Figure 2: Extent of HLN area with ward boundaries

Figure 3: Deprivation levels in HLN area at LSOA level

Figure 4: Green spaces and street trees in HLN area

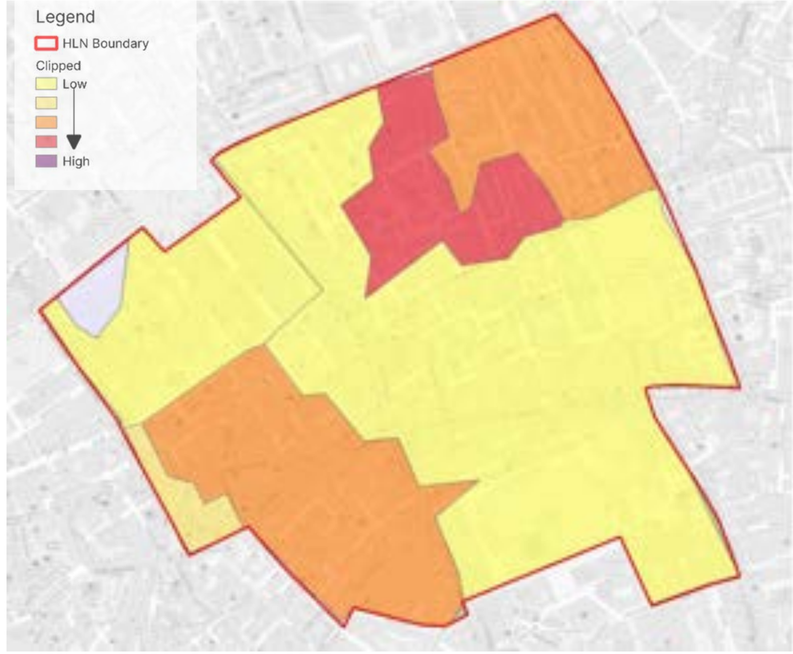


Figure 5: Heat risk levels in HLN area at LSOA level

Holborn Liveable Neighbourhood

02

Methodology

This chapter outlines the methodology used to assess heat risk in the HLN area, combining heat exposure and heat vulnerability analyses.

Heat exposure was modelled using 3D environmental software to assess factors such as direct sun hours, incident radiation, sky exposure, mean radiant temperature (MRT), and the Universal Thermal Comfort Index (UTCI). Heat vulnerability was evaluated using geographical information systems (GIS) analysis, stakeholder engagement, and demographic data, identifying populations, assets, and businesses most sensitive to heat.

The findings informed the selection of priority areas for heat adaptation and resilience measures. The outputs have contributed to a Heat Resilience Strategy, incorporating a high-level Shade and Cooling Masterplan, and a hierarchy of Thermal Comfort Design Principles.

The methodology acknowledges limitations such as weather data assumptions, uniform surface properties, and the simplifications inherent in human thermal comfort modelling, ensuring a balanced and evidence-based approach to understanding and mitigating heat risk in Holborn.

Methodology - Overview

To establish a greater understanding of the spatial and temporal distribution of heat risk at the neighbourhood level in the HLN area, two main analyses have been undertaken:

1. Heat exposure, and
2. Heat vulnerability.

Heat Exposure Analysis Overview

The heat exposure analysis was undertaken using environmental modelling software which integrated a 3D massing model of the HLN area and selected climate data. This is explained further on pages 11 to 13.

Baseline models and maps showing areas of heat exposure across the HLN area were developed enabling the identification of a longlist of the most exposed areas.

Heat Vulnerability Analysis Overview

The heat vulnerability analysis was undertaken using both geographical information systems (GIS) and qualitative techniques, including stakeholder engagement. This is explained further on page 14.

The areas of high heat exposure were analysed from a vulnerability perspective, and areas of high heat risk (based on exposure and vulnerability to heat) were identified and shortlisted.

Heat Adaptation and Resilience Measures

Potential heat adaptation measures were identified for shortlisted areas of highest heat risk. These measures included:

- Human-made shade
- Nature-based shade and cooling
- Water
- Albedo, and
- Services and policy

Physical measures such as shade giving trees and shade structures, were modelled in terms of their potential cooling and comfort benefit, alongside consideration of wider benefits. Measures for which cooling and comfort benefit could not be modelled, such as albedo and water features, were analysed using publicly available evidence on cooling potential.

For further details on the range of heat adaptation and resilience measures considered for this study see **Appendix H.**

Based on the analyses and modelling, evidence review and stakeholder engagement with Camden Council officers, a heat resilience strategy (HRS) for the HLN area has been developed. The HRS includes a high-level 'shade and cooling masterplan', and thermal comfort design principles for different public realm typologies within Holborn.

Image 2: Tybald's Estate on a hot and sunny day.

Heat Exposure Analysis – Methodology

Heat Exposure

Heat exposure of external spaces within the HLN area was assessed using a 3D software model and environmental analysis techniques for the following metrics of climate and human comfort:

- Direct Sun Hours
- Incident Radiation
- Sky Exposure
- Mean Radiant Temperature (MRT), and
- Universal Thermal Comfort Index (UTCI).

These terms are explained on the following page.

Output

The outputs of the heat exposure analyses indicate how comfortable, or uncomfortable, external spaces within the HLN area might be for an individual person during hot weather.

Levels of comfort vary spatially and are dependent on several model variables. Of these variables, the urban geometry (built mass and vegetation geometry) has been thoroughly considered for any variations between 2020s to 2050s. Alongside this the surface material properties of this urban geometry were considered, using assumed fixed inputs. However, variables such as evaporative cooling, human activities and heating from equipment (e.g. vehicles and external condenser units) have not been considered in this heat exposure study.

It should be noted that all the analysis outputs depict indicative values, and not absolute values, due to high number of variables influencing the parameters. For further details on limitations and assumptions for the heat exposure analyses see page 15 and **Appendix A.**

Collectively, the outputs of the heat exposure analyses provide a picture of how exposed external spaces in the HLN area are to sunlight and heat.

These outputs were considered as inputs to the vulnerability analysis, and subsequently enabled the identification of areas of high heat risk.

Heat Exposure Analysis – Methodology

Climate and Weather Data

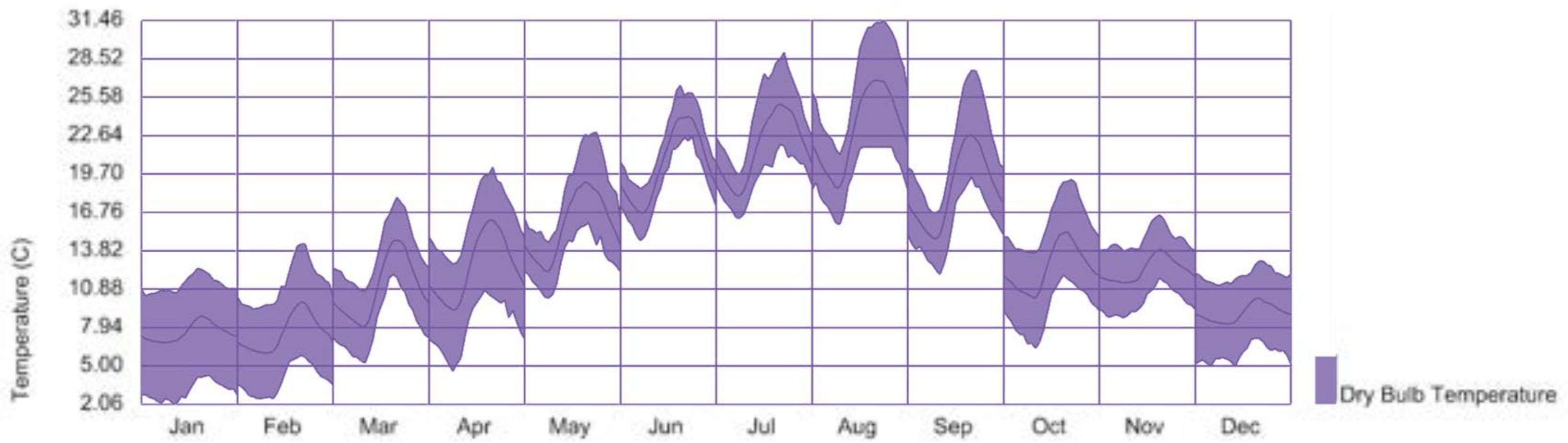
The analyses of heat exposure and thermal comfort focused on the summer period defined for the purposes of this project as 1 May - 30 September for any given year. This date range is used to pick up any outlying high temperatures in late spring and early autumn.

CIBSE Design Summer Year (DSY) weather data has been used to conduct analysis for the following periods:

- 2020s (current scenario), and
- 2050s (future scenario).

Within this period, specific dates have been used, most notably the summer solstice (21 June for any given year) when daylight hours are longest, and the hottest day recorded in the weather files (10 August 2020) (Figure 6).

2020s



2050s

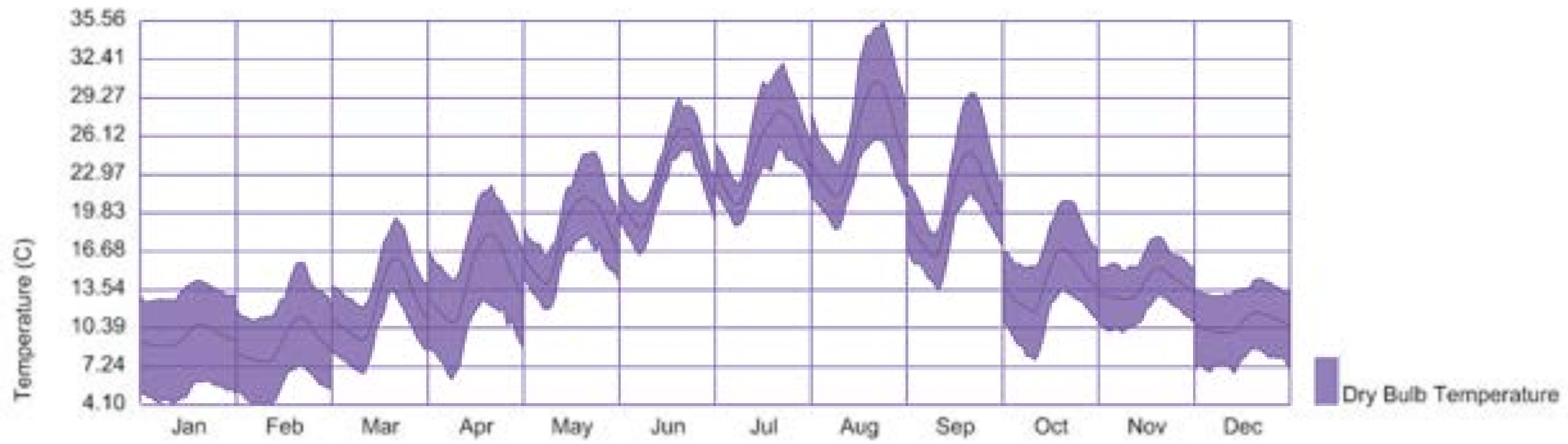


Figure 6: The charts represents annual dry bulb temperature for the 2020s weather file (top) and 2050s weather file (bottom), taken from a CIBSE weather file. As per the weather file, the highest temperatures are recorded in August. Source: https://www.cibse.org/weatherdata

Heat Exposure Analysis – Methodology

Direct Sun Hours

The direct sun hours represent the total duration which a surface is exposed to direct sunlight over a specific period. Shade the UK have conducted this analysis for 21 June 2020, the summer solstice and therefore the longest day of the year. This value is measured in hours and provides insight into how much direct sunlight different parts of the urban area receive during the day.

Incident Radiation

This analysis has determined the intensity of sunlight within the HLN area on the longest day of the year in 2020 (21 June). This helped to identify areas that experience higher levels of solar radiation and therefore likely to heat up more rapidly. The unit of measurement is kilowatt hours (kWh).

Sky Exposure

The sky exposure analysis calculates the amount of visible sky a surface or point in an urban area can 'see', indicating how open or enclosed a space is relative to the sky. The analysis uses the 3D urban model to determine how much of the sky dome is obstructed by surrounding buildings or structures, with results represented as a factor from 0 to 1, with 1 indicating a completely unobstructed view of the sky.

Mean Radiant Temperatures (MRT)

MRT is an average temperature of surrounding surfaces that influence human heat exchange through radiation. The unit of measurement is degrees Celsius (°C). MRT depends on the surface temperatures and reflectance properties of building materials present in the urban space. In this calculation, all the materials were assumed to have the same temperature as the ambient air and a uniform reflectance value of 0.25.

For further details on limitations and assumptions for the heat exposure analyses see page 15 and **Appendix A.**

Universal Thermal Comfort Index (UTCI)

The UTCI measures human thermal comfort by assessing the combined effects of temperature, humidity, wind speed, and MRT. This metric is also known as the 'feel like temperature' as it gives an output which is closest to how the person in a specific location is actually feeling.

UTCI values are expressed in degrees Celsius (°C) and indicate how the body's thermal balance is affected by the surrounding environment. Higher values reflecting higher levels of heat exposure and greater risk of heat stress.

For further details on the sources of data for the heat exposure analysis see **Appendix A.**

Please see page 15 for limitations of the heat exposure methodology.

Heat Vulnerability Analysis - Methodology

The heat vulnerability analysis of the HLN area was undertaken in two stages.

The first stage of the analysis comprised a desktop and GIS based analysis of data for the HLN area to identify potentially vulnerable receptors of interest – groups of **people, assets and features, and businesses**. This stage of the analysis was based on a combination of both publicly available data and datasets supplied by Camden Council.

The second stage of the heat vulnerability analysis was a more detailed analysis of the vulnerability of specific areas identified as experiencing high heat exposure.

First stage vulnerability analysis

People

The first stage of the analysis identified the following groups of potentially vulnerable people within the HLN area:

- Low-income households
- Young children
- Older adults / the elderly
- People with mental or physical health issues
- People experiencing homelessness, and
- Outdoor workers.

The following groups of people are not typically considered to be vulnerable, but due to their high presence within the HLN area they have been included within the analysis, but not accorded the same weight:

- Tourists, and
- Students.

Assets and features

The following assets and features within the HLN area were identified as sensitive and potentially vulnerable to urban heat:

- Sensitive Housing (Homeless Shelters and Social Housing)
- Sensitive Transport and Outdoor Infrastructure (Pedestrian Crossings, Bus Stops, Playgrounds, Stations)
- Sensitive Buildings of Public Interest
- (Places of Worship, Nurseries, Schools, Museums, Higher Education, Libraries)
- Health Infrastructure (GP Practices, Health Centres, Pharmacies, Hospitals)

In addition, the following assets and features were identified to indicate where heat adaptation measures exist already, and to identify potential gaps in provision:

- Areas of tree canopy cover
- GLA 'Cool Spaces', and
- Water Refill Points.

Businesses

The following categories of businesses within the HLN area were identified as being heat sensitive and potentially vulnerable to urban heat impacts:

- Butchers
- Care homes
- Catering
- Cleaning
- Clinical diagnostics
- Clinical research
- Collection and delivery
- Dairy products
- Electricity generation
- Emergency services
- Food and drink processing
- Gyms and spas
- Hospital and clinics
- Nurseries
- Pharmaceuticals
- Physical fitness coaching and training
- Pregnancy and parenting, and
- Sporting events and activities.

For further details on the sources of data for the vulnerability analysis see **Appendices D, E and F.**

Limitations of Methodology

Limitations of Heat Exposure Methodology

Weather Data - The weather file used is based on historical averages, not real-time conditions, so short-term fluctuations in solar intensity are not accounted for.

3D Urban Model - The HLN area model may not capture all detailed urban features, such as smaller vegetation

Uniform Surface Properties - All surfaces are assumed to have the same reflective and absorptive properties, which may differ from 'real-world' materials.

No Movable Objects - The analysis considers only static elements like buildings, ignoring movable objects (e.g. trees, vehicles, temporary shading).

Wind Speed - Computational fluid dynamic (CFD) modelling has not been carried out as part of this project; this could lead to certain areas experiencing lower temperatures owing to the cooling effect of higher wind speeds.

Evaporative Cooling - The evaporative cooling benefit from trees, vegetation, and urban greenery has not been considered in the model. This could be explored as part of future work which allows for dynamic modelling of hyper local fluctuations in air movement and humidity.

Indicative, Not Absolute - The results provide guidance on solar exposure and identifies locations across the model which are most exposed. The outputs are not necessarily true representations of the absolute temperature or comfort an individual may experience at the given location.

UTCI Reduction – Total reductions in UTCI values are used when summarising the efficacy of heat adaptation measures. The total UTCI reduction values are indicative and are primarily used to inform the level of cooling benefit, as opposed to the exact degree of reduction.

Time of Day for Maps – Meteorological data from 3pm has been used for all the maps. Whilst radiation at 12pm is highest in the weather files, dry bulb temperatures are highest at 3pm. Dry bulb temperature is considered more critical for the modelled outputs and therefore this time has been used.

Limitations of Heat Vulnerability Methodology

Stage 1

Sources of data - The sources of data for the desk top research and the GIS analysis are robust and comprehensive but are not exhaustive. Other relevant datasets may exist which provide additional insights into HLN area wide vulnerability.

Location Based Data - The accuracy of location-based data varies between data sources, so some manual adjustments have been made to certain datasets where necessary.

Stage 2

Objectivity of Analysis – The analysis of the 16 longlisted hotspots has been undertaken in as objective and rigorous a way as possible. However, there will inevitably be an element of subjectivity and professional judgement in determining the analysis results.

Weighting of Criteria – The six criteria used for the analysis have each been given equal weighting and all have a potential score of '5'.

Universal Thermal Comfort Index (UTCI) – The UTCI model has a 'person setting'. It applies a code for a 'universal average' person, with the metabolism and thermal comfort level of a healthy man in his 30s with light brown skin, standing still and wearing clothing 'appropriate for the weather'. This 'universal average' does not take into consideration the characteristics of more vulnerable people, meaning the UTCI methodology has data gaps on factors which contribute to heat vulnerability such as demographics, biological sex, health conditions, cultural and religious practices, and physical activity. Together with environmental conditions, these factors may alter a person's experience of thermal comfort.

Holborn Liveable Neighbourhood

03

Analysis Results

This chapter presents the analysis results of heat exposure and vulnerability within the HLN area, highlighting key risk areas and assets sensitive to heat.

South-facing, unshaded external spaces experience the highest heat exposure, with UTCI temperatures exceeding 41°C in some areas on the hottest day within the 2020s weather file (10 August 2020 at 3pm). Spaces which are shaded or overshadowed were found to be much cooler.

The heat vulnerability analysis identified social housing, public buildings, transport hubs, children's play areas, and health infrastructure as particularly sensitive to heat stress, along with businesses dependent on temperature-sensitive operations. These insights inform the prioritisation of adaptation measures, such as tree planting, shade structures, cool surfaces, water features, and policy interventions, to enhance thermal comfort and resilience across the HLN area.

Heat Exposure Analysis – Modelled Values

Direct Sun Hours

Figure 7 indicates the number of direct sunlight hours falling on external spaces within the HLN area on 21 June 2020.

The spaces highlighted with white and blue receive minimal (white) or no (blue) direct sun. These spaces could potentially be of value in terms of cooling and comfort benefit during hot weather.

Conversely, the spaces highlighted with red and purple receive more than six hours of direct sun on the hottest day of the year.

These spaces are generally south facing and have minimal (dark red) or no (purple) shade or overshadowing.

These spaces would potentially benefit from some kind of permanent or temporary shading during hot weather.

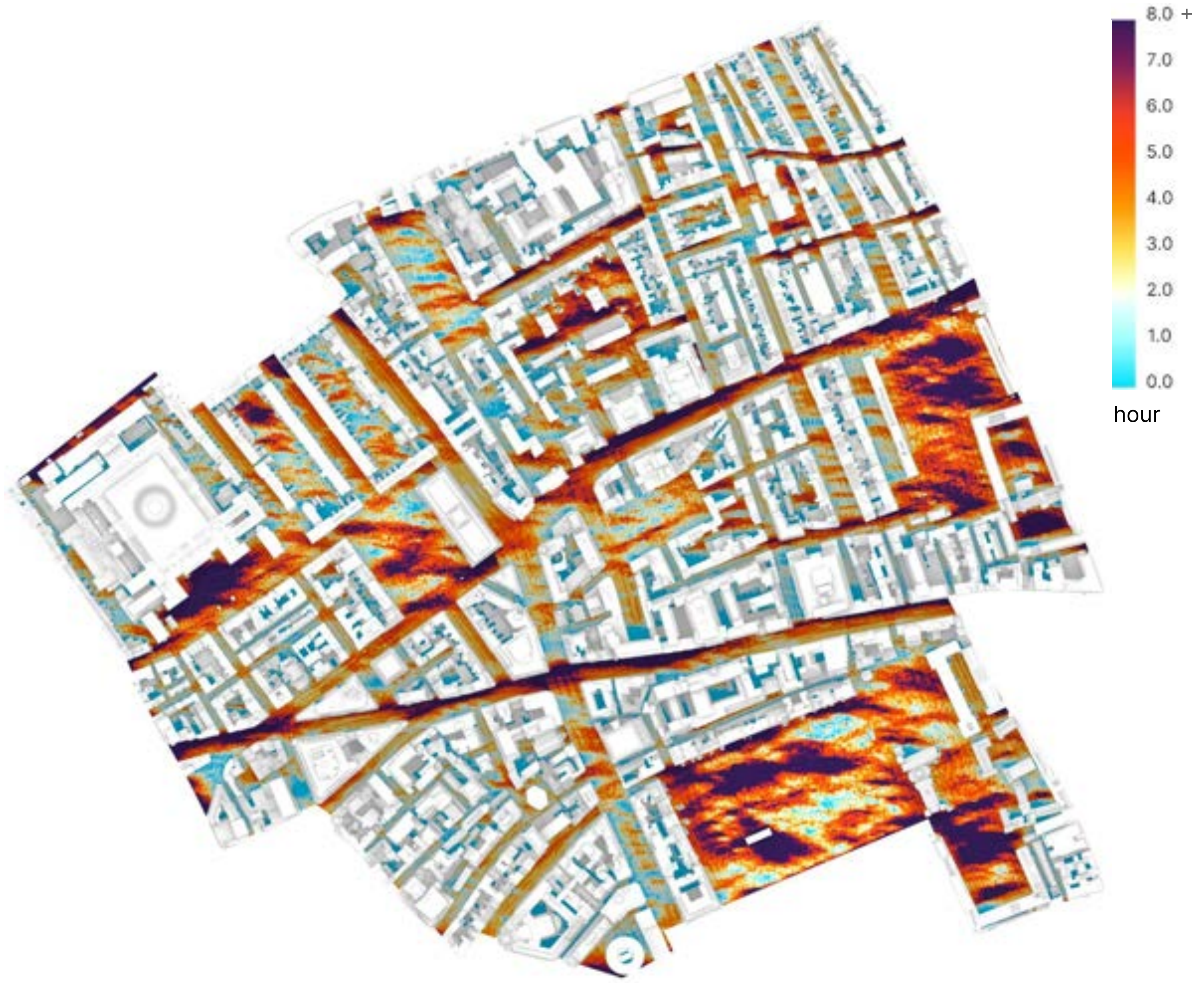


Figure 7: Direct Sun Hours in external spaces within the HLN area / 21 June 2020

Heat Exposure Analysis – Modelled Values

Incident Radiation

Figure 8 indicates the amount of incident radiation falling on external spaces within the HLN area on 21 June 2020.

The spaces highlighted with yellow and white receive minimum (yellow) or no (white) incident radiation.

The areas highlighted with red and purple receive high amounts of incident radiation, defined as more than 4 kilowatts per hour (kWh).

Incident Radiation and Direct Sun Hours are related metrics, therefore modelled results are comparable for both datasets.

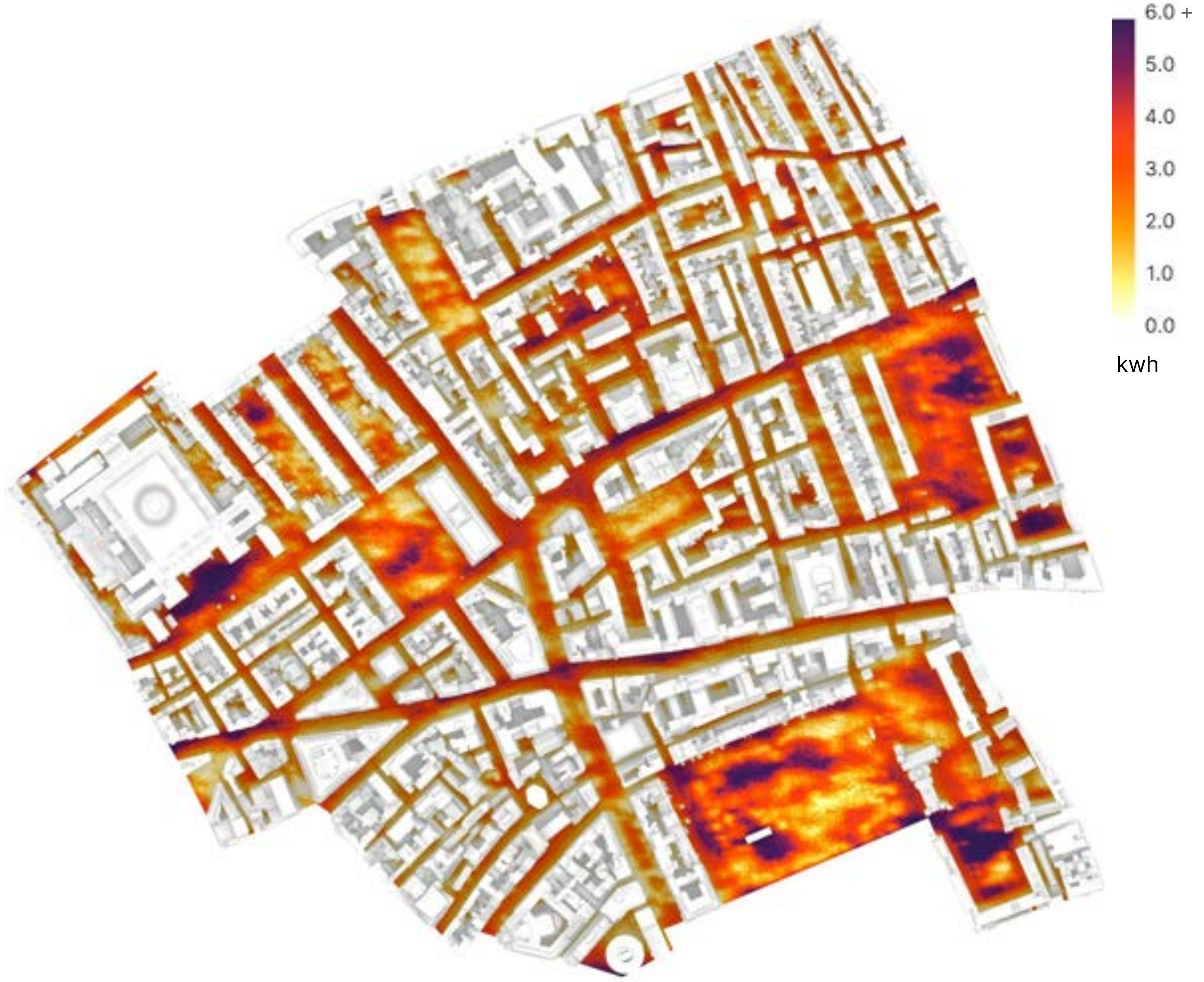


Figure 8: Incident Radiation in external spaces within the HLN area / 21 June 2020

Heat Exposure Analysis – Modelled Values

Sky Exposure

Figure 9 shows the varying sky exposure values for external spaces across the HLN area.

The spaces highlighted with yellow have a sky exposure closer to zero, meaning they are shaded and therefore have an obstructed view of the sky. This means they are likely to be relatively cooler areas during hot, sunny weather.

The spaces highlighted with orange and red have high sky exposure values that are close to 0.6. These spaces have a greater view of the sky and are likely to be relatively hotter areas during hot, sunny weather.

MRT and UTCI calculations are dependent on sky exposure values, therefore modelled results are comparable for all three datasets.

Figure 9: Sky Exposure values in spaces within the HLN area / Any given time of the year

Heat Exposure Analysis – Modelled Values

Mean Radiant Temperature (MRT)

Figure 10 indicates the distribution of MRT values across the HLN area.

Yellow spaces have low MRT values at approximately 40°C, which is close to the ambient air temperature on 19 August 2020. They have low levels of direct solar exposure due to shade provided by trees or structures, or due to overshadowing from other buildings.

The spaces highlighted with red and purple have high MRT values, close to 55°C. This is due to high solar exposure and less shading and overshadowing in these spaces.

In these high solar exposure spaces, MRT values can vary further based on the types of surface materials present in each space. Surface temperatures of materials like dark asphalt and concrete can rise up to 65°C when Dry Bulb Temperatures reach 35°C as they have low reflectivity and high heat absorption properties. Conversely, surface materials like wet, green grass have surface temperatures much lower than Dry Bulb Temperatures.

Figure 10: MRT values in external spaces within the HLN area / 10 August 2020 / 3pm

Heat Exposure Analysis – Modelled Values

Universal Thermal Comfort Index (UTCI)

Figure 11 indicates the distribution of UTCI temperature values across the ground level surfaces within the HLN area.

Light yellow spaces have the lowest UTCI values, at approximately 38°C, which is equivalent to ambient air temperatures on 19 August 2020.

Yellow and orange spaces depict areas with some solar exposure, and some shade provided from trees or structures, or overshadowing from other buildings.

Spaces highlighted with dark red and purple have the highest UTCI values, exceeding 41°C, which is three degrees Celsius higher than the ambient air temperature across the HLN area. This is typically due to less or no shading or overshadowing in these areas, and the absence of other factors that contribute to cooling and comfort of the space.

Additional shading or cooling measures, such as trees, pavilions and water fountains, can help to lower UTCI temperatures.

It should be noted that all the analysis outputs depict indicative values, and not absolute values, due to high number of variables influencing the parameters. For further details on limitations and assumptions for the heat exposure analyses see page 15 and **Appendix A.**

Figure 11: UTCI values in external spaces within the HLN area / 10 August 2020 / 3pm

Heat Vulnerability Analysis – Identified Assets and Features

Sensitive Assets and Features

Figure 12 (overleaf) shows the location of assets and features within the HLN area which have been identified as sensitive and potentially vulnerable to urban heat. This is based upon the following criteria:

Sensitive Housing

Social housing, homeless shelters and housing association properties have been considered sensitive to heat impacts due to the higher degree of socioeconomic and demographic vulnerability of people living there.

Sensitive Buildings of Public Interest

Places of worship, nurseries, schools, museums, libraries, and community centres have all been considered sensitive due to the high number of users, the high sensitivity of users (e.g. children at nurseries) and/or the demographic of users.

A heat sensitive business is one whose core work, space, assets, service, products, employees, customers and/or service users are susceptible to heat impacts. They are potentially vulnerable if heat impacts are negative and could cause health and safety issues.

Sensitive Transport and Outdoor Infrastructure

Bus stops, tube stations, pedestrian crossings and playgrounds help to understand where individuals will be outside and potentially spending extended periods of time – whether this is waiting for a bus or navigating crossings to reach a public building.

Health infrastructure

Health infrastructure includes GP services, health centres, hospitals, and pharmacies. The locations of these types of health infrastructure provide an indication of where vulnerable people may need to go for medical care and treatment, pick up prescriptions or purchase essential medicines and health and wellbeing products.

For further information about how assets and features have been identified as sensitive and potentially vulnerable to urban heat see **Appendix E.**

For individual maps of all the sensitive features displayed in Figure 12, see **Appendix B.**

Figure 12: Map of assets and features within the HLN area identified as sensitive and potentially vulnerable to heat.

Holborn Liveable Neighbourhood

04

Hot Spots Longlist

This chapter outlines the identification and evaluation of heat exposure hot spots within the HLN area. 16 locations were initially identified based on highest UTCI values, with areas exceeding 41°C being captured as part of the longlist for further assessment.

A vulnerability analysis was conducted using five key criteria: proximity to vulnerable populations or assets, high footfall, long dwell times, and use for physical activity or events. Each hot spot was scored based on these factors, revealing Theobalds Road and Lincoln's Inn Fields as the most vulnerable locations, followed closely by British Museum Forecourt and Great Russell Street, and Tybald's Estate.

Following a detailed shortlisting exercise with Camden Council officers and project stakeholders, five priority locations were selected for further study, including John's Mews and St George CoE Primary School, due to its unique exposure of young children to heat risks.

These findings guide the next phase of targeted adaptation measures to improve thermal comfort and urban resilience in Holborn's public realm.

Hot Spots Longlist

Following the heat exposure analysis, the UTCI values across the HLN area were plotted on GIS software. Locations where UTCI values exceeding 41°C, at or above, the 50th percentile of all modelled values, were considered heat exposure 'hot spots'.

16 locations comprise the longlist of UTCI based heat exposure 'hot spots' (Figure 13). Please note these hot spots are not ranked by heat exposure:

1. British Museum Forecourt and Great Russell Street
2. Tybald's Estate
3. High Holborn and Southampton Row Junction
4. Theobalds Road
5. Gray's Inn Fields
6. Lincoln's Inn Fields
7. Bloomsbury Square Gardens
8. John's Mews and St George CoE Primary School
9. Montague Street Gardens
10. New Oxford Street/Bloomsbury Way
11. Great Ormond Street
12. Southampton Row
13. Southampton Place
14. Long Yard
15. Great Queen Street/Wild Street, and
16. New Square

The main reasons for these locations being so hot are observed to be related to one or more of the following three factors:

- built form (i.e. they are open spaces with no shade or overshadowing)
- orientation (i.e. they are south or south-west facing), and
- low albedo (i.e. they have a high presence of human-made surface materials).

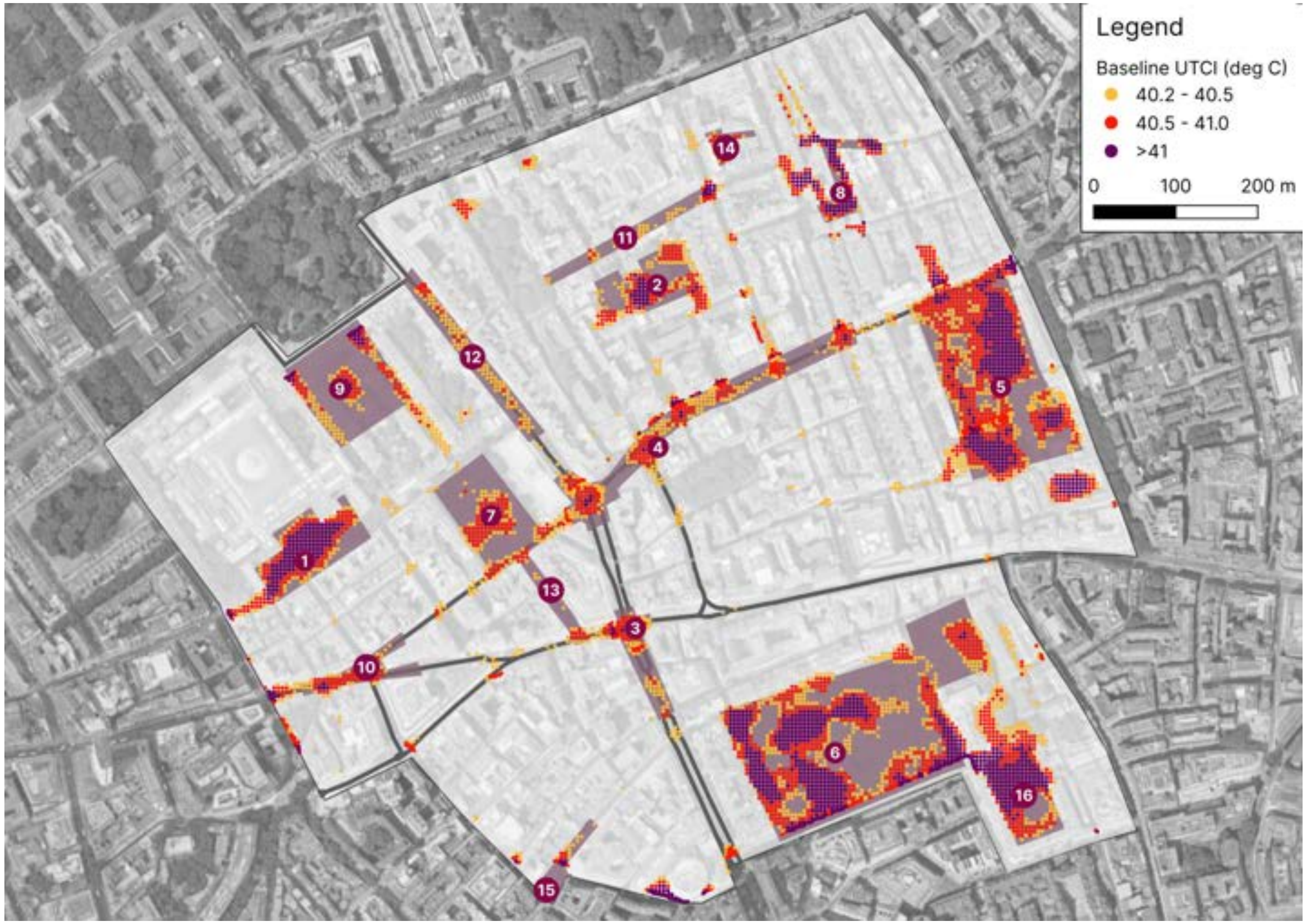


Figure 13: Locations of the 16 longlisted hot spot locations within the HLN area based on heat exposure.

Summary of Hot Spot Vulnerability Analysis Scores

Hot Spot Longlist Vulnerability Analysis

A vulnerability analysis of each of the 16 hotspots on the longlist was undertaken using the following five criteria, with a maximum score of five points per criteria and 25 points in total:

a. Proximity to / used by vulnerable people (e.g. close to social housing or used by young children)
b. Proximity to / on route to a vulnerable asset or feature (e.g. close to a hospital or on route to a tourist attraction)
c. High footfall 11am-6pm (e.g. lots of people move through or pass by this space during the warmest part of the day)
d. Long dwell / use times 11am-6pm (e.g. people spend time here through choice or necessity), and
e. Used for physical activity / outdoor events (e.g. a space to exercise, play, come together or celebrate).

The GIS mapping of sensitive assets and features which might be potentially vulnerable to heat informed this analysis (Figure 14).

Based on the analysis of these criteria:

- The highest scoring hot spots were **Hot Spots 4** Theobalds Road and **6** Lincoln's Inn Fields with scores of 21 out of 25.
- These were followed in by **Hot Spots 1** British Museum Forecourt and Great Russell Street, and **2** Tybald's Estate with scores of 20 out of 25.
- **Hot Spots 3** High Holborn/Southampton Row Junction, and **8** John's Mews and St George CoE Primary School had a scores of 19 out of 25
- **Hot Spots 7, 10, 11, 12 and 15** (Bloomsbury Square Gardens, New Oxford Street/Bloomsbury Way, Great Ormond Street, Southampton Row and Great Queen Street/Wild Street) all had medium scores ranging from 16 out of 25 to 18 out of 25.
- **Hot Spots 5, 9, 14, 16 and 13** (Gray's Inn Fields, Montague Square Gardens, Long Yard, New Square, and Southampton Place) all had the low scores ranging from 12 out of 25 to 14 out of 25.

- The highest scoring hot spots indicate areas where heat adaptation and resilience measures are needed as a priority to increase thermal comfort, health and safety for vulnerable people.
- The medium scoring hot spots indicate areas where any HLN project related interventions could be enhanced to contribute to thermal comfort, health and safety, and overall heat adaptation and resilience, in the HLN area.
- The lower scoring hot spots indicate areas where there is no urgent need for heat adaptation and resilience measures at present, but they may be worth considering to increase thermal comfort of people using those spaces.

Table 1 provides a summary of the scores for all 16 hotspots against each of the vulnerability criteria.

For details of the vulnerability analysis of the 16 hot spots, see **Appendix I.**

Hot Spots Longlist

Sensitive Assets and Features

Figure 14 shows the location of the 16 longlisted hot spots in relationship to assets and features within the HLN area identified as sensitive and potentially vulnerable to urban heat.

For further information about how assets and features have been identified as sensitive and potentially vulnerable to urban heat see **Appendix E.**

For individual maps of all the sensitive features displayed in Figure 14, see **Appendix B**.

For details of the vulnerability analysis of the 16 hot spots, see **Appendix I.**

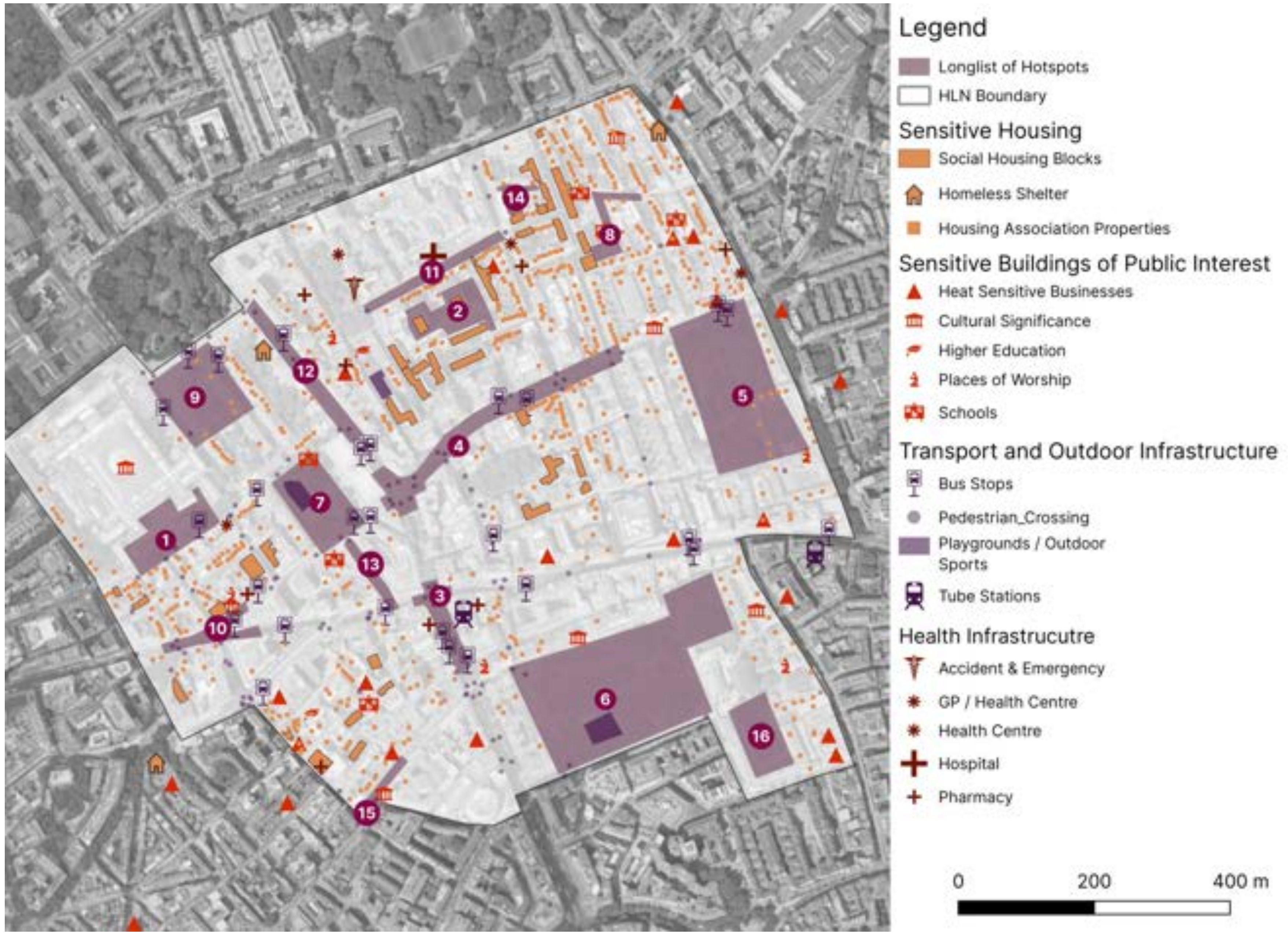


Figure 14: Location of longlisted hot spots (based on heat exposure) in relationship to assets and features within the HLN area identified as sensitive and potentially vulnerable to heat.

1. British Museum Forecourt and Great Russell Street
2. Tybald's Estate
3. High Holborn/Southampton Row Junction
4. Theobalds Road
5. Gray's Inn Fields
6. Lincoln's Inn Fields
7. Bloomsbury Square Gardens
8. John's Mews and St George CoE Primary School
9. Montague Street Gardens
10. New Oxford Street/Bloomsbury Way
11. Great Ormond Street
12. Southampton Row
13. Southampton Place
14. Long Yard
15. Great Queen Street/Wild Street
16. New Square

Summary of Vulnerability Analysis of Hot Spot Longlist

Table 1: Heat vulnerability analysis of the 16 longlisted hot spots

H-Spot ID V-criteria	1 BM	2 TE	3 HH	4 TR	5 GIF	6 LIF	7 BSG	8 JM	9 MSG	10 NOS	11 GOS	12 SR	13 SP	14 LY	15 GQS	16 NS
a. Prox to vuln people	3	5	4	5	3	5	5	5	2	3	5	3	2	4	3	3
b. Prox to vuln asset	3	5	4	4	3	4	3	4	3	4	5	3	4	2	4	3
c. Footfall / usage	5	2	5	4	2	3	3	3	2	4	4	5	3	2	4	3
d. Dwell / use time	5	4	3	4	2	4	4	3	4	3	2	2	2	2	3	2
e. Physical activity / events	3	4	3	4	2	5	4	4	2	3	2	3	3	4	3	3
Total score out of 25	20	20	19	21	12	21	18	19	12	16	18	16	14	13	17	13

1. British Museum Forecourt and Great Russell Street
2. Tybald's Estate
3. High Holborn/Southampton Row Junction
4. Theobalds Road
5. Gray's Inn Fields
6. Lincoln's Inn Fields
7. Bloomsbury Square Gardens
8. John's Mews and St George CoE Primary School
9. Montague Street Gardens
10. New Oxford Street/Bloomsbury Way
11. Great Ormond Street
12. Southampton Row
13. Southampton Place
14. Long Yard
15. Great Queen Street/Wild Street
16. New Square

Key to scores:
5 = high heat vulnerability
1 = low heat vulnerability

>19/25 = high heat vulnerability
>15-<18/25 = medium heat vulnerability
<14/25 = low heat vulnerability

Holborn Liveable Neighbourhood

05

Hot Spots Shortlist and Priority Hot Spots

This chapter refines the hot spot analysis, narrowing the 16 longlisted locations to a shortlist of five, and further prioritising three key sites for heat adaptation measures:

British Museum Forecourt & Great Russell Street
High heat exposure with nearly 6 million annual visitors, including vulnerable groups such as tourists, school children, and individuals with mobility issues.

Tybald's Estate
A social housing estate with heat-vulnerable residents, including families with young children, older adults, and people experiencing deprivation. Also, a key pedestrian route to Great Ormond Street Hospital.

Theobalds Road
A major movement corridor with high public transport, private vehicle, and pedestrian use, connecting key local assets and bordering dense residential areas.

Lincoln's Inn Fields and **John's Mews & St George CoE Primary School** were excluded due to scope limitations.

These priority hot spots will undergo further analysis for targeted heat adaptation strategies to enhance urban resilience.

Hot Spots Shortlist

Following the vulnerability analysis of each hot spot on the longlist (based on HLN area level heat exposure) we undertook a robust and detailed shortlisting exercise with Camden Council officers and HLN project stakeholders to select five of the highest scoring hot spots for further analysis. The exercise comprised two on-line workshops using a Miro board to review the work undertaken and the interim outputs from the vulnerability analysis. Follow up meetings were then held with hot spot-specific stakeholders. The hot spots carried forward to the shortlist were **Hot Spots 1, 2, 4, 6** and **8** illustrated below.

Hot Spot 8 John's Mews and St George CoE Primary School was carried forward to the shortlist of five rather than **Hot Spot 3** High Holborn/Southampton Row Junction despite their comparable total scores. This was due to **Hot Spot 8** scoring higher on criterion 'a' due to its proximity to social housing and a school, and use by young children. It was also the only shortlisted hot spot with education facilities within its boundary. This was considered to be useful in terms of informing the identification of other potential hot spots near schools in Camden. In addition, the complex interface of vehicles, pedestrians and safety requirements were considered to make natural and human shade measures harder to deliver at major road junctions such as **Hot Spot 3**.

Hot Spot 1
British Museum Forecourt and Great Russell Street
01

=20 out of 25

Hot Spot 2
Tybald's Estate
02

=20 out of 25

Hot Spot 4
Theobalds Road
03

=21 out of 25

Hot Spot 6
Lincoln's Inn Fields
04

=21 out of 25

Hot Spot 8
John's Mews & St George CoE Primary School
05

=19 out of25

Priority Hot Spots

Based on the insights obtained from engagement with Camden Council officers and HLN project stakeholders about the vulnerability criteria for the five shortlisted hot spots, a final priority list of three hot spots was established. These were taken forward for further analysis of potential heat adaptation measures.

Hot Spot 1

British Museum Forecourt and Great Russell Street

01

=20 out of 25

Hot Spot 2

Tybald's Estate

02

=20 out of 25

Hot Spot 4

Theobalds Road

03

=21 out of 25

Summary of Priority Hot Spot Selection

Priority Hot Spot Selection

Hot Spot 1 British Museum and Great Russell Street was considered a priority hot spot for the following reasons:

- High heat exposure, mainly due to built form, orientation and dominance of human-made surface materials.
- The British Museum was the most visited museum in the UK in 2023 - with 5,820,860 people visiting it throughout the year.
- The number of children visiting the Museum from schools across the UK was around 146,000 in 2023/24. The British Museum employs about 1,000 people.
- High numbers of museum visitors include international tourists, young children, school groups, people with mobility issues and older people use both of these spaces. A considerable number of people are likely to be vulnerable to heat here.
- Great Russell Street is an important pedestrian / cycling route for locals, commuters and tourists between the West End and Bloomsbury. There are a high number of pedestrian crossings along this road, and bus routes. Therefore, large numbers of pedestrians use the footways.
- There is social housing to the south of Great Russell Street and a number of tourism related businesses are located on the south side of Great Russell Street and down Museum Street.
- There are often queues to get into the museum snaking around the forecourt and out into Great Russell Street. Groups of tourists and visitors often congregate in both these areas before and/or after entering the museum.
- Heat risk is therefore high within this hot spot, and improving thermal comfort for close to 6 million visitors per year, is a priority.

Hot Spot 2 Tybald’s Estate was considered a priority hot spot for the following reasons:

- High heat exposure, mainly due to built form, orientation and dominance of human-made surface materials.
- Residents of Tybald’s Estate are predominantly social housing tenants. Therefore, residents are likely to include a high proportion of people and households with characteristics which make them vulnerable to heat e.g. relatively high levels of deprivation, overcrowding, families with young children, multi-generational families with older adults, or older adults living in social isolation.
- Tybald’s Estate can be used as a pedestrian through route to Great Ormond Street Hospital from Theobalds Road.
- Children and young people use the public realm between the residential blocks for hanging out, socialising and playing ball games as flats have no private outdoor space.
- Heat risk is therefore high in this hot spot, and improving thermal comfort for social housing tenants and vulnerable residents is a priority.

Hot Spot 4 Theobalds Road was considered a priority hot spot for the following reasons:

- High heat exposure, mainly due to built form, orientation and dominance of human-made surface materials.
- Theobalds Road is a major road and movement corridor and is part of many people's daily journey and active travel route to and from places in the HLN area.
- It is a key bus route running west to east used by a wide range of people including those with characteristics which may make them vulnerable to heat.
- Local assets of note within short walking distance include Holborn Library, Holborn Police Station, Gray's Inn Square, Red Lion Street, Lambs Conduit Street, and Great Ormond Street Hospital.
- There are dense residential areas to the north and south of Theobalds Road, including Tybald’s Estate to the north.

Summary of Priority Hot Spot Selection

Hot Spot 4 Theobalds Road (continued)

- There are some cafes, pubs and shops with outdoor seating areas and licenses along Theobalds Road which create opportunities for dwelling.

- Heat risk is high in this hot spot, and improving thermal comfort for people who either choose to use active travel and/or public transport, or who have no other option in order to get to local assets, is a priority.

Hot Spot 6 Lincoln's Inn Fields was not taken forward to the final priority list of three for the following reasons:

- The HLN is focused on the improvement of streets and public realm around green spaces in the area, along with connections between them, and less on improvements to the green spaces themselves

- Lincoln's Inn Fields is a historic garden square where any interventions would require further engagement with stakeholders and may require bespoke heritage sensitive solutions. Lincoln's Inn Fields has an active Friends Group, whose members may be open to discussing temporary, seasonal, shading measures without the need for additional thermal comfort modelling.

Hot Spot 8 John's Mews and St George's CoE Primary School was not taken forward to the final priority list of three for the following reasons:

- On closer analysis, the school entrance gate on John's Mews was confirmed as the secondary access gate rather than the main gate. Therefore, it is not used on a daily basis by large numbers of vulnerable groups of people. The main school entrance gate, where daily footfall and use by vulnerable groups is much higher, is on Millman Street which is a less heat exposed street.

- In addition, part of Hot Spot 8 fell within the school grounds, which are not within the direct scope of the HLN project which is focussed on improving the streets and public realm around public buildings in the HLN area, including schools.

- Given existing relationships between Camden Council and St George's CoE Primary School, the headteacher may be open to discussing school grounds-specific heat adaptation and resilience measures without the need for additional thermal comfort modelling.

This report will be shared with stakeholders of both Lincoln's Inn Fields and John's Mews and St George CoE Primary School.

Holborn Liveable Neighbourhood

06

British Museum and Great Russell Street

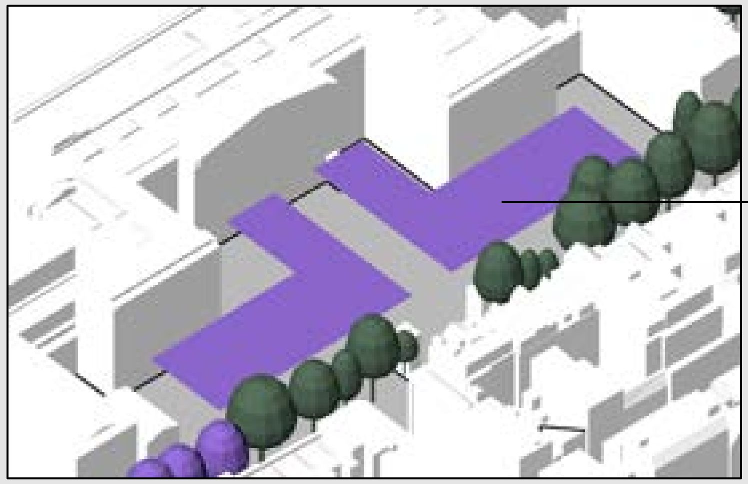
Analysis of Heat Adaptation Measures, Recommendations and Considerations:

This chapter assesses heat adaptation strategies for the British Museum Forecourt and Great Russell Street, where UTCI temperatures reach up to 41°C in the 2020s and are projected to reach up to 46°C in the 2050s, posing heat stress risks to visitors and pedestrians.

Recommended measures include:
- Large shade structures improving thermal comfort by up to 7% in the 2020s and up to 6% in the 2050s.
- Green roofs and climbing plants on and around the shade structures, adding up to 4°C cooling.
- Additional planting and water features, reducing temperatures further by up to 9°C.
- Street trees and heritage-sensitive awnings, improving comfort by up to 7% in the 2020s and 6% in the 2050s.
- Street-level plants and hanging plants, adding up to 4°C cooling.

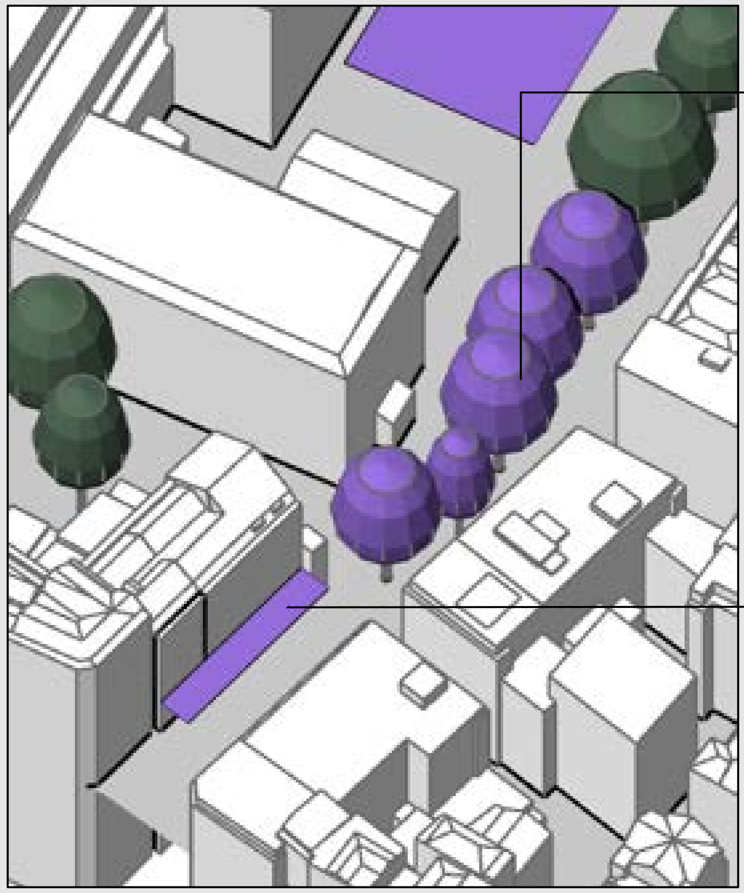
All recommended heat adaptation measures will be subject to the relevant planning policies, building regulations, and necessary consents. For this hot spot, heritage and security considerations are key and must be addressed specifically, ensuring effective and integrated solutions for this high-profile and high-footfall area.

Recommended Heat Adaptation Measures



1

Large horizontal shade structures ~3m above the forecourt ground level



2

Row of four/five new trees on the footway of Great Russell Street

3

Heritage sensitive awnings along Great Russell Street shops/entrances

For larger versions of all the modelled output images see **Appendix K.**

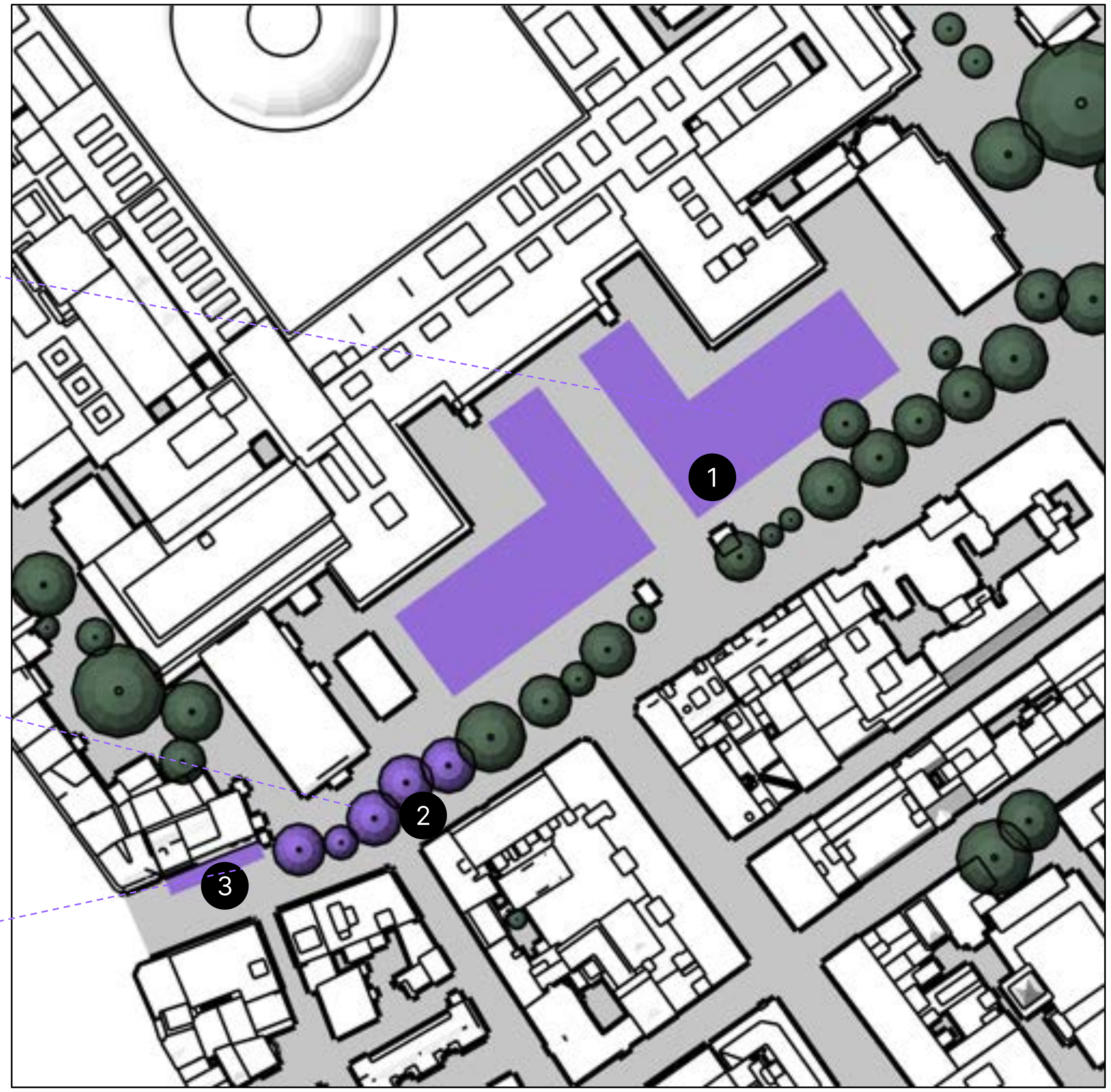


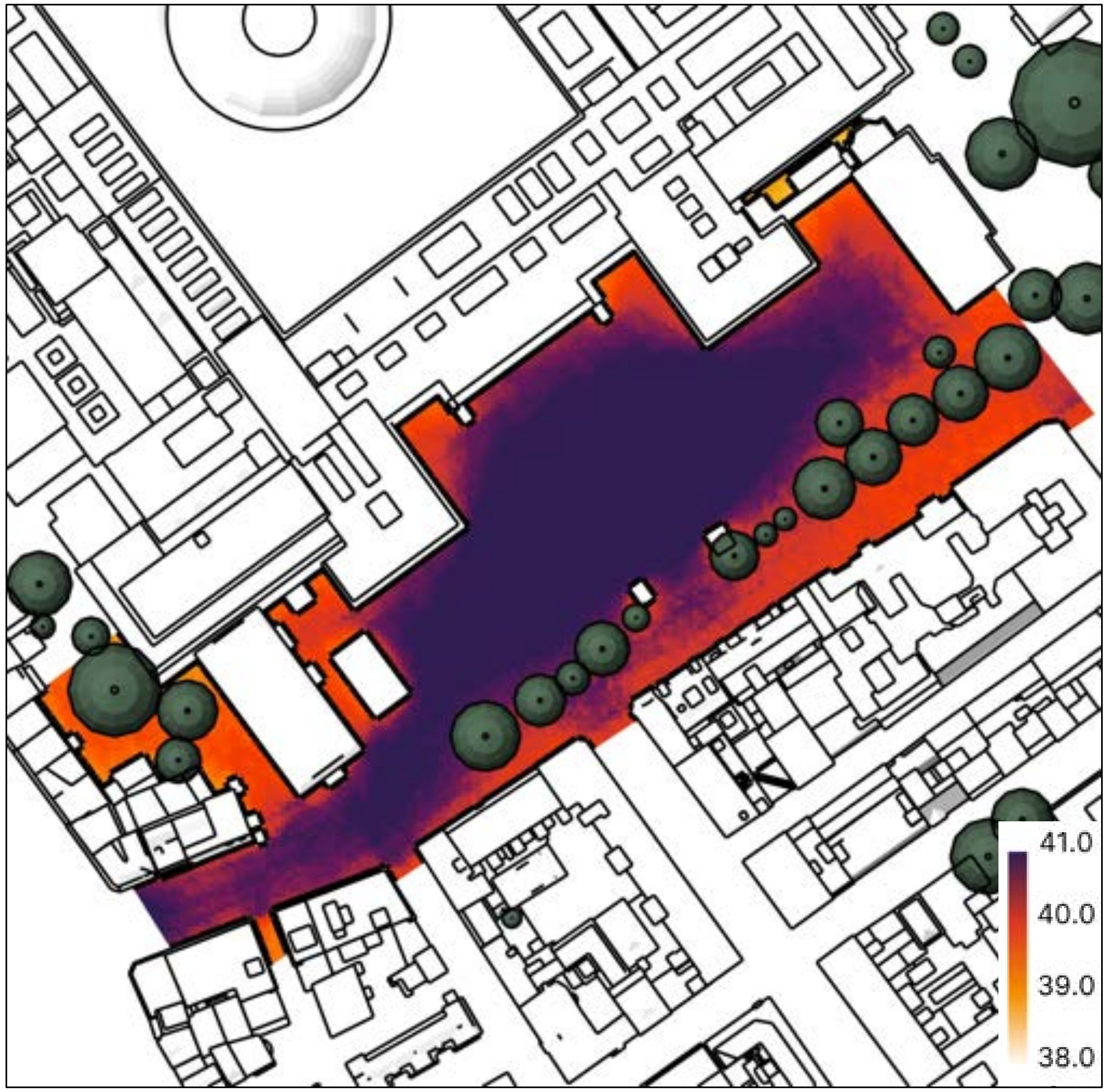
Figure 15: Recommended heat adaptation measures for British Museum and Great Russell Street

Existing Buildings

Existing Vegetation

Proposed Shade

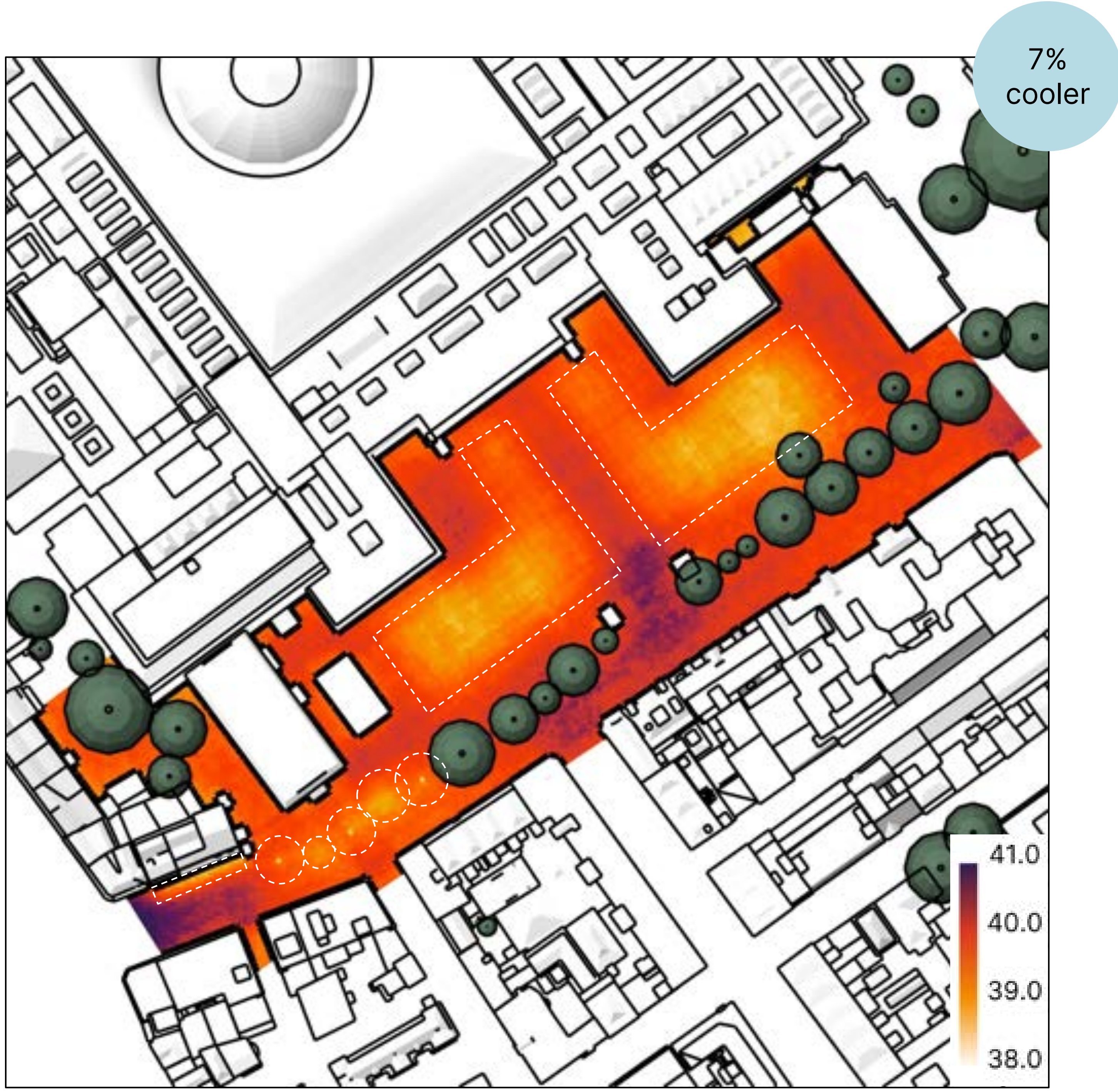
Thermal Comfort Analysis for 2020s



2020s Baseline Scenario

Dry Bulb Temperature = 38°C

Figure 16: This indicates the distribution of UTCI temperature values at 3pm around the British Museum southern forecourt and Great Russell Street in the 2020s. This area has very high solar exposure which cause UTCI temperatures to reach up to 41°C, which is three degrees higher than the Dry Bulb Temperature of the space. This presents a potentially very high heat risk scenario if the space is used by vulnerable people.



2020s Additional Shade Scenario

Dry Bulb Temperature = 38°C

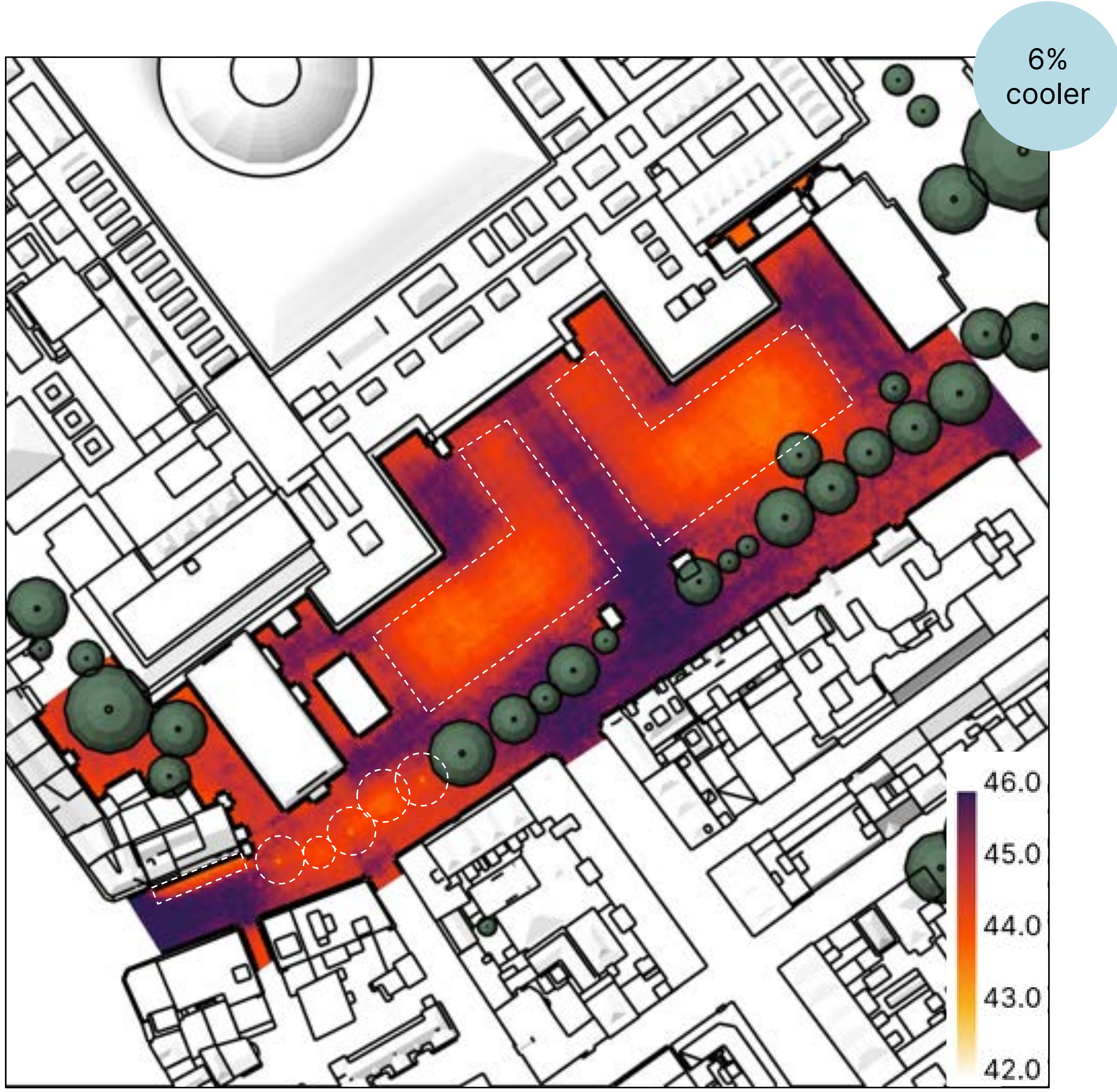
Figure 17: This indicates the reduction in UTCI temperature values at 3pm that can be achieved by implementing the recommended heat adaptation measures (indicated with dotted white line) within and around the British Museum southern forecourt and Great Russell Street in the 2020s. In the shaded areas a reduction of 0.5°C -2.9°C is observed, making the shaded space 7% cooler than the baseline scenario.

Thermal Comfort Analysis for 2050s

2050s Baseline Scenario

Dry Bulb Temperature = 42°C

Figure 18: This indicates the distribution of UTCI temperature values at 3pm around the British Museum southern forecourt and Great Russell Street in the 2050s. The UTCI temperatures can reach up to 46°C, which is 4ºC higher than the Dry Bulb Temperature of the space.



2050s Additional Shade Scenario

Dry Bulb Temperature = 42°C

Figure 19: This indicates the reduction in UTCI temperature values at 3pm that can be achieved by implementing the proposed heat adaptation measures (indicated with dotted white line) within and around the British Museum southern forecourt and Great Russell Street in the 2050s. In the shaded areas a reduction of 0.5°C -2.9°C is observed, making the shaded space 6% cooler than the baseline scenario.

Heat Reduction Analysis 2020s - Mapped

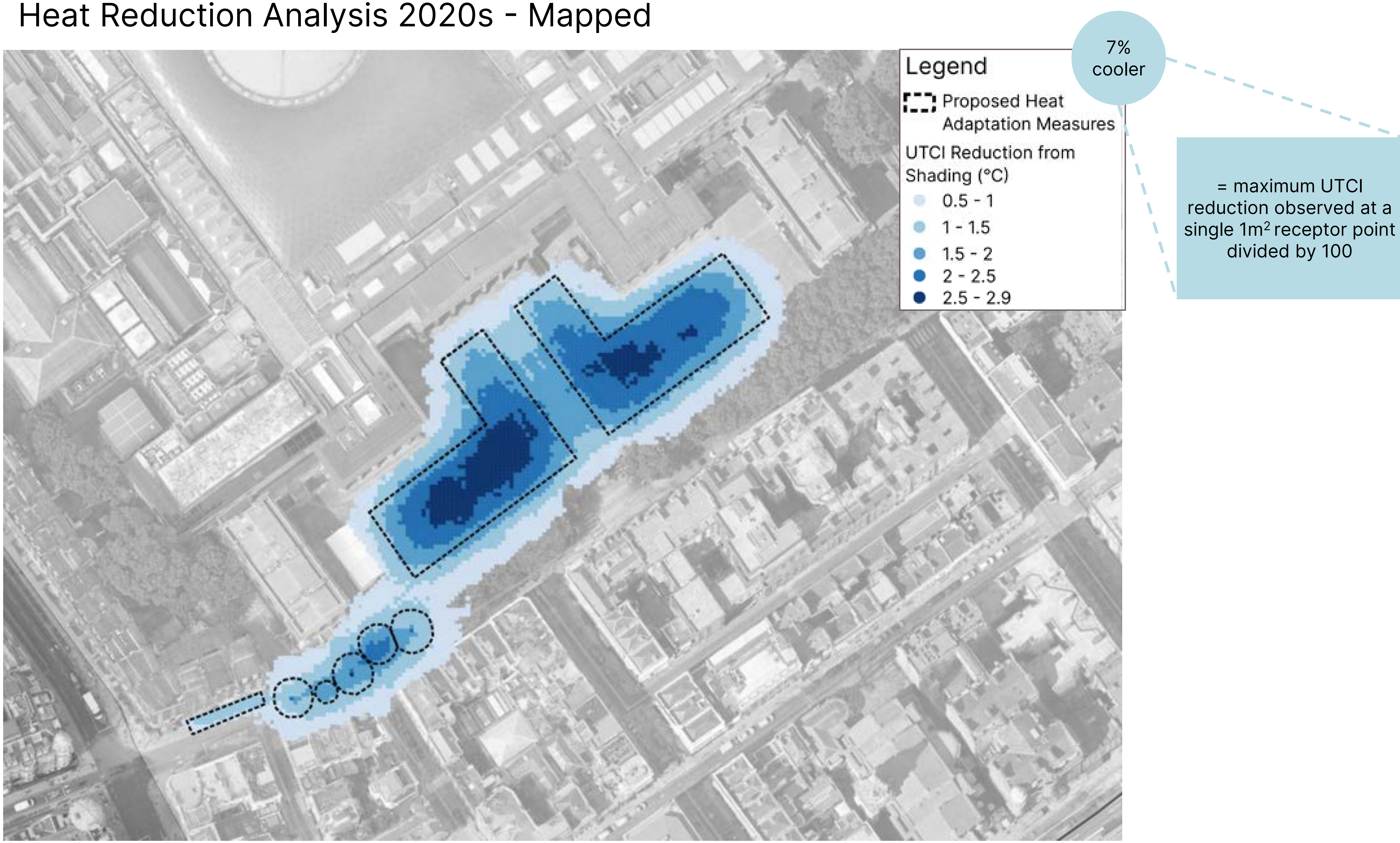


Figure 20: Cooling benefit (UTCI °C reduction) of recommended heat adaptation measures for the British Museum Forecourt and Great Russell Street hot spot in the 2020s.

Recommendations and Considerations

British Museum Forecourt

- The analysis supports the installation of two large shade structures/pavilions in the southern forecourt of the British Museum.
- Based on UTCI modelling the two shade structures/pavilions alone, if made of a solid, opaque material, would improve thermal comfort by up to 7% for museum visitors and staff during hot weather in the 2020s and by up to 6% in the 2050s.
- The analysis further supports the integration of planting within and around the structures/pavilions, and the introduction of at least one ground level water feature into the surrounding space.
- If the structures were a hybrid of human-made and nature-based materials, and incorporated climbing plants and/or green roofs (Figure 21), there is potential for further cooling benefits (up to an additional 4°C reduction[14]) as well as enhanced biodiversity within the space.
- If one or more water features were introduced into the forecourt, which could also support the irrigation of the planting in/on the shade structures, the cooling benefits within the space could be enhanced further by 1°C – 9°C[16].
- The shade structures could be permanent or semi-permanent, with moveable, or seasonally adjustable components, and with temperature or sunlight responsive controls.
- Depending on the material of the structures, they could also serve as rain proof and/or wind sheltered spaces for people queuing and spending time in the forecourt at other times.
- Key considerations for the forecourt, in addition to the large volume of people moving through it on a daily basis, almost every day of the year, are:
  - stringent security requirements, and
  - heritage designations and related view points.
- The design of the shade structures and water features will need to respond to the operational requirements of the museum security team, the facade of the museum, the surface materials of the forecourt and the perimeter railings. As a Grade 1 listed building, any interventions need to be designed to reflect its listed status and are subject to the required consents.

Great Russell Street

- The analysis supports the planting of four or five new street trees along the pavement to the south-west of the main entrance to the museum (Figure 22). This intervention has been explored with the public realm design consultants working on the HLN plans and is considered to be feasible based on current understanding of proposals and site constraints.

Figure 21: Potential shade structures for British Museum southern forecourt integrating climbing plants and green roofs.

Figure 22 : Potential street tree planting along Great Russell Street, adjacent to Grade II listed railings of British Museum

Figure 23: Potential heritage-sensitive shade canopies / awnings overhanging properties along Great Russell Street, with street level planting and hanging planting

Recommendations and Considerations

- The analysis further supports the installation of a series of heritage-sensitive shade canopies / awnings, above the properties on Great Russell Street, between Bloomsbury Street and the museum access gates, extending 3 metres over the footway (Figure 23). These would be subject to the required consents

- Based on UTCI modelling the trees and building mounted heritage-sensitive shade canopies could improve thermal comfort by up to 7% in the 2020s and by up to 6% in the 2050s for people walking along this stretch of Great Russell Street, for visitors queuing for the museum, and for people accessing the properties.

- If street level planting was introduced at the base of the museum railings, and in large pots along the footway in front of the properties with the canopy/canopies, the cooling benefits along this section of Great Russell Street could be enhanced further (up to an additional 4°C reduction)[14].

- Cooling benefits could be enhanced further if hanging plants were encouraged from the upper floor balconies of these properties.

For further details about the evidence supporting the potential cooling benefits of non-modelled measures see **Appendix J**

For larger version of all the visualisation images see **Appendix K.**

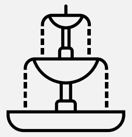
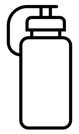
Recommended Heat Adaptation Methods

Table 2: Summary of heat adaptation methods to be considered for British Museum Forecourt and Great Russell Street

Heat adaptation method	Cooling benefit (UTCI/ºC)	Wider benefits	Cost (Cap)	Cost (Op)	Issues to consider
Shade structures / pavilions	**High** (potential 6%-7% reduction in UTCI)	• Shelter from other elements e.g. rain / wind.	High	Low	• Security / Operational • Heritage
Additional street trees	**High** (potential 6%-7% reduction in UTCI) (a 10% increase in urban tree canopy cover may reduce air temperature by 1.4°C)[17]	• Shelter from other elements e.g. rain / wind • Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Medium	Medium	• Heritage • Underground utilities • Irrigation • Maintenance
Building mounted heritage-sensitive shade canopies / awnings	**High** (potential 6%-7% reduction in UTCI)	• Shelter from other elements e.g. rain / wind • Aesthetic value	Medium	Low	• Heritage • Ownership / Control
Ground level planting	**Medium** (with an 8% increase in green area there is a potential 1.3°C reduction of PET)[19]	• Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Medium	Medium	• Security / Operational • Heritage • Irrigation • Maintenance
Integration of climbing plants and/or hanging plants	**Medium** (potential reduction of up to 4°C in air temperature assuming a green wall)[14]	• Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Medium	Medium	• Security / Operational • Heritage • Irrigation • Maintenance

Recommended Heat Adaptation Methods

Table 2: Summary of heat adaptation methods to be considered for British Museum Forecourt and Great Russell Street

Heat adaptation method	Cooling benefit (UTCI/°C)	Wider benefits	Cost (Cap)	Cost (Op)	Issues to consider
Nature-based or lighter coloured / reflective surface materials 	**Medium/High** (potential 9%-13% reduction of surface temperature compared to dark ground surface)[15]	• Aesthetic value • Enhanced biodiversity	Medium	Medium	• Heritage • Maintenance
Water feature/s 	**Medium** (potential reduction of 1°C to 9°C in air temperature)[16]	• Aesthetic value	High	Medium	• Heritage • Thames Water co-ordination • Drought periods may limit use • Maintenance
Drinking water refill points 	**Very Low** (water spilled around refill point may have some minor cooling benefit)	• Increased hydration • Reduced single use plastic water bottles	Medium	Medium	• Thames Water co-ordination • Maintenance

07

Tybald's Estate

Analysis of Heat Adaptation Measures, Recommendations and Considerations:

This chapter assesses heat adaptation measures for Tybald's Estate, where UTCI temperatures reach 41°C in the 2020s and 46°C in the 2050s, posing risks to residents and public space users.

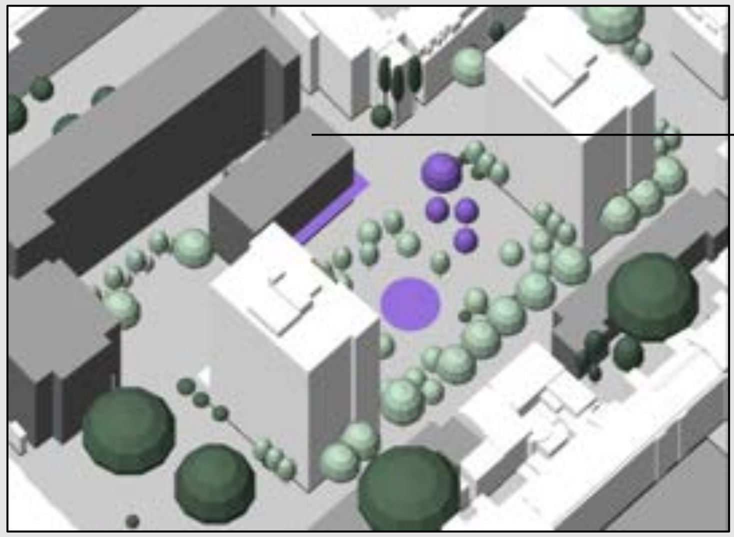
Recommended measures include:

- Four additional trees in New Tybald's Square, improving thermal comfort by up to 5% in both the 2020s and the 2050s.
- Shade canopies/awnings above the new TRA Hall, reducing temperatures by up to in both the 2020s and the 2050s.
- A central shade pavilion, creating a cooler, multi-generational gathering space while maintaining recreational use.
- Ground-level planting and climbing plants, enhancing cooling by up to 4°C and supporting biodiversity.
- Lighter coloured, heat reflective ground materials, potentially reducing surface temperatures by 9%–13%.

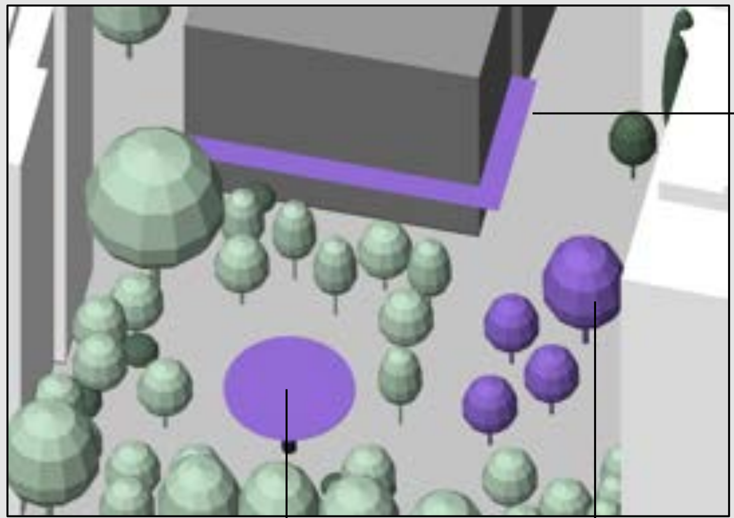
All recommended heat adaptation measures will be subject to the relevant planning policies, building regulations, and necessary consents. For this hot spot, key considerations include balancing residents' needs, maintaining active play areas, preventing anti-social behaviour, and ensuring long-term maintenance. Adaptation solutions must be integrated, flexible, and responsive to estate dynamics.

Holborn Liveable Neighbourhood

Recommended Heat Adaptation Measures



1 Potential Development – Tybald’s Estate Regeneration Scheme including new building blocks (grey) and landscaping (light green)



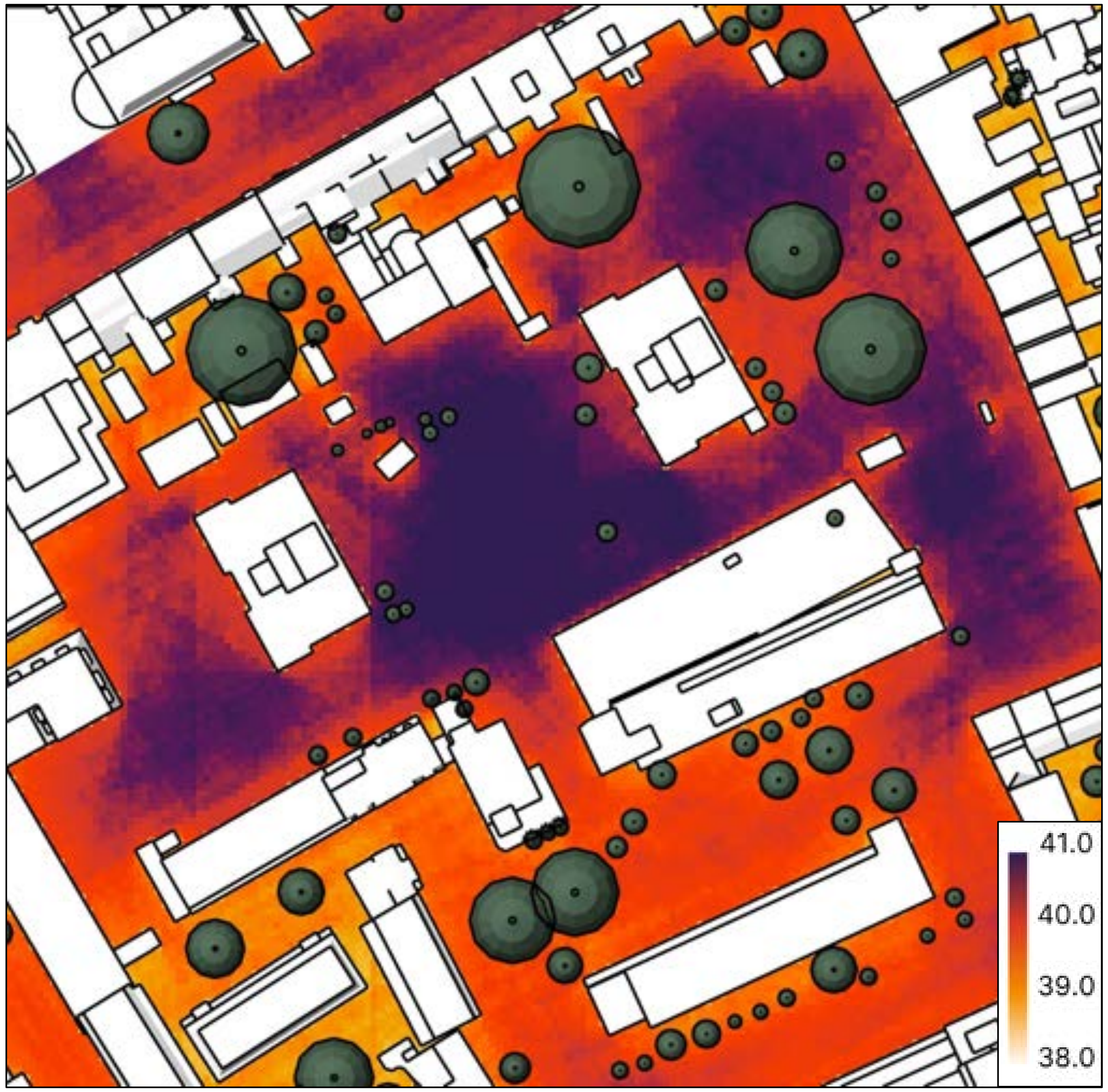
2 Proposed shade canopies / awnings above main entrance and access spaces of new TRA Hall (Block C building)

3 Proposed additional shade providing trees to south-west corner of New Tybald’s Square and shade structure / pavilion at the centre of New Tybald’s Square

For larger versions of all the modelled output images see **Appendix K.**

Figure 24: Recommended heat adaptation measures for Tybald’s Estate

Thermal Comfort Analysis for 2020s



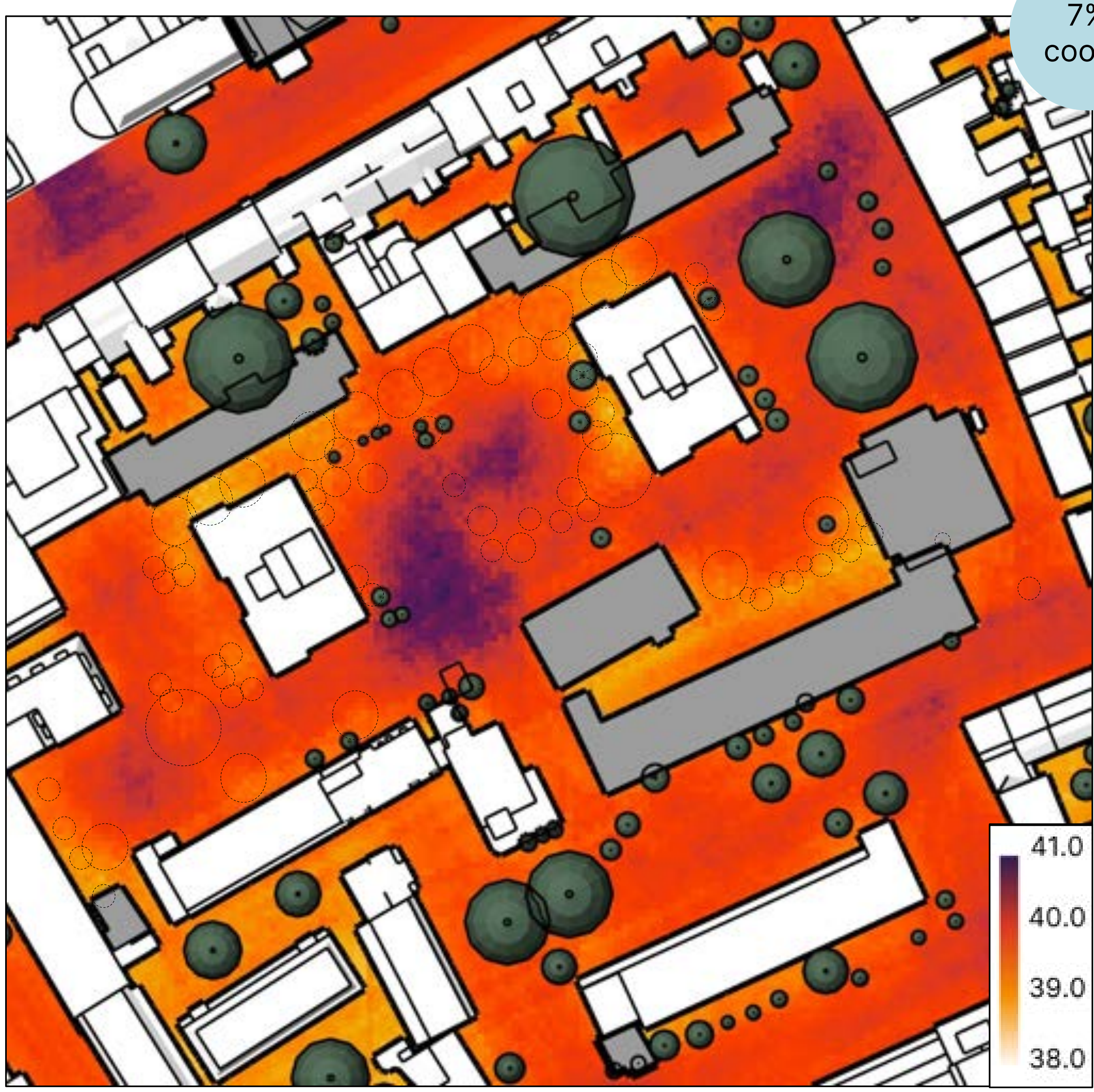
Dry Bulb Temperature = 38°C

2020s Baseline Scenario

Existing Development

Figure 25: Indicates the distribution of UTCI temperature values within the Tybald’s Estate in the 2020s. This area has very high solar exposure which causes UTCI temperatures to reach up to 41°C, which is three degrees higher than the Dry Bulb Temperature of the space. This presents a potentially very high heat risk scenario if this space is used by vulnerable people.

7% cooler



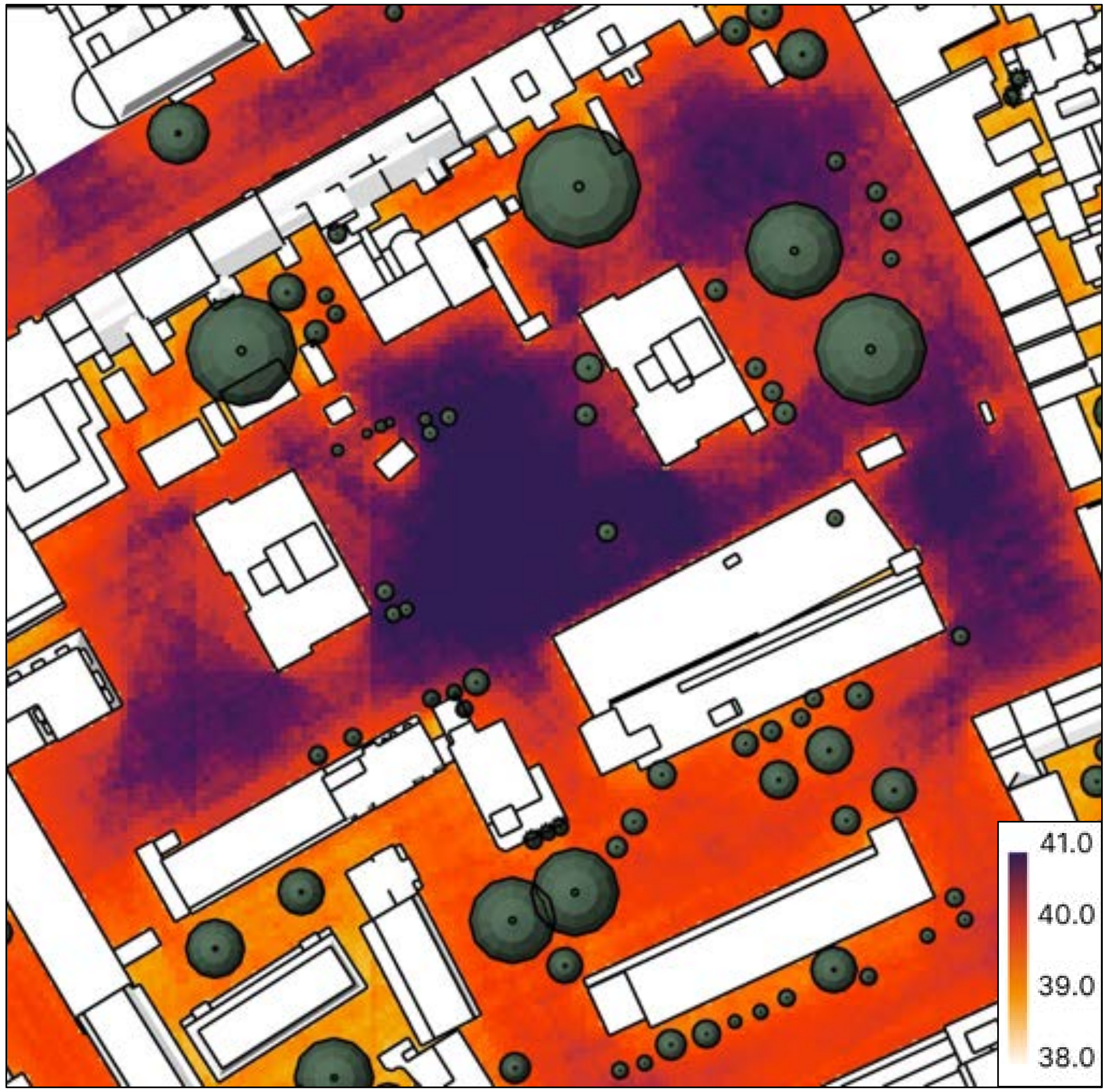
Dry Bulb Temperature = 38°C

2020s Potential Development Scenario

Potential Development

Figure 26: Indicates the reduction in UTCI temperature values that can be achieved by implementing the potential building development (indicated with solid grey blocks) and the potential landscape design (indicated with dotted black lines) within Tybald’s Estate in the 2020s. In the areas shaded by the new buildings and landscape, a reduction of 0.5°C - 2.9°C is observed, making the shaded space up to 7% cooler than the baseline scenario. However, there are still areas of New Tybald’s Square with UTCI values of up to 41oC (indicated in purple).

Thermal Comfort Analysis for 2020s



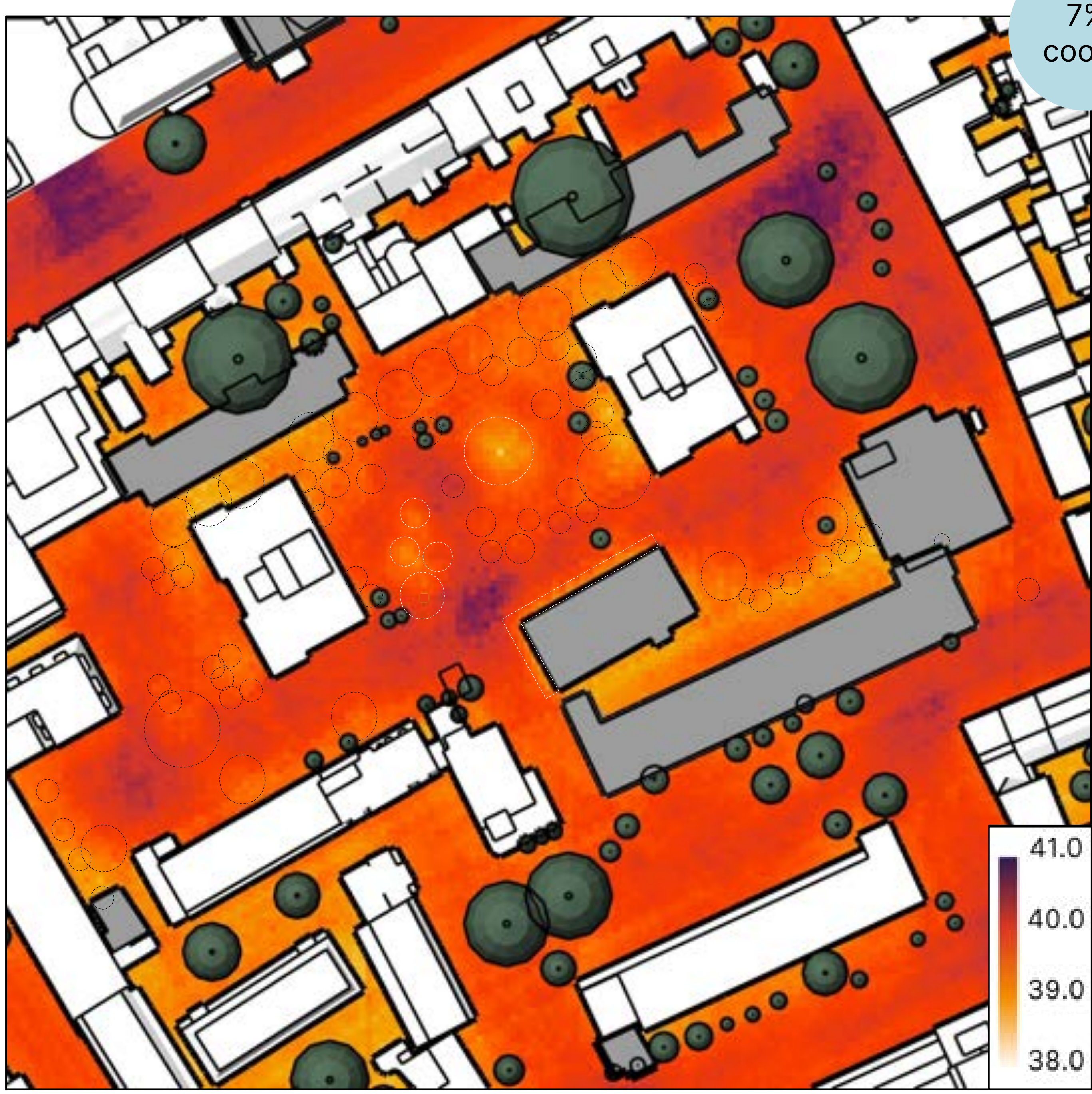
2020s Baseline Scenario

Dry Bulb Temperature = 38°C

Existing Development

Figure 25: Indicates the distribution of UTCI temperature values within the Tybald's Estate in the 2020s. This area has very high solar exposure which causes UTCI temperatures to reach up to 41°C, which is three degrees higher than the Dry Bulb Temperature of the space. This presents a potentially very high heat risk scenario if this space is used by vulnerable people.

7% cooler



2020s Additional Shade Scenario

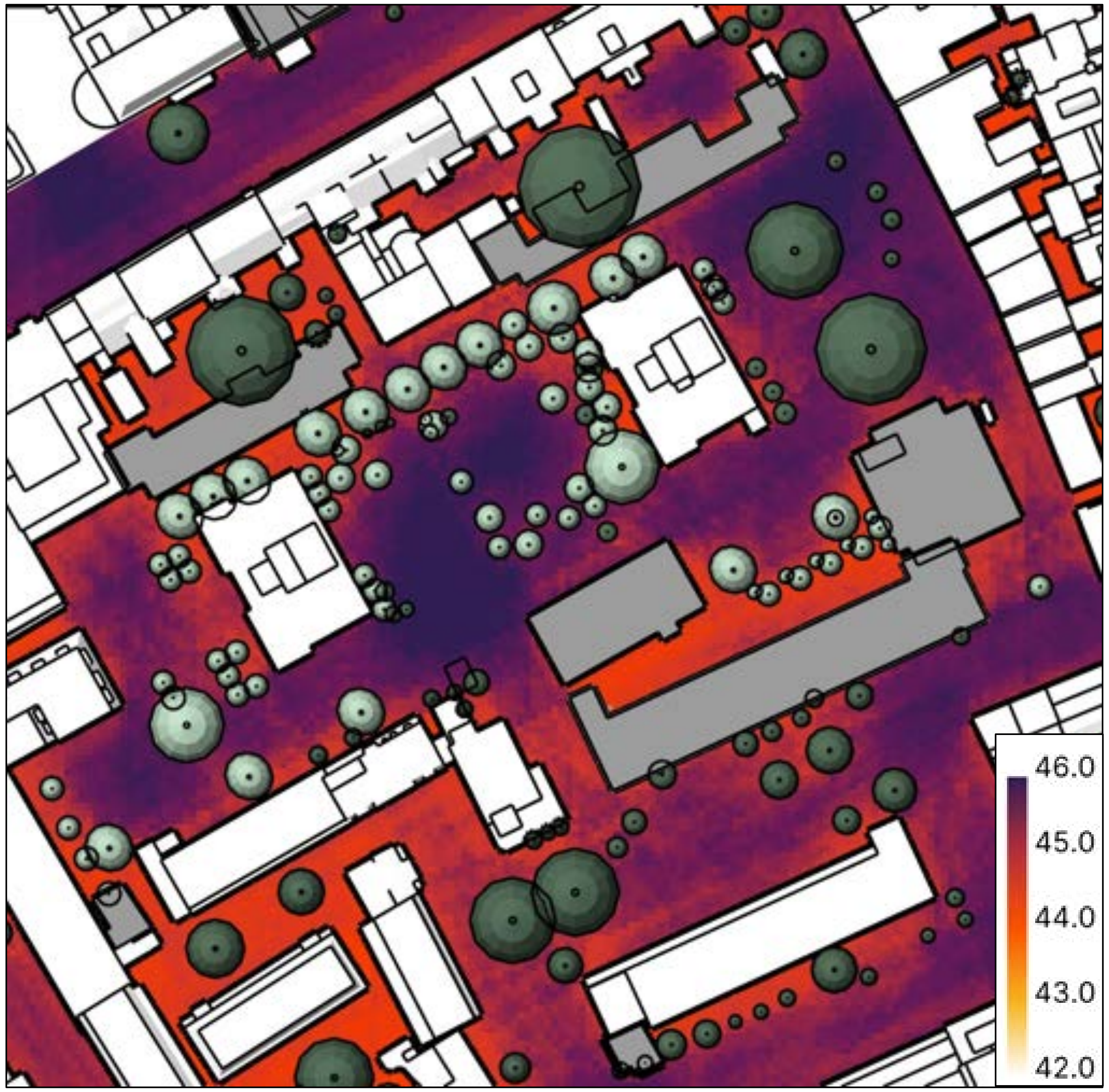
Dry Bulb Temperature = 38°C

Potential Development + Additional Shade

Figure 27: Indicates the reduction in UTCI temperature values that can be achieved by implementing the recommended heat adaptation measures (indicated with dotted white lines) within Tybald's Estate in the 2020s in addition to the potential building development (indicated with solid grey blocks and dotted black lines). In the additional shaded areas a reduction of 0.5°C -2.5°C is observed, increasing the area of shaded space which is 7% cooler than the baseline scenario. There is now only a limited area of New Tybald's Square with UTCI values still reaching up to 41°C (indicated in purple).

Thermal Comfort Analysis for 2050s

5% cooler

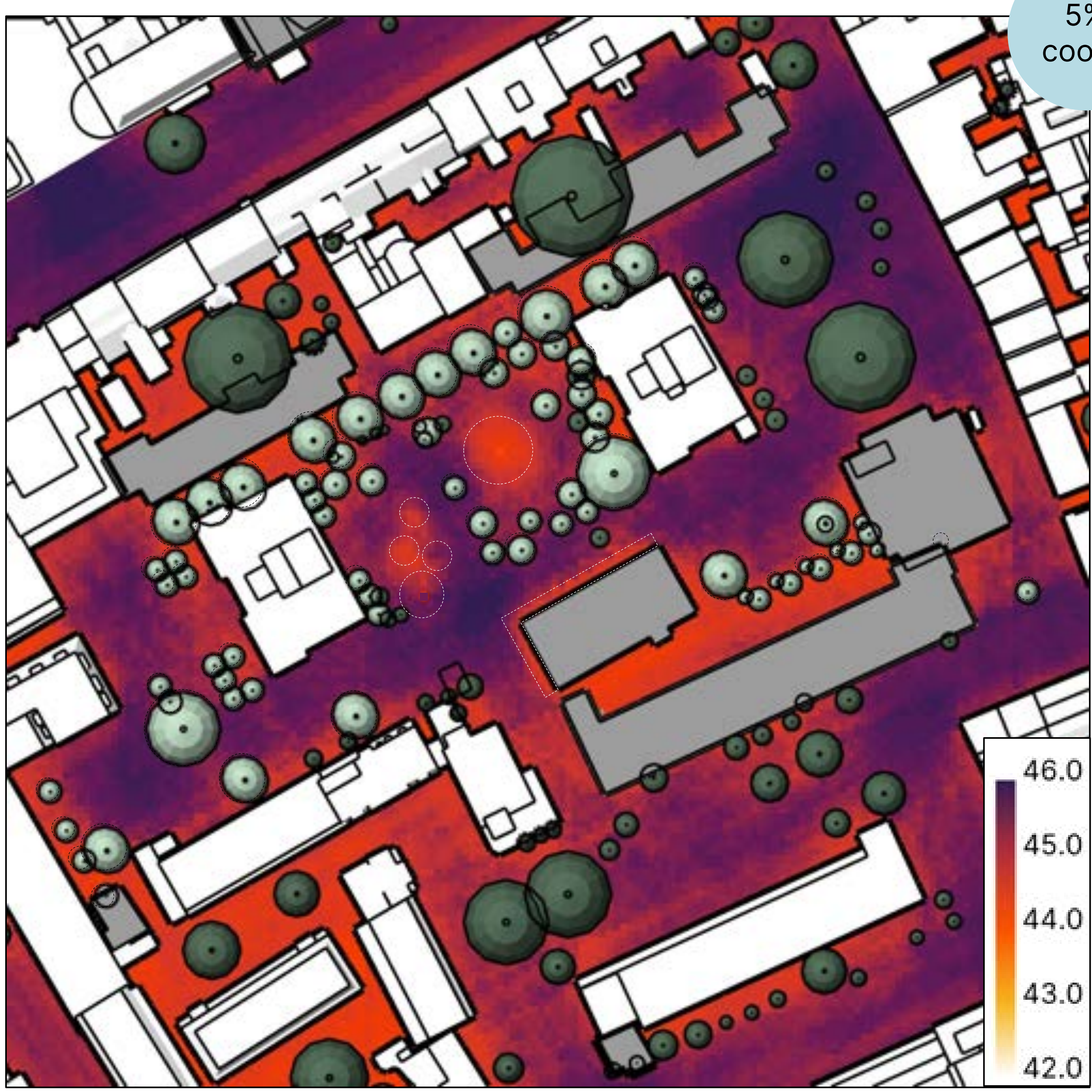


UTCI (°C)

2050s Baseline Scenario
Potential Development

Dry Bulb Temperature = 42°C

Figure 28: Indicates the distribution of UTCI temperature values within Tybald's Estate including potential development in the 2050s. In the 2050s, the UTCI temperatures can reach up to 46°C, which is four degrees higher than the Dry Bulb Temperature of the space.



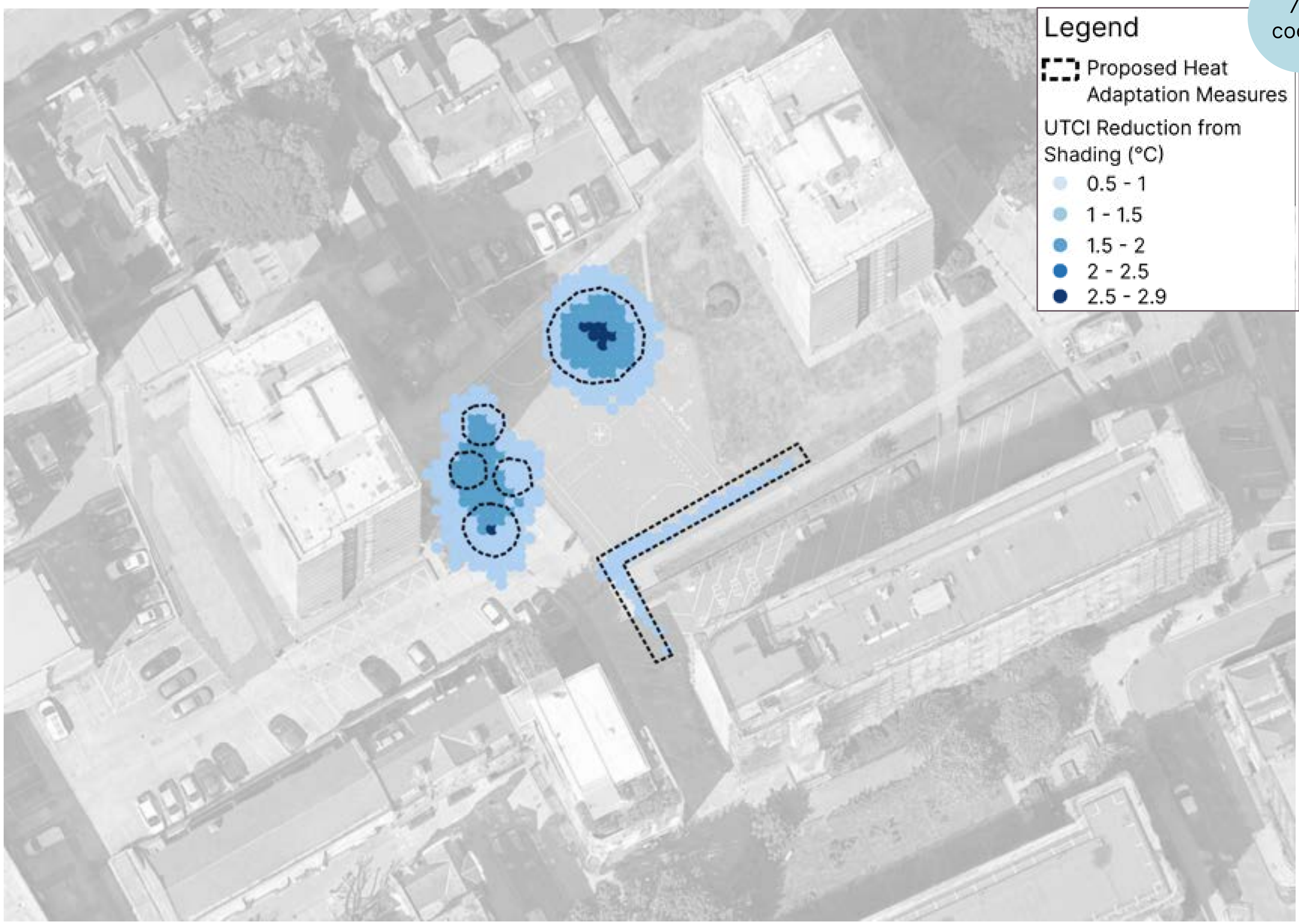
UTCI (°C)

2050s Additional Shade Scenario
Potential Development + Additional Shade

Dry Bulb Temperature = 42°C

Figure 29: Indicates the reduction in UTCI temperature values that can be achieved by implementing the potential development (solid grey blocks and light green circles representing trees) and recommended heat adaptation measures (indicated with dotted white line) within Tybald's Estate in the 2050s. In the shaded areas a reduction of 0.5°C - 2.9°C is observed, making the shaded space 5% cooler than the baseline scenario.

Heat Reduction Analysis 2020s - Mapped



7% cooler

= maximum UTCI reduction observed at a single 1m^2 receptor point divided by 100

Figure 30: Cooling benefit (UTCI °C reduction) of recommended heat adaptation measures for the Tybald’s Estate hot spot in the 2020s.

Recommendations and Considerations

- The analysis supports the planting of at least four additional trees in the south-west corner of New Tybald's Square.
- Based on UTCI modelling the planting of four additional trees in the south-west corner of New Tybald's Square could improve thermal comfort by up to 1°C-2°C or 5% during Year 1 of planting (2025) and by 1°C-2°C or 5% by Year 25 of planting (2050) for people using the square during hot weather.
- If the four additional trees were surrounded by ground level planting, the cooling benefits within New Tybald's Square could be enhanced further by up to 4°C, and biodiversity would be enhanced.
- The analysis further supports the installation of two large shade canopies / awnings above the main entrance / west facade of the new Tenants and Residents Association (TRA) Hall facing on to New Tybald's Square (Figure 31). This will be a vital public building used by residents and local people. It has the potential to be used as a cool space by vulnerable people during hot weather.
- The building mounted shade canopies / awnings for the new TRA Hall, if made of a solid, opaque material, could improve thermal comfort by up to 1°C-2°C or 5% (2020s) and 1°C-2°C or 5% (2050s) for people using the square and accessing the TRA Hall community centre during hot weather.
- If the shade canopies / awnings above the new TRA Hall were a hybrid of human-made and nature-based materials, and incorporated climbing or hanging plants, there is potential for further cooling benefits (up to an additional 4°C) as well as enhanced biodiversity within the estate.
- The shade canopies / awnings could be permanent or semi-permanent, with moveable, or seasonally adjustable components, and with temperature or sunlight responsive controls.
- Depending on the material of the shade canopies / awnings above the TRA Hall, it could also create a rain proof social space for people to use at other times.
- The analysis supports the installation of a shade structure / pavilion in the middle of New Tybald's Square, to provide a cool space for all generations and abilities within the hottest area on the estate (Figure 32). With careful design, it would not impede the use of New Tybald's Square for ball games, and may even enable greater physical activity to take place here during hot weather.
- Based on UTCI modelling of the shade structure / pavilion, thermal comfort in the middle of New Tybald's Square could be improved by up to 1°C-2°C or 5% (2020s) and 1°C-2°C or 5% (2050s) for people using the square during hot weather.
- If the ground surface materials of New Tybald's Square were lighter in colour and more reflective than standard asphalt, there is potential for further cooling benefits (a potential reduction of 9%-13% in surface temperatures).

Figure 31: Potential shade canopies / awnings and street level planting above and around entrance to new TRA Hall.

Figure 32: Potential shade structure / pavilion and additional tree planting in and around New Tybald's Square.

Recommendations and Considerations

Key considerations for Tybald's Estate, in addition to respecting and balancing the needs of all residents are:

- Vital function of New Tybald's Square as a space for children and young people to play in, be active and socialise
- Role of estate as a through route from north to south, and to a lesser extent east to west
- Need to reduce opportunities for, and spaces conducive to, anti-social behaviour and crime
- Responsibility for maintenance and irrigation of trees, ground level planting, and climbing or hanging plants
- Boundaries (physical, thermal, visual, acoustic) between the public realm of estate and the private realm of individual properties

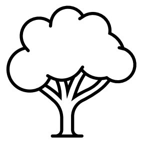
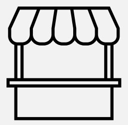
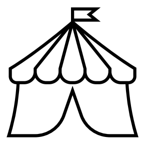
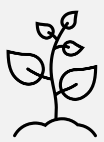
The layout and design of the additional trees, shade canopies / awnings, and the shade structure / pavilion will need to respond to these considerations.

For further details about the evidence supporting the potential cooling benefits of non-modelled measures see Appendix J

For larger version of all the visualisation images see Appendix K.

Recommended Heat Adaptation Methods

Table 4: Summary of heat adaptation methods to be considered for Tybald’s Estate

Heat adaptation method	Cooling benefit (UTCI/°C)	Wider benefit	Cost (Cap)	Cost (Op)	Issues to consider
Additional trees 	**Medium** (potential 2% reduction in UTCI) (a 10% increase in urban tree canopy cover may reduce air temperatures by 1.4°C)[17]	• Shelter from other elements e.g. rain / wind • Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Low	Medium	• Underground utilities • Wheelchair access • Irrigation • Maintenance
Building mounted shade canopies / awnings 	**Medium** (potential 2% reduction in UTCI)	• Shelter from other elements e.g. rain / wind • Aesthetic value • Social value	Medium	Low	• Robustness • Maintenance
One large free standing shade structure / pavilion 	**Medium** (potential 2% reduction in UTCI)	• Shelter from other elements e.g. rain / wind. • Social value	High	Low	• Multiple uses of the space • Robustness • Anti-social behaviour and crime • Vandalism
Additional ground level planting 	**Medium** (with an 8% increase in green area there is a potential 1.3°C reduction of PET)[19]	• Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Medium	Low	• Wheelchair access • Irrigation • Maintenance

Recommended Heat Adaptation Methods

Table 4: Summary of heat adaptation methods to be considered for Tybald's Estate (continued)

Heat adaptation method	Cooling benefit (UTCI/°C)	Wider benefit	Cost (Cap)	Cost (Op)	Issues to consider
Incorporation of climbing and/or hanging plants.	**Medium** (potential reduction of up to 4°C in air temperatures, assuming a green wall)[14]	• Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Medium	Low	• Ownership • Irrigation • Maintenance
Nature-based or lighter coloured / reflective surface materials	**High** (potential reduction of 9%-13% of surface temperature compared to dark ground surface)[15]	• Aesthetic value • Enhanced biodiversity	Medium	Medium	• Maintenance
Drinking water refill points	**Very Low** (assuming a non-shaded structure, water spilled around refill point may have some minor cooling benefit)	• Increased hydration • Reduced single use plastic water bottles	Medium	Medium	• Thames Water co-ordination • Maintenance

Holborn Liveable Neighbourhood

08

Theobalds Road

Analysis of Heat Adaptation Measures, Recommendations and Considerations:

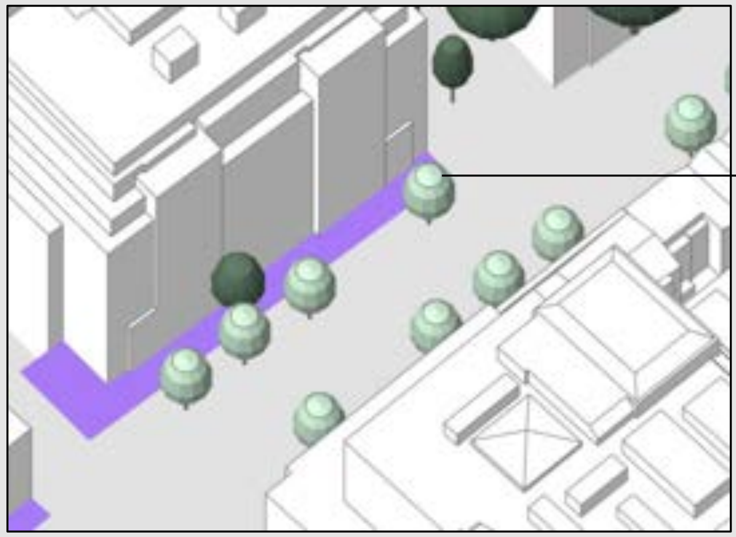
This chapter evaluates heat adaptation measures for Theobalds Road, where UTCI temperatures reach 41°C in the 2020s and 46°C in the 2050s, posing risks to pedestrians and building users.

Recommended measures include:

- Street trees along the northern footway, improving thermal comfort by 1°C–2°C in the 2020s and the 2050s.
- Heritage-sensitive canopies and awnings on historic properties, reducing temperatures by up to 5% in both the 2020s and the 2050s.
- Bespoke shade canopy for the entrance to Holborn Library, enhancing comfort for a key community space.
- Additional cooling from street-level planting, shade-integrated seating, and climbing plants, offering up to 4°C extra cooling and biodiversity benefits.

All recommended heat adaptation measures will be subject to the relevant planning policies, building regulations, and necessary consents. For this hot spot, key considerations include underground utilities, bus and cycle route requirements, maintenance responsibilities, and heritage constraints. Flexible, seasonal, and responsive designs will ensure effective integration into this high-traffic corridor.

Recommended Heat Adaptation Measures



1

Potential landscaping design proposed by HLN landscape consultants

2

Heritage sensitive awnings on all south facing buildings along Theobalds Road and bespoke shade canopy for Holborn Library

3

Heritage sensitive awnings slightly extended to west facade of corner buildings

For larger versions of all the modelled output images see **Appendix K.**

Figure 33: Recommended heat adaptation measures for Theobalds Road

Existing Buildings

Existing Vegetation

Proposed Shade

Potential Landscaping Development

Thermal Comfort Analysis for 2020s

2020s Baseline Scenario

Dry Bulb Temperature = 38°C

Figure 34: Indicates the distribution of UTCI temperature values along Theobalds Road in the 2020s. This area has very high solar exposure which cause UTCI temperatures to reach up to 41°C, which is three degrees higher than the Dry Bulb Temperature of the space. This presents a potentially very high heat risk scenario if this space is used by vulnerable people.

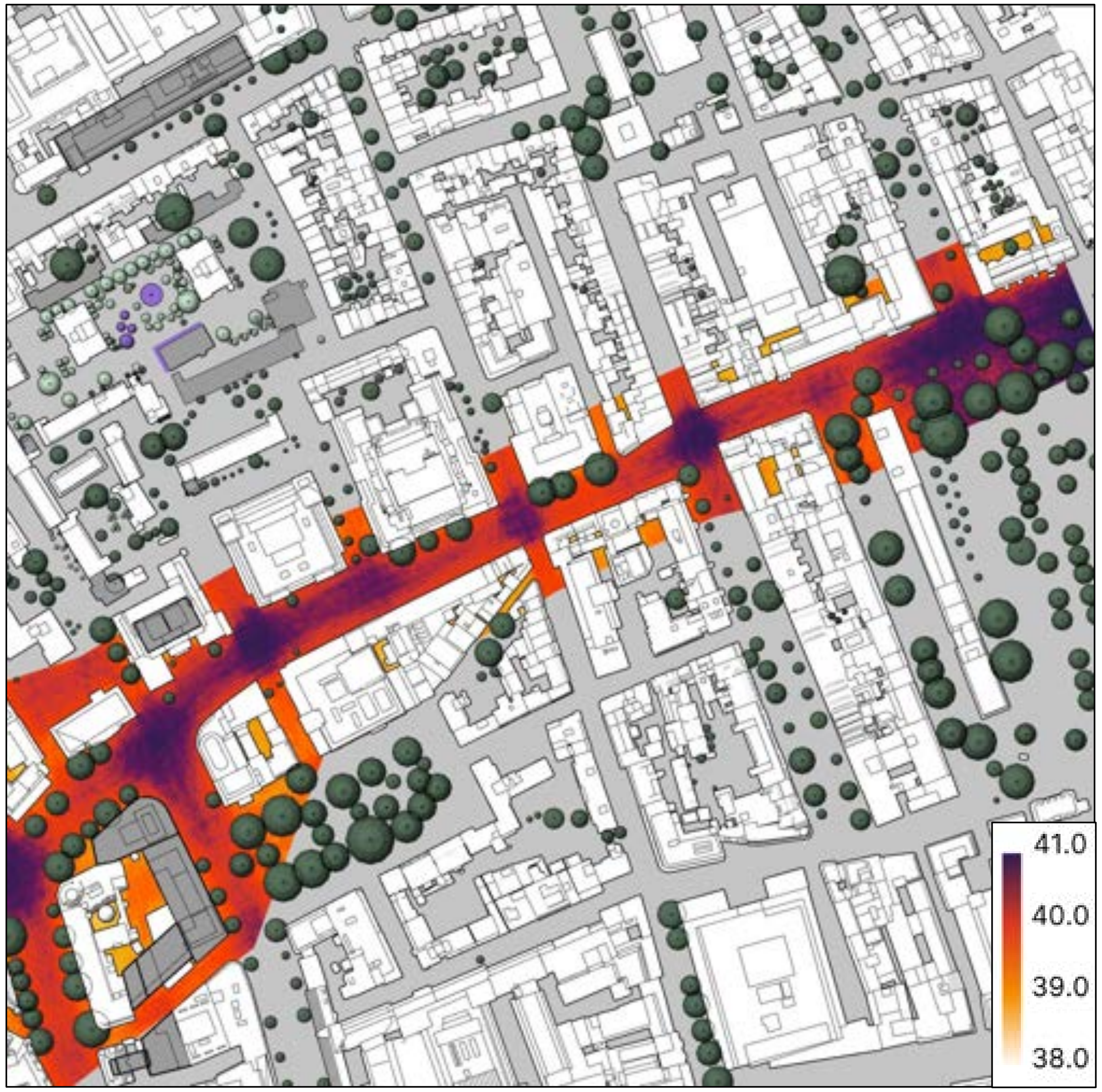
2020s Potential HLN Landscaping Scenario

Dry Bulb Temperature = 38°C

Figure 35: Indicates the reduction in UTCI temperature values that can be achieved by implementing the potential HLN project landscape design ideas* (indicated with dotted black lines) along Theobalds Road in the 2020s. In the shaded areas a reduction of 0.5°C - 2.9°C is observed, making the shaded space 2% cooler than the baseline scenario. However, there are still areas along the footway of Theobalds Road with UTCI values of up to 40ºC (indicated in red).

**Based on work in progress information provided by HLN project team in January 2025.*

Thermal Comfort Analysis for 2020s



UTCI (°C)
Dry Bulb Temperature = 38°C

2020s Baseline Scenario

Figure 34: Indicates the distribution of UTCI temperature values along Theobalds Road including potential landscaping design in the 2020s. This area has very high solar exposure which cause UTCI temperatures to reach up to 41°C, which is three degrees higher than the Dry Bulb Temperature of the space. This presents a potentially very high heat risk scenario if this space is used by vulnerable people.

UTCI (°C)
Dry Bulb Temperature = 38°C

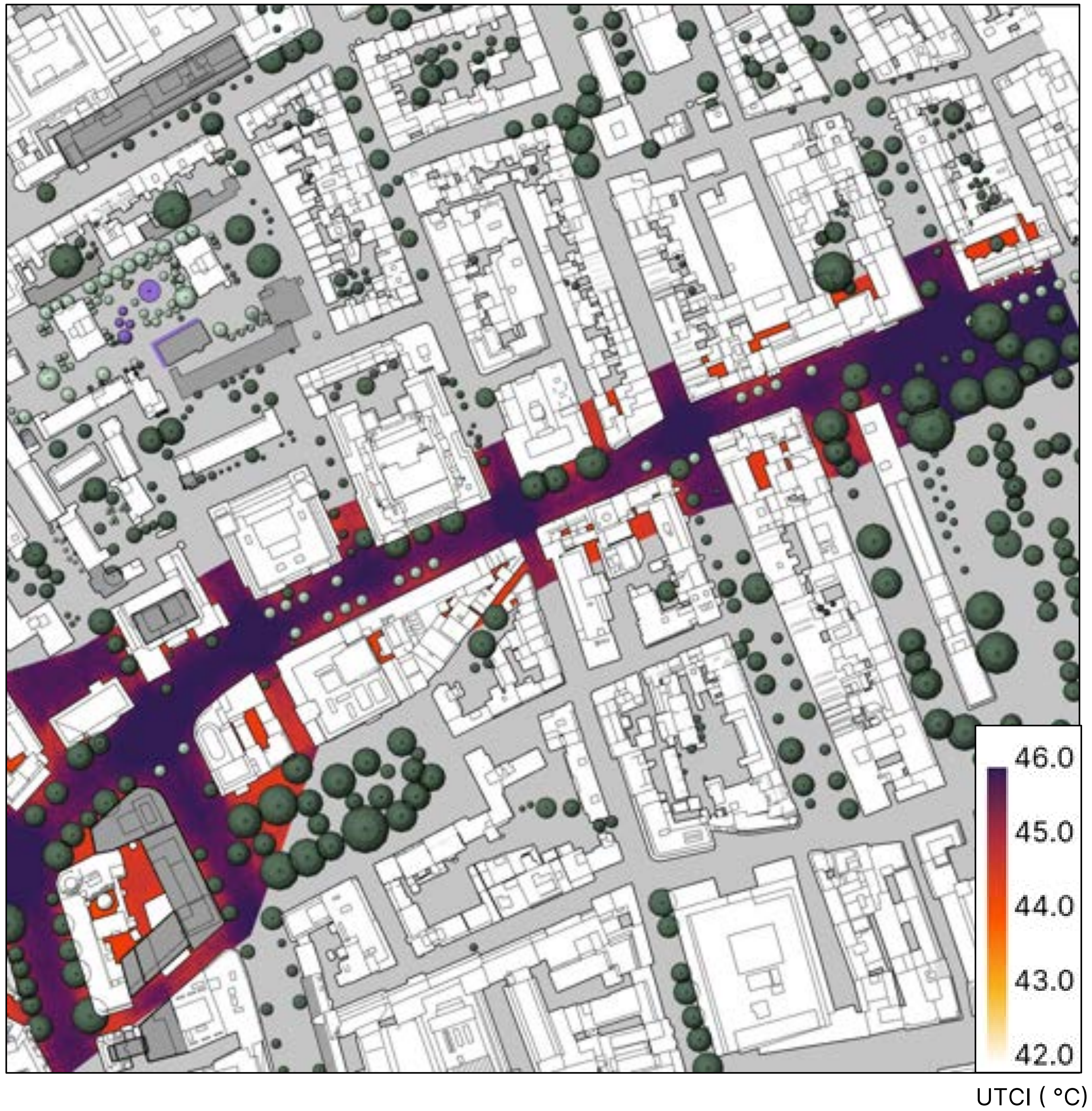
2020s Additional Shade Scenario

Potential HLN Landscaping + Additional Shade

Figure 36: Indicates the reduction in UTCI temperature values that can be achieved by implementing the recommended heat adaptation measures (indicated with dotted white line) along Theobalds Road in the 2020s in addition to the potential HLN project landscape design ideas* (indicated with dotted black lines). In the additional shaded areas a reduction of 0.5°C -2.9°C is observed, making the shaded space 6% cooler than the baseline scenario. There is an increase in the area along the northern footway of Theobalds Road with lower UTCI values of approximately 39ºC (indicated in yellow).

**Based on work in progress information provided by HLN project team in January 2025.*

Thermal Comfort Analysis for 2050s



2050s Baseline Scenario

Figure 37: Indicates the distribution of UTCI temperature values along Theobalds Road in the 2050s. In the 2050s, the UTCI temperatures can reach up to 46°C, which is four degrees higher than the Dry Bulb Temperature of the space.

2050s Additional Shade Scenario

Potential HLN Landscaping + Additional Shade

Figure 38: Indicates the reduction in UTCI temperature values that can be achieved by implementing the recommended heat adaptation measures (indicated with dotted white line) along Theobalds Road in the 2050s in addition to the potential HLN project landscape design ideas* (indicated by light green circles representing trees). In the additional shaded areas a reduction of 0.5°C -2.9°C is observed, making the shaded space 5% cooler than the baseline scenario.

*Based on work in progress information provided by HLN project team in January 2025.

Heat Reduction Analysis 2020s - Mapped

6% cooler

= maximum UTCI reduction observed at a single 1m² receptor point divided by 100

Figure 39: Cooling benefit (UTCI ºC reduction) of recommended heat adaptation measures for the Theobalds Road hot spot in the 2020s.

LOVE DES/GN STUD\O ST UK

Recommendations and Considerations

- Theobalds Road was considered as one hot spot despite having multiple areas of high heat exposure along it. This is due to two main reasons. Its status as a major movement corridor through the HLN area, and the high number of buildings and businesses along it, which are used by a wide range of people, including vulnerable groups.

- The analysis supports the integration of street trees along the northern footway of Theobalds Road as far as practicable given other requirements and constraints of the footway.

- Based on UTCI modelling the integration of street trees could improve thermal comfort by up to 1ºC-2ºC or 5% during Year 1 of planting (2020s) and by up to 1ºC-2ºC or 5% by Year 25 of planting (2050s) for pedestrians and people accessing the properties along Theobalds Road during hot weather.

- If the street trees were surrounded by street level planting, and shade-integrated seating, the cooling benefits along the northern footway could be enhanced further by up to 4ºC, and biodiversity would be enhanced.

- The analysis further supports the installation of heritage-sensitive shade canopies and awnings on the frontages of as many of the historic properties along Theobalds Road as possible.

- For Holborn Library, an iconic public building used by local people, and with the potential to be used as a cool space by vulnerable group of people during hot weather, the analysis supports the attachment of a bespoke shade canopy to the facade above the main entrance.

- The building mounted shade canopies and awnings for both the historic properties and Holborn Library, if made of a solid, opaque material, could improve thermal comfort by up to 1ºC-2ºC or 5% (2020s) and up to 1ºC-2ºC or 5% (2050s) for pedestrians and people accessing the properties along Theobalds Road during hot weather.

- If the shade canopies, awnings and shade-integrated seating, were a hybrid of human-made and nature-based materials, and incorporated climbing or hanging plants (Figure 40 and Figure 41), there is potential for further cooling benefits (up to an additional 4ºC) as well as enhanced biodiversity.

- The shade canopies and awnings could be permanent or semi-permanent, with moveable, or seasonally adjustable components, and with temperature or sunlight responsive controls.

- Depending on the material of the shade canopies, awnings, and shade-integrated seating, they could also serve as rain proof spaces for people accessing properties with street frontages at other times.

Figure 40: Potential heritage-sensitive awnings and street level planting along northern footway of Theobalds Road, outside pub with seating

Figure 41: Potential canopy above Holborn Library entrance, with street level planting and shade integrated seating along widened pavement.

Recommendations and Considerations

- Key considerations for Theobalds Road, in addition to the large numbers of people using the footway on a daily basis, are:

    - Location of underground utilities
    - Requirements of a major bus route and bus stops
    - Requirements of a major cycle route, cycle lanes, and cycle parking
    - Responsibility for maintenance and irrigation of street trees and street level planting
    - Heritage designations of properties, and
    - Boundaries between the public realm and privately owned or leased spaces and buildings

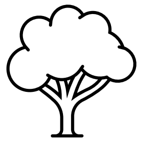
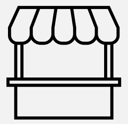
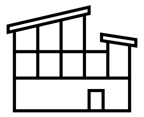
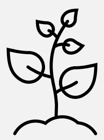
- The layout and design of the street trees, shade canopies and awnings, street level planting and shade integrated seating will need to respond to these considerations.

For further details about the evidence supporting the potential cooling benefits of non-modelled measures see **Appendix J**

For larger version of all the visualisation images see **Appendix K.**

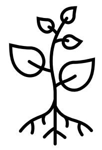
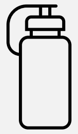
Recommended Heat Adaptation Methods

Table 3: Summary of heat adaptation methods to be considered for Theobalds Road

Heat adaptation method	Cooling benefit (UTCI/°C)	Wider benefit	Cost (Cap)	Cost (Op)	Issues to consider
Additional street trees 	**High** (potential 5% reduction in UTCI) (a 10% increase in urban tree canopy cover may reduce air temperatures by 1.4°C)[17]	• Shelter from other elements e.g. rain / wind • Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Low	Medium	• Heritage • Underground utilities • Footway width • Irrigation • Maintenance
Heritage sensitive building mounted shade canopies / awnings 	**High** (potential 5% reduction in UTCI) (potential Physiological Equivalent Temperature (PET) reduction of 2.5°C)[18]	• Shelter from other elements e.g. rain / wind • Aesthetic value	Medium	Low	• Heritage • Ownership / Control
Bespoke building mounted shade canopy / awning 	**High** (potential 5% reduction in UTCI) (potential PET reduction of 2.5°C)[18]	• Shelter from other elements e.g. rain / wind • Aesthetic value	High	Low	• Heritage • Public access during construction
Ground level planting 	**Medium** (with an 8% increase in green area there is a potential 1.3°C reduction of PET)[19]	• Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Medium	Low	• Wheelchair access • Irrigation • Maintenance

Recommended heat adaptation methods

Table 3: Summary of heat adaptation methods to be considered for Theobalds Road (continued)

Heat adaptation method	Cooling benefit (UTCI/°C)	Wider benefit	Cost (Cap)	Cost (Op)	Issues to consider
Integration of climbing plants and/or hanging plants 	**Medium** (potential reduction of up to 4°C in air temperature, assuming a green wall)[14]	• Surface water flood resilience • Enhanced biodiversity • Aesthetic value	Medium	Low	• Heritage • Ownership / Control • Irrigation • Maintenance
Drinking water refill points 	**Very Low** (assuming a non-shaded structure, water spilled around refill point may have some minor cooling benefit)	• Increased hydration • Reduced single use plastic water bottles	Medium	Medium	• Thames Water co-ordination. • Maintenance

Holborn Liveable Neighbourhood

09

Overview of Heat Resilience Strategy, Shade Masterplan and Design Principles

This chapter outlines the **Heat Resilience Strategy** for the Holborn Liveable Neighbourhood (HLN) area, which aims to protect vulnerable people, assets, and businesses from extreme heat.

The strategy is based on heat exposure and vulnerability analysis, insights from hot spot assessments, and seven public realm typologies, guiding the implementation of five types of heat adaptation measures: nature-based shade (trees, shrubs, and climbing plants), hybrid shade (pergolas, green walls, and trellises), human-made shade (canopies, pavilions, and awnings), water features (fountains and misting systems), and albedo strategies (lighter coloured surface materials with higher solar reflectance).

The **Shade and Cooling Masterplan** outlines a conceptual spatial framework for the creation of 'cool spots' and 'cool routes' in the HLN area with a focus on enhancing and connecting existing area with high levels of tree canopy, and existing locations of drinking water refill stations. It also supports the implementation of heat adaptation measures for the 16 hot spots. Nature-based solutions are preferred, with hybrid and human-made shade and cooling where necessary, and water plays a key role.

The **Thermal Comfort Design Principles** establish a hierarchy of heat adaptation principles for the external public realm in the HLN area: shade the space, cool the surfaces, and move and cool the air.

Heat Resilience Strategy for HLN - overview

Heat Resilience Strategy

A proposed **Heat Resilience Strategy** for the HLN area is set out in the sections that follow. The main objectives of the HRS are to contribute to greater heat resilience for:

- vulnerable people
- sensitive assets and features, and
- vulnerable businesses in the Holborn area.

The strategy has been informed by four key elements of this study:

- Our understanding of heat exposure and heat vulnerability within the HLN area based on data analysis and insights from stakeholder engagement.

- The specific characteristics of the 16 longlisted hot spots, the five shortlisted hot spots, and the three priority hot spots.

- The seven public realm typologies identified within the HLN area as most relevant to this study, listed below:
  - Gardens, parks and playgrounds
  - Pedestrian-only streets
  - Outdoor seating areas
  - Public buildings
  - Semi-public / semi-private spaces
  - Streets, and
  - Transit spaces.

- The five types of heat adaptation and resilience measures considered within this study, listed below:
  - Nature-based shade and cooling
  - Human-made shade
  - Water
  - Albedo, and
  - Policy and services.

The strategy is intended to serve as the overarching 'policy and services' framework for reducing heat risk, and increasing heat resilience, in Holborn's public realm.

It complements and reinforces the objectives of the following key plans, strategies, projects and documents:

- Camden Council's Climate Adaptation and Resilience Plan[5]
- Holborn Public Realm Strategy[3]
- HLN Major Projects and STARter Projects[6],
- Holborn Vision Supplementary Planning Document (SPD)[7,]
- Draft New Camden Local Plan[21], and
- Camden Health and Wellbeing Strategy 2022-30[22].

As well as setting out a strategic framework and practical heat resilience recommendations, the strategy comprises a high-level 'Shade and Cooling Masterplan' concept, and a hierarchy of 'Thermal Comfort Design Principles' for the external public realm in the HLN area.

The 'Shade and Cooling Masterplan' component of the strategy outlines a conceptual spatial framework for the enhancement of 'cool spots' and 'cool routes' in the HLN area, with a focus on connecting existing areas with high levels of tree canopy, and existing locations of drinking water refill stations.

The 'Thermal Comfort Design Principles' component of the strategy provides a guide to how heat adaptation and resilience measures should be considered, prioritised, and implemented in different public realm typologies within the HLN area.

Heat Resilience Strategy for HLN

Table 5: Heat Resilience Strategy recommendations for consideration within the HLN area

Strategy item	Who	Where	Cooling benefit	Wider benefit	Effort	Cost (Cap)	Cost (Op)	Issues to consider
1. Designate a Camden Council officer as a 'Heat Resilience Officer' for HLN.	• Camden Council	Across HLN	**High** (potential) Potential to co-ordinate and implement heat adaptation and resilience strategies in HLN	• Focusses efforts and streamlines communications • Sets a precedent in Camden • Shows commitment	Low Minimal effort if an extension of an existing role	Low Extension of an existing role / covered by an existing salary	Medium May require some additional operational budget	Long-term commitment Seasonal nature of role
2. Set up a Heat Resilience Working Group, and potential sub-groups, for the HLN area.	• HLN Heat Resilience Officer • Camden Council • Central District Alliance • Resident / community groups	Across HLN	**High** (potential) Potential to co-ordinate and implement heat adaptation and resilience strategies in HLN	• Strengthen existing partnerships / collaboration • Cross sector working opens opportunities	Medium Requires stakeholder engagement and coordination	Low No investment in equipment required.	Medium May require some additional operational budget	Long-term commitment Seasonal nature of group efforts
3. Implement a pop-up, seasonal cooling station network, and/or a mobile heat-health and cooling service for vulnerable people in HLN.	• Camden Council • Healthwatch Camden[24]. • Camden Mobile Health Bus[25].	In parks / garden squares, streets with high footfall, and outside public buildings Mobile service to visit care homes, areas with rough sleepers, and sites with outdoor workers	**Medium** to **High** (depending on number of stations and extent of mobile service)	• Reduced strain on NHS, homeless charities and public transport network	High Requires considerable stakeholder engagement and coordination	Low (if pop-up stations are in existing cool spots) Medium (if a new vehicles are required and equipped with cooling materials	Medium Seasonal but requires resources for adequate coverage	Disruption to existing uses of internal and external spaces Demand may be too high for available pop-up stations

Heat Resilience Strategy for HLN

Table 5: Heat Resilience Strategy recommendations for consideration within the HLN area (continued)

Strategy item	Who	Where	Cooling benefit	Wider benefit	Effort	Cost (Cap)	Cost (Op)	Issues to consider
4. Design and deliver heat health awareness and response training for frontline workers.	• British Red Cross • St John's Ambulance • Healthwatch Camden • Health / care / social workers • Teachers / youth workers • First aiders • Community groups	To be delivered in community centres, care homes, schools and youth centres in HLN Online training modules to be designed and delivered in parallel	**Medium** (potential) Potential to enable people to share knowledge about how to cool down in the heat in HLN	• Improved heat health awareness / preparedness • Employment skills • Reduces strain on the NHS	Medium Requires stakeholder engagement and collaboration to commissioning appropriate training	Low Minimal need for equipment and materials	Medium Trainers will need to be paid and travel and subsistence costs for training attendees may need to be covered	• Training content and level may need to be adapted to different audiences
5. Increase the number drinking water refill stations fountains in the HLN area.	• Camden Council • Greater London Authority • Thames Water	Across HLN with a focus on priority hot spots, and shortlisted hot spots	**Low** (if unshaded) **Medium** (if refill stations are shaded)	• Increased hydration • Reduced single use plastic water bottles	High Installing new drinking water infrastructure can be complex.	High Costs of purchasing and installing high quality products and connecting infrastructure can be high.	Medium Refill stations likely to require regular maintenance	• Locations • Maintenance
6. Increase number of public toilets and/or designated community toilets (i.e. publicly accessible toilets within buildings in HLN area.	• Camden Council • Central District Alliance	Across HLN and on digital apps Public / community toilets should be clearly signposted in public realm and could be incorporated into an app	**Low** (standard design) **Medium** (if toilets are designed/ adapted to be cool spaces)	• Encourages increased hydration • Particularly for older adults or parents / carers with young children	High (if installing new public toilets) Medium (if utilising existing toilets)	Medium Public toilets could be twinned with water refill points to make the most of any hard infrastructure requirements.	High Toilets likely to require regular maintenance and deep cleaning	• Locations • Maintenance

Heat Resilience Strategy for HLN

Table 5: Heat Resilience Strategy recommendations for consideration within the HLN area (continued)

Strategy item	Who	Where	Cooling benefit	Wider benefit	Effort	Cost (Cap)	Cost (Op)	Issues to consider
7. Improve physical and digital wayfinding between 'cool spots' and 'cool routes' within HLN. Use the high-level 'Shade and Cooling Masterplan' as the conceptual spatial framework for implementation. See Figure 44.	• Camden Council • Greater London Authority • Transport for London • HLN landscape design consultants	Across Holborn and on digital apps Cool spots and routes should be clearly signposted in the public realm and incorporated into public transport apps as a 'cool route option' for active travel	**High** (potential if spots and routes are made cool, and if wayfinding is legible)	• Encourages active travel • Enhances appreciation of green infrastructure in HLN	Medium Can be incorporated into planned public realm improvement projects	Medium Investment in signage design and materials, and app software	Low Data for apps may need updating	• Spots and routes need to be made cool in first instance • Need to be compatible with well used apps • Accessibility and inclusion
8. Identify and designate internal cool spaces within HLN for vulnerable people to use.	• Camden Council • Greater London Authority	Public buildings could include: • Holborn Library • Holborn Community Association • Dragon Hall • New community hall within Tybald's Estate Internal cool spaces should be clearly signposted in the public realm and locations added to relevant online resources	**Medium** to **High** (depending on number of designated cool spaces and capacity of spaces)	• Encourages social interaction • Reduces loneliness	High Requires considerable stakeholder engagement and collaboration with space owners / managers	Medium Some spaces may need major upgrades to maintain cooler temperatures	Medium Additional energy and water consumption may be required for cooling internal spaces Some one may need to review and renew designations each year, if designations are not permanent / in perpetuity	• Permanence of designation and need to review/ renew designation • Competing / conflicting uses of cool spaces • Safeguarding concerns regarding interactions between vulnerable users of cool spaces

Heat Resilience Strategy for HLN

Table 5: Heat Resilience Strategy recommendations for consideration within the HLN area (continued)

Strategy item	Who	Where	Cooling benefit	Wider benefit	Effort	Cost (Cap)	Cost (Op)	Issues to consider
9. Real-time Dry Bulb Temperature monitoring. Install network of temperature sensors strategically positioned across HLN.	• Camden Council • Transport for London • Local people, businesses and organisations	Across HLN with a focus on priority hot spots, and shortlisted hot spots. Consider existing locations of air quality sensors too	**Medium** (potential – could enable threshold related measures to be deployed)	• Improved heat awareness / preparedness	Medium Sensors can be installed relatively easily	Low Sensor technology is relatively low cost	Medium Sensor data will need to be analysed and sense checked occasionally Sensors may need maintaining	• Temperature data would need to be monitored carefully if intended to enable threshold related measures to be deployed
10. Paint buildings, footways, and streets with heat-reflective paints and/or heat reflective murals designed by local art/urban design students.	• Camden Council • Transport for London • Central District Alliance • LSE • KCL • UAL Central St Martins	Across HLN with a focus on priority hot spots, and shortlisted hot spots. More specifically, areas of hot spots which can't easily be shaded or cooled via other means	**Medium** (in isolation) **High** (in combination with other measures)	• Improved visual amenity • Stakeholder engagement with further education, arts and cultural sector	Medium Requires stakeholder engagement and collaboration with high education institutions	Medium Cost of heat reflective paints and other materials	Medium Painted surfaces may need cleaning and re-touching eventually	• Practicalities of necessary works for busy areas of the public realm • Required consents including Listed Buildings and advertising
11. Extend depth of bus stop shelters which face south and add PV panels to power energy efficient local cooling for waiting passengers.	• Camden Council • Transport for London • Central District Alliance	South facing bus stops in proximity to the 16 longlisted hot spots	**Medium** (extended shelter) **High** (PV powered local cooling)	• Shade and cooling can be provided for passersby as well as bus stop passengers.	High Requires stakeholder engagement and collaboration Practicalities of necessary works for operational bus stops	High Cost of robust shelter extension materials and PV panels	Medium Would require additional maintenance than a standard bus stop	• Practicalities of necessary works for operational bus stops. • Maintenance

Heat Resilience Strategy for HLN

Table 5: Heat Resilience Strategy recommendations for consideration within the HLN area (continued)

Strategy item	Who	Where	Cooling benefit	Wider benefit	Effort	Cost (Cap)	Cost (Op)	Issues to consider
12. Establish an extreme temperature emergency response heat plan for HLN, similar to a Severe Weather Emergency Plan (SWEP) for cold weather. If temperature threshold is exceeded, heat adaptation and resilience measures are deployed.	• Camden Council • Greater London Authority • British Red Cross • St John's Ambulance • Crisis • Community Groups	Across HLN with a focus on 16 longlisted hot spots, and potential cool spots. For example, a stockpiled gazebos and pop-up cooling stations are temporarily setup in designated areas.	**Medium** to **High** (depending on scale of plan extent of measures deployed)	• Improved heat awareness / preparedness	Medium Requires considerable stakeholder engagement and coordination	Medium Requires up front investment in stockpiled equipment	Medium Will need a team of people to ensure measures are deployed appropriately	• Need to avoid clutter in public realm
13. All streets in HLN area which put up Christmas lights in winter to install temporary shade measures in summer. These could be mounted on buildings, attached on or between lamp posts, free standing, or even extending across whole streets.	• Camden Council • Transport for London • Central District Alliance • JC Decaux (or equivalent)	Across HLN with a focus on 16 longlisted hot spots.	**Medium** to **High** (depending on detailed design and location of shade measures installed)	• Improved visual amenity • Sustained or increased footfall and economic activity along high streets in hot weather	Medium Requires stakeholder engagement and collaboration with businesses and potential sponsors	Medium Requires up front investment in shade measures Cost could be offset by commercial sponsorship or art- and culture-led approaches to the shade measures	Low Once shade measures are installed - minimal maintenance until they are removed	• Need to avoid clutter in public realm • Materials used for shade measures will need to meet all relevant planning / building policies, regulations and consents

Heat Resilience Strategy for HLN

Table 5: Heat Resilience Strategy recommendations for consideration within the HLN area (continued)

Strategy item	Who	Where	Cooling benefit	Wider benefit	Effort	Cost (Cap)	Cost (Op)	Issues to consider
14. Set up a network of volunteers with remit to protect vulnerable people in HLN during extreme heat episodes. This would involve identifying vulnerable people in advance of hot weather and checking in on them during hot weather episodes. Cooling measures and equipment could be handed out for free or loaned via a 'library of things' system to those in need.	• HLN Heat Resilience Officer • HLN Heat Resilience Working Group • Camden Council • Shade the UK • British Red Cross • St John's Ambulance • Crisis • Holborn Community Association	Across HLN	**Medium** to **High** (depending on scale of network and extent of cooling measures / equipment handed out or loaned)	• Encourages social interaction • Reduces loneliness • Circular economy	High Requires considerable stakeholder engagement and coordination	Medium Requires up front investment in cooling measures equipment which may be given or loaned to vulnerable people / communities	Low This is a volunteer led measure but may require an additional. dedicated coordinator with a salary	• Need to consider any existing initiatives that this could reinforce. • Need minimum levels of commitment agreed with volunteers so that basic needs of vulnerable people are met
15. Ensure relevant policies in New Camden Local Plan, Climate Action Plan, and other public realm strategies, reference the Thermal Comfort Design Principles for external spaces.	• Camden Council	Across HLN Across Camden	**Medium** to **High** (potential)	• Improved heat literacy amongst planning officers, developers and consultants • Improved visual amenity in public realm • Sustained or enhanced activities in public realm during hot weather	Low	Low	Medium Would require planning officers to be proactive in ensuring policies were being adhered to and implemented	• Continuing Professional Development type training may be required for planning officers

High-Level Shade and Cooling Masterplan for HLN - Overview

The high-level **Shade and Cooling Masterplan** for the HLN area is a conceptual spatial framework for implementing recommended heat adaptation measures and enhancing existing green and cooling infrastructure. It is intended to complement and reinforce the objectives of following key strategies, projects and planning documents:

- Holborn Public Realm Strategy[3]
- HLN Major Projects and STARter Projects[6], and
- Holborn Vision SPD[7].

The starting point for the masterplan is that all 16 identified hot spots with the highest UTCI values (yellow, red and purple areas on Figure 42) should be considered as locations where shade measures, and/or other heat adaptation measures, may be needed.

Shade measures should be considered as the priority heat adaptation measure for these locations, and the order of priority for shade measures, due to wider benefits for biodiversity, and surface water flood risk, should be considered as:

1. Nature-based shade (e.g. trees, tall shrubs, and climbing plants)
2. Hybrid shade (e.g. pergolas, trellises, and green walls)
3. Human-made shade (e.g. pavilions, canopies and awnings)

A vital component of the masterplan is the existing green and cooling infrastructure within the HLN area, particularly areas with good tree canopy cover (see Figure 43) and drinking water refill points (see Figure 44).

These areas, streets, and points should be considered as valuable heat resilience assets for Holborn, with the potential to serve as recognised 'cool spots' connected by 'cool routes'.

Connections between these potential cool spots and routes should be enhanced and reinforced through new street tree planting, and pocket forests, where possible and appropriate. Over time, as the trees and shrubs grow, this would create a green shade network within Holborn.

The provision of additional nature-based shade within and along these cool spots and routes, could also incorporate hybrid and human-made shade measures. Where nature-based shade is not possible (i.e. underground utilities or width of footway prevent street tree planting), hybrid and human-shade should be considered as a priority. The exact type of hybrid or human-made shade measure will depend on the public realm typology.

For example, pergolas with climbing plants may work best over seating areas (e.g. Great Queen Street/Wild Street), awnings and canopies extending from buildings over footways may work best along streets with high footfall (e.g. Theobalds Road), and pavilion-like shade structures may be most appropriate in formal garden squares (i.e. Bloomsbury Square Gardens) or open courtyards (i.e. Tybald's Estate and British Museum Forecourt).

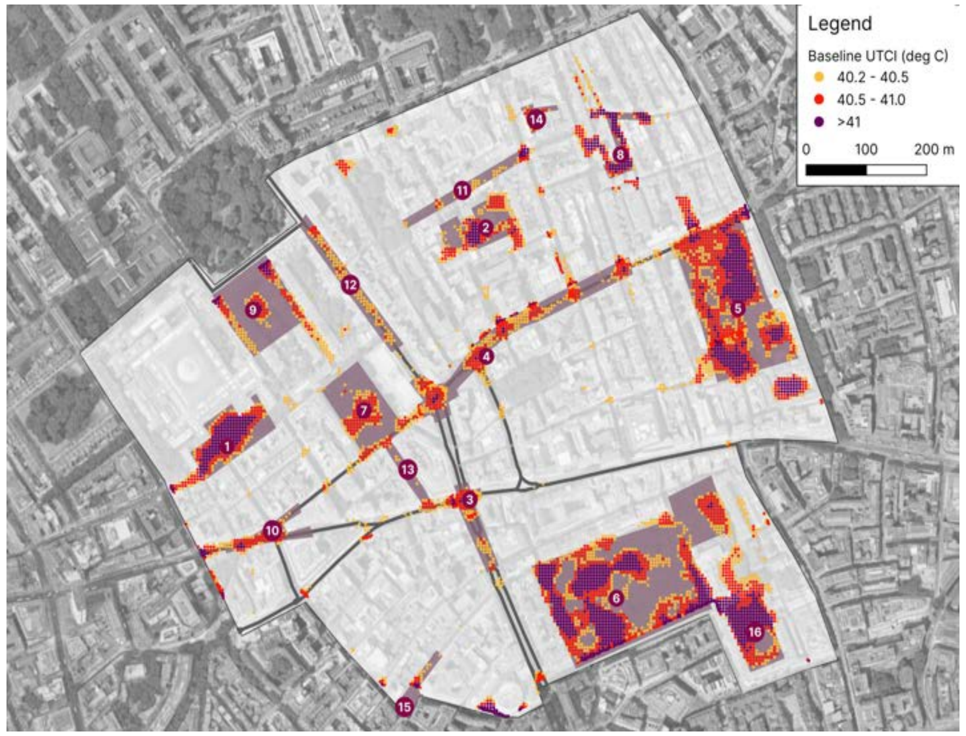


Figure 42: The 16 hot spots within the HLN area based on highest UTCI values.

Figure 43: The 16 hot spots within the HLN area shown in relation to tree canopy cover.

High-Level Shade and Cooling Masterplan for HLN - Overview

Figure 44 shows the proposed locations of potential ‘cool spots’ and ‘cool routes within the HLN area, which together provide a high-level, conceptual spatial framework for implementing shade and cooling measures in HLN area.

The potential cool spots (blue circles) are based on the locations of existing green and cooling infrastructure within the HLN area (i.e. areas of green spaces with good tree canopy cover and water refill points). The potential ‘cool routes’ (blue lines) are based on the locations of tree lined streets, and existing and potential public realm improvement projects. These would connect cool spots along streets which, would providing increasing levels of shade and cooling over time.

If the recommended heat adaptation measures are implemented for the three priority hot spots, and eventually for all other identified hot spots, they have the potential to become cool spots and cool routes in the future.

The high-level Shade and Cooling Masterplan concept is inspired by, and could eventually be comparable to, the ‘Green Corridors’ initiative in Medellin, Colombia[8], and the ‘Shade Phoenix’ Action Plan for Trees and Built Shade in Phoenix, Arizona[9].

It also has the potential to join up with and extend the Camden Green Loop concept[10], led by the Camden Town Unlimited and Euston Town BIDS, and the Bloomsbury Green Corridor proposal[20].

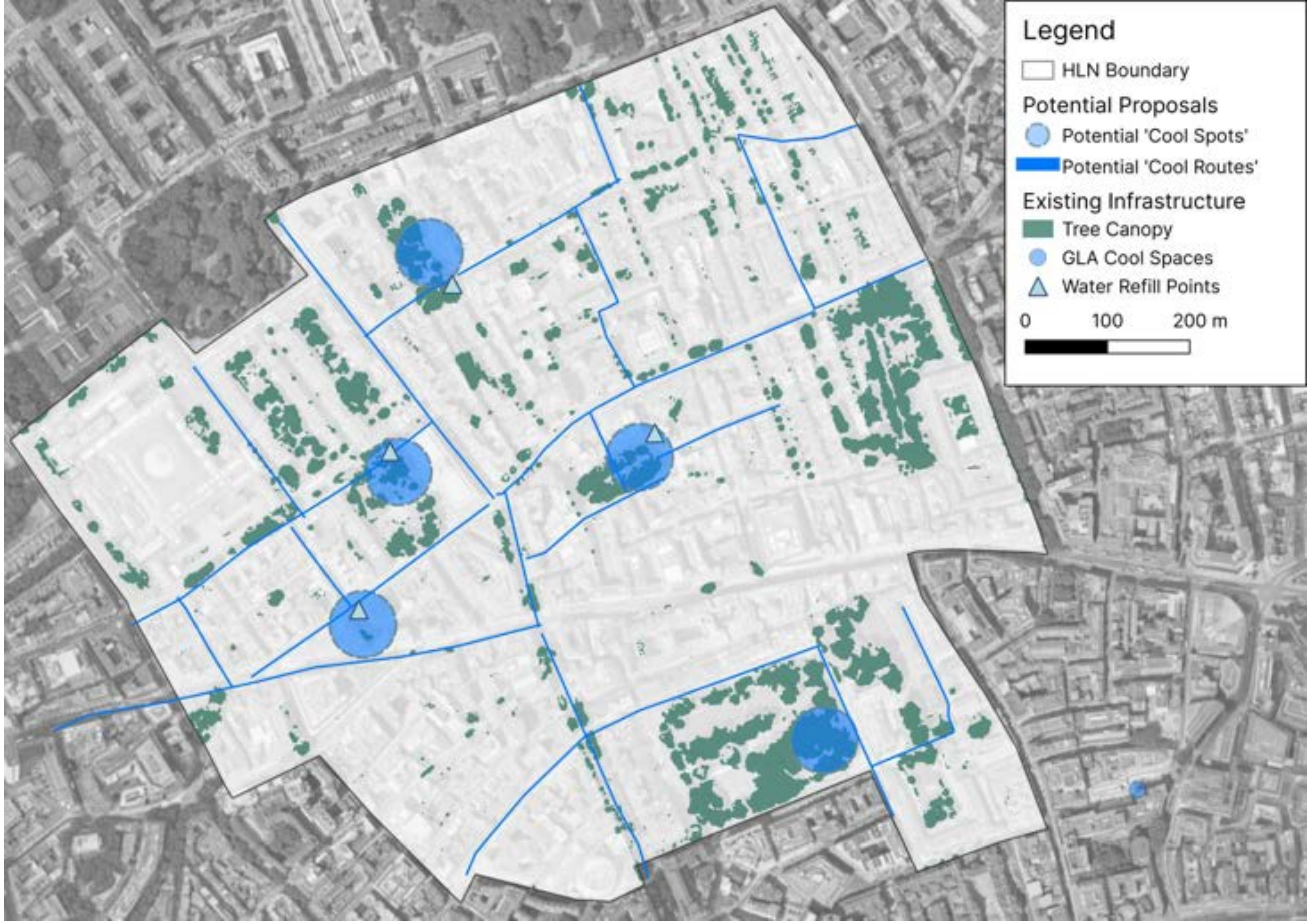


Figure 44: Locations of potential cool spots and cool routes within the HLN area. These are based on existing green and cool infrastructure, and existing and potential public realm connections between identified hot spots.
Source (for existing infrastructure data): https://apps.london.gov.uk/cool-spaces/

Thermal Comfort Design Principles for HLN - Overview

Based on our analysis of the three priority hot spots, our recommended heat adaptation measures, and evidence from the supporting literature review, a three-level hierarchy of **Thermal Comfort Design Principles** has been developed for the HLN area. The three design principles for improving thermal comfort in the external public realm are:

1. Shade the space
2. Cool the surfaces, and
3. Move and cool the air.

Once these design principles have been considered and implemented as far as practicable, other cooling and shading hierarchies should be applied to internal spaces of buildings in HLN area, namely the London Plan Cooling Hierarchy in Policy SI 4 'Managing heat risk'[23], and the Camden Draft New Local Plan Policy CC8 'Overheating and cooling'[21].

These design principles are derived from the physical heat adaptation methods considered in this study, with an additional 'hybrid shade' method included:

- Nature-based shade and cooling
- Hybrid shade (nature-based + human-made)
- Human-made shade
- Albedo, and
- Water.

The reasons for the hierarchy order of the design principles are based on the cooling effectiveness and energy efficiency of each level:

1. Shade is the most effective and efficient way to limit exposure to heat, preventing unwanted solar gains reaching external spaces and being absorbed by surfaces.

2. Reducing the amount of heat absorbed and re-radiated by horizontal and vertical surfaces within external spaces through material choices is the next most effective and efficient way to lower air temperatures.

3. Creating conditions and opportunities for air and moisture to move around naturally, cooling external spaces further, is then more effective and efficient, within a cooler space. Less energy and water is then required for any additional movement of air or water which may be necessary or desirable.

It is recommended that these design principles are considered in this order for improving thermal comfort and reducing heat risk in the HLN area.

The physical heat adaptation methods are also set out in order of priority for implementation based not only on cooling effectiveness and efficiency, but wider benefits for biodiversity, and reducing surface water flood risk.

It is recommended that the five heat adaptation methods are considered in this order. However, they are even more effective and efficient used in combination rather than individually.

Figure 45 illustrates the hierarchy of Thermal Comfort Design Principles and their relationship with the physical heat adaptation methods.

HLN Thermal Comfort Design Principles - Hierarchy

The HLN Thermal Comfort Design Principles for the external public realm are set out in Figure 45 as a three-level hierarchy. The heat adaptation methods which fall under each principle are also set out to the left in order of priority for consideration and implementation. They range from passive design measures at the top, to more active design measures at the bottom, with some overlap between measures.

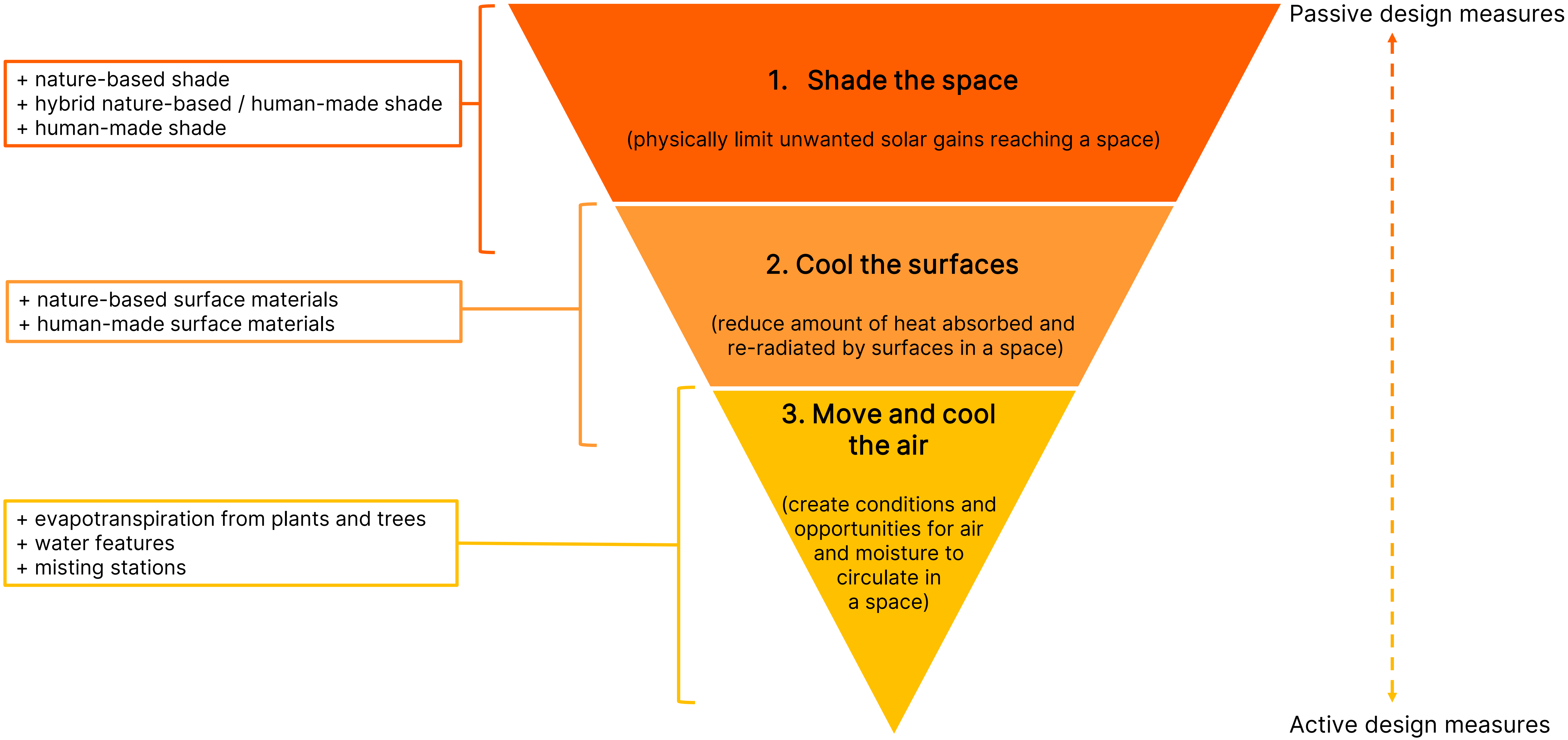


Figure 45: Hierarchy of Thermal Comfort Design Principles for HLN. These principles and this hierarchy can be applied at the HLN area level scale and at the hot spot specific scale.

Thermal Comfort Design Principles for HLN – Public Realm Typologies

Table 6 sets out how the Thermal Comfort Design Principles and physical heat adaptation methods should be considered and applied to the seven public realm typologies in the HLN area. The typologies are listed below:

- Gardens, parks and playgrounds
- Pedestrian-only streets
- Outdoor seating areas
- Public buildings
- Semi-public / semi-private spaces
- Streets, and
- Transit spaces.

For further details about these public realm typologies, and images of examples of them within the HLN area, please see **Appendix G.**

Please note, the permanence, moveability, and material choices of physical heat adaptation and resilience measures, for all public realm typologies, need to be carefully considered. This will help to ensure these measures do not prevent the enjoyment of warm sunny weather, nor impede the implementation of any cold weather or wet weather measures which may also be necessary.

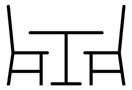
HLN Thermal Comfort Design Principles – Public Realm Typologies

Table 6: Thermal comfort design principles for public realm typologies within the HLN area

Public realm typology	Characteristics and sub-types	HLN examples	Heat issues	Thermal Comfort Design Principles (hierarchy order)
(i) Gardens, parks and play areas	Landscaping, open areas, fenced off areas, diverse planting, sports facilities, and play equipment for children.	• Bloomsbury Square Gardens • Lincoln's Inn Fields • Queen Square • Red Lion Square • Gray's Inn Fields	People enjoy using formal gardens, parks and play areas when the sun is out. This is important for physical activity, mental health, social interaction and Vitamin D intake. Open spaces within gardens, parks, and play areas that don't have sufficient nature-based or human-made shade can become sun- and heat-traps that may be uncomfortable, or even unsafe, for people especially if used for extended periods. Dark coloured, human-made surface materials exposed to direct sun absorb and re-radiate heat in these spaces.	• Consider planting more shade giving trees in areas of formal gardens, parks and play areas with low tree canopy. Also, consider in areas where succession planting may be necessary to replace mature trees reaching the end of their healthy life. • Free standing shade structures should be considered in the context of providing rain shelter too. • Temporary or seasonal shade structures should be considered in areas which are pleasantly sunny in spring, autumn and winter, but which have uncomfortably high sun or heat exposure in summer. • Any new/improved play equipment should be located or designed/adapted to incorporate existing shade or provide new shade. • Natural and/or lighter coloured materials should be considered for play surfaces and equipment instead of dark coloured metal, plastic and rubber. • New slides made of metal and plastics in particular should face north, not south, to avoid exposure to direct sun. • Water features should be considered in central areas of gardens and parks, and splash pads should be considered in play areas.
(ii) Pedestrian-only streets	Alleyways, underpasses, overpasses, and bridges.	• New Turnstile • Gate Street • Little Turnstile	Pedestrian only streets can enhance the public realm by providing quieter, shorter, routes for active travel. People who use them can be exposed to direct sun if there is no shade or respite. Dark coloured, human-made surface materials exposed to direct sun absorb and re-radiate heat in these spaces.	• Pedestrian routes which are well shaded or overshadowed by surrounding buildings should be incorporated into networks of cool routes within the HLN area. • Pedestrian routes which are unshaded and exposed to direct sun should be reviewed in more detail for feasibility of implementing heat adaptation measures using the TCDP Hierarchy. • Install natural or lighter coloured surface materials.

HLN Thermal Comfort Design Principles – Public Realm Typologies

Table 6: Thermal comfort design principles for public realm typologies within the HLN area (continued)

Public realm typology	Characteristics and sub-types	HLN examples	Heat issues	Thermal Comfort Design Principles (hierarchy order)
(iii) Outdoor seating areas 	Outdoor seating areas in all public realm typologies that are not within gardens or parks or playgrounds e.g. seats and benches on streets and outside public buildings.	• Queen Square • Brookes Market • Great Queen Street/Wild Street.	Areas of outdoor seating provide valuable places for rest and respite for people as they move through the HLN area. Outdoor seating areas that don't have sufficient nature-based or human-made shade can become sun- and heat-traps that may be uncomfortable or even unsafe for people, especially if used for extended periods. Dark coloured, human-made surface materials exposed to direct sun absorb and re-radiate heat in these spaces.	• Any new/improved seating areas should be located or designed/adapted to incorporate existing shade or provide new shade. • Shade-integrated seating products should be considered in areas where space is limited. • Install natural or lighter coloured surface materials around seating areas.
(iv) Public buildings 	Areas outside buildings that are publicly accessible, but which may have restrictions on access and use e.g. opening hours, security, and noise levels. Can include museums, universities, libraries, civic centres, religious buildings, community centres, and tenants and residents' association halls.	• British Museum • London School of Economics • Great Ormond Street Hospital • Holborn Library	Public buildings tend to have a higher footfall around them due to visitors, tourists and students. Popular and highly used buildings may have higher dwell times in the external spaces around them. Some buildings may be suitable for 'cool spaces'. Areas outside public buildings can be well used by people accessing the building or as a meeting up point. If these areas don't have sufficient nature-based or human-made shade they can become sun- and heat-traps that may be uncomfortable, or even unsafe, for people especially if used for extended periods. They can also contribute to unwanted heat being bought into buildings and potential internal overheating issues. Dark coloured, human-made surface materials exposed to direct sun absorb and re-radiate heat in these spaces.	• If tree canopy cover is low in areas outside public buildings, consider feasibility of planting new shade giving trees. • Building mounted shade structures should be considered at main entrances/exits and access routes to and around public buildings. • Install natural or lighter coloured surface materials. • If the space is appropriate install a water feature.

HLN Thermal Comfort Design Principles – Public Realm Typologies

Table 6: Thermal comfort design principles for public realm typologies within the HLN area (continued)

Public realm typology	Characteristics and sub-types	HLN examples	Heat issues	Thermal Comfort Design Principles (hierarchy order)
(v) Semi-public / semi-private spaces	Privately owned spaces, such as formal gardens, squares or roof gardens, that are partially open to the public, either with restricted access or access during certain times of the day. Semi-public spaces also include the space between privately owned buildings and public footpaths, including building facades, walls and seating areas. Housing estates can fall within this category due to boundaries between shared and personal spaces.	• Sicilian Avenue • The Walks at Gray's Inn Fields. • New Square • Tybald's Estate • Montague Street Gardens	Semi-public spaces with no nature-based or human-made shade can become sun- and heat-traps that may be uncomfortable or even unsafe for people, especially if used for extended periods. Dark coloured, human-made surface materials exposed to direct sun absorb and re-radiate heat in these spaces.	• If tree canopy cover is low in semi-public / semi-private spaces, consider feasibility of planting new shade giving trees. • If trees are not feasible, free standing shade structures should be considered in the context of providing rain shelter too. • Temporary or seasonal shade structures should be considered in areas which are pleasantly sunny in spring, autumn and winter, but which have uncomfortably high sun/heat exposure in summer. • Building mounted shade structures should be considered along public buildings or privately owned buildings fronting on to the space. • Install natural or lighter coloured ground surface materials.
(vi) Streets and roads	Streets and roads have one or two lanes for cars, possibly a bus and/or a bike lane, and a pedestrian footway on one or both sides. Residential, public or commercial buildings fronting the public highway.	• Great Ormond Street • Theobalds Road • Great Russell Street	People walking along pavements and footways of streets and roads can be exposed to direct sun if no shade is provided. Dark coloured, human-made surface materials exposed to direct sun absorb and re-radiate heat in these spaces. This can be a serious issue if people require more time to walk due to mobility issues, or need to rest at regular intervals along the footway.	• If tree canopy cover is low along streets and roads, consider feasibility of planting new shade giving trees. • If trees are not feasible, building mounted shade structures should be considered along public buildings or privately owned buildings fronting on to the street/road. • Install natural or lighter coloured surface materials on roadway and footways.

HLN Thermal Comfort Design Principles – Public Realm Typologies

Table 6: Thermal comfort design principles for public realm typologies within the HLN area (continued)

Public realm typology	Characteristics and sub-types	HLN examples	Heat issues	Thermal Comfort Design Principles (hierarchy order)
(vii) Transit spaces	Entrances to tube stations, areas around bus stops, spaces around cycle / scooter racks, taxi ranks.	• Holborn tube station • Chancery Lane station • Theobalds Road • High Holborn • Great Queen Street/Wild Street • Russell Square tube station (just outside the HLN area)	People can be exposed to direct sunlight when waiting for a bus or taxi, looking for directions, and/or acquiring or returning a bicycle or scooter.	• If tree canopy cover is low in transit spaces, consider feasibility of planting new shade giving trees. • If trees are not feasible, free standing shade structures should be considered for waiting spaces and queues, in the context of providing rain shelter too. • Temporary or seasonal shade structures should be considered in areas which are pleasantly sunny in spring, autumn and winter, but which have uncomfortably high sun or heat exposure in summer. • Building mounted shade structures should be considered outside entrances to tube stations. • Install natural or lighter coloured ground surface materials around bus stops and cycle / scooter racks.

Holborn Liveable Neighbourhood

10

Conclusions and Next Steps

The HLN Heat Resilience Study has identified key heat risk areas and developed targeted adaptation strategies to improve thermal comfort in Holborn's public realm. Through data analysis, modelling, and stakeholder engagement, it ensures that solutions are practical and responsive to real-world needs.

Next Steps
- Immediate Actions (Summer 2025) – Set up pop-up or mobile cooling stations and temporary cool spaces for vulnerable people.
- Long-Term Planning (2030–2050) – Implement tree planting and shade infrastructure to enhance future heat resilience.
- Scaling Beyond HLN – Apply findings to other Camden neighbourhoods and public spaces.
- Year-Round Comfort – Integrate winter warmth and rain protection strategies alongside summer cooling.

With a **Heat Resilience Strategy**, a high-level **Shade and Cooling Masterplan**, and a hierarchy of **Thermal Comfort Design Principles** for the public realm, the HLN area is now equipped to reduce heat risk and enhance urban resilience for the future.

Conclusions

The HLN Heat Resilience Study has achieved a greater and more detailed understanding of the spatial distribution of heat risk and thermal comfort in Holborn's public realm during the hottest months of the year, and the hottest times of day.

The study has identified the external spaces within the HLN area at highest heat risk through quantitative and qualitative analysis. From a longlist of 16 hot spots (based on heat exposure), to a shortlist of five hot spots (based on heat exposure and heat vulnerability), down to a final top three priority hot spots.

These three priority hot spots can now serve as focal points for more detailed design and practical implementation of the identified heat adaptation and resilience measures. If these measures are designed and implemented effectively, thermal comfort in these three spaces can be noticeably improved and heat risk can be reduced.

In addition, the HLN area as a whole now has a Heat Resilience Strategy, a high-level Shade and Cooling Masterplan, and a hierarchy of Thermal Comfort Design Principles. These resources are intended to guide the strategic consideration, and ultimately the practical implementation, of heat adaptation and resilience measures across the HLN area, and the different public realm typologies within it.

The key conclusions from this study are as follows:

- Prioritise the spaces with the highest heat risk and focus on the needs of the most vulnerable people within these spaces when considering heat adaptation and resilience measures.
- This will help to achieve the greatest good (most comfort and health equity) for the greatest number (of people) during hot weather.
- Use the hierarchy of Thermal Comfort Design Principles as a practical decision-making and design tool for implementing heat adaptation and resilience measures in these spaces:

  1. Shade the space
  2. Cool the surfaces, and
  3. Move and cool the air.

- Heat adaptation and resilience measures are more effective at cooling a space when used in combination than in isolation.
- As temperatures increase due to climate change, shade measures alone may not be sufficient to keep spaces cool and comfortable.
- The approximate costs associated with implementing heat adaptation and resilience measures for the HLN area should be seen as an investment in public health and health equity, critical infrastructure resilience, and sustainable economic activity in Camden, and not as a climate resilience cost.
- Making the public realm in HLN safer, more efficient, greener, more active and more connected is of vital importance. Approaching these objectives with a thermal comfort and heat resilience lens, making the public realm cooler and more comfortable during hot weather, will contribute to achieving them. It will also result in wider benefits for people, nature, transport networks, businesses and institutions in the HLN area.

This study has integrated both top-down and bottom-up methodologies, combining desktop thermal comfort modelling with on-the-ground survey work, and stakeholder engagement. This has helped to ensure our analyses reflect, as far as practicable, the reality of the public realm in the HLN area.

The study has focussed on protecting people who are most vulnerable to heat risk, ensuring that spaces with high footfall, due to choice or necessity, remain accessible, comfortable, and equitable for all. However, achieving 'heat resilience' is not a matter of a single intervention or a technological fix. It is a process which requires a collaborative and iterative approach, and physical heat adaptation measures need to be supported by commitment, community engagement, behavioural adaptation, and effective communication strategies. Information sharing, wayfinding, and clear guidance on accessing cooler routes and spaces are key in enabling both proactive and responsive measures, particularly for vulnerable groups.

It is hoped that this study will help to highlight these issues to all relevant council officers, and other built environment practitioners, to educate and inform future plans, designs and projects.

Resilience to extreme heat is a shared responsibility, requiring coordinated efforts across policy, infrastructure, and community engagement. By integrating this study's evidence-based recommendations with behavioural and social strategies, the HLN area can be thermally comfortable, healthy, and safe, as well as more inclusive, equitable and vibrant. Ultimately, the HLN will be better equipped for, and more resilient to, the challenges of a warming climate.

Next Steps

The Beginning, not the End

The outputs of this study should be considered as the beginning of a new phase of strategic thinking and practical implementation of heat adaptation and resilience measures for the HLN area and Camden more widely.

However, studies and strategies are only useful if there is a collective will and commitment to implement the recommended measures which they set out.

Partnership and Collaboration

The challenge of heat risk in Holborn, and Camden more widely, is bigger than one organisation, one project, or one team. There is a need to build upon existing partnerships with stakeholders in the HLN area, and to collaborate on the detailed design, and the practical implementation, of heat adaptation and resilience measures.

Key stakeholders with the HLN area, who are vital to the successful delivery of heat adaptation and resilience measures for priority hot spots, and shortlisted hot spots, include:

- All Camden Council teams
- Central District Alliance
- Great Ormond Street Hospital
- Transport for London
- LDA Design
- Studio Weave
- The British Museum, and
- Holborn Community Association.

To ensure impact is optimised, the study's outputs and recommendations must be embedded within existing and planned public realm improvement projects, and emerging strategic plans such as the Camden Local Plan and the Local Implementation Plan, alongside supportive public awareness campaigns. This will help to ensure that people (both professionals and the general public) understand the risks posed by hot weather, and are empowered to make informed decisions.

Transferability and Replicability

Whilst the outputs of this study are place- and evidence-based, specific to the local context of the HLN area, they can be transferred to and replicated within (to some extent) other neighbourhoods and external spaces in Camden.

For example, to other planning and regeneration priority areas including:

- Somers Town
- Camden High Street
- Gospel Oak and Haverstock
- Regis Road, and
- West End Lane to Finchley Road[11].

And to other areas with similar public realm typologies undergoing improvements including:

- Entrances to museums and cultural institutions (e.g. British Library Extension)[12].
- High streets and active travel routes (e.g. Camden High Street)[13]
- Housing estates undergoing regeneration School streets and grounds

The high-level Shade and Cooling Masterplan for HLN also has the potential to join up with existing urban greening projects in Camden, such as the Camden Green Loop[10], and the Bloomsbury Green Corridor[11].

Act now for Summer 2025 and Summer 2050

There are things that can be done, and need to be done, immediately, to ensure that summer 2025 in HLN is as comfortable, healthy and safe as it can be. For example, get the network of pop-up or mobile cooling stations established, and identify and designate temporary cool spaces for vulnerable people. Then there are things that need to be done as soon as possible, and over the coming years, to ensure summers 2030, 2040 and 2050 in HLN are as comfortable, healthy and safe for our older selves and future generations. For example, planting more street trees in preparation for when we'll need them even more.

All-Season Thermal Comfort and Resilience

The focus of this study has been on thermal comfort in external spaces at the hottest times of day, in the hottest months of the year. Therefore, the Heat Resilience Strategy, the high-level Shade and Cooling Masterplan and the hierarchy of Thermal Comfort Design Principles reflect that focus, but also acknowledge related considerations and potential co-benefits.

Further work may be needed on year-round, all-season thermal comfort and weather resilience in the HLN area. This may include, for example, identifying and creating warm spaces for people in winter, and dry spaces for people when it rains.

Holborn Liveable Neighbourhood

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Glossary

This chapter provides a glossary of key terms used throughout the report.

As this is a technical document, we recognise that some concepts may be complex or unfamiliar. The glossary is designed to support the reader by offering clear definitions of important terms related to heat resilience, thermal comfort, and adaptation measures.

We hope this resource enhances understanding and makes the findings more accessible and useful.

Terms included in the glossary are underlined throughout the report and hyperlinked to this chapter.

Glossary

Term	Definition
Albedo	The reflectivity of solar energy by materials and surfaces. A surface with a high albedo, such as white coloured buildings, reflect more heat than it absorbs. A surface with a low albedo, such as asphalt, absorbs more heat and warms its local environment.
Cool spot	An area identified in this report as having low heat exposure or heat risk (exposure x vulnerability). These areas could be enhanced to provide even greater cooling benefits to people and businesses in the HLN area.
Climate scenarios	Projected climate and weather beyond the 2020s. For climate modelling, the 2050 and 2080 climate scenarios are typically used.
Direct Sun Hours	Direct sun hours represent the total duration which a surface is exposed to direct sunlight over a specific period. This value is measured in hours and provides insight into how much direct sunlight different parts of the urban area receive during the day.
Geographical Information Systems (GIS)	GIS is a technology that is used to create, manage, analyse, and map all types of data. GIS connects data to a map, integrating location data (where things are) with descriptive information (what things are like there).
Heat exposure	The susceptibility of external spaces to the adverse effects of extreme heat, which in this report is determined by (i) Direct Sun Hours, (ii) Incident Radiation (iii) Sky Exposure, (iv) Mean Radiant Temperature, and (v) Universal Thermal Comfort Index (UTCI).
Heat impact	A heat impact is an experienced consequence of hot weather. It can be adverse/negative or beneficial/positive.
Heat risk	Heat risk is a factor of heat exposure and heat vulnerability. It refers to a future adverse heat impact.
Heat stress	Heat stress happens when the body's way of controlling its internal temperature starts to fail. It generally results from a combination of factors including high ambient temperatures, physical activity, fluid intake, humidity, and clothing.
Heat vulnerability	This report defines heat vulnerability as the susceptibility of individuals, communities, or spaces to the adverse effects of extreme heat, which is determined by socioeconomic, physiological and psychological factors.

Glossary

Term	Definition
Hot spot	An area identified in this study as having either a high level of heat exposure or heat risk (exposure x vulnerability). Interventions in these areas may be necessary to improve outdoor thermal comfort and mitigate overheating impacts and risks.
Incident Radiation	The solar energy received by surfaces (like buildings and streets) in an urban space. This metric helps to identify areas that experience higher levels of solar radiation and therefore likely to heat up more rapidly. The unit of measurement is kilowatt hours (kWh).
Lower Super Output Area (LSOA)	A geographical unit used in the UK for Office for National Statistic (ONS) reporting and spatial analysis of regions. LSOAs are smaller than Local Authority areas and are typically used for census data.
Microclimate	The climate of a small geographical area, which is determined by several factors, such as temperature, humidity, wind patterns, and sunlight exposure.
Mean Radiant Temperature (MRT)	MRT is an average temperature of surrounding surfaces that influence human heat exchange through radiation. The unit of measurement is degrees Celsius (°C). MRT depends on the surface temperatures and reflectance properties of building materials present in the urban space.
Physiological Equivalent Temperature (PET)	PET is a calculated air temperature that represents the perceived thermal comfort of a human body under specific environmental conditions.
Public realm	Areas of the built and natural environment where the general public has free access.
Sensitive asset or feature	This report defines a sensitive asset or feature as a building, public space, or infrastructure which can be considered as sensitive to the impacts of heat.
Sky exposure	Sky exposure is the amount of visible sky a surface or point in an urban area can ‘see’, indicating how open or enclosed a space is relative to the sky. It is measured from 0 to 1, with 1 indicating a completely unobstructed view of the sky.
Thermal comfort	The personal satisfaction with the environment with regards to temperature, humidity, ventilation, and clothing.

Glossary

Term	Definition
Universal Thermal Comfort Index (UTCI)	A measure of human thermal comfort which assesses the combined effects of temperature, humidity, wind speed, and mean radiant temperature. This metric is also known as the 'feel like temperature' as it gives an output which is closest to how a person in a given area actually feels.
Urban heat island (UHI) effect	Refers to the effect of grey infrastructure (e.g. buildings and roads) and darker coloured surface materials (e.g. asphalt and steel), absorbing and emitting more heat than green infrastructure (e.g. trees and plants) and lighter coloured surface materials (e.g. stone and sand). This causes urban areas which contain densely built grey infrastructure, to be hotter than surrounding rural areas.
Vulnerable asset or feature	This report defines a vulnerable asset or feature as a building, public space, or infrastructure which can be considered as potentially vulnerable to heat.

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References

This chapter provides a list of references used throughout the report, ensuring transparency and credibility of the findings.

Given the technical nature of this study, the references serve as a resource for further reading, supporting the data, methodologies, and recommendations presented.

We hope this section helps readers explore the topic in greater depth and informs future work on heat resilience and urban adaptation.

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