

South Creek Urban cooling modelling

July 2020

Sydney
WATER



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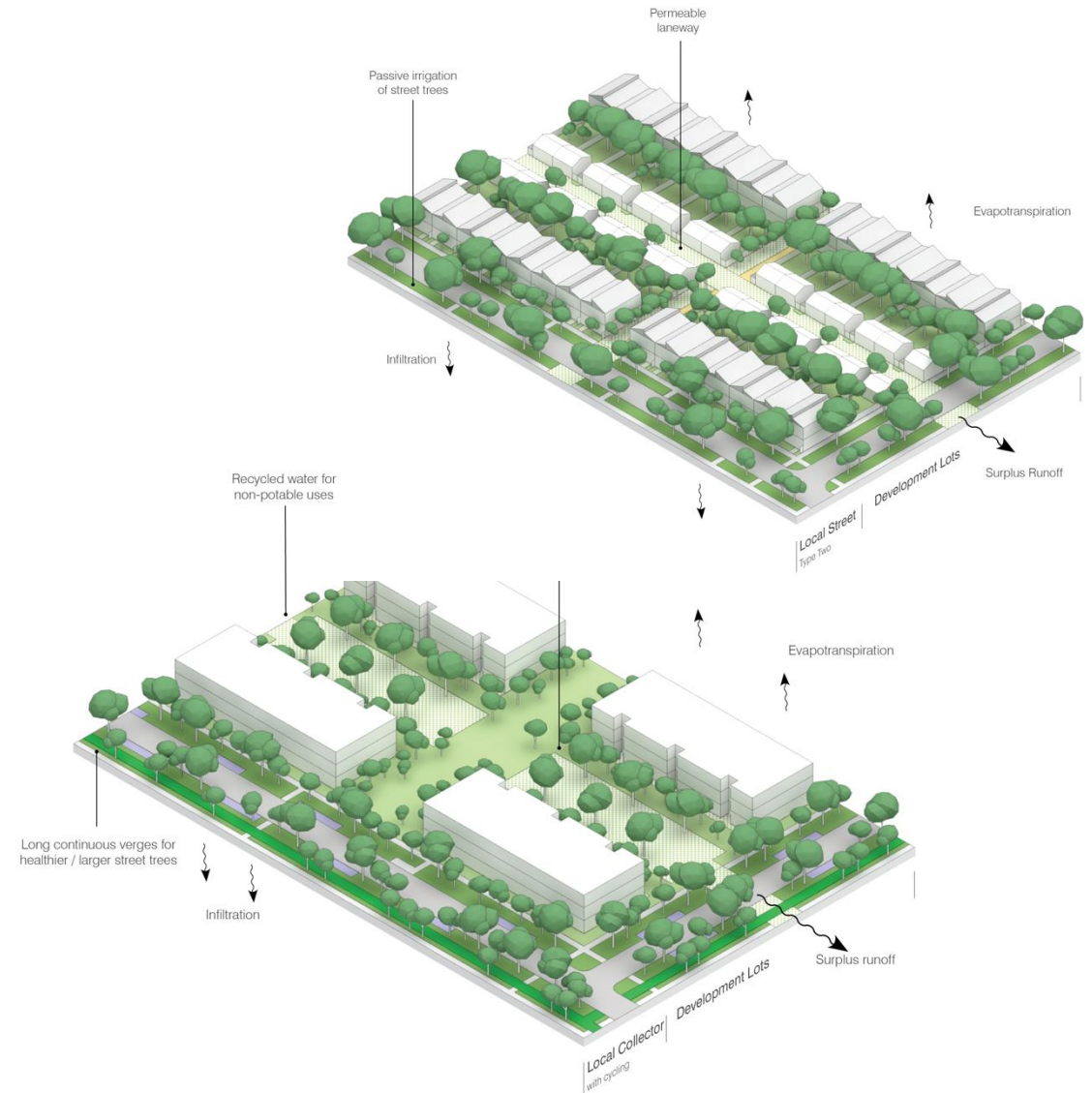
Introduction

Context

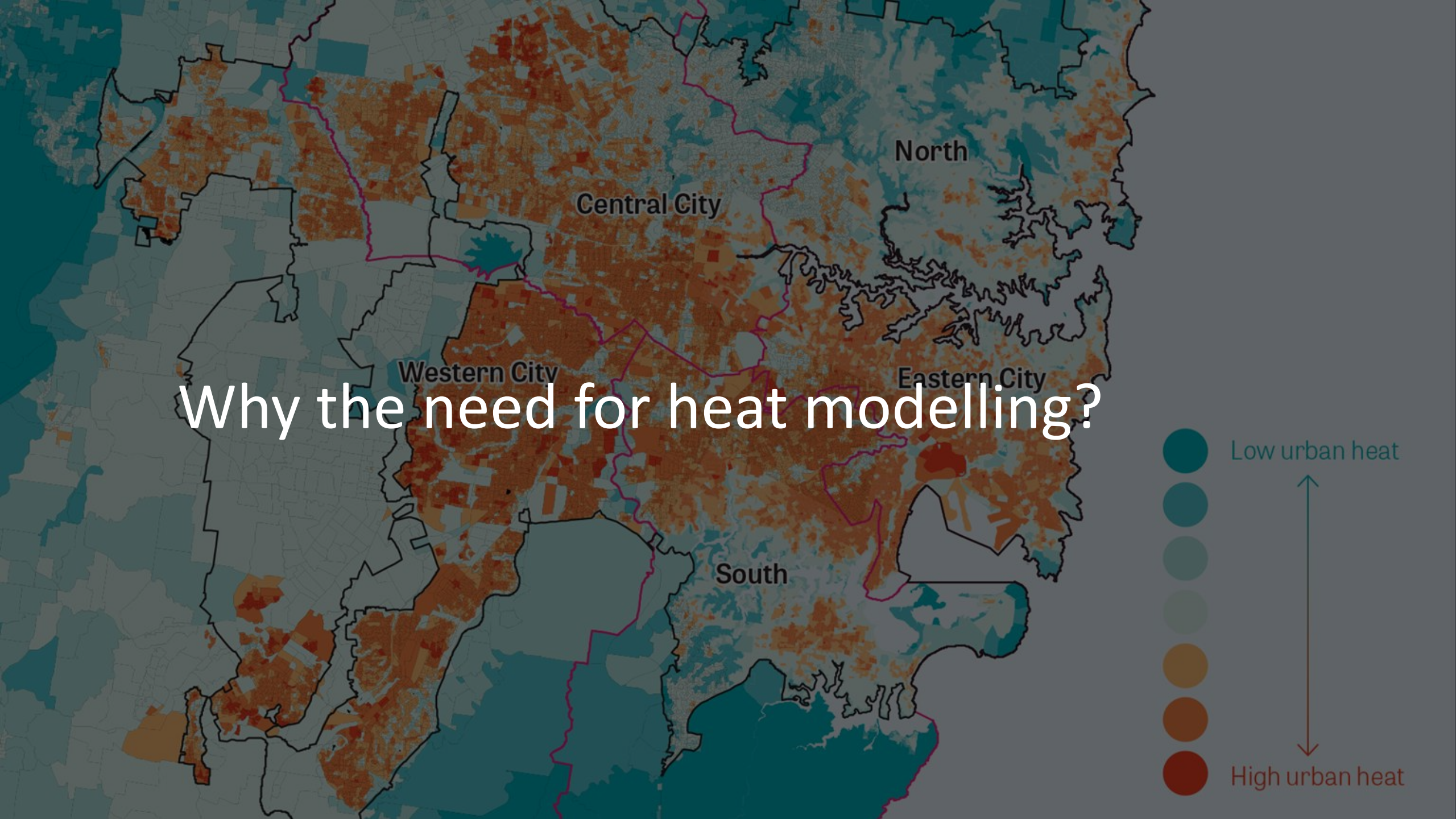
- The VISION for Western Parkland City is for *'a city in its landscape'* restoring a sustainable ecological and hydrological system.

Task

- To provide strategic evidence that application of the proposed **building typologies** would protect South Creek from the detrimental impacts of a BAU approach to development, and deliver the VISION
- Mosaic Insights used the proposed **building typologies** (the masterplan) and quantified the cooling benefit compared to a BAU scenario.



Why the need for heat modelling?



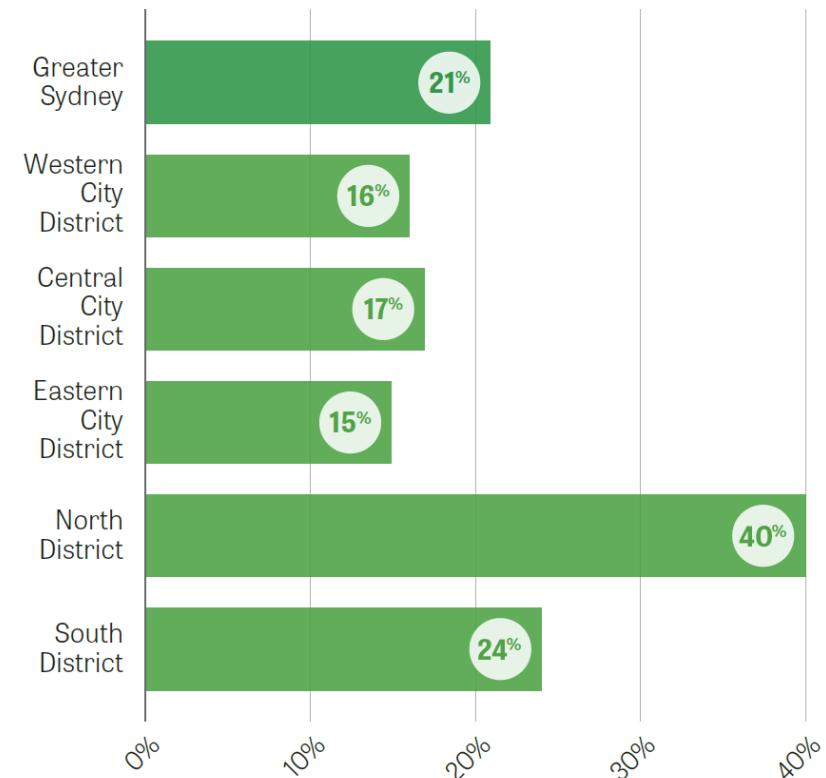
Western Sydney is hot

Western Sydney experiences more hot days than other parts of the city - On 4 January 2020 Penrith hit 48.9°C and 2019 was Australia's hottest on record.



Western Sydney:

- Is hot and getting hotter,
- Is sparsely treed with one of the lowest canopy covers
- Has vulnerable communities in a number of areas
- Is experiencing significant population growth



Humans are at risk during heat stress days

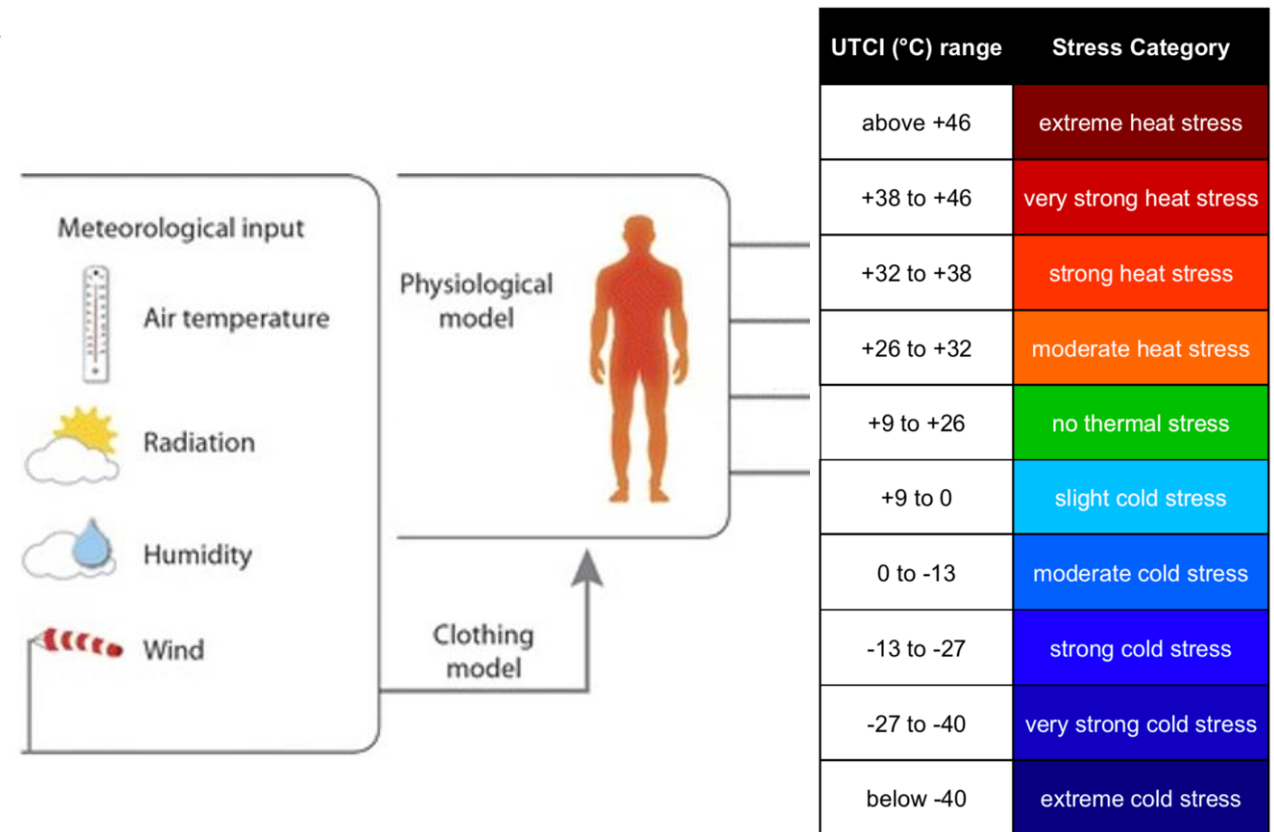
Humans cope with heat through perspiring and breathing. When a person is exposed to heat for a very long time, the first thing that shuts down is the ability to sweat. Once a person stops perspiring, in very short time a person can move from heat exhaustion to heat stroke¹.

Universal Thermal Climate Index (UTCI) measures human thermal comfort and considers:

- air temperature,
- radiation,
- humidity and
- wind speed.

It uses a physiological model and clothing model to produce the UTCI ².

The UTCI is then sorted into stress category ranges.



¹Harmon, K. 2010. Scientific American, How does a heat wave affect the human body?

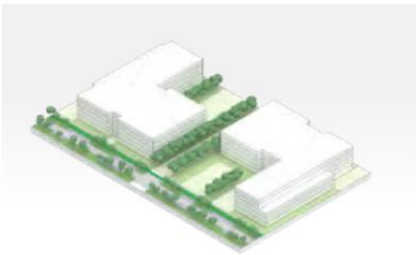
²Loughnan, ME, Tapper, NJ, Phan, T, Lynch, K, McInnes, JA 2013, A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities, National Climate Change Adaptation Research Facility, Gold Coast, 128 pp.

Proposed Building Typologies - Masterplans

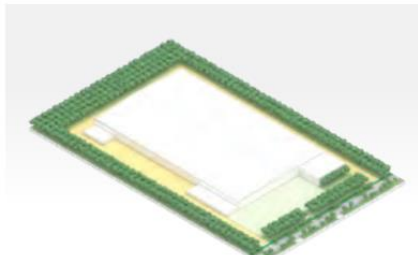
Masterplans of the residential and employment typologies for the new South Creek developments were created using 14 typologies developed by Sydney Water.

Constraints such as the location of

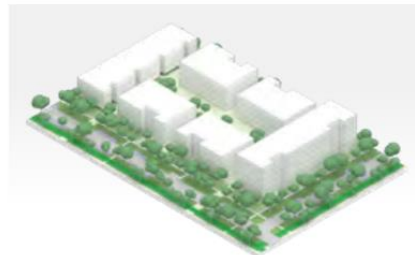
existing roads and complex geometry of the sites were considered against opportunities such as utilising the creek corridor as an open space asset and habitat rehabilitation to create the residential and employment masterplans.



*Employment: Office
Urban Office: Deep soil setbacks and planting*



*Employment: Industrial
Large floorplate: Pervious paving and perimeter planting*



*Apartment buildings
Deep soil front setbacks*



*Attached housing
Large rear yards*



*Detached housing
Two storey dwelling on a regular lot*

Proposed Building Typologies – Residential

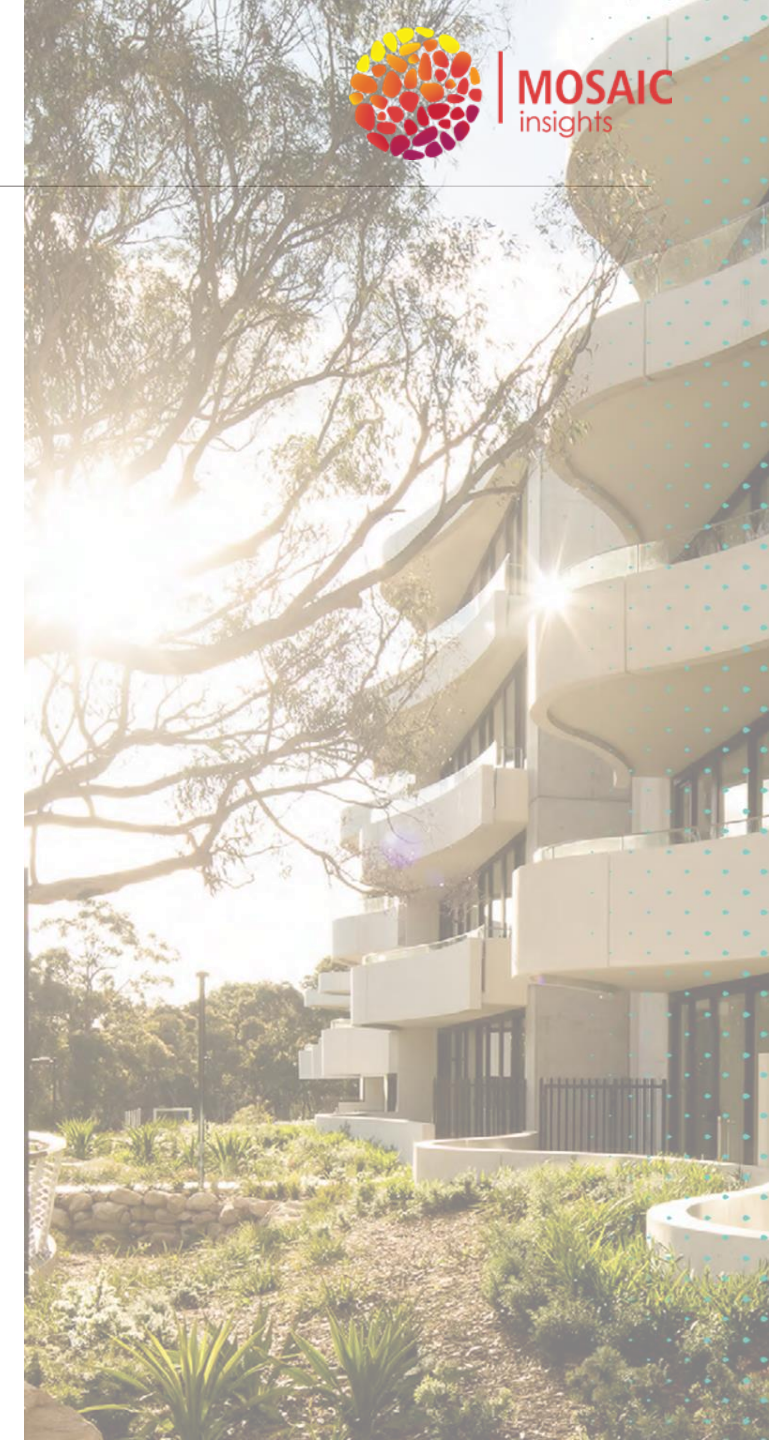


The **residential masterplan** features 14% local public open space, 31% streets and 55% development lots. These lots are a diverse mix of dwelling types and densities.



Proposed Building Typologies – Employment

The **employment masterplan** (below) focuses on amenity around the floodplain corridor, a simple road network and a focus on the 'green grid' with ecological connections across the site.



An aerial photograph of a large freight train yard. The yard is filled with numerous freight cars of various colors, including blue, green, red, yellow, and white. The cars are arranged in long, parallel rows, creating a grid-like pattern. The ground between the tracks is dark and appears to be gravel or dirt. The overall scene is a dense collection of industrial equipment.

Urban heat modelling

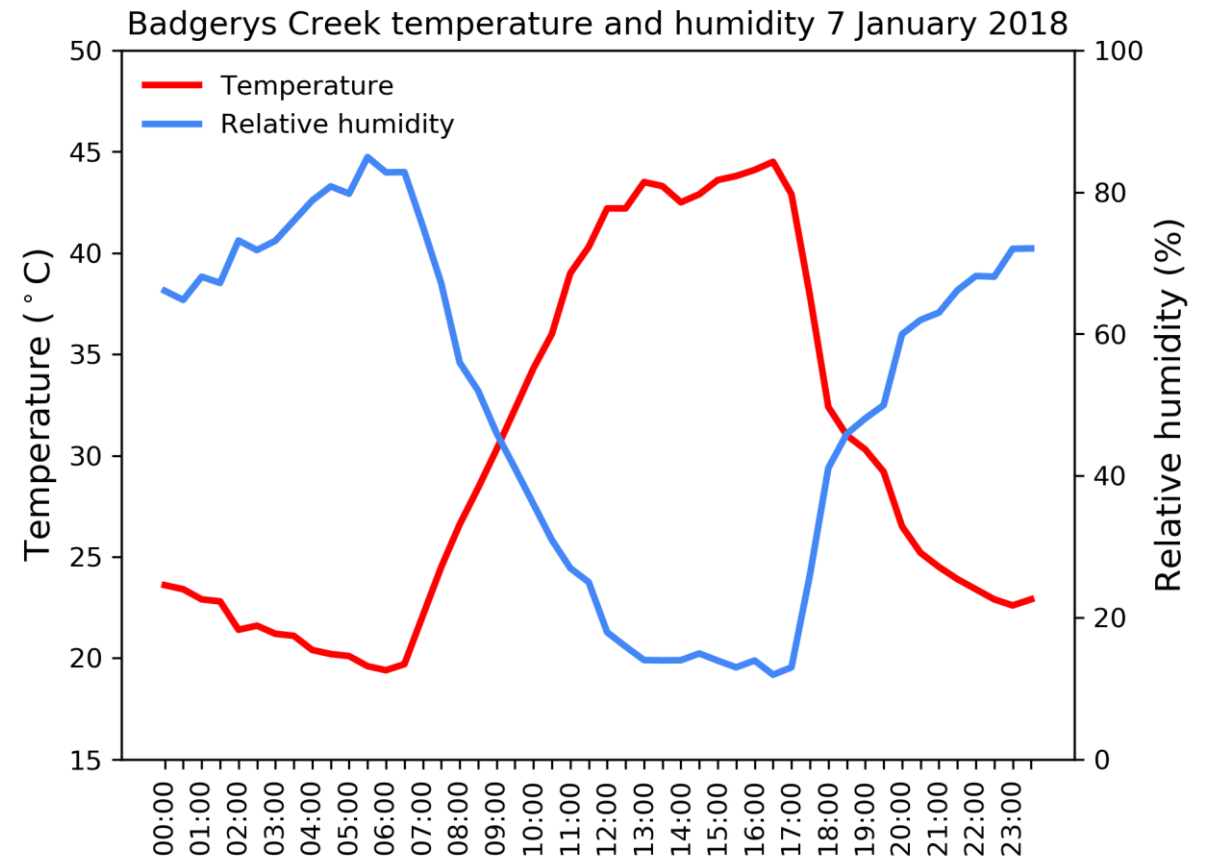
Meteorological data + land use → TARGET = temperature maps

Badgery's Creek weather station. Recent extreme heat day, January 7 2018, Tmax = 44.5°C

- 2 m air temperature (°C)
- Relative humidity (%)
- Wind speed (m/s)
- Surface pressure (hPa)
- Downward shortwave radiation (W/m²)
- Downward longwave radiation (W/m²)

Added climate model data from eight climate models, RCP8.5 for 2035 and 2055

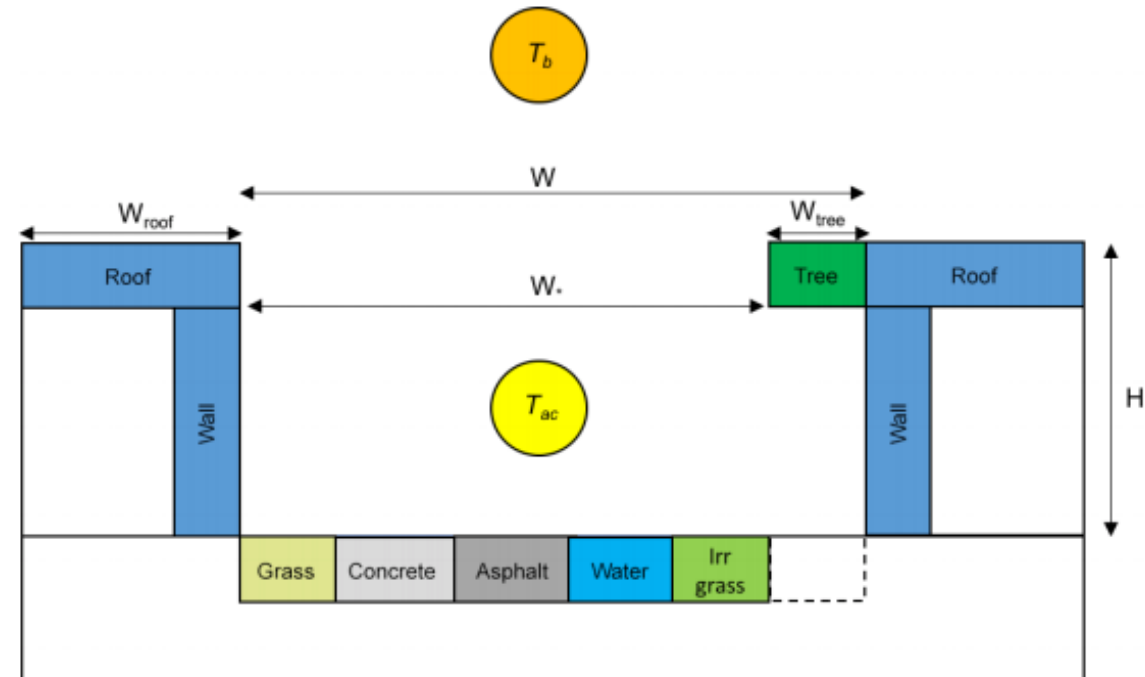
Climate variable	2035	2055
Average temperature	+1.23°C	+2.15°C
Relative humidity	-0.99%	-1.62%
Wind speed	+0.34%	+1.46%
Surface pressure	+0.03%	+0.05%
Solar radiation	+1.33%	+2.02%



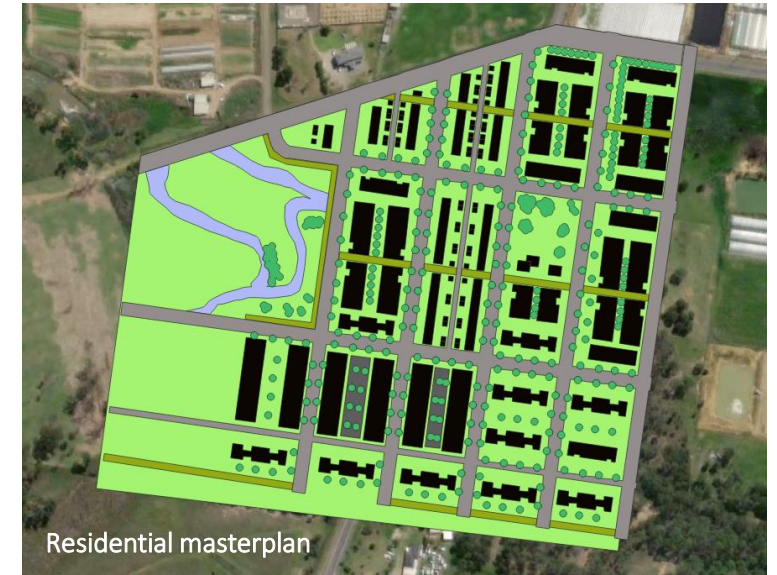
Meteorological data + land use → TARGET = temperature maps

In the TARGET model every spatial grid point contains a fraction

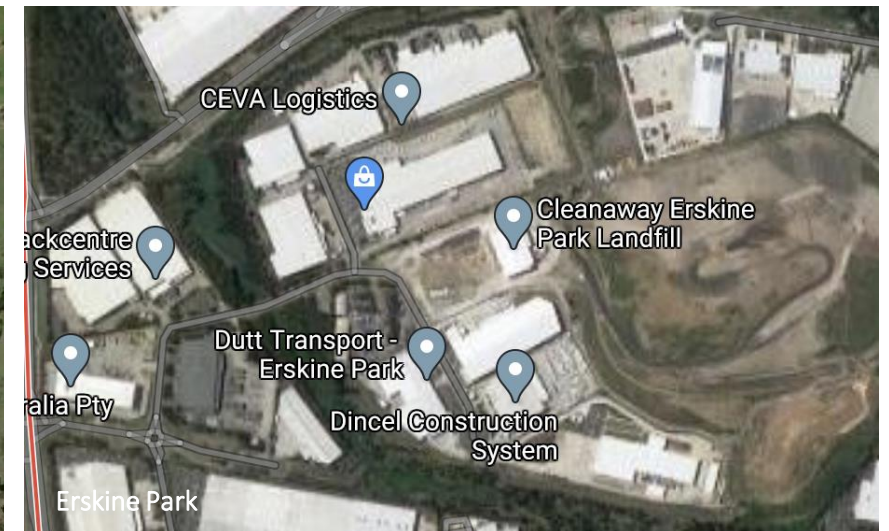
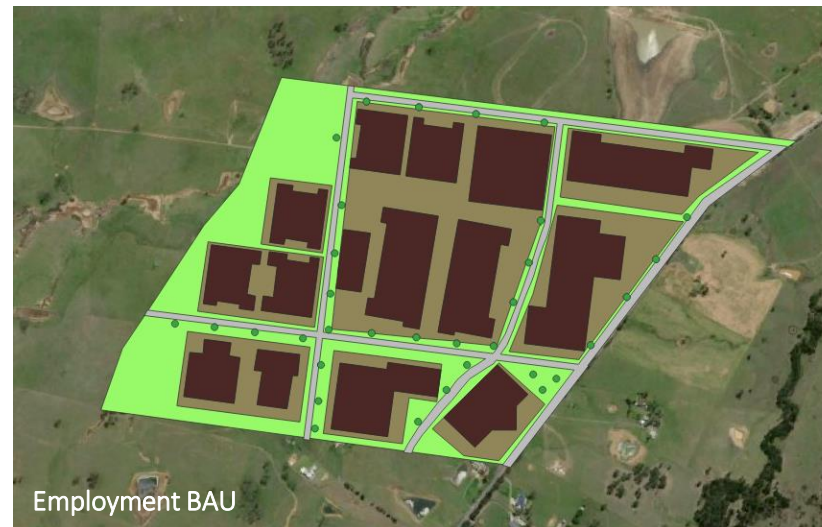
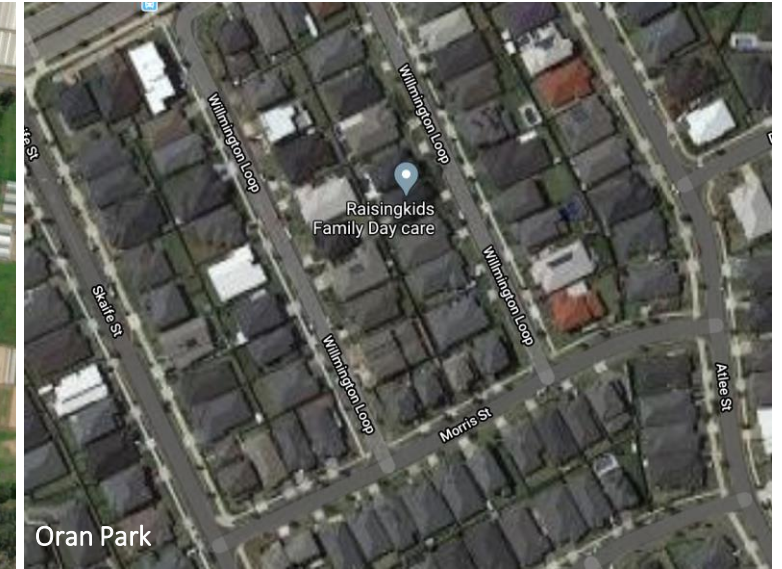
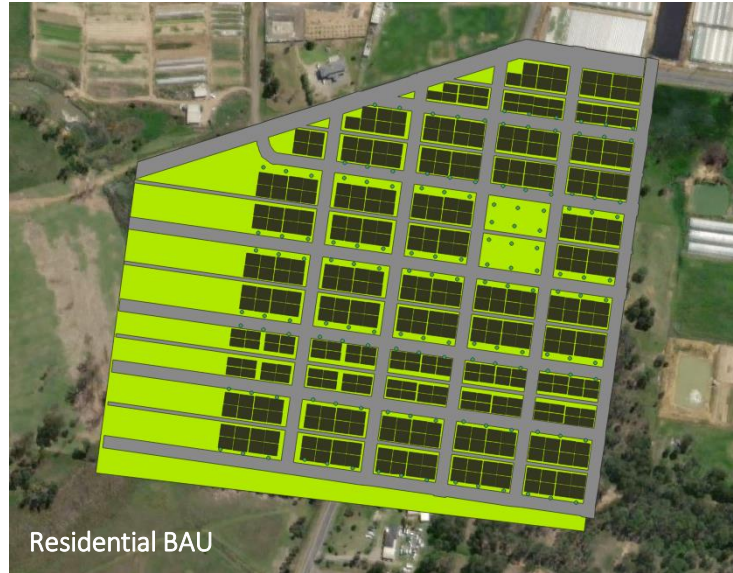
1. Dry Roof (irrigated roof)
2. Road
3. Concrete
4. Water
5. Trees
6. Dry grass
7. Irrigated grass
8. Building height
9. Road width



Spatial data – Masterplan



Spatial data → what is the BAU?



Assumptions

BAU residential:

- Houses are two storey, 8m high.
- The grass is unirrigated
- Trees are unirrigated

Masterplan residential:

- Buildings range from 1-4 storeys, depending on the density in the masterplan and typologies (right)
- All grass is 50% irrigated
- The trees are irrigated
- The trees are at maturity




BAU employment:

- Buildings are 13m tall
- The grass is unirrigated
- Trees are unirrigated

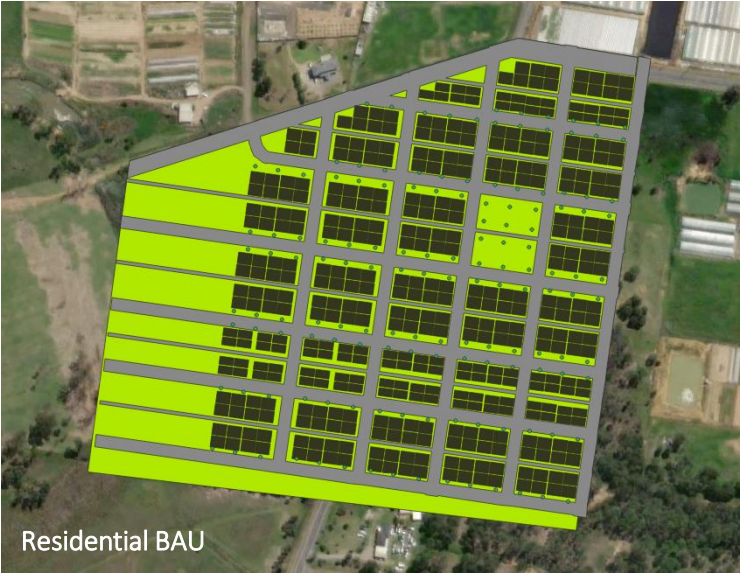
Masterplan employment:

- Buildings are 13m tall
- All grass is 50% irrigated
- Building roofs are irrigated by having running water across the top
- The trees are irrigated
- The trees are at maturity

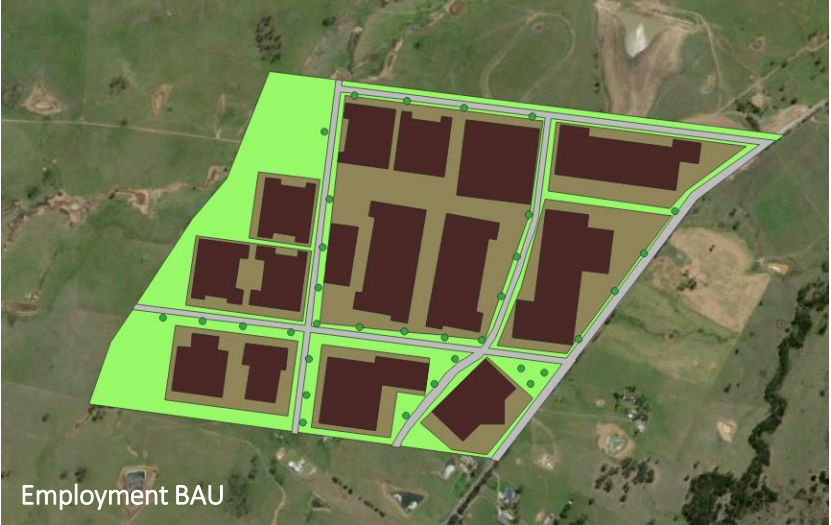


-  Local centres including shops, high density residential and public transport focussed on transport and close to the amenity of open space including the flood plain corridor. This includes the new urban park which is located in the centre of the precinct.
-  Medium density development consisting of terrace houses and three storey apartment blocks mediate between the high and low density development as well as providing activity and connections fronting the open space corridors.
-  Low and medium density development, made up of detached and attached dwellings, furthest from major transport, centres and the riparian corridor.

Modelling BAU and Masterplan



Compare the ~~meerkat~~ results



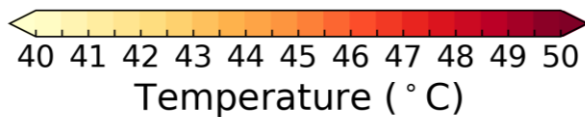
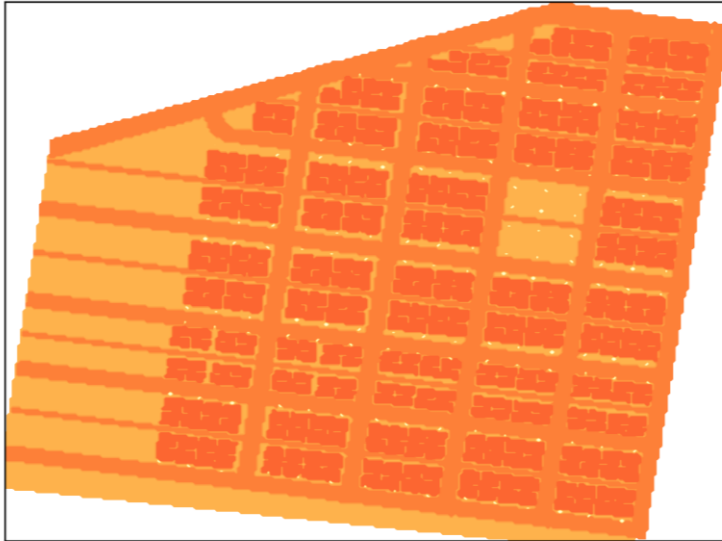
An aerial photograph of a lush green field with several clusters of trees and a thin fence line. The word "Results" is centered in white text.

Results

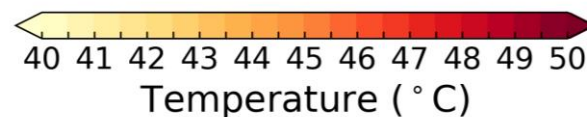
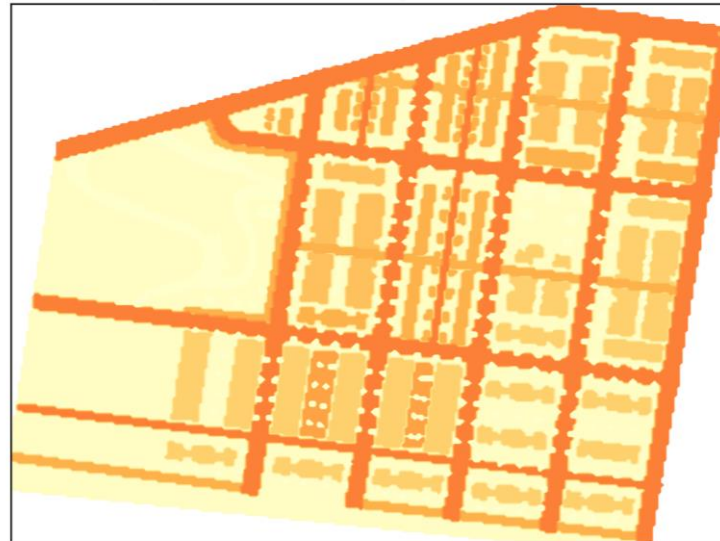
Residential precinct – current climate

At 4:30pm Badgerys Creek automatic weather station is 44.5°C.

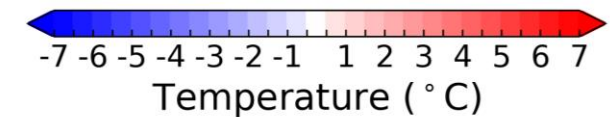
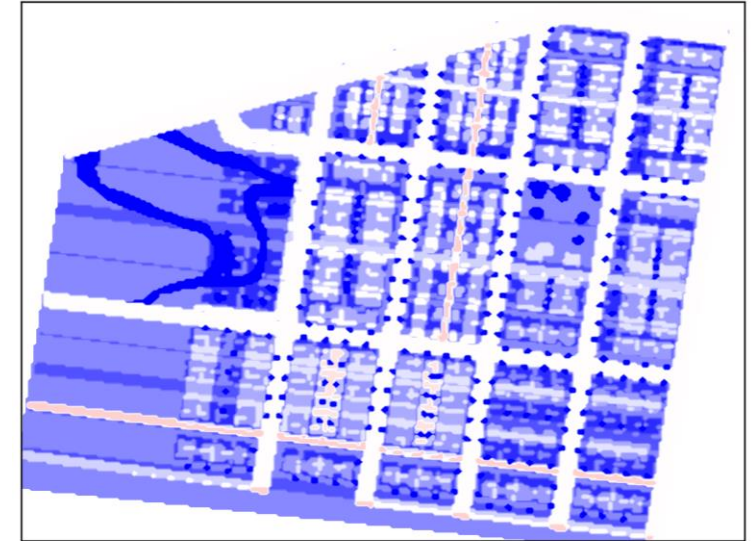
BAU air temperature 16:30



Masterplan air temperature 16:30



Air temperature difference 16:30

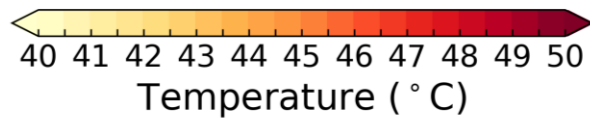
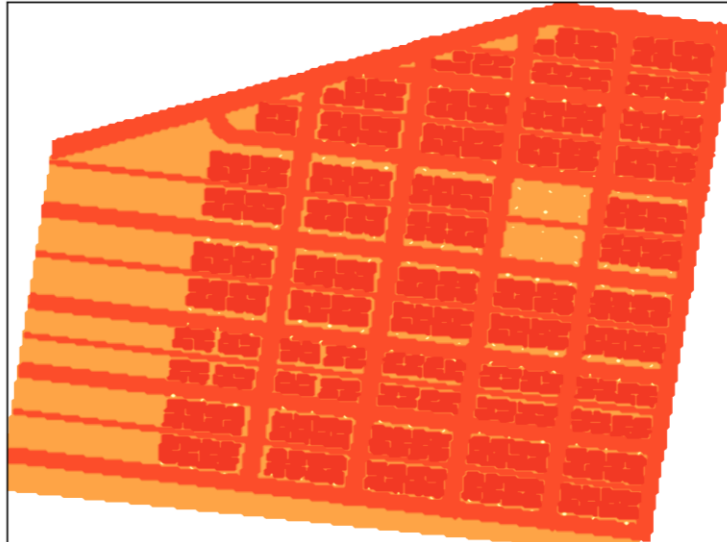


- Over 24 hours Masterplan is 1.2°C cooler
- At 4:30pm the Masterplan scenario is on average 3.4°C cooler.

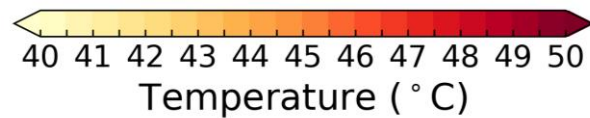
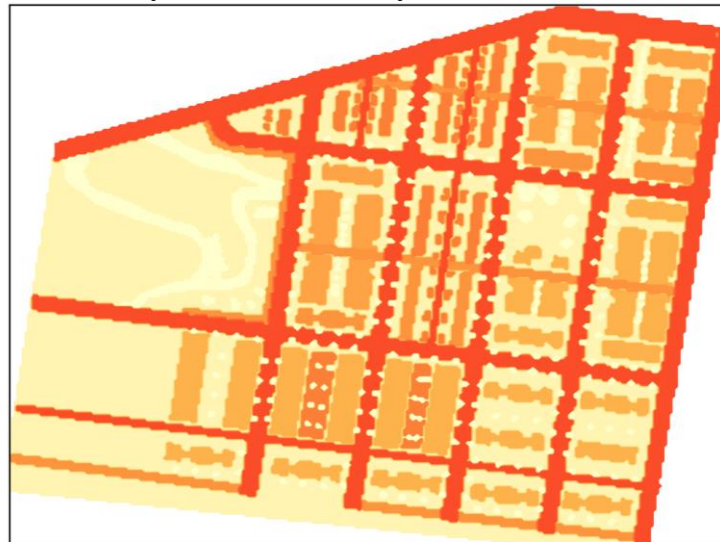
Residential precinct – 2035

At 4:30pm Badgerys Creek automatic weather station is 45.7°C.

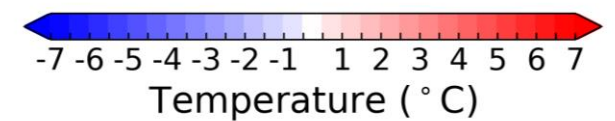
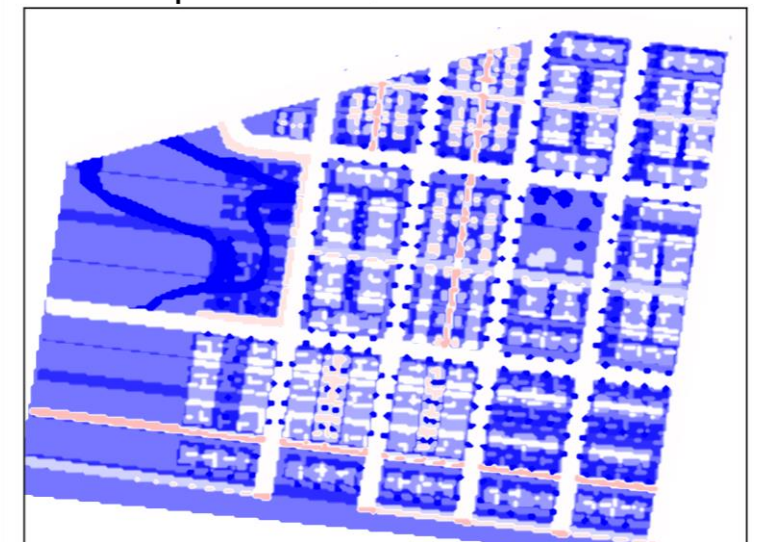
BAU air temperature 2035 16:30



Masterplan air temperature 2035 16:30



Air temperature difference 16:30

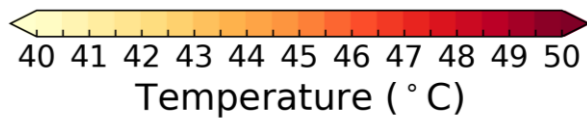
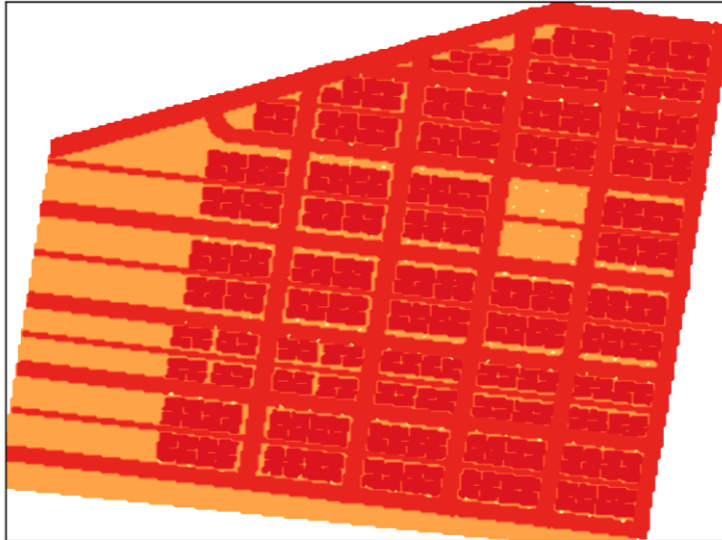


- Over 24 hours Masterplan is 1.3°C cooler
- At 4:30pm the Masterplan scenario is on average 3.7°C cooler.

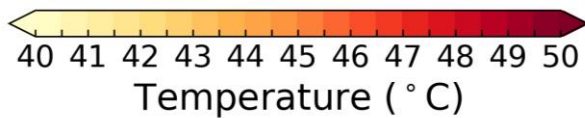
Residential precinct – 2055

At 4:30pm Badgerys Creek automatic weather station is 46.6°C.

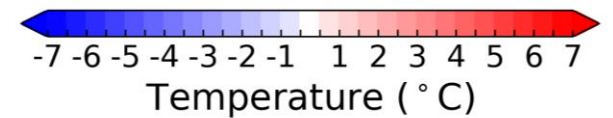
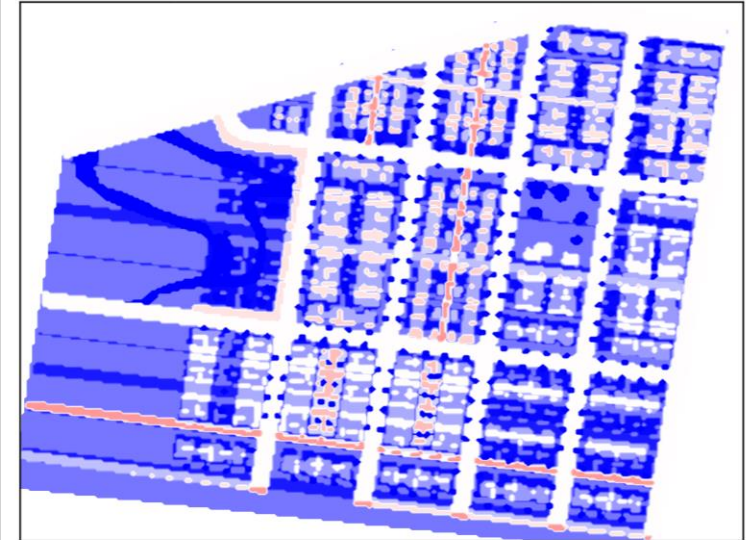
BAU air temperature 2055 16:30



Masterplan air temperature 2055 16:30



Air temperature difference 16:30

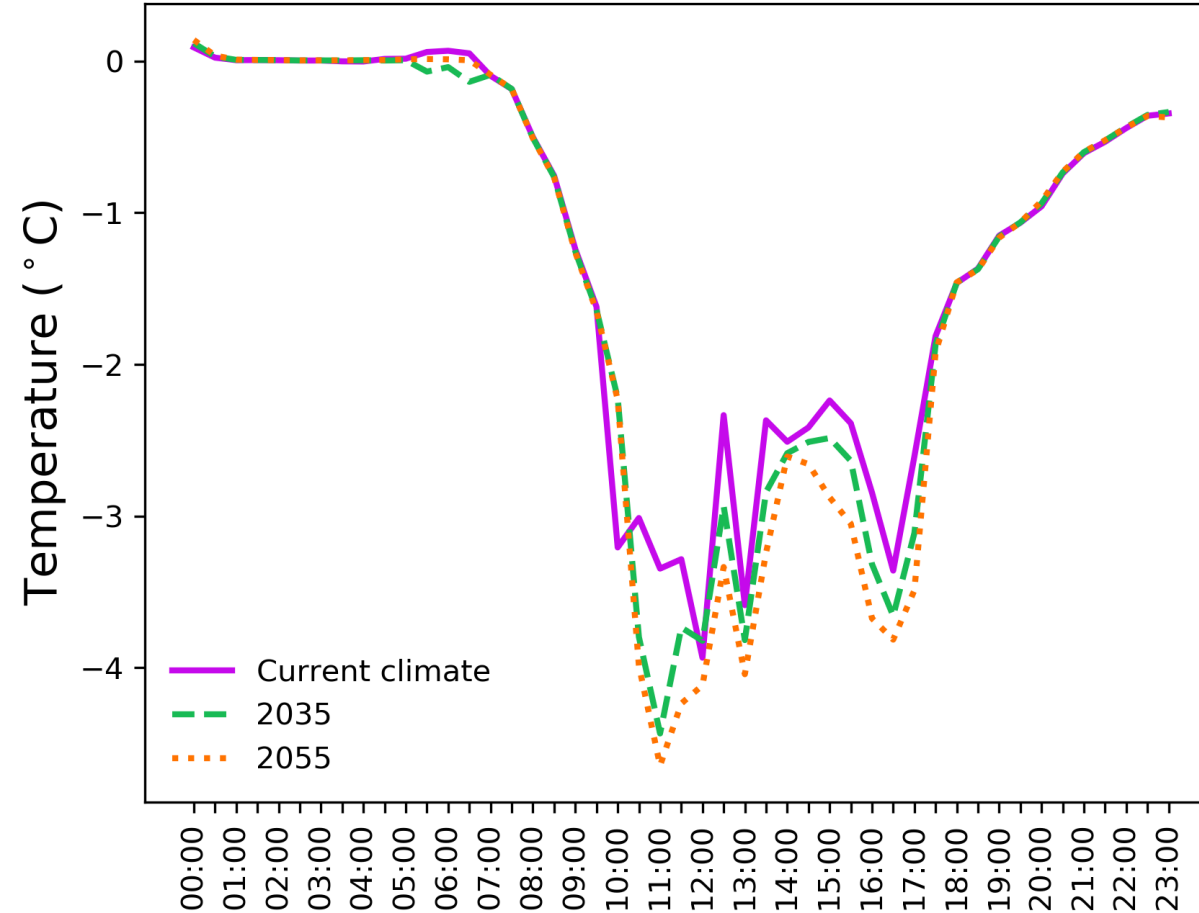


- Over 24 hours Masterplan is 1.4°C cooler
- At 4:30pm the Masterplan scenario is on average 3.8°C cooler.

Residential precinct – 24 hour analysis

- Main differences between 9am and 6pm
- Cooling becomes larger in the future due to trees blocking increasing solar radiation

24 hour air temperature difference

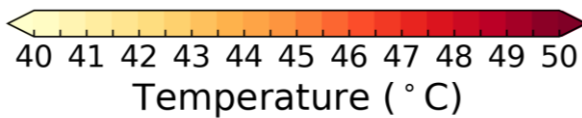
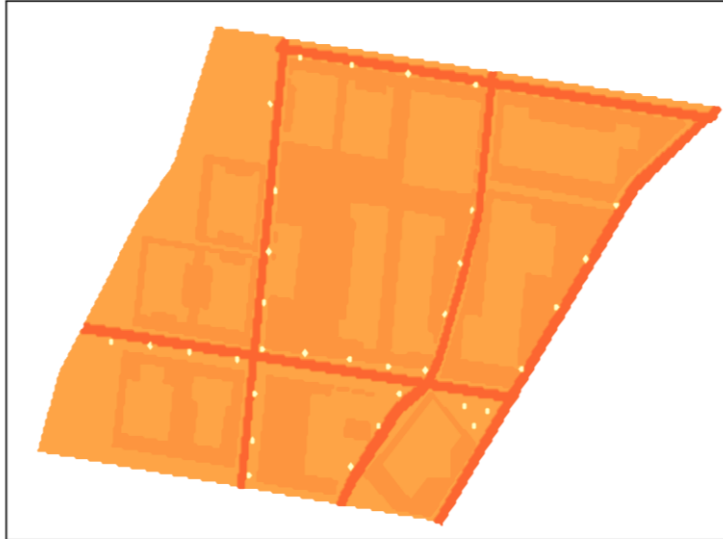


Precinct average difference between masterplan and BAU air temperature

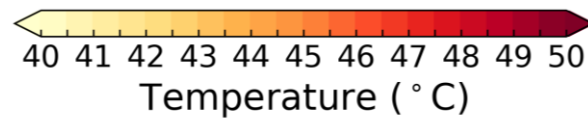
Employment precinct – current climate

At 4:30pm Badgerys Creek automatic weather station is 44.5°C.

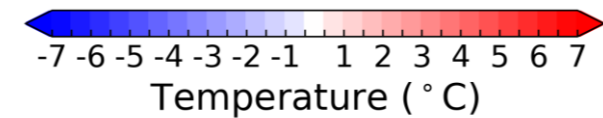
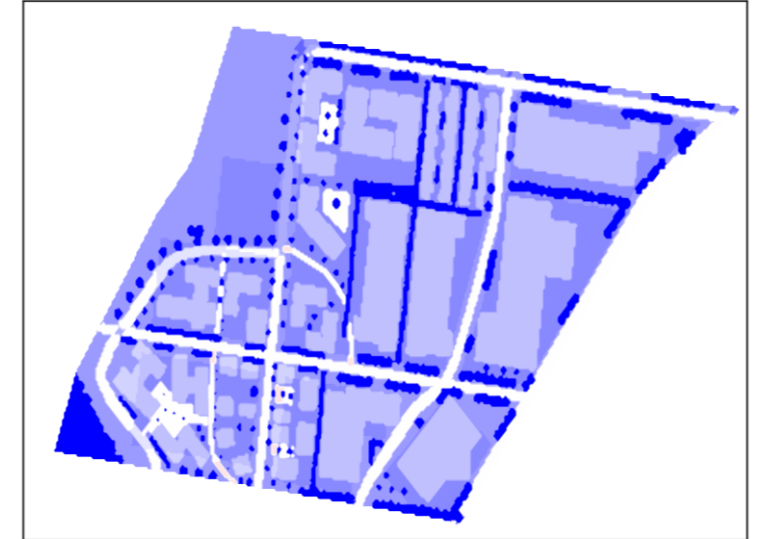
BAU air temperature 16:30



Masterplan air temperature 16:30



Air temperature difference 16:30

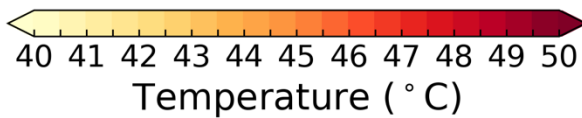
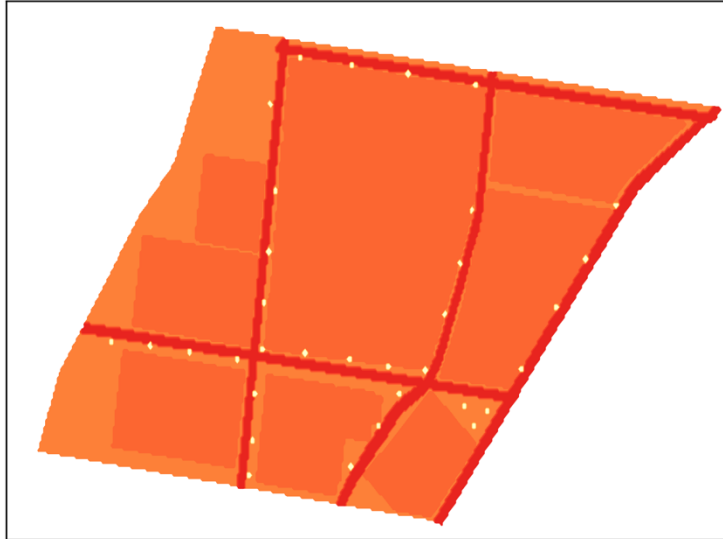


- Over 24 hours Masterplan is 1.6°C cooler
- At 4:30pm the Masterplan scenario is on average 3.5°C cooler.
- Running water reduces temperature above roofs by 1.5°C

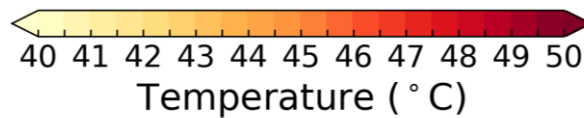
Employment precinct – 2035

At 4:30pm Badgerys Creek automatic weather station is 45.7°C.

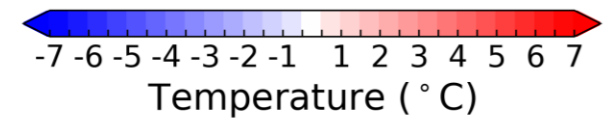
BAU air temperature 2035 16:30



Masterplan air temperature 2035 16:30



Air temperature difference 16:30

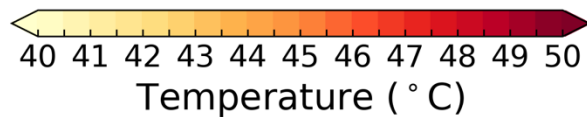
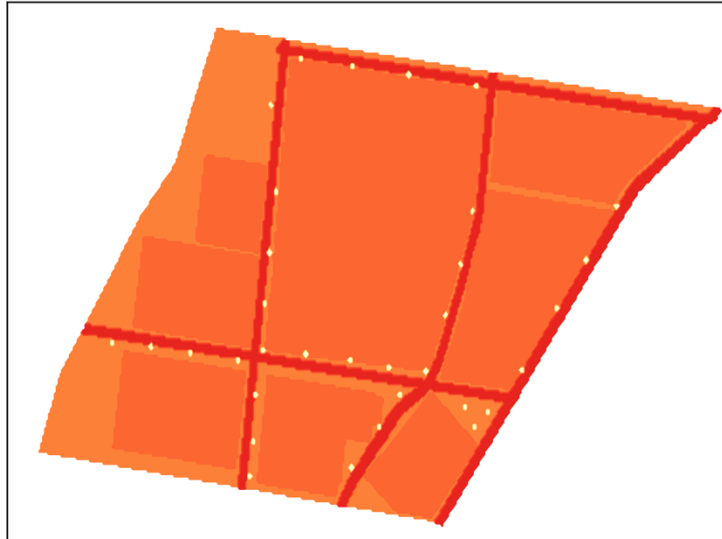


- Over 24 hours Masterplan is 1.7°C cooler
- At 4:30pm the Masterplan scenario is on average 4.1°C cooler.

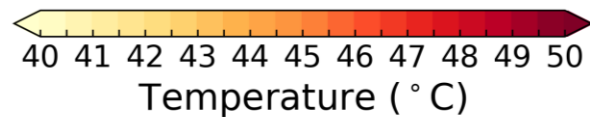
Employment precinct – 2055

At 4:30pm Badgerys Creek automatic weather station is 46.6°C.

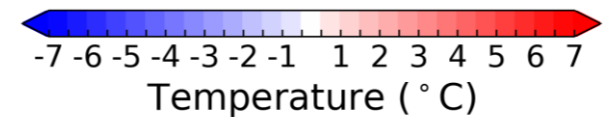
BAU air temperature 2055 16:30



Masterplan air temperature 2055 16:30



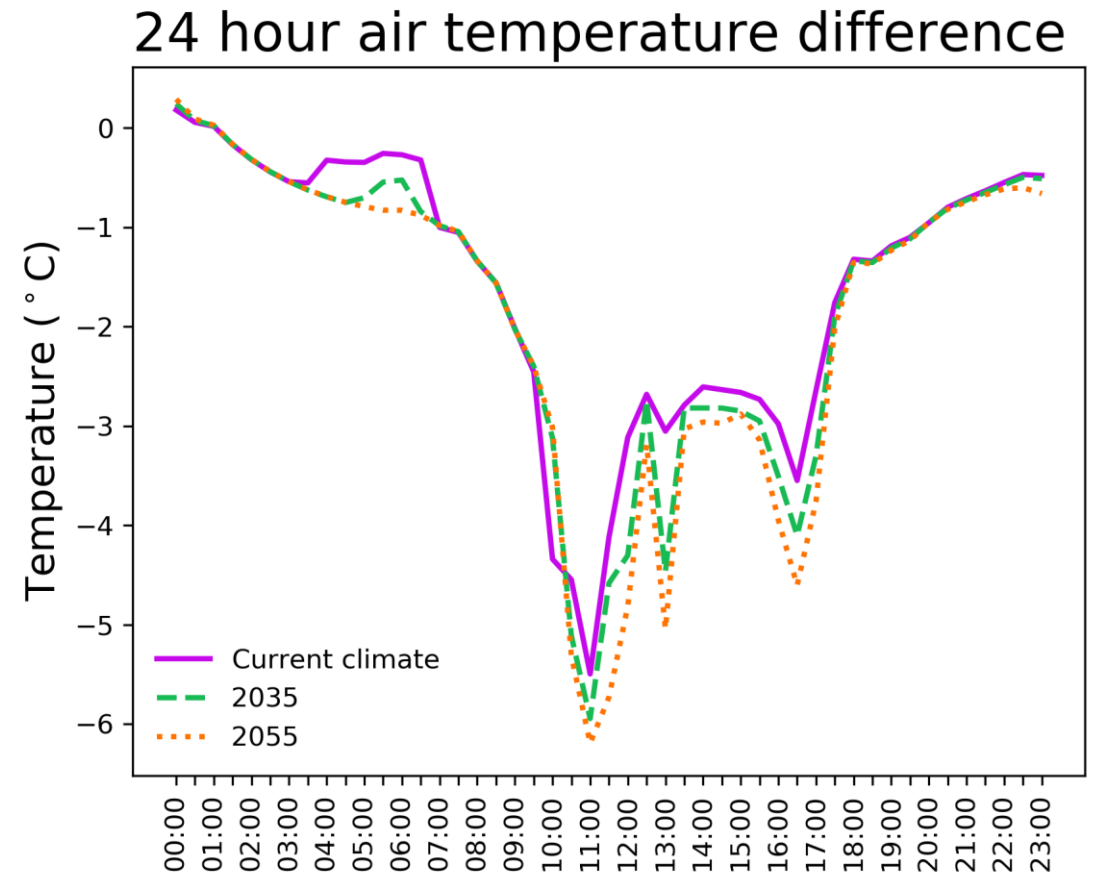
Air temperature difference 16:30



- Over 24 hours Masterplan is 1.9°C cooler
- At 4:30pm the Masterplan scenario is on average 4.6°C cooler.

Employment precinct – 24 hour analysis

- Main differences between 9am and 6pm
- Cooling becomes larger in the future due to trees blocking increasing solar radiation



Precinct average difference between Masterplan and BAU air temperature

Human thermal comfort and heat stress days – South Creek

Universal Thermal Climate Index (UTCI) was 4°C cooler in Masterplan

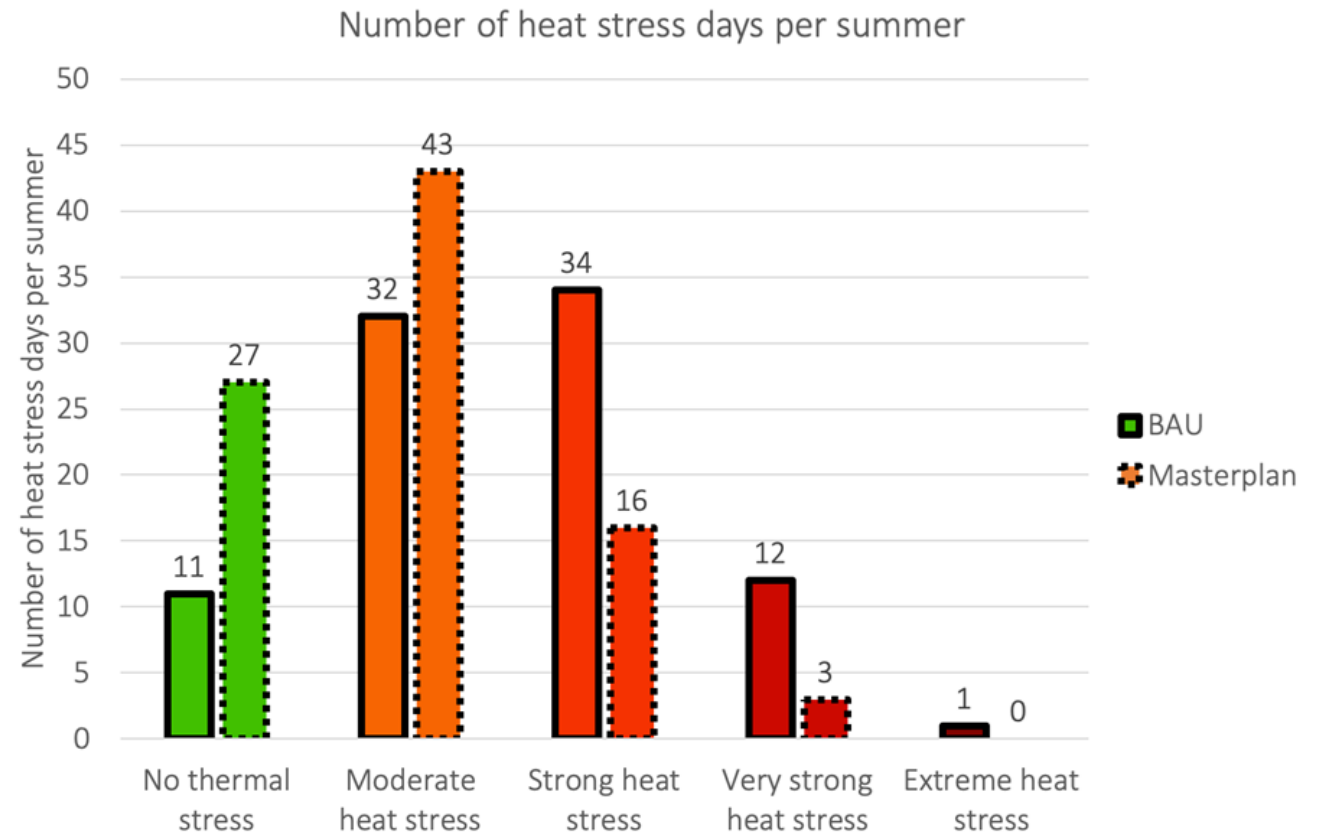
On the study day January 7 2018:

BAU: UTCI = extreme heat stress

Masterplan: UTCI = very strong heat stress

Apply 4°C UTCI cooling across last six summers

- the number of **extreme, very strong and strong heat stress** days per summer decreases dramatically from 47 to 19 days
- the number of days with **no thermal stress** more than doubles.



Summary of findings – Residential



Impact on Human Thermal Comfort and Health

If the cooling actions (permeable surfaces, tree planting, vegetation and management activity e.g. irrigation) from the masterplan are implemented:

- the number of **extreme, very strong and strong heat stress** days per summer decreases dramatically from 47 to 19 days
- the number of days with **no thermal stress** more than doubles.

Residential	Current climate	2035	2055
Over 24 hours, masterplan is:	1.2 °C cooler	1.3 °C cooler	1.4 °C cooler
Maximum temperature (4:30pm) is:	3.4 °C cooler	3.7 °C cooler	3.8 °C cooler
Irrigated grass at 4:30pm is:	3.4 °C cooler	3.8 °C cooler	3.8 °C cooler
Creek at 4:30pm is:	>7 °C cooler	>7 °C cooler	>7 °C cooler
Trees at 4:30pm are:	>7 °C cooler	>7 °C cooler	>7 °C cooler
Thermal stress at 4:30pm BAU	Extreme heat stress	Extreme heat stress	Extreme heat stress
Thermal comfort at 4:30pm masterplan	Very strong heat stress	Very strong heat stress	Very strong heat stress

Summary of findings – Employment



Employment	Current climate	2035	2055
Over 24 hours, masterplan is:	1.6 °C cooler	1.7 °C cooler	1.8 °C cooler
Maximum temperature (4:30pm) is:	3.5 °C cooler	4.1 °C cooler	4.6 °C cooler
Irrigated grass at 4:30pm is:	3.4 °C cooler	3.8 °C cooler	3.8 °C cooler
Irrigated roof at 4:30pm is:	1.5 °C cooler	1.5 °C cooler	1.5 °C cooler
Trees at 4:30pm are:	>7 °C cooler	>7 °C cooler	>7 °C cooler
Thermal stress at 4:30pm BAU	Extreme heat stress	Extreme heat stress	Extreme heat stress
Thermal comfort at 4:30pm masterplan	Very strong heat stress	Very strong heat stress	Very strong heat stress