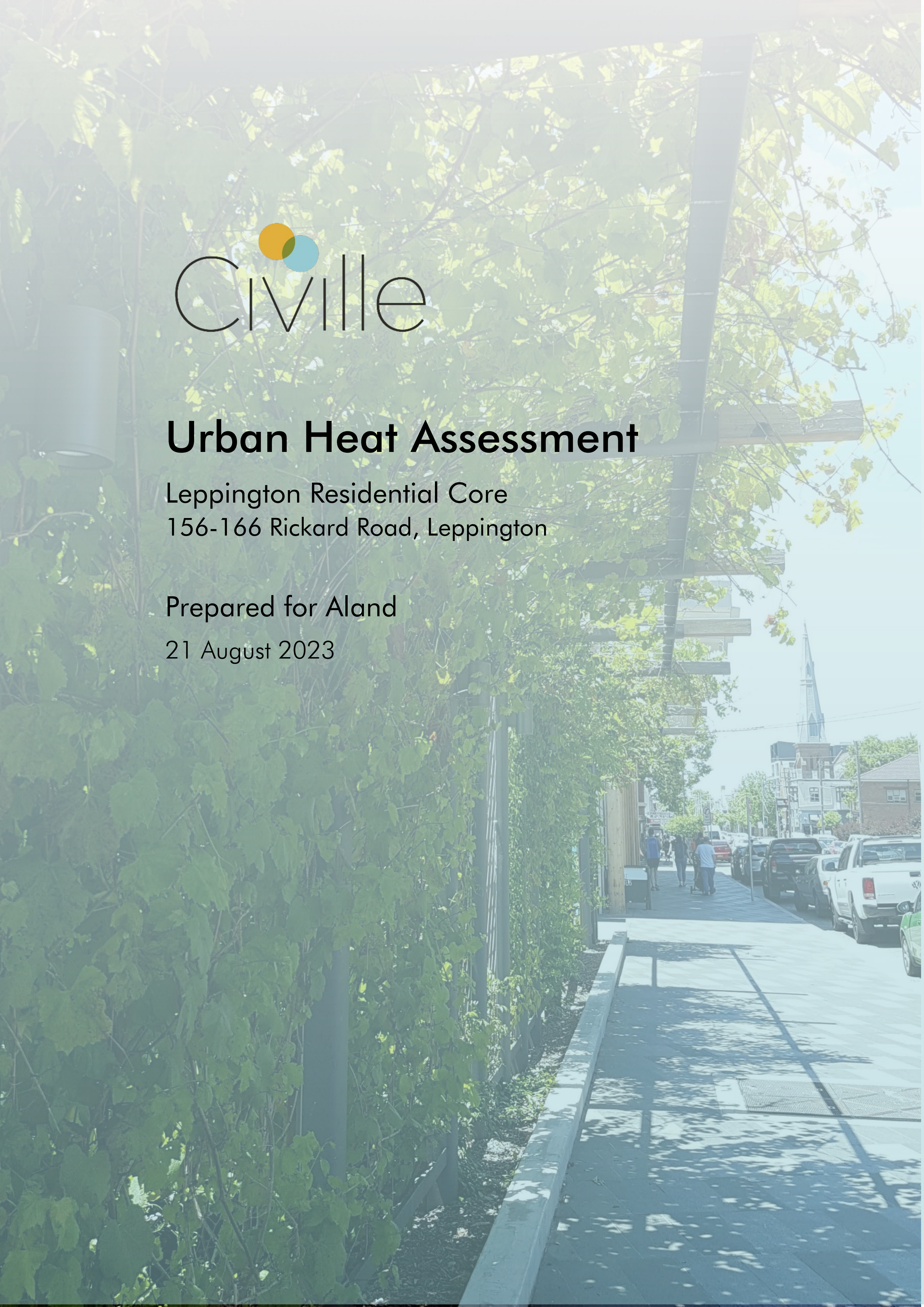

Civille

Urban Heat Assessment

Leppington Residential Core
156-166 Rickard Road, Leppington

Prepared for Aland

21 August 2023

Project name:
Urban Heat Assessment for Leppington Residential Core – 156-166 Rickard Road, Leppington

Project number: 2221

Date: 21 August 2023

Report authors:
Alexa McAuley, Civille
Thomas Hawthorne, Civille

DOCUMENT HISTORY AND STATUS

Revision	Status	Date
A	Draft for client review	14 February 2023
B	Draft for coordination	28 July 2023
C	Draft for client review	21 August 2023

CONTENTS

EXECUTIVE SUMMARY

Proposed development of the Leppington Residential Core should support community adaptation to increasing future urban heat and heatwaves.

Measures to reduce the impacts of heat should be applied in both the private and public domain, to ensure thermal safety indoors and maximise thermal comfort outdoors.

Green, blue, and grey infrastructure all play a role, including:

- Canopy cover and green cover
- Green roofs and green walls
- Water in the landscape, including irrigation, passive irrigation, WSUD, and water features
- Cool roofs
- Cool paving
- Shade structures

Landscape plans for the site illustrate how vegetation will be integrated into the public domain. This report proposes other measures to be applied as planning and design progresses in more detail.

1 INTRODUCTION

1.1 THE PROJECT

The Aland Leppington Residential Core Planning Proposal seeks to amend State Environmental Planning Policy (Precincts – Western Parkland City) 2021 (Parkland City SEPP) for the lots located at 156-166 Rickard Road (referred to as 'the site') (see Figure 1).

The site is strategically located, towards the centre of the Leppington Town Centre, within the Southwest Growth Area (SWGA) and to the south of the Leppington train station and immediate north of Leppington Public School. It is intended for the site to serve a central and residential accommodating function within the context of the town centre. The Planning Proposal is supported by the Leppington Residential Core Master Plan which facilitates the realisation of the Leppington Town Centre vision through the provision of a mixed use zoned land, that is intended to primarily facilitate residential uses, with some retail and other community serving uses on ground.

The site is under the single control of the proponent and presents a highly capable land parcel, to the near south of the Leppington train station, that by its nature and location will function as an exemplar transit-oriented development in the Leppington Town Centre and SWGA. As such, the site presents an immediate opportunity to deliver new homes and jobs as part of a holistic and integrated land use and transport-oriented development.

To the west of the Leppington Residential Core is an adjoining Aland landholding at 173-183 Rickard Road, Leppington which will form part of future development stages and will be subject to a separate planning application.

The proposal seeks to rezone the site comprising 4.2ha of land in the in the Leppington Town Centre Precinct which was first identified by the NSW Government in 2013 as a key strategic centre within the SWGA to deliver new homes and jobs in close proximity to public transport. This was followed by the announcement of the Western Sydney International Airport (WSI) in 2014 and in anticipation of the delivery of Leppington Train Station in 2015.

In 2017, the Department of Planning and Environment (DPE) commenced a review of the Leppington Town Centre, to investigate a potential new vision and associated land use controls for the area. Following this review, DPE announced a new approach to precinct planning in 2019, returning precinct planning and rezoning powers back to Liverpool and Camden Council.

Both Councils have since consulted with key Government agencies in relation to the Leppington Town Centre and conducted a number of technical studies to inform a new planning proposal and rezoning of the town centre.

The Leppington Residential Core proposal provides a site-specific planning framework that will help support Council's vision for the Leppington Town Centre and enable it to transition into a new thriving transit-oriented residential community that builds on the NSW Government's vision and aspirations under the Western Sydney Growth Area program.

The Leppington Residential Core Master Plan is a potential 'catalyst project' that would complement the delivery of the wider Leppington Town Centre plan proposed by Camden Council. The proposal leverages the unique opportunity offered by the site's strategic location within the town centre and its close proximity to transport and educational infrastructure, by rezoning the site to enable transit-oriented development within a town centre and increasing building height and floor space ratio development standards to enable additional housing supply and diversity.

Aland has engaged Civille to prepare to prepare an urban heat assessment to inform the zoning amendments for the Residential Core Master Plan and Planning Proposal.

1.2 SITE DESCRIPTION

The land to which this proposal relates is 156-166 Rickard Road, Leppington. The site is accessed via Rickard Road and is located within the Leppington Town Centre. Leppington Town Centre extends across both the Camden and Liverpool LGA; however, the site is located entirely within the Camden LGA portion of the town centre. The site is more broadly situated in the SWGA.

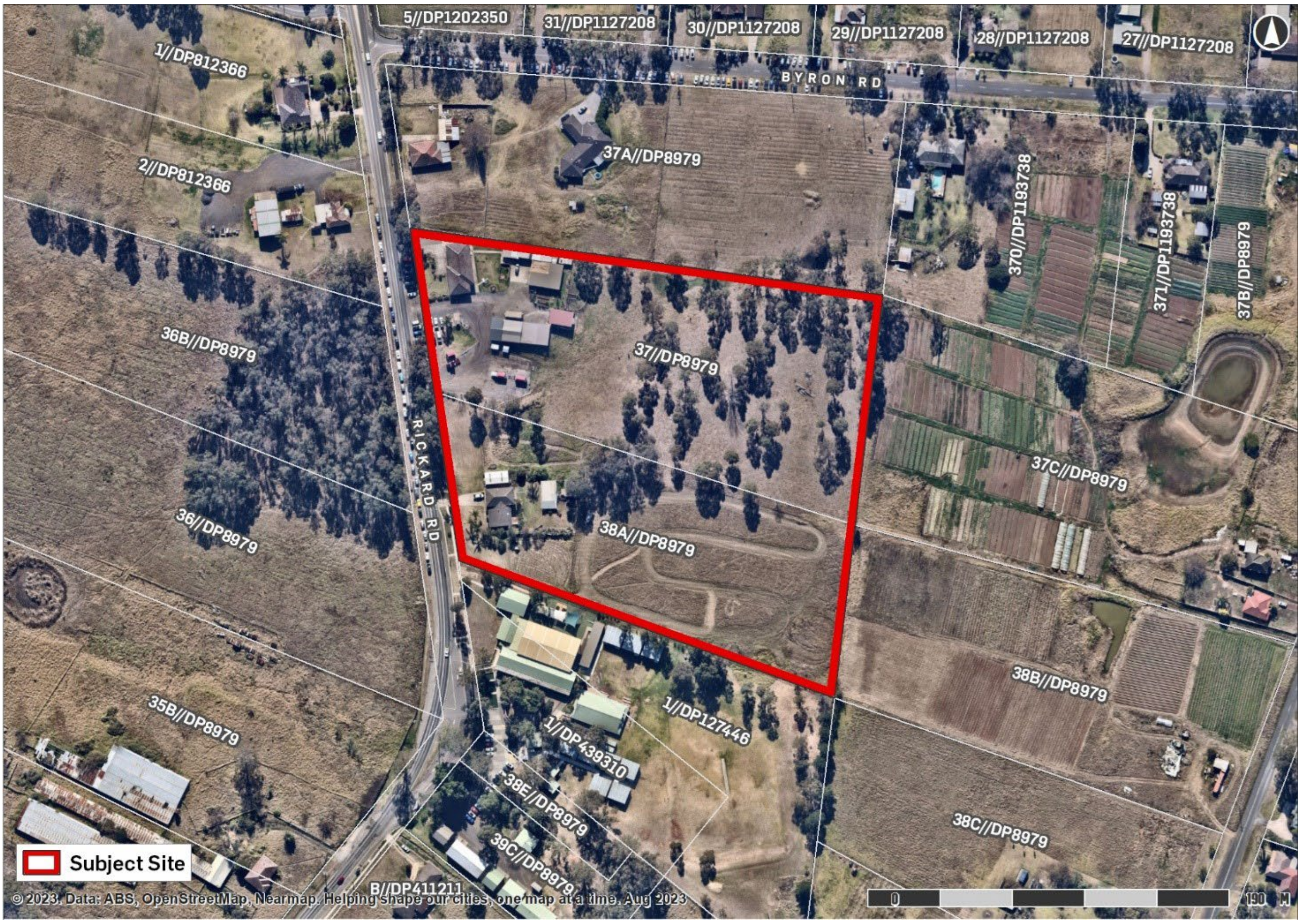

Figure 1: Aerial photo of the site (Urbis 2023)

Table 1: Key features of site

Feature	Description
Street Address	156-166 Rickard Road, Leppington
Legal Description	Lot 37 DP 8979 (166 Rickard Road) Lot 38A DP 8979 (156 Rickard Road)
Site Area	4.2ha
Site frontage	180m frontage to Rickard Road
Site Topography	The topography and slope of the site is generally low to moderate. The site generally falls from the northeast to the southwest with high points being along the Rickard Road frontage.
Vegetation & Biodiversity	The site is partly cleared. The rear of 166 Rickard Road is sparely populated with remnant vegetation, while 156 Rickard is mostly cleared with a small only a number of trees lining its northern boundary. The remaining remnant vegetation is comprised of Cumberland Plain Woodland. The entirety of the site is biodiversity certified.
Bushfire	Both sites are mapped as being affected by bushfire risk. This is largely associated with the patch of clustered vegetation in the adjoining lots to the west – 163 Rickard Road, Leppington.
Existing Services and Utilities	▪ Potable Water: There is an existing 250mm water main along Rickard Road ▪ Sewer: There is an existing 225mm sewer main approximately 230m to the west ▪ Electricity: The site is located within the Endeavour Energy electrical supply zone. The North Leppington Zone Substation is located approximately 1km north-west of the site, on Bringelly Road, while along Rickard Road there is an existing 11kV HV main feeder. ▪ Gas: The site is currently not serviced by the Jemena natural gas network
Hydrology	The site is not flood affected by mainstream flooding in either the 1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) storm event.

1.3 THIS REPORT

This report presents an urban heat assessment for the proposed development. It summarises the urban heat risks to be considered at the site and proposes a framework, objectives, and potential measures to address urban heat in the future development.

The objectives of the report are:

- To describe the planning context as it relates to urban heat (Section 2)
- To describe he physical context of the development area, in terms of its weather, climate and exposure to heat (Section 3).
- To identify opportunities to address urban heat in the planning and development process (Section 4).
- To describe specific measures that can be incorporated into the development as part of its design, to reduce the impacts of urban heat (Section 5).

This report considers both how the proposed development can be designed to minimise its contribution to the Urban Heat Island effect, as well as how it can be designed to minimise heat-related risks to the local community.

This report proposes potential planning objectives and design measures that could be integrated into later stages in the development process.

The report concludes:

- The site is exposed to heat and heatwaves are becoming more severe as the climate changes.
- There are opportunities in the precinct's planning and design to reduce the heat island effect and reduce the impacts of urban heat on the local community.
- Green, blue, and grey infrastructure can all play a role in mitigating the impacts of heat at the site.
- Urban heat mitigation measures should be included in both the public and private domain of future development.

2 PLANNING CONTEXT

Existing planning documents clearly identify the need, strategic directions, and draft requirements to address urban heat risks in planning and design of future development in the Leppington Residential Core.

2.1 URBAN HEAT IN STRATEGIC PLANS

GREATER SYDNEY REGION PLAN

The Greater Sydney Region Plan (Greater Sydney Commission, 2018) sets the direction for Sydney's growth to 2056, showing how the city will accommodate growth within a liveability, productivity and sustainability framework. It establishes the objective that "heatwaves and extreme heat are managed", and includes Strategy 38.1: "Mitigate the urban heat island effect and reduce vulnerability to extreme heat". It notes:

- Particular exposure of the Western Parkland City to heat
- That climate change will increase urban heat
- Health aspects of urban heat
- The role of heat in placing pressure on infrastructure, particularly the electricity network
- Impacts of heat on liveability.

WESTERN CITY DISTRICT PLAN

The Western City District Plan (Greater Sydney Commission, 2018) establishes three key priorities related to urban heat for the Western Sydney District. These priorities are:

1. W20: Adapting to the impacts of urban and natural hazards and climate change
2. W19 Reducing carbon emissions and managing energy, water and waste efficiently
3. W15 Increasing urban tree canopy cover and delivering Green Grid connections.

Under each of these planning priorities there are objectives, including:

- Objective 36: People and places adapt to climate change and future shocks and stresses
- Objective 37: Exposure to natural and urban hazards is reduced
- Objective 38: Heatwaves and extreme heat are managed
- Objective 33: A low-carbon city contributes to net-zero emissions by 2050 and mitigates climate change
- Objective 34: Energy and water flows are captured, used and re-used
- Objective 30: Urban tree canopy cover is increased

CAMDEN LSPS

Camden Council's Local Strategic Planning Statement (LSPS) (Camden Council, 2020) identifies heatwaves as a serious stressor to the community and notes that impacts due to hot weather will increase with climate change. The Camden LSPS also identifies that increasing urban development can create a warmer microclimate for the community and that "it is important to consider ways to reduce the local heat effects of urban development." (Camden Council, 2020).

Local Priority S6 is "Improving Camden's resilience to hazards and extreme weather events". Under this priority area, there is one main action relevant to mitigating the impacts of urban heat:

- 124. Council will undertake a climate risk assessment and identify priority issues for Council and the community

Through Local Priority S1: "Improving the accessibility and connectivity of Camden's Green and Blue Grid and delivering high quality open space", Camden Council also proposes actions relevant to mitigating the impacts of urban heat, including:

- 82. Council will prepare a Green and Blue Grid Analysis for Camden and identify mechanisms to implement the Green and Blue Grid
- 83. Council will investigate opportunities to provide physical and visual connections to waterways and green spaces

- 84. Council will advocate for the retention of remnant vegetation in the masterplanning of new urban areas
- 85. Council will investigate the State Government's Canopy Cover targets and identify opportunities to implement improved canopy cover on public and private land in line with these
- 86. Council will develop a Street and Public Tree Masterplan to inform a LGA-wide tree planting program

CAMDEN GREEN AND BLUE GRID STRATEGY

Camden Council has adopted a Green and Blue Grid strategy (Camden Council, 2023). This includes the NSW Government's tree canopy cover target of 40% but does not put a time frame on achieving this in Camden. The strategy states that Camden LGA's urban tree canopy cover in 2019 was 15%. Therefore, there is a significant gap between the current condition and the 40% target.

2.2 URBAN HEAT IN PLANNING PROVISIONS

The existing planning provisions relevant to the Leppington Town Centre are contained within the following:

- SEPP (Precincts—Western Parkland City) 2021 – Camden Growth Centres (Appendix 5)
- Camden Growth Centre Precincts DCP
- Camden Growth Centre Precincts DCP Appendices
- Camden Growth Centre Precincts DCP – Schedule 1 and 2 – Austral and Leppington Major Centre

The SEPP (Precincts—Western Parkland City) 2021 does not include any specific urban heat provisions, but the Camden Growth Centre Precincts DCP does – see below.

In late 2022, Camden Council and Liverpool City Council endorsed a draft Planning Proposal Package for Leppington Town Centre, which has been submitted to the Department of Planning and Environment for Gateway Determination. This proposes new planning provisions for the town centre, relevant to urban heat.

CAMDEN GROWTH CENTRE PRECINCTS DCP

The Camden Growth Centre Precincts Development Control Pan (DCP) (NSW Department of Planning and Environment, 2017) applies development controls for Growth Centre areas of the Camden LGA. There are several development controls related to mitigating the effects of urban heat for future developments in Growth Centres of Camden LGA. These controls include:

- Section 3.3 Movement network (pg. 59): "Street planting is to: provide appropriate shade in summer and solar access in winter, including shading of road carriageways and other hard paved areas to minimise heat retention in summer," and
- Section 4.1.3 Sustainable building design (pg. 77):
  - "4. The orientation of dwellings, location of living rooms and the positioning and size of windows and other openings is to take advantage of solar orientation to maximise natural light penetration to indoor areas and to minimise the need for mechanical heating and cooling."
  - "8. Roof and paving materials and colours are to minimise the retention of heat from the sun."
- Section 6.3.3 Landscaping of car parking areas (pg. 151):
  - "2. Allotment car parking areas are to be effectively landscaped to: reduce heat generation and glare from hard paved surfaces;"

DRAFT LEPPINGTON TOWN CENTRE PLANNING PROPOSAL

Camden Council has prepared a draft Planning Proposal for the Leppington Town Centre (Camden Council and Liverpool City Council, 2022). This identifies urban heat as a significant issue for urban communities of Western Sydney and by extension the people of the proposed Leppington Town Centre.

The draft Planning Proposal (pp.142-143) notes the following measures by which it aims to mitigate the effects of extreme heat and the heat island effect:

- The Proposal includes bonus FSR incentive for low carbon buildings and urban heat strategy considerations for consideration in planning proposals.
- The proposal includes urban heat controls which seek to ensure new development incorporates effective planning and design to reduce the impacts of urban heat, to help the community survive heatwaves and thrive in a warmer climate.
- Leppington Town Centre aims to exceed the draft Greener Places Design Guide for street tree canopy coverage in Western Sydney. A Street Tree Masterplan for the Leppington Town Centre aims to provide extensive tree coverage along all road types.

- The three creeks (Kemps, Scalabrini and Bonds) are being utilised to further cool the city in a North South direction. Tree lined linear plazas connect the creeks and with provide east west cooling.
- Controls and Objectives have been included into the DCP to further enhance the low carbon precinct identity including not permitting dark materials for roofing, which can potentially reduce energy use required for cooling a building by up to 20% and reducing the heat island effect.

Draft provisions proposed in the SEPP and DCP for Leppington Town Centre are reproduced in Box 1 and Box 2 below.

Box 1: Draft SEPP Provision 6.10 "Urban heat", as proposed in the Leppington Town Centre Planning Proposal (Camden Council and Liverpool City Council, 2022)

1) The objective of this section is to ensure new development incorporates effective planning and design to reduce the impacts of urban heat, to help the community survive heatwaves and thrive in a warmer climate.
2) This section applies to all developments in residential, business, industrial, recreation and special purpose zones within the Leppington Town Centre to which this Part applies.
3) Before granting development consent, the consent authority must be satisfied that:
    a) The development makes adequate allowance for green infrastructure, including an appropriate contribution to tree canopy cover targets adopted by Council. This means allowing for sufficient deep soil and plantable area to encourage root development and minimise conflicts with utilities,
    b) Building roofs (other than green roofs) are designed as cool roofs, wherever they are not designed as green roofs or covered with solar panels,
    c) Building exteriors are designed to minimise heat impacts in their immediate surroundings, particularly where these spaces are frequented by people. This includes solar radiation reflected from façades, heat absorbed and re-radiated from walls and heat ejected from heating, ventilation and cooling systems,
    d) Buildings are designed to achieve high passive thermal performance and reduce reliance on air conditioning to maintain comfortable and safe indoor conditions, even during heatwaves,
    e) Public and private outdoor spaces that are accessible to residents, workers or the general public, including gardens, courtyards, parks, plazas and streetscapes, are designed as cool spaces,
    f) The development makes a contribution, proportionate to its scale, to renewable energy supply and/or storage, which will reduce the peak demands on the grid during heatwaves, and
    g) The development has access to an appropriate sustainable supply of non-potable water (e.g. rainwater, harvested stormwater or recycled water) to enable irrigation for cooling, even at times when drinking water use is restricted.
    h) The development or work has demonstrated that shade trees are to be retained where practical, unless an AQF Level 5 Arborist has determined that the tree should not be preserved as it is dead, dying or may present as a hazard to human health if retained.
4) In this section:
    a) Green infrastructure includes all types of vegetation found in urban areas, including natives and exotic species, remnant and planted vegetation, trees, shrubs, grasses and groundcovers, vegetation in parks, streetscapes, public and private domain. It includes elements such as green walls and roofs, rain gardens, wetlands and swales, productive, ornamental and native gardens, trees, turfed areas, bushland and riparian vegetation.
    b) Cool roofs use materials of high reflectivity (particularly in the infrared and near infrared spectrum) and/or high thermal emittance (they easily re-radiate any absorbed solar energy).
    c) Passive thermal performance is achieved by designing with passive heating/cooling measures (such as orientation, natural ventilation, cool materials, external shading, glazing and appropriate use of thermal mass), to reduce the reliance on mechanical heating or cooling to maintain thermal comfort.
    d) Cool spaces in the outdoor environment (in both the public and private domain, including parks, streetscapes, plazas/public squares, private gardens, courtyards, balconies, outdoor work areas) are designed to implement principles that maximise human thermal comfort in outdoor environments, including:
        i) Maximising summer shading (e.g. via shade structures or tree canopy),
        ii) Minimising heat reflected from building walls and façades into pedestrian gathering or circulation areas,
        iii) Minimising heat input to pedestrian circulation areas from sources such as vehicles and building HVAC systems,

iv) Maximising the amount of water retained in the landscape, including both rainfall intercepted and retained in soils, and the use of irrigation (using sustainable water supplies such as rainwater, harvested stormwater or recycled water) to maintain healthy vegetation and maximise evapotranspiration,

v) Incorporating evaporative cooling systems such as water features or misting fans to create particular cool zones, and

vi) Using permeable paving where possible and prioritising the use of cool paving materials wherever glare is not a constraint and there are potential cooling benefits.

e) A tree which provides for canopy shading can be practically preserved when:

i) The tree and its canopy are located wholly within a landscaped area, or

ii) Techniques such as underboring or provision of root barriers around utilities, footings, or foundations can reduce or remove any potential damage to public utility undertakings, and buildings, or

iii) The position of driveways, hard surfaces and other paved areas can be practically displaced or removed entirely to avoid removal of existing trees. or

iv) The development has not demonstrated, by means of building plans, or flood mitigation works, that cutting or filling of the land is necessary, which would subsequently result in the removal of trees, or

v) Minor articulation of the built form, location of proposed lot boundaries, or minor variations to the street alignment or design can otherwise retain shade trees.

Box 2: Proposed urban heat provisions in the draft Leppington Town Centre Development Control Plan (NSW Department of Planning and Environment, 2022)

In Leppington Town Centre, all development will be required to implement design principles that minimise the impacts of urban heat. This means that each development should minimise its carbon emissions, reduce its peak demand on the electricity grid and minimise its contribution to the urban heat island effect; as well as being designed to ensure that both indoor and outdoor spaces stay as cool as possible in hot weather.

The requirements for urban heat mitigation and the information required to support a development application varies for different types and scales of development.

Objectives

a) To reduce carbon emissions from the development, considering both construction and operational emissions.

b) To reduce peak demand on the electricity grid and support a robust electricity network, by improving energy efficiency and installing solar panels.

c) To reduce the development's contribution to the urban heat island effect, by minimising hard surfaces, using cool materials, maximising landscaped area, and retaining water in the landscape where it is available for evapotranspiration.

d) To design homes for high passive thermal performance, so that they stay as cool as possible through heatwaves and maintain habitable conditions even in the event of an extended power outage.

e) To design non-residential buildings for high passive thermal performance, so that they remain comfortable for workers and visitors in hot weather, while also minimising energy demands. Prioritise buildings (or parts of buildings) which are open to the public and those where people work.

f) To design outdoor areas that are accessible to residents, workers or the general public to stay as cool as possible during hot weather, so that people can still work, socialise and recreate outdoors and also use active transport modes.

Design principles: buildings

i. Design buildings for high passive thermal performance, to reduce reliance on energy for cooling (and heating).

ii. Install energy-efficient fittings and appliances.

iii. Install or connect to renewable energy systems, to offset energy demands and reduce peak electricity demands

iv. Use cool roofing materials, with a high Solar Reflectance Index (SRI). Green roofs are also encouraged, particularly where there is a need to minimise glare from roofs.

v. Limit the solar reflectivity of glazed façades, and shade reflective façades with vegetation and/or architectural features.

vi. For external walls, minimise the use of thermally massive materials like concrete that absorb energy and stay warm, re-emitting heat into outdoor areas.

Design principles: outdoor areas

vii. Design outdoor spaces to stay cool in hot weather, considering orientation, including as much shade as possible, and providing irrigation to landscaped areas.

i. Prioritise these design measures in areas frequented by people, including town centres, transport nodes, active transport routes.
ii. Shade paved surfaces and walls where possible, also considering solar access in the cooler months.
iii. Consider cool paving (high albedo and/or high thermal emittance) or permeable paving. Although these materials are not suitable in all situations, they should be used wherever possible. Use cool paving wherever glare is not a constraint and there are potential cooling benefits. Use permeable paving where traffic loads are light and where there is an opportunity for rainfall to soak into soil below the pavement.
iv. Maximise landscaped area within the development. Within landscaped areas, maximise soil volumes, and plant trees that will grow to have large, dense canopies. Also include understorey plantings.
v. Provide irrigation to landscaped areas, to support healthy vegetation and enable evapotranspiration, which has a cooling effect.
vi. Where an irrigation system is not feasible, provide passive irrigation – enable runoff from adjacent hard surfaces to soak into landscaped areas.
vii. Include features that store water in the landscape – for example rain gardens, wetlands and ponds. Also consider the use of fountains, misting fans or water play features to create particular cool zones in the landscape.
viii. Connect irrigation systems and water features to a sustainable supply of non-potable water (e.g. rainwater tank, stormwater harvesting scheme, recycled water) so that a water supply is more likely to be available for cooling, even in times of drought and restricted mains water use.

Controls

1. All development must demonstrate substantial consistency with the design principles above.

3 HEAT RISKS AND VULNERABILITY

Leppington's physical conditions mean that urban heat is a risk to the future community, particularly in a changing climate.

Urban heat risks can be understood in terms of three key factors: exposure, sensitivity, and low adaptive capacity, as shown in Figure 2 below. Exposure is the heat conditions to which a place is exposed (See Section 3.1). Sensitivity is a measure of how sensitive people and urban systems are to heat, for example health and age are important factors in sensitivity of people (See Section 3.2).

Adaptive capacity is a measure of how readily a community can adapt to prolonged or acute exposure to heat (see Section 3.3).

These three high level factors (exposure, sensitivity, adaptive capacity) can be influenced to some extent by urban planning and design of new development.

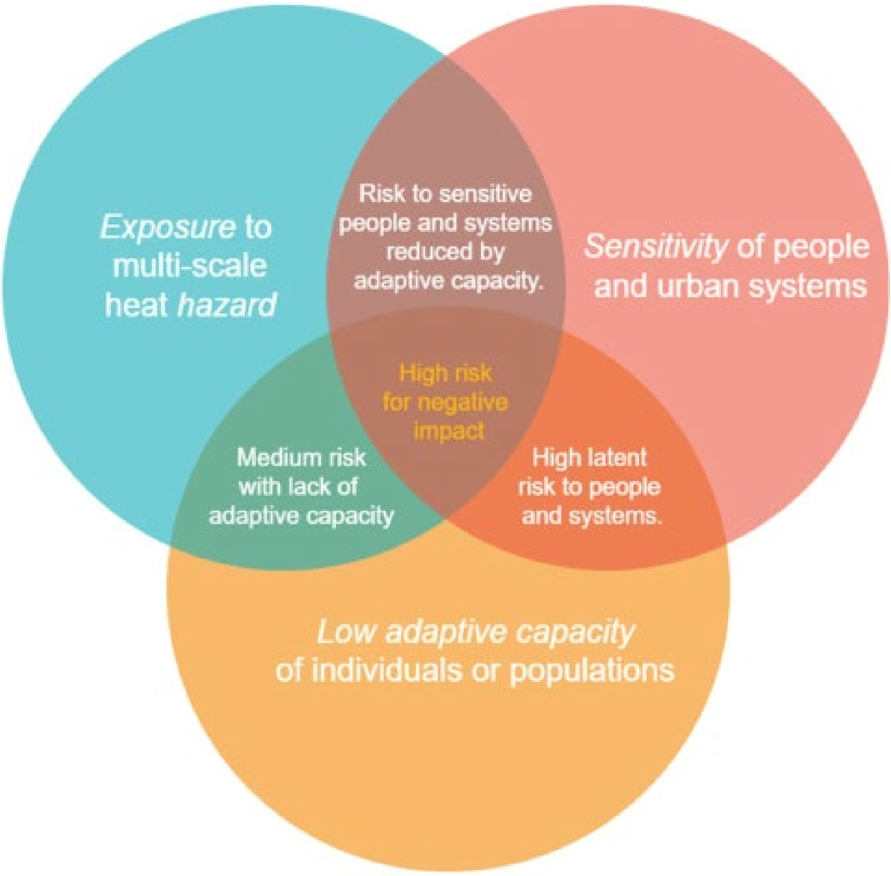

Figure 2 Risk framework for urban heat impacts to people (Nazarian et al. 2022)

3.1 HEAT EXPOSURE

AIR TEMPERATURES AND HOT DAYS

Leppington is exposed to both heat and cold. The warmest months are December to February (Figure 3).

The former NSW Office of Environment and Heritage (2014) and the Greater Sydney Commission (2018) have both defined "hot days" as those where the temperature reaches above 35°C, and the Greater Sydney Commission (2018a) has recommended the number of hot days as a performance measure for addressing urban heat.

Data from the Badgerys Creek AWS weather station has been used for as a reference for the proposed Leppington Town Centre, as this weather station is reasonably close to the site (~10 km) with very similar climatic conditions. Badgerys Creek AWS has a long time series of data available, including temperature, rainfall, humidity, and wind data.

While average conditions in the area in summer are comfortable, Figure 3 shows that Decile 9 maximum temperatures (i.e., one day in every ten) in December to February exceed 35°C.

Based on recent data (1991-2020), as shown in Figure 4, the area experiences an average of 15 hot (>35°C) days per year, including 2.8 days where the temperature peaks over 40°C. The number of hot days is expected to increase as the climate changes over the coming decades. The number of hot days is expected to increase as the climate changes over the coming decades. Figure 5 shows the projected increase in the number of hot days across Sydney by 2060-79 (NSW OEH 2014). Near the site, the projected increase is 10-20 days.

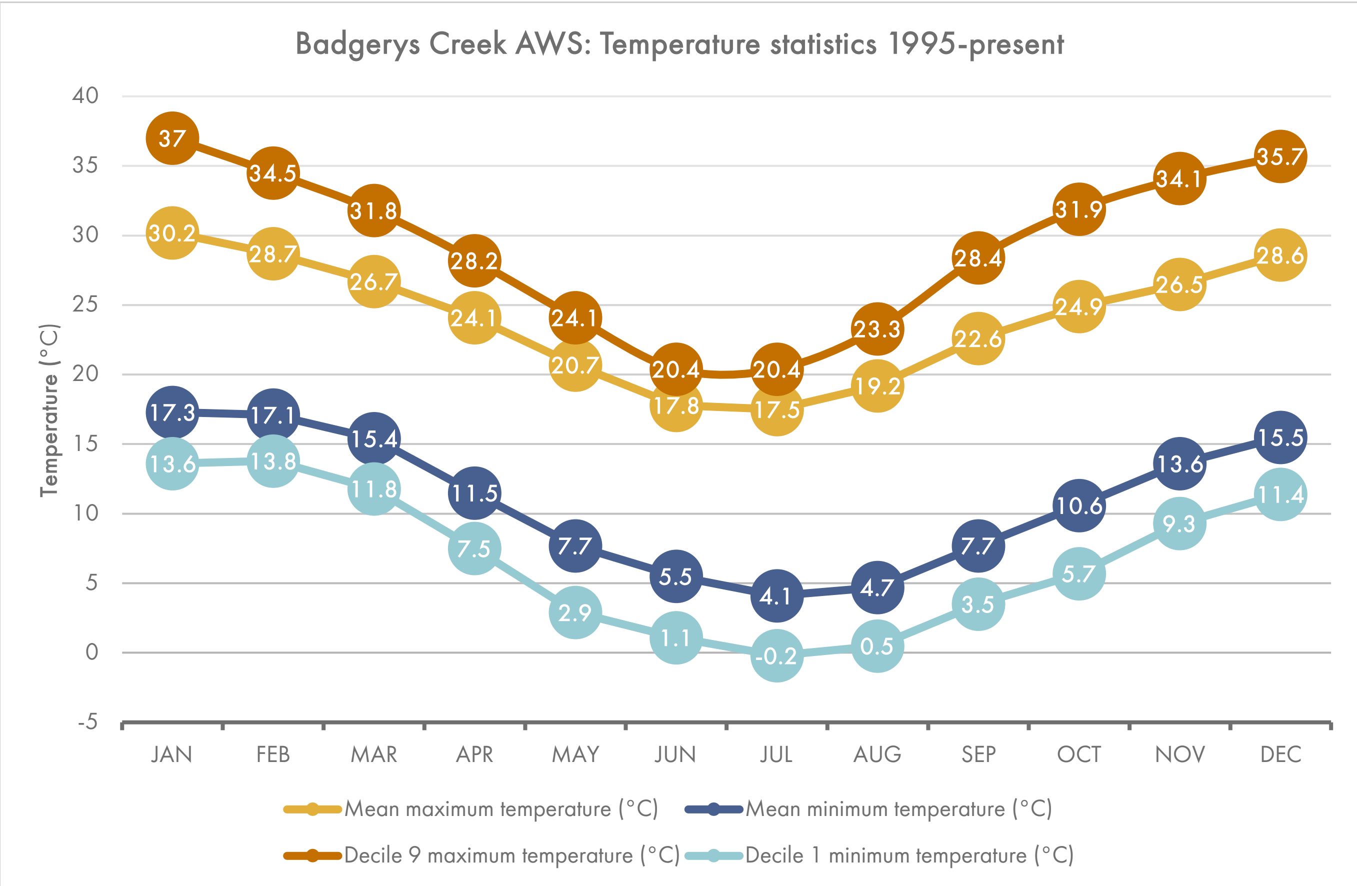

Figure 3: Badgerys Creek AWS temperature statistics, 1995-present (based on data from Australian Bureau of Meteorology)

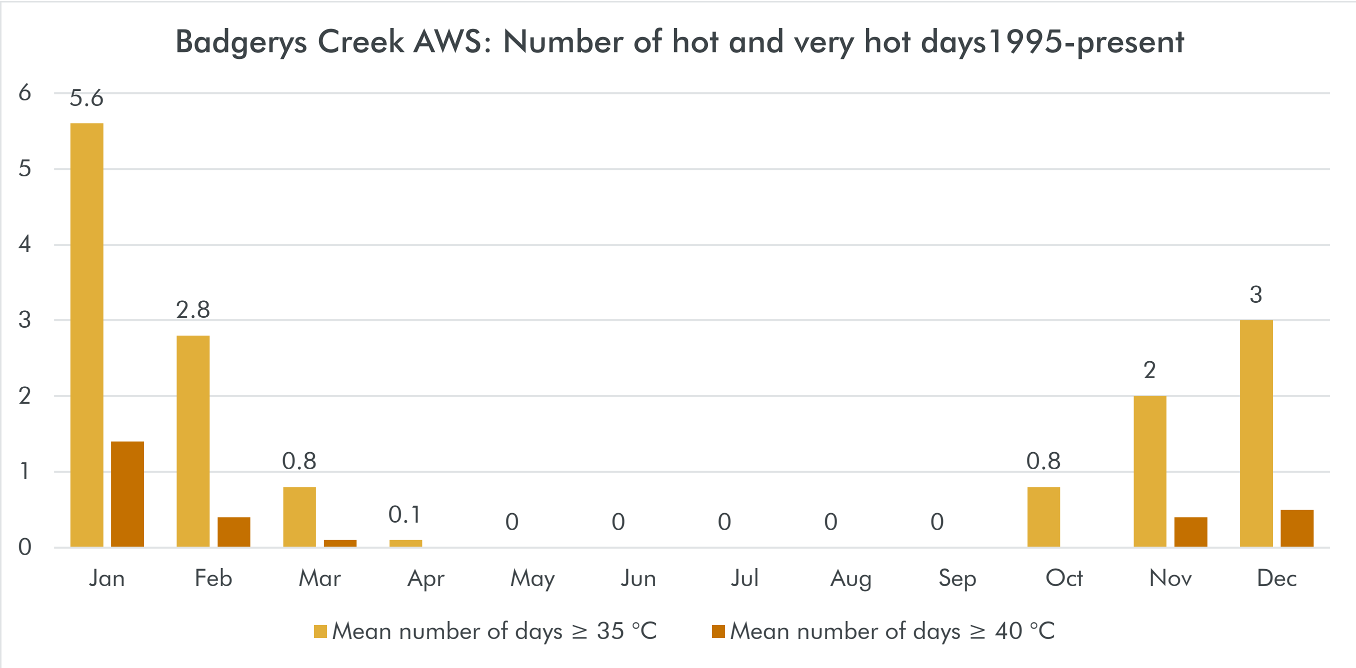

Figure 4: Badgerys Creek AWS number of hot days, 1995-present (based on data from Australian Bureau of Meteorology)

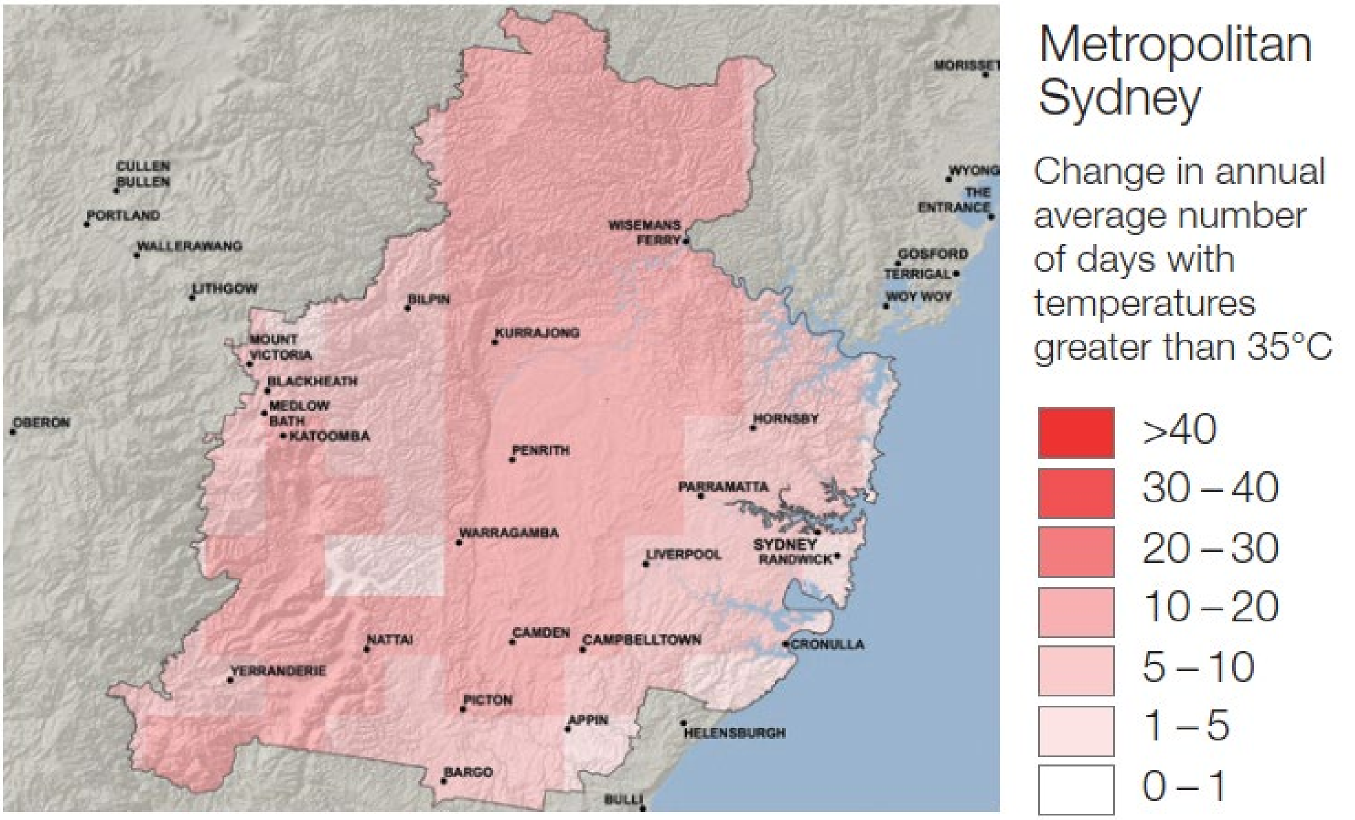

Figure 5: Future (2060–2079) projected changes in the number of days per year with maximum temperatures above 35°C (NSW OEH 2014)

HUMIDITY AND AIR MOVEMENT

Humidity data for Camden Airport (<15 km from the site) is plotted in Figure 6. This shows that conditions in summer can range from dry to muggy and occasionally oppressive. As humidity increases, evaporative cooling strategies become less effective, but they are still recommended as part of the suite of cooling strategies for Leppington, as in Western Sydney, very hot days and heatwaves tend to be relatively dry, and evapotranspiration will be effective at these times.

Breezes are an effective cooling measure in humid conditions. Figure 7 shows that in summer, prevailing breezes tend to be easterly. Exposure to easterly breezes in Leppington Town Centre will help with summer cooling, and this should be considered in the orientation and layout of the development.

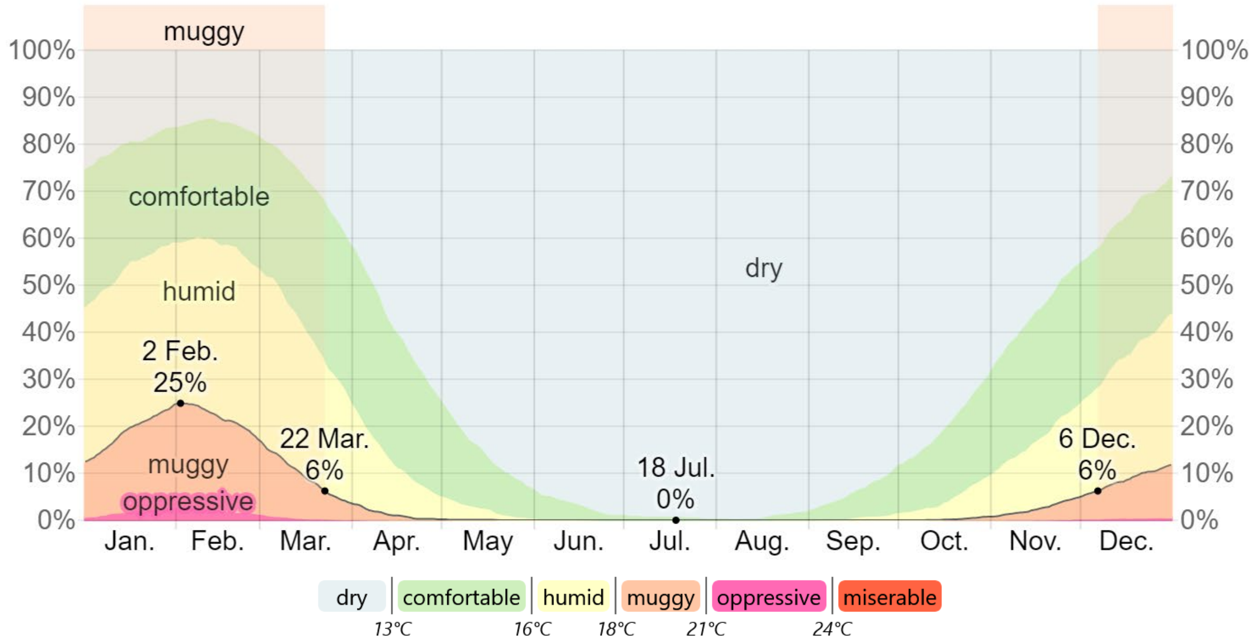

Figure 6: The percentage of time spent at various humidity comfort levels, categorized by dew point. (Source: Weatherspark)

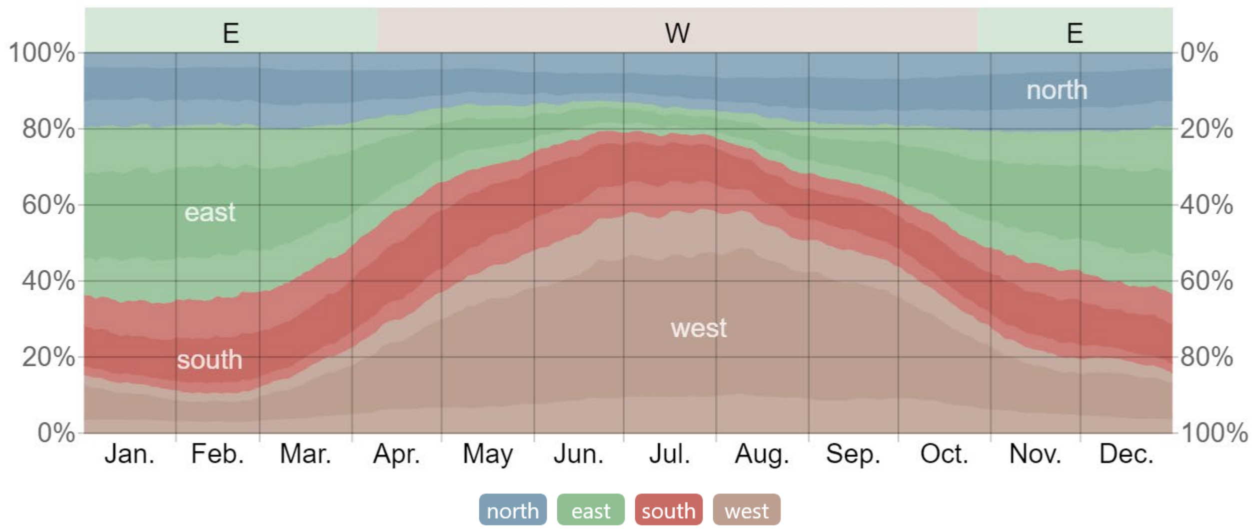

Figure 7: The percentage of hours in which the mean wind direction is from each of the four cardinal wind directions, excluding hours in which the mean wind speed is less than 1.6 km/h. (Source: Weatherspark)

HEATWAVES

Heatwaves are defined by the Bureau of Meteorology as three or more days in a row when both daytime and night-time temperatures are unusually high in relation to the local long-term climate and the recent past for a particular location.

Heatwaves are also classified based on intensity. Low-intensity heatwaves are the most common. Most people are able to cope with this level of heat. Severe heatwaves are less frequent and are challenging for vulnerable people such as the elderly particularly those with pre-existing medical conditions. Extreme heatwaves are the rarest kind. They affect the reliability of infrastructure, like power and transport, and are dangerous for anyone who does not take precautions to keep cool even those who are healthy. People who work or exercise outdoors are particularly at risk.

AdaptNSW's Heatwaves Climate Change Impact Snapshot report (2015) investigated future projections for heatwaves in NSW. Heatwave amplitude is defined as the hottest day of the hottest heatwave of the year. AdaptNSW showed that the heatwave amplitude is predicted to increase in the near (2030) and far future (2070) climate scenarios across NSW (Figure 8). AdaptNSW (OEH 2015) also showed that the number of heatwave events and the number of days classified as heatwave conditions will significantly increase in both near and far future scenarios, with the far future scenario having the greatest increase (Figure 9 and Figure 10).

AdaptNSW's climate change projections show that heatwaves will be hotter, last for longer and occur for frequently in the near (2030) and far (2070) futures in NSW, including the location of the future Leppington Town Centre. The future population of Leppington Town Centre will require the necessary infrastructure for managing exposure to heat and heatwaves in a climate that is only becoming hotter due to climate change.

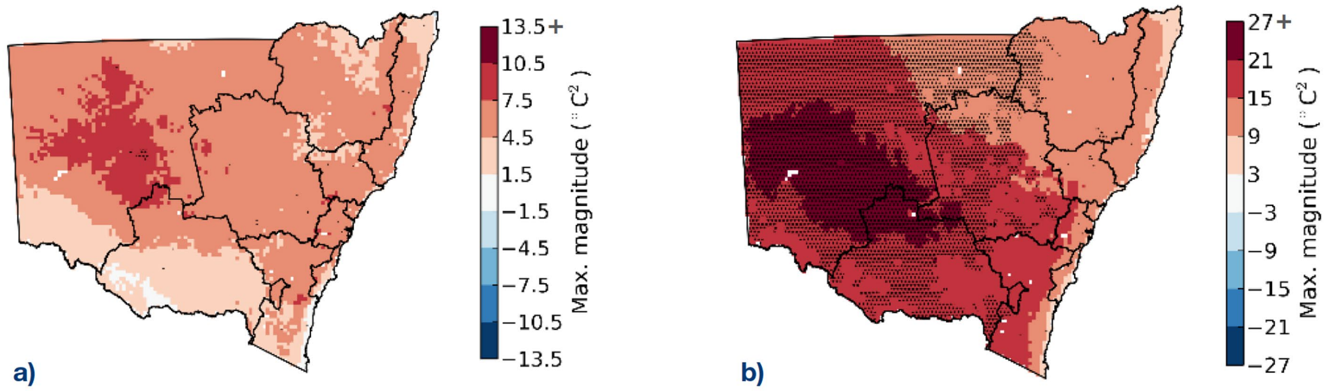

Figure 8 : Projected changes to heatwave amplitude for NSW, a) near future (2030), b) far future (2070) (OEH 2015)

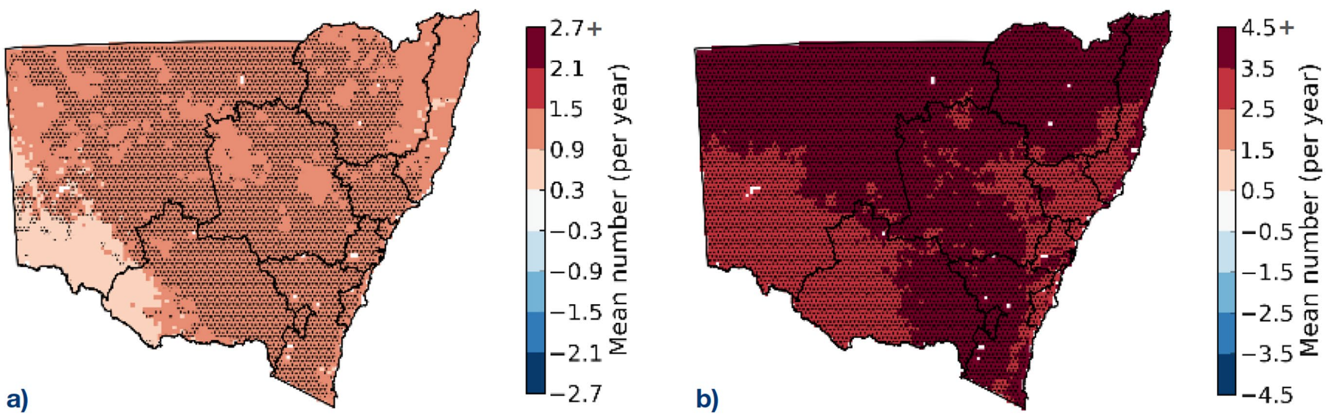

Figure 9 Projected changes to mean number of heatwaves (per year) for NSW, a) near future (2030), b) far future (2070) (OEH 2015)

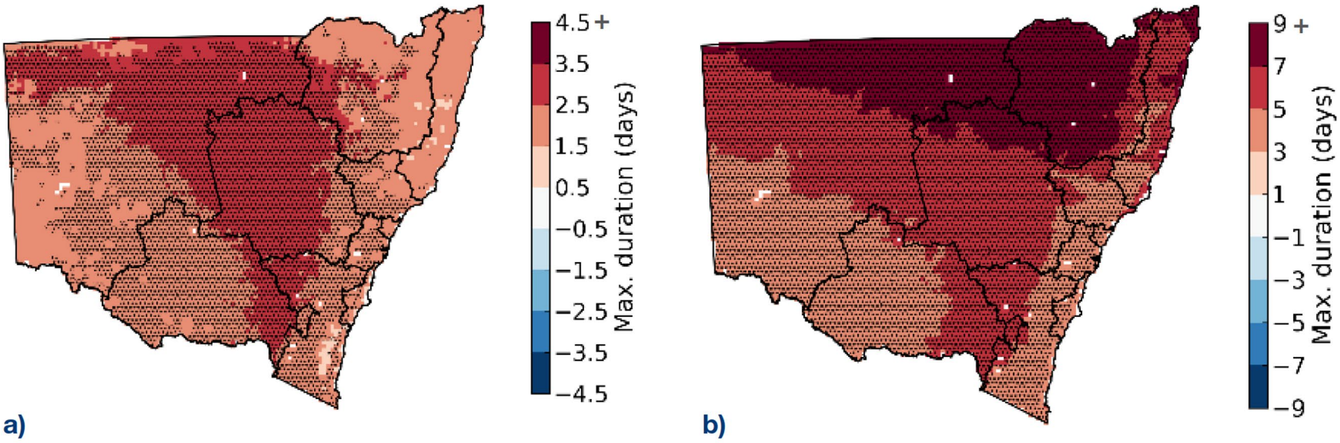

Figure 10 Projected changes to maximum duration for NSW, a) near future (2030), b) far future (2070) (OEH 2015)

3.2 SENSITIVITY

Sensitivity to heat can be defined as the physical characteristics of people and urban systems that increase the vulnerability to heat. For people, age and underlying health conditions are important factors. Of particular sensitivity are older adults >65 years old and young children <4 years old.

Urbis's (2022) Social Infrastructure and Open Space Assessment has composed an age profile for the community likely to inhabit the proposed development. The expected age profile is:

- 11.5% Babies and pre-schoolers (0-4)
- 12.5% Primary schoolers (5-11)
- 7.0% Secondary schoolers (12-17)
- 19.6% Young workforce (25-34)
- 7.0% Older workers and pre-retirees (50-59)
- 5.2% Empty nesters and retirees (60-69)
- 4.5% Older adults (>70)

As above, the report predicts that 11.5% of the population will be children under the age of 4 years old and 9.7% of the population would be over the age of 60 years old. This equates to 2,247 (~20%) out of the predicted 10,602 people residing in Leppington following development of the site.

3.3 ADAPTIVE CAPACITY

Adaptive capacity can be broadly defined as to what extent an individual or population can adapt to heat. This is usually calculated based on socio-economic indices of a population living in an area and may include:

- Income level
- Education level
- Unemployment rate
- Proportion of population in low skilled occupations

Generally, adaptive capacity is considered lower for people in lower socio-economic groups. However, while there is a correlation between socio-economic disadvantage and low adaptive capacity, it is not a direct causative link, and there are opportunities to improve the adaptive capacity of any with measures like good quality housing, public infrastructure and facilities.

4 ADDRESSING HEAT AT LEPPINGTON

To improve resilience to urban heat, urban areas should be designed both to reduce heat at city scale and reduce its impacts at a human scale.

Addressing heat and its impacts involves working at multiple scales. WSROC's Urban Heat Planning Toolkit (WSROC, 2021) proposes a framework for planning and design for urban heat resilience, which is shown in Figure 11. Two related principles form the starting point of this framework:

1. **Plan and design urban environments to reduce urban heat.** This relates to the city scale and means applying measures to reduce the urban heat island effect, as well as measures to reduce carbon emissions and mitigate climate change.
2. **Plan and design urban environments so that people can adapt to a hotter climate.** This relates to a human scale, and involves both enabling people to survive heatwaves, and to thrive in a hotter climate.

To survive heatwaves, people need housing that remains comfortable during heatwave conditions, therefore reliable energy supplies are important to meet cooling needs. Apartments should also be designed to stay cool enough for residents to survive heatwaves at home, even when power supplies are interrupted. Improved passive thermal performance of apartments would also help reduce peak energy demands.

To thrive in a hotter climate, people also need to be able to participate in everyday activities such as work, education, and recreation, and to access essential services in safety and comfort, even when conditions are hot. Therefore, non-residential buildings also need to stay cool in hot weather, and outdoor spaces, including streets and parks, need to remain useable. Green and blue infrastructure can both play an important role here, and sustainable water supplies get a special mention in Figure 11 due to the cooling potential that would be unlocked by water being available for irrigation and evaporative cooling at the times when it is most needed.

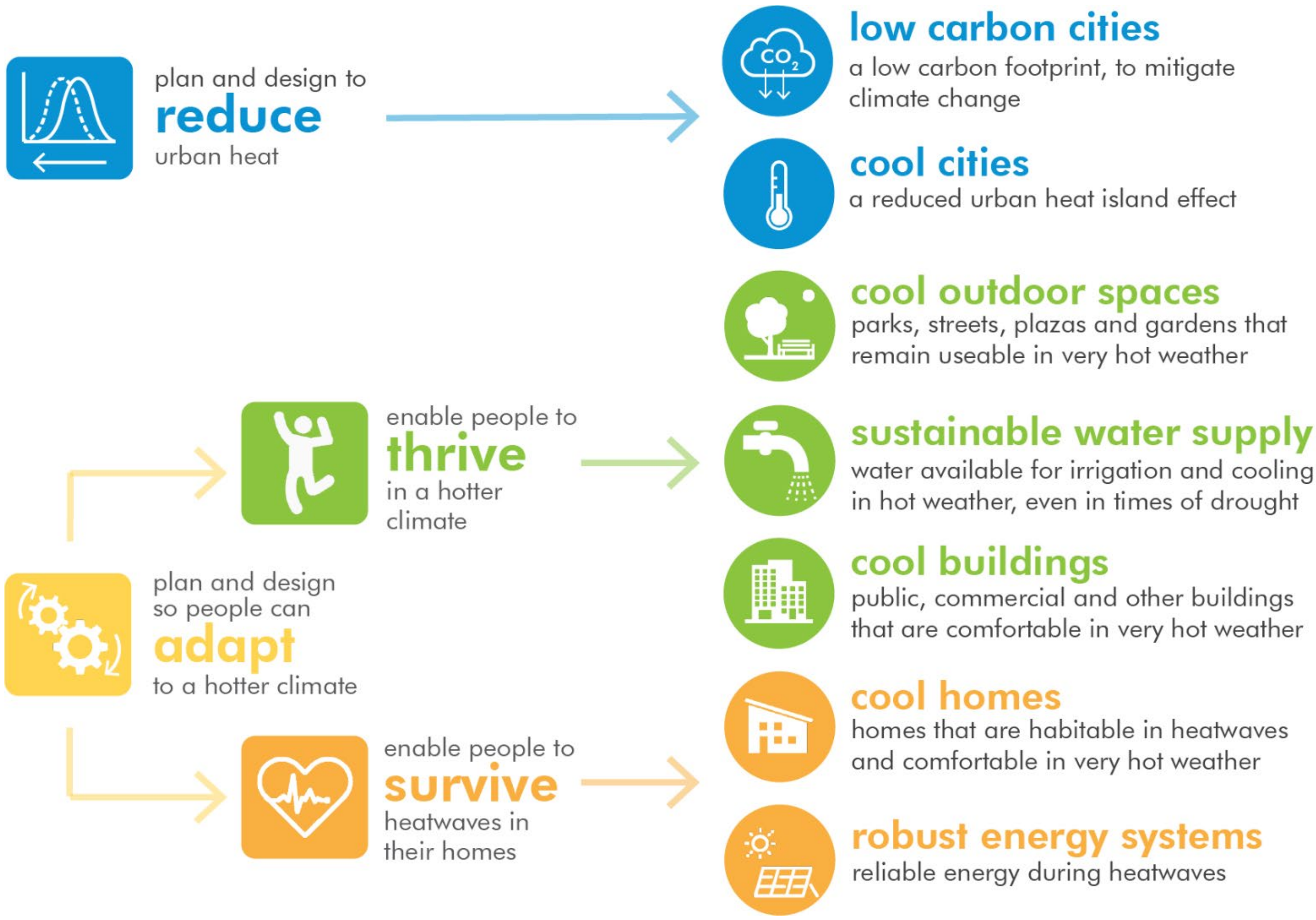

Figure 11: Urban planning and design approaches to reduce urban heat and help people adapt to urban heat (WSROC, 2021)

4.1 OBJECTIVES FOR HEAT RESILIENCE

It is recommended that the same objectives proposed in the draft Leppington Town Centre Development Control Plan (NSW Department of Planning and Environment, 2022) are adopted for the planning and design of proposed development at the site:

- To reduce carbon emissions from the development, considering both construction and operational emissions.
- To reduce peak demand on the electricity grid and support a robust electricity network, by improving energy efficiency and installing solar panels.
- To reduce the development's contribution to the urban heat island effect, by minimising hard surfaces, using cool materials, maximising landscaped area, and retaining water in the landscape where it is available for evapotranspiration.
- To design homes for high passive thermal performance, so that they stay as cool as possible through heatwaves and maintain habitable conditions even in the event of an extended power outage.
- To design non-residential buildings for high passive thermal performance, so that they remain comfortable for workers and visitors in hot weather, while also minimising energy demands. Prioritise buildings (or parts of buildings) which are open to the public and those where people work.
- To design outdoor areas that are accessible to residents, workers or the general public to stay as cool as possible during hot weather, so that people can still work, socialise and recreate outdoors and also use active transport modes.

4.2 PLANNING PRINCIPLES FOR HEAT RESILIENCE

Recommended planning principles for to support heat resilience in the public domain reflect those in the Draft SEPP Provision 6.10 "Urban heat", as proposed in the Leppington Town Centre Planning Proposal (Camden Council and Liverpool City Council, 2022).

The recommended principles are listed separately below for the public domain and the private domain (built form).

PUBLIC DOMAIN PLANNING PRINCIPLES

- The public domain is to include large canopy trees to provide shade in summer and contribute to Camden Council's tree canopy target. Trees are to be supported by access to adequate uncompacted soil volume and water.
- Public open space is designed with adequate shade, green infrastructure, cool materials, and water in the landscape to support its use in hot conditions.
- Where practical, retain existing shade trees, unless an AQF Level 5 Arborist has determined that the tree should not be preserved as it is dead, dying or may present as a hazard to human health if retained.

BUILT FORM PLANNING PRINCIPLES

- Buildings are designed to make adequate allowance for green infrastructure on site, including deep soil volume, tree canopy cover and total planted area.
- Building roofs are to be designed as cool roofs. Either green roofs or roofing materials with a high Solar Reflectance Index are appropriate. Solar panels are also acceptable as part of a cool roof design.
- Building exteriors are designed to minimise heat impacts in their immediate surroundings, particularly where these spaces are frequented by people. This includes solar radiation reflected from façades, heat absorbed and re-radiated from walls and heat ejected from heating, ventilation and cooling systems.
- Buildings are designed to achieve high passive thermal performance and reduce reliance on air conditioning to maintain comfortable and safe indoor conditions, even during heatwaves.
- Private outdoor spaces are designed with adequate shade, green infrastructure, cool materials, and water in the landscape to support its use in hot conditions.
- Buildings are designed to minimise their energy demands, including the use of renewable energy supply and/or storage, which will reduce the peak demands on the grid during heatwaves.
- Buildings are designed with access to an appropriate sustainable supply of non-potable water (e.g. rainwater, harvested stormwater or recycled water) to enable irrigation for cooling, even at times when drinking water use is restricted.

4.3 PROPOSED MEASURES IN THE PUBLIC DOMAIN

MATERIALS

Reduce heat by selecting cool materials for paving.

Road pavements will need to meet relevant standards. Standard asphalt road pavements can be finished with a lighter coloured coating where this is acceptable to Council.

Standard concrete paving is generally light in colour due to the naturally light colour of cement. In concrete pavements, the use of light-coloured aggregate will help ensure that a light-coloured surface is maintained long-term, as the aggregate becomes more exposed over time.

Where other paving materials are used (for example, in in parking bays, laneways and pedestrian areas) select cool materials including:

- Lighter coloured paving materials, which will absorb less heat than dark colours.
- Paving materials with high thermal emittance.
- Permeable paving can also be effective as a cool material, providing that it is designed with an underlying layer of planting media/natural soil, from which moisture can evaporate through the paving.

STREET TREES

Reduce heat by maximising street tree canopy cover, and ensuring that street trees have access to sufficient soil and water.

When designing the streets, maximise canopy cover with the following design measures:

- Organise services to maximise space for tree root zones in street verges.
- Locate and design other streetscape infrastructure (such as driveways, street lights and street furniture) to avoid conflicts with trees and avoid gaps in the canopy.
- Select large trees where possible, or the maximum size which can be accommodated within other constraints in the streetscape.
- Wherever possible, minimise paving around trees and include understorey planting.
- Where trees need to be surrounded by paving, include soil vaults under the paving, so that trees still have access to a sufficient volume of uncompacted soil to support their growth.
- Where trees are surrounded by paving, ensure they have access to water. Design for irrigation during establishment and passive irrigation long-term.

PARKS, PLAZAS AND PUBLIC OPEN SPACE

Canopy cover and total green cover will contribute to cooler parks, plazas and public open spaces. Landscape plans for the site show trees and planted areas to be included in parks, plazas and public open space.

Parks, plazas and public open space should also include the following in their design, to help maintain cooler conditions in hot weather:

- Wherever possible, minimise paving around trees and include understorey planting.
- Where trees need to be surrounded by paving, include soil vaults under the paving, so that trees still have access to a sufficient volume of uncompacted soil to support their growth.
- Where trees are surrounded by paving, ensure they have access to water. Design for irrigation during establishment and passive irrigation long-term.
- Wherever trees cannot be planted into deep soil, a sufficient volume and depth of uncompacted soil needs to be provided over underlying structures to support the proposed trees.
- Trees and other vegetation planted on structures need to be provided with irrigation to sustain them through dry times.
- Provide shade (preferably, a combination of structural shade and tree shade) over key areas where people gather, including playgrounds, picnic tables and seating.
- Where there are WSUD features in the public domain, design these to retain water for evaporation and / or evapotranspiration during dry times between rain events (for example, bioretention systems should include a saturated zone).
- In at least one location at the site, create an outdoor 'cool zone' including a water feature, shade, seating and drinking water.

LANDSCAPE PLANS

The site Landscape Design report (McGregor Coxall, 1 Aug 23) shows that:

- The site includes several public parks, all of which include trees and other planting.
- Trees are shown along all the public streets.

The landscape plan is shown in Figure 12.

Figure 12: Landscape Masterplan for the Residential Core site (McGregor Coxall 1 Aug 2023)

4.4 PROPOSED MEASURES FOR BUILDINGS

THERMAL PERFORMANCE

Design all buildings to meet high standards of energy efficiency and passive thermal design.

High standards of passive thermal performance are particularly important in facilities for vulnerable groups (e.g. aged care, child care) so that in the event of energy service disruption, thermally safe conditions can be maintained inside the building.

In multi-storey apartment buildings, provide indoor 'cool refuges' where residents can retreat in the event of a prolonged power outage. Cool refuges should be designed to maintain thermal safety during a power outage. Consider the number of residents who will not have access to natural cross-ventilation in their dwelling and size cool refuges appropriately.

Avoid heat rejection anywhere that it could contribute to warming of residential dwellings or the public domain. Preferably, heat should be rejected from the uppermost floor of a building and directed upwards.

COOL ROOFS

Cool roofs are to meet the following Solar Reflectance Index (SRI) benchmark:

- For roof pitch $< 15°$, 3-year SRI minimum of 64
- For roof pitch $> 15°$, 3-year SRI minimum of 34

COOL FAÇADES

Design building façades to minimise the amount of heat reflected into public domain areas. Ensure reflective façades are designed with shade integrated into their design to minimise solar reflectance.

PRIVATE OUTDOOR SPACES

In private domain outdoor areas:

- Maximise total canopy cover, deep soil area and total green cover of the private domain.
- Consider green walls and green roofs as a measure to help cool both indoor and outdoor areas.
- Irrigate vegetation to maintain evapotranspiration during dry conditions. Use alternative (non-potable) water supplies for irrigation.

5 DESIGN MEASURES TO REDUCE HEAT

Green, blue and grey infrastructure can all play a role in mitigating the impacts of urban heat.

This section provides further information on design measures to reduce heat.

The Western Sydney Regional Organisation of Councils' (WSROC) Urban Heat Planning Toolkit (WSROC, 2021) provides guidance for local councils to develop land use, planning and design controls that prioritise resilience to urban heat. The toolkit identifies various design measures to reduce the impacts of urban heat, identifying how each measure works, summarising key evidence and noting limitations. There are seven broad ways for reducing the impacts of urban heat, as identified in the Urban Heat Planning Toolkit (WSROC, 2021). Figure 13 below provides some ways that urban heat impacts may be mitigated at the proposed Leppington Residential Core.

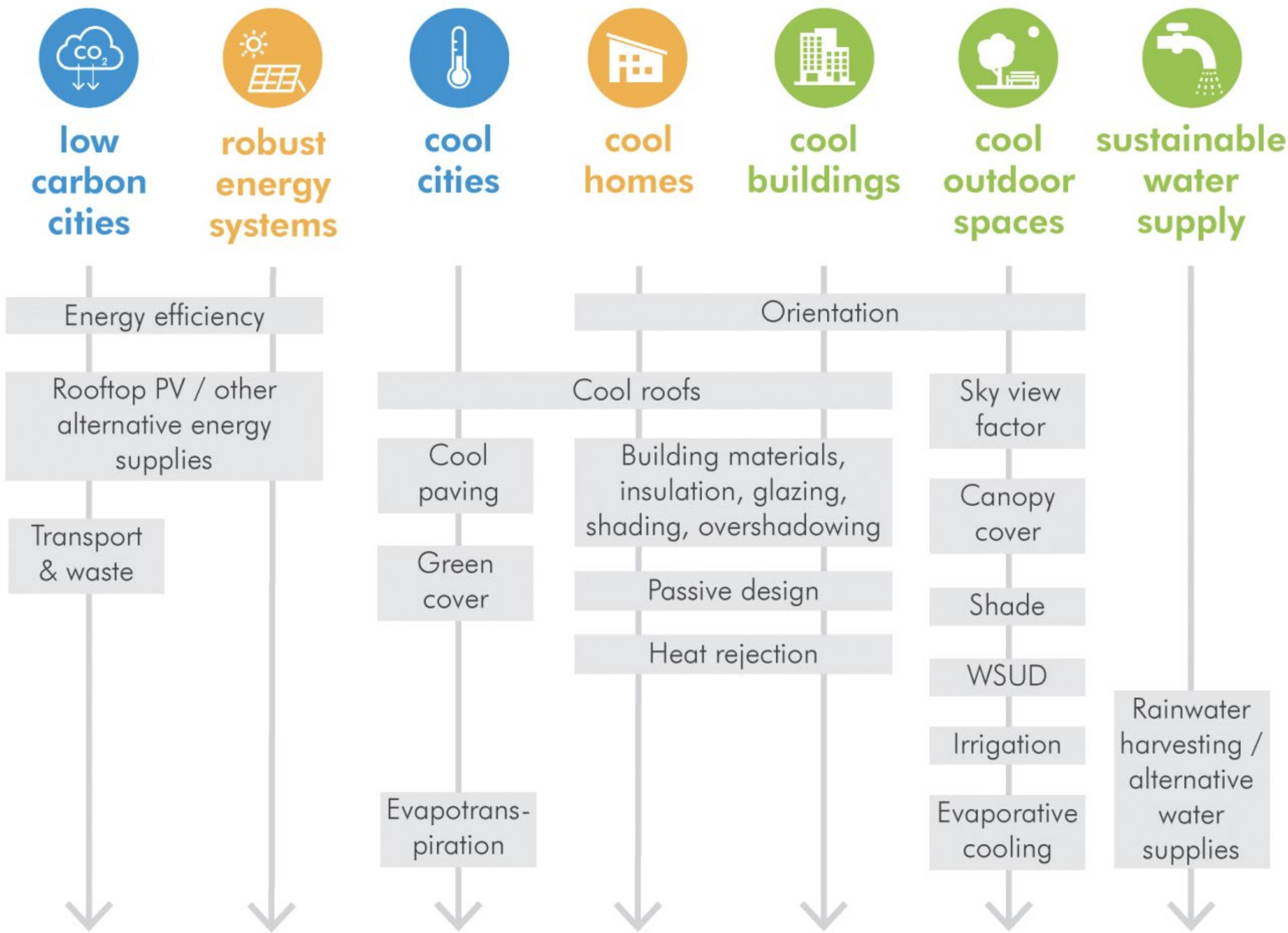

Figure 13 Mitigation measures for reducing urban heat impacts (WSROC, 2021)

5.1 GREEN INFRASTRUCTURE

Green cover should be maximised in the development to reduce the UHI effect.

Trees should be selected for the proposed development that maximise canopy cover. This should include a mix of tree species including:

- Some fast-growing species that will help establish reasonable canopy cover relatively quickly.
- Some species that grow to a large size (e.g. >10m height and >8m canopy spread), which are likely to make a greater contribution to long-term canopy cover.
- Where possible, select species with reasonably dense canopy cover.
- Where possible, select species likely to thrive in future climatic conditions.

A mix of native and exotic species is likely to be most appropriate to meet this range of objectives.

Consideration should also be given to the location of trees. Trees should be distributed throughout the landscape to provide shade where it is of most value. Consider locating trees:

- Where people are likely to be most active outdoors
- Where they can cast shade to other typically hot structures such as buildings, walls and paved areas
- To maintain natural cooling mechanisms such as ventilation (encourage air to move through vegetation as this will assist with cooling – see Figure 14).
- Tree canopies should be prioritised on wide, open streets with a low "Building Height to Street Width ratio" (H:W). Wide, open streets experience higher daytime heat stress as they are exposed to greater solar radiation than narrow streets. In streets that run east to west, prioritise street tree canopies on the southern side of the street because these streets are exposed to a large amount of solar radiation throughout the day. In streets that run north to south, prioritise trees on the eastern side of the street (Figure 15).

Trees and other green infrastructure should be supported by generous soil zones and access to water, including irrigation where practicable. Vegetation with access to water is significantly cooler than dry vegetation.

Green roofs and green walls can play a role in cooling, however typically most of their benefits accrue to the private domain and simpler green infrastructure options will need to be applied in the public domain.

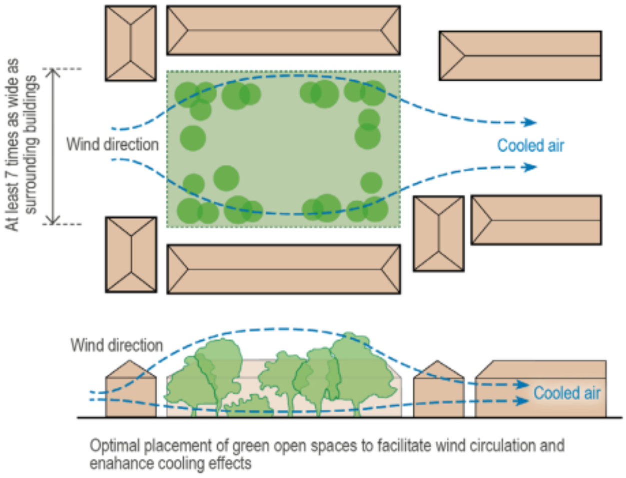

Figure 14 Utilise natural cooling mechanisms for urban heat mitigation (Source: Victorian DELWP 2020)

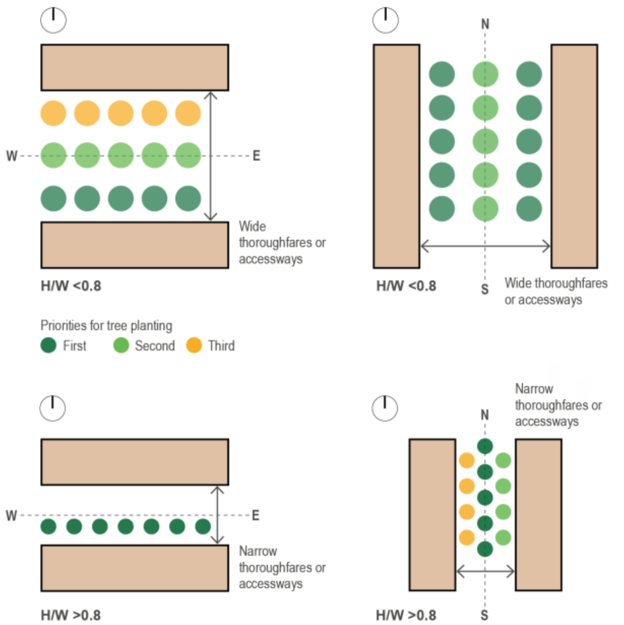

Figure 15 Street tree canopy orientation for urban cooling effects (Source: Victoria DELWP 2020)

5.2 BLUE INFRASTRUCTURE

Water should be retained in the landscape to support a cooler microclimate.

The Western City District Plan (Greater Sydney Commission 2018) says: "Retaining more water in the landscape and integrating waterways in the design of new communities will help create a greener and cool city. Water-play features and connections with water will become essential elements of urban areas, while green walls, green roofs and initiatives such as rain gardens will help cool urban environments."

The principle of retaining water in the landscape is reflected in the draft Leppington Town Centre DCP in Section 4.8 Water Sensitive Urban Design (WSUD). A number of controls and objectives for WSUD are provided in the document.

The idea of retaining more water in the landscape relates to multiple objectives, including reducing stormwater runoff and protecting natural waterways.

Stormwater treatment systems (e.g. wetlands/bioretention basins) will likely be required to meet WSUD objectives for the development. These provide an opportunity to contribute to urban heat mitigation. Where natural treatment systems are proposed as part of the WSUD strategy for Leppington, vegetated stormwater treatment systems should be designed to retain water for passive irrigation, infiltration, and evapotranspiration. Wetlands and saturated zone bioretention systems are preferable to fully drained systems.

Planning for Leppington Residential Core should also consider the potential to incorporate passive irrigation into the design of street trees and other vegetation. For example, the draft Aerotropolis Phase 2 DCP proposes passively irrigated street trees as shown in Figure 16 below.

The WSUD strategy should consider the site-wide potential to retain water and reduce runoff. Flow objectives, a site-wide runoff reduction target or a commitment to passive irrigation over a certain area should be considered to formalise a commitment to retain water in the landscape. For example, the Aerotropolis Precinct Plan (NSW Government 2022) includes stormwater flow targets.

By retaining water in the landscape, well-watered plants including street trees are able to cool the air around them through a mechanism called evapotranspiration. Evapotranspiration is the process by which a plant uses water from the soil for photosynthesis and then releases water vapour to the atmosphere from the pores in its leaves, simultaneously cooling the air around the plant. Without irrigated trees and other irrigated planting, this process is reduced or does not occur at all.

In parks, town centres and transit hubs, irrigated landscapes and water features would also help reduce temperatures.

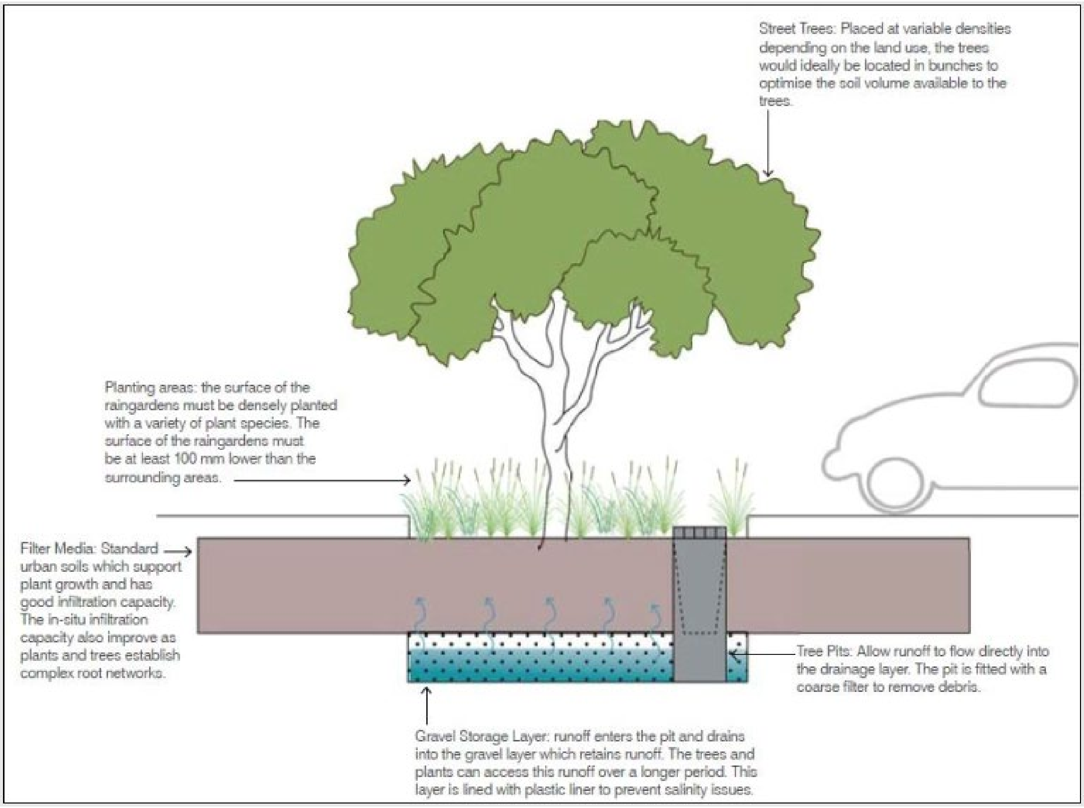

Figure 16: Passively irrigated street tree proposed in the Aerotropolis Phase 2 DCP (NSW Government 2021b)

5.3 GREY INFRASTRUCTURE

COOL ROOFS

Cool roofs are a simple, low- or no-cost measure easily integrated into new urban development.

Cool roofs can be specified in terms of their Solar Reflectance Index (SRI) or solar absorptance (SA). While light-coloured roofs (including lighter tones of green, brown, blue, and grey) would be likely to rate well by either measure, darker-toned colours with special surface coatings can also meet cool roof standards.

While the use of natural colours with special surface coatings could assist with visual integration of the urban form with the surrounding landscape, light coloured or white roofing should not be excluded from consideration altogether, as it offers a cost-effective option to achieve high SRI/low SA. This could be particularly important for low density residential areas where home buyers are sensitive to building costs. For example, consider light-coloured roofing for areas that will not be in direct proximity to surrounding natural landscapes.

Figure 17 Cool roof for mitigation of urban heat impacts (Source: A&D 2022)

COOL OR PERMEABLE PAVING

Conventional paving materials can significantly contribute to urban heat because they absorb, store and release heat back to the built environment. Cool pavements reflect solar radiation, conduct and store less heat.

A range of different products and materials can be used to enhance the thermal performance of ordinary paving materials:

- Paving with light-coloured aggregates, pigments and binders.
- Paving with light-coloured coatings (e.g. cementitious coating, elastomeric coating).
- Materials with a high emissivity rating, meaning they will be less prone to embodying heat.

Permeable paving (including porous asphalt, porous concrete, block pavements, reinforced grass pavements) can also reduce heat via evapotranspiration, providing it is installed on a subgrade with the capacity for infiltration or temporary storage of water below the pavement.

Note, when using lighter coloured materials for paving, take care to avoid unwanted glare. In areas where glare could be an issue, avoid high albedo, white or very light surfaces.

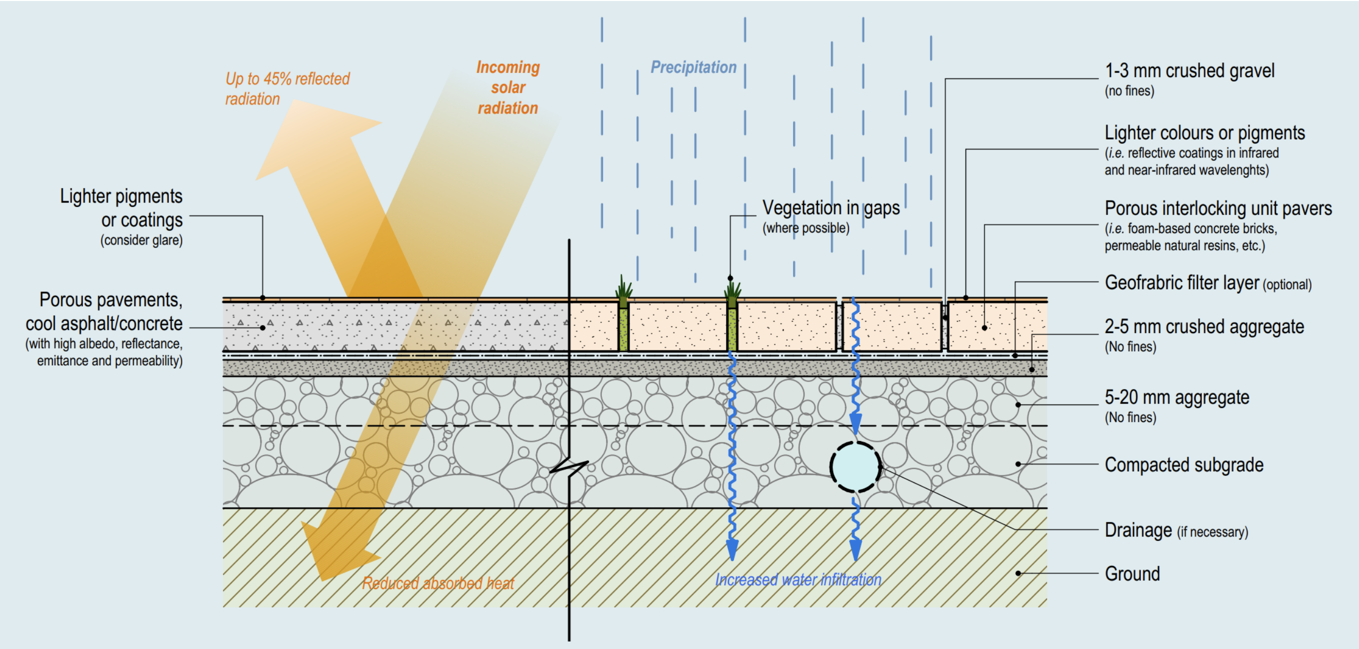

Figure 18 Cross-section of urban surfaces that mitigate impacts of urban heat (Source: Osmond & Sharifi 2017)

SHADE STRUCTURES

Shade structures mitigate the impacts of urban heat by limiting the amount of solar radiation experienced by a specific area. Shade structures are considered an effective, cost-effective method for reducing the impacts of urban heat.

Shade structures are particularly effective when paired with other methods for urban cooling such as misting fans, permeable paving, cool surfaces and vegetated areas (Figure 19).

Figure 19 Diversity of shade structures that can mitigate impacts of urban heat (Source: Victoria DELWP, 2020, based on Osmond & Sharifi 2017)

6 CONCLUSIONS

The proposed development can be planned and designed to minimise its impact on the urban heat island and for improved heat resilience.

New development at Leppington is likely to be exposed to increasing heat as the climate changes. An increasing number of hot days (>35°C) are expected to occur in the coming decades as well as increasing number of heat wave events and increase in heatwave duration.

There are opportunities in the Leppington Residential Core planning and design to minimise the heat island effect and reduce the impacts of urban heat at a human scale by increasing the adaptive capacity of the community. Green, blue, and grey infrastructure all play a role, including:

- Canopy cover and green cover: trees in parks and the public domain play a role in urban cooling and should be included wherever possible. Where trees are not feasible, other vegetation can also play a cooling role.
- Green roofs and green walls: could be incorporated into the design of apartment buildings.
- Water: irrigated landscapes, passive irrigation. WSUD, water play elements and water features can all play a cooling role. A site-wide target for runoff reduction, passively irrigated areas and creation of water bodies would formalise the objective to retain water in the landscape.
- Cool roofs: cool roofs are a simple measure that should be applied wherever possible. Adopt a minimum SRI/maximum SA value for roofs and consider light coloured roofing.
- Cool paving: use light coloured paving and permeable paving where appropriate, to reduce heat absorption and re-radiation.
- Shade structures can also play a cooling role and are effective when combined with other strategies such as cool pavements and landscaped areas.

This report has outlined proposed measures to minimise the impacts of heat including measures applicable in the public and private domain.

7 REFERENCES

Camden Council. (2020). *Local Strategic Planning Statement.*

Camden Council. (2022). *Camden Council and Liverpool City Council Growth Centre Precincts Development Control Plan – Leppington Town Centre Development Control Plan. Draft Plan.*

Camden Council. (2023). *Greener Places, Healthier Waterways - a Vision for the Camden Green and Blue Grid.* Camden: Camden Council.

Camden Council and Liverpool City Council. (2022). *Leppington Town Centre Planning Proposal.*

Greater Sydney Commission. (2018). *Sydney's District Plans*. Retrieved from https://www.greater.sydney/district-plans

NSW Department of Planning and Environment. (2017). *Camden Growth Centre Precincts Development Control Plan, November 2016.*

NSW Department of Planning and Environment. (2022). *ePlanning Spatial Viewer - bushfire prone land layer for precinct*. Retrieved from https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address

NSW Department of Planning and Environment. (2022). *Leppington Town Centre Development Control Plan (DRAFT).*

NSW Department of Planning, Industry and Environment. (2022). *A Guide to the South West Growth Area and updated Structure Plan.*

NSW Office of Environment and Heritage. (2014). *Metropolitan Sydney Climate Change Snapshot.*

NSW Office of Environment and Heritage. (2015). *Adapt NSW Heatwaves Climate Change Impact Snapshot.*

NSW Rural Fire Service. (2019). *Planning for Bushfire Protection - A guide to councils, planner, fire authorities and developers.*

WSROC. (2021). *Urban Heat Planning Toolkit.* Sydney: Western Sydney Regional Organisation of Councils.