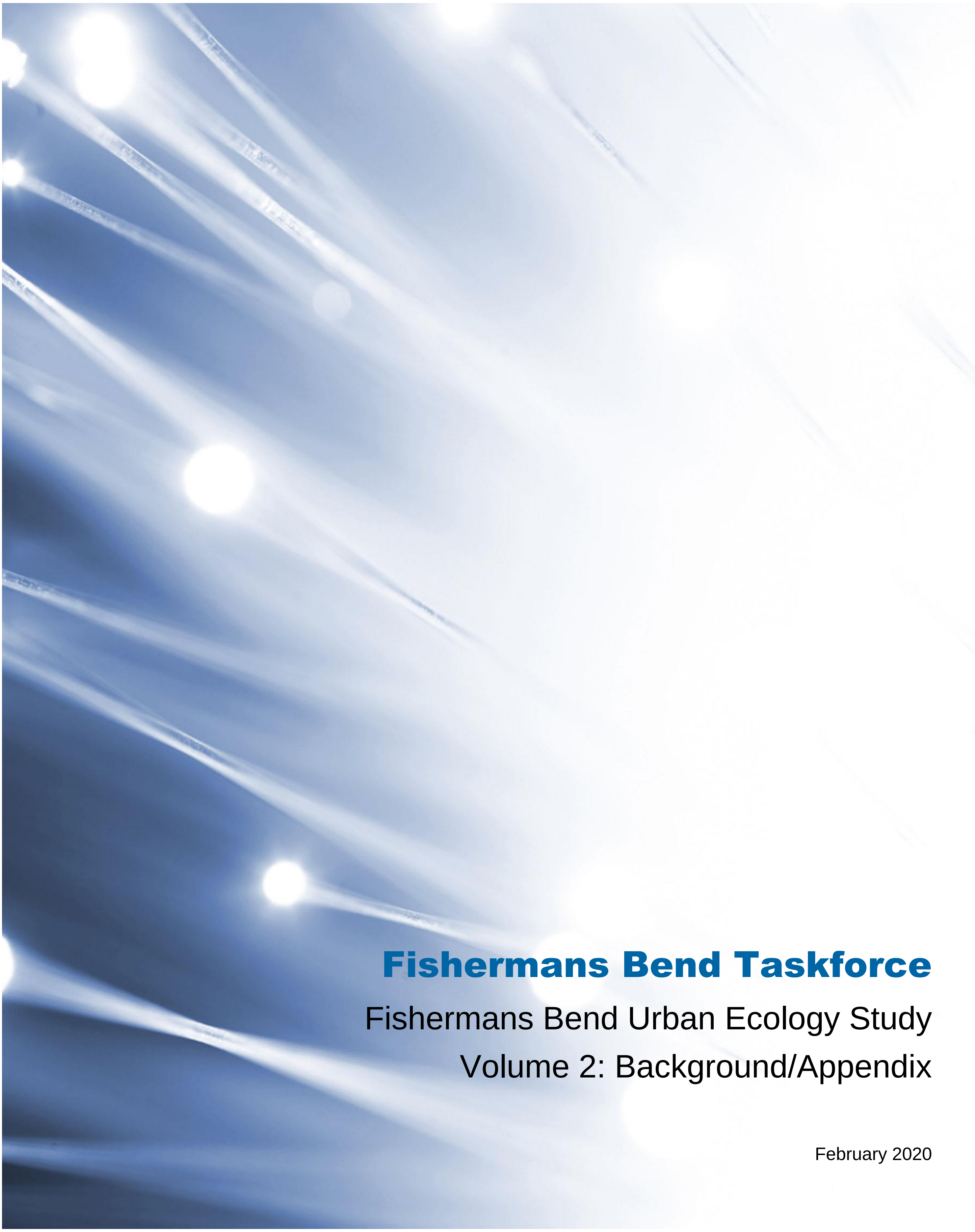

Fishermans Bend Taskforce

Fishermans Bend Urban Ecology Study

Volume 2: Background/Appendix

February 2020

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

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Scope and limitations

This report has been prepared by the GHD Project Team for the Fishermans Bend Taskforce and may only be used and relied on by the Fishermans Bend Taskforce for the purpose agreed between GHD Project Team and the Fishermans Bend Taskforce as set out in ***Volume 1*** *of this report.*

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1. Appendix A: Fishermans Bend context

1.1 Aboriginal traditional ecological knowledge in the urban environment

The Framework clearly states a commitment to embedding Aboriginal traditional ecological knowledge into the ongoing design of Fishermans Bend. By integrating these with contemporary ecological knowledge we can deliver better environmental outcomes and make Fishermans Bend more resilient, sustainable and inclusive. *Caring for Country: An urban perspective* (Monash University) proposed twelve draft principles which we recommend the Taskforce endorse for inclusion in implementation. They are:

1. Recognising Aboriginal knowledge of what came before the city and how this knowledge can be used today
2. Recognising Aboriginal knowledge of natural systems and cycles and how this knowledge can be used today
3. Reflecting Aboriginal naming in the city
4. Highlighting Aboriginal ceremony, dance, song and visual art
5. Meeting the Aboriginal expectation and obligation of duty and respect for Country which applies to anyone visiting or living in the city
6. Reframing existing sustainable practices as Caring for Country
7. Taking from Country only what you need to sustain you and giving back to Country what it needs to sustain it
8. Reflecting Caring for Country in strategic urban planning
9. Reflecting Caring for Country in the built environment
10. Using Caring for Country as a framework and rationale for long term thinking and decision making
11. Embracing Aboriginal culture to make the city unique
12. Enabling Aboriginal people to undertake Caring for Country practices in the city, both from a traditional and contemporary perspective

1.2 Additional context on precincts

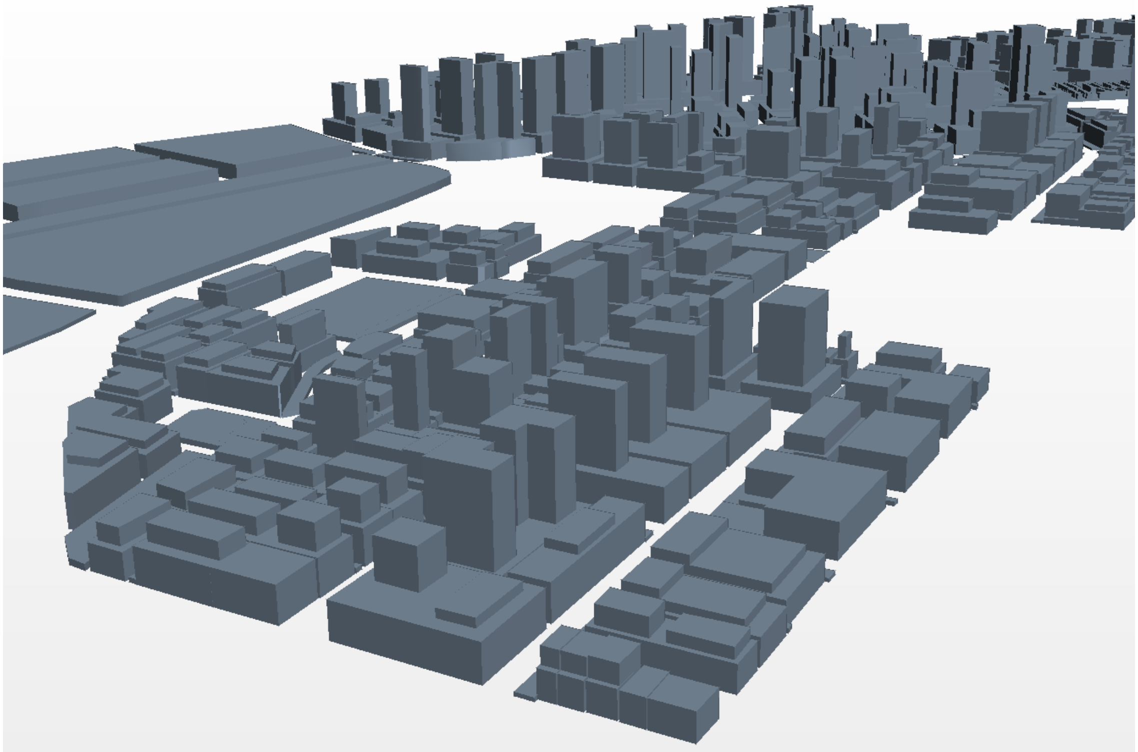

Figure 1 Different building shapes and heights across Fishermans Bend

The intended character of each of these precincts is shown in Table 1.

Table 1 Fishermans Bend Precincts (table text replicated from Fishermans Bend Framework)

Precinct	Vision	Intended development	Already rezoned?
Montague	A diverse and well-connected mixed-use precinct celebrating its significant cultural and built heritage, and network of gritty streets and laneways	South: predominantly a mix of low to mid-rise housing that includes infill and terrace developments, and hybrid developments that include towers along Buckhurst spine and east of the 96 tramline North: hybrid developments that are predominantly mid-rise with some towers	Yes
Lorimer	A vibrant, mixed-use precinct close to the Yarra River and connected to Melbourne's CBD, Docklands and emerging renewal areas	A mix of mid-rise and hybrid development that incorporate courtyard apartments, and perimeter block developments as well as towers	Yes
Sandridge	One of Melbourne's premium office and	A mix of low to mid-rise housing south of the core area that includes infill	Yes

	commercial centres, balanced with diverse housing and retail	developments, shop-top housing and courtyard apartments; elsewhere hybrid developments that include mid-rise, perimeter block developments as well as towers	
Wirraway	A predominantly family-friendly inner city neighbourhood close to the bay and Westgate Park	A mix of low and mid-rise housing, including townhouses, infill developments, shop-top housing, courtyard and perimeter block development; hybrid developments that are predominantly mid-rise with slender towers included along Plummer Street	Yes
Employment Precinct	Australia’s leading design, engineering and advanced manufacturing precinct	Predominantly low-rise industrial area, with the inclusion of (at least) two university campuses, and the possibility of some residential areas along tram (and potential train) line	No

2. Appendix B: Technical analyses

2.1 Urban Forest

2.1.1 Introduction

Urban forestry, also known as urban greening, creates many benefits for humans and nature, as discussed in Volume 1 Introduction. The City of Melbourne and City of Port Phillip both have urban forest strategies that guide the planning and implementation of vegetation within their areas.

Figure 2 Existing guidance on urban forestry from CoM and CoPP

There is significant opportunity to incorporate urban greening into Fishermans Bend, within both the public and private realm, as shown in Figure 3.

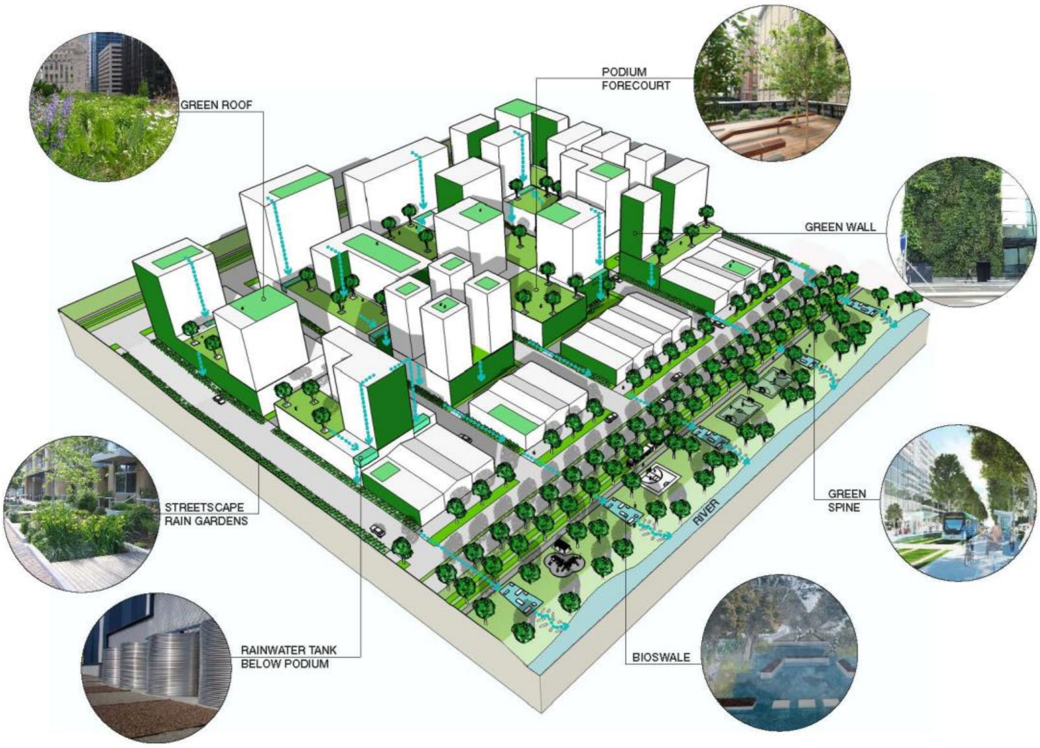

Figure 3 Visualisation of greening across Fishermans Bend

The objective of the urban forest component of this study was not to replicate or reinvent already established strategies, but to build on these foundations to add additional design guidance (for streets, public spaces, and the private realm), consider the interactions with the other themes (heat, and biodiversity), and test the achievement of the Fishermans Bend Framework Sustainability Goals.

2.1.2 Method

In order to achieve this the following approach was implemented:

- Before other themes were analysed
  - Mapping of trees across all streets (using a indicative standardised spacing of 10 m) and public spaces (using an indicative standardised spacing of 15 m x 15 m grid)
  - Development of lower, median and upper scenarios for canopy width and height in all street typologies and for public space
  - Application of low, median and high tree height/width scenarios to develop maps for three scenarios
  - Spatial analysis of percentage of public realm covered by tree canopy within each scenario
- After other themes were analysed, and integrated recommendations were developed
  - Design guidance, streetscape and public space palettes (refer to recommendations sections of this report)

2.1.3 Results

The initial mapping exercise resulted in indicative tree locations for the public realm in all of Fishermans Bend, as shown in Figure 4.

Figure 4 Indicative tree mapping across streets and public spaces

After this, a brief assessment took place to determine the approximate tree canopy width that would typically be expected within streets of different sizes, and the associated tree species. These preliminary tree species assumptions were used only to develop an indicative width and height profile for the mapping exercise, with the final tree species recommendations being developed later, as part of the design guidance at the conclusion of this report. Indicative median tree canopy widths for each CoPP street typology are shown in Table 2.

Table 2 Indicative median tree canopy width for all CoPP street typologies

Typology	CoPP street typology	Number of trees rows	Canopy size of typical tree	Indicative species (based on CoM FB Tree Species List)
1	Arterial Road (30 m)	3	Big canopy tree in streetscape e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.
2	Arterial Road with tram (30 m)	3	Medium canopy tree e.g. 7 m width = 38.5 m2	Ficus platypoda (Rock Fig)
			Narrow tree next to tram lines 4 m width = 12.6 m2	Narrow trees e.g. Pyrus calleryana
3	Plummer / Fennell Street civic boulevard (36 m)	3	Big canopy tree in streetscape e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.
			Narrow tree next to tram lines 4 m width = 12.6 m2	Narrow trees e.g. Pyrus calleryana
4	Buckhurst Street civic boulevard (30 m)	2	Big canopy tree in streetscape e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.
			Big canopy tree in parkland e.g. 10 m width = 79 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.
5	Collector Street with bus (30 m)	1	Big canopy tree e.g. 10 m width = 79 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.

6	Collector Street / Local Street with 12 m linear park (30 m)	2	Big canopy tree e.g. 1 tree 10 m width = 79 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.
			Big canopy tree in parkland e.g. 10 m width = 79 m2	Including productive trees e.g. Carob, Olive Trees etc
7	Collector Street / Local Street (30 m)	3	Big canopy tree in parkland e.g. 1 tree 10 m width = 79 m2. Big canopy tree in streetscape e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.
			Medium canopy tree e.g. 7 m width = 38.5 m2	Ficus platypoda (Rock Fig)
8	Local Street with 12 m linear park (34 m)	3	Huge canopy tree e.g. 1 tree 14 m width = 154 m2 (nb average based on varying canopy size from 18 m in parkland to 10 m in street settings)	Moreton Bay Fig, Camphor Laurel, Turkey Oak, Wichita Osage Orange, South African Wild plum
9	Local Street with 12 m linear park and recreational cycling path (30-34 m)	1, 3	Big canopy tree in streetscape e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Camphor Laurel, Turkey Oak, South African Wild plum etc.
			Huge canopy tree e.g. 1 tree 14 m width = 154 m2 (nb average based on varying canopy size from 18 m in parkland to 10 m in street settings)	Moreton Bay Fig, Camphor Laurel, Turkey Oak, Wichita Osage Orange, South African Wild plum
10	Local Street (22 m)	2	Medium to big canopy tree e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Turkey Oak, South African Wild plum, Rock Fig etc.
11	Local Street no separated cycle path (20 m)	2	Medium to big canopy tree e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Turkey Oak, South African Wild plum, Rock Fig etc.
12	Local Street (12-15 m)	2	Medium to big canopy tree e.g. 1 tree 7 m width = 38.5 m2	Cape Chestnut, Yellow Gum, Turkey Oak, South African Wild plum, Rock Fig etc.

An average width to height relationship was determined and used to generate Scenario 2 (median canopy scenario). These median width/heights were decreased by 30% to form Scenario 1 (low canopy scenario), and increased by 30% to form Scenario 3 (high canopy scenario). Spatial analysis was then used to determine the proportion of public realm covered by tree canopy. The percentage of public realm covered by tree canopy in each of these scenarios is shown in Table 3.

What this shows is that with the assumed tree locations, and the assumed width/height tree canopies for each street typology, the percentage of public realm likely to be covered by tree canopy is 18 - 49%, with the best guess using existing assumptions estimating a result of 33%.

Table 3 Percentage of public realm covered by canopy in low, median and high tree canopy scenarios

	Public Space (m^2)	Scenario 1 (smaller canopy)	Scenario 2 (median canopy)	Scenario 3 (larger canopy)
Area (m2)		418,937	756,970	1,133,182
Total public space area	2,308,437	18 %	33 %	49 %

2.1.4 Recommendations

Unlike the other themes covered in the following sections, the urban forest theme does not have theme-specific recommendations, as these are incorporated into the design guidance for public spaces, streets and the private realm, and included within the recommendations chapters of this report.

2.2 Heat

2.2.1 Introduction

Amelioration of heat, also known as urban cooling, creates many benefits for humans as discussed in Volume 1 Introduction. Different materials and forms within an urban area have different reactions to incoming solar radiation, as shown in Figure 5. The Urban Heat Island Effect is caused by reductions in tree canopy, and increases in impervious hard surfaces that trap heat for longer. As climate change worsens, increasing average temperatures as well as the number and length of heat waves and extreme heat, urban form needs to be adapted to mitigate the risks and impacts.

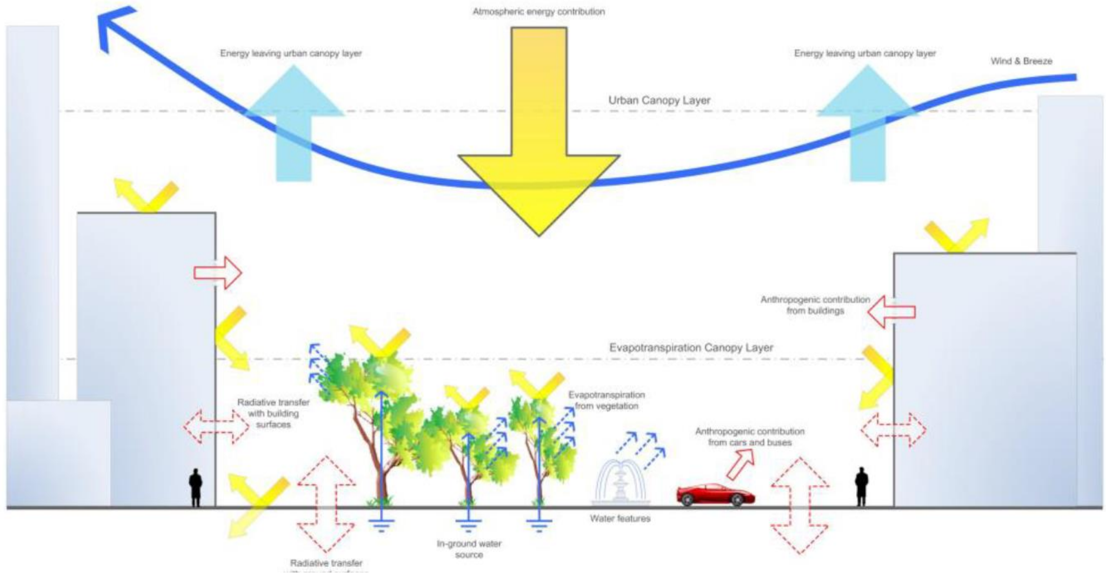

Figure 5 Illustration of the components that contribute to the urban heat island effect (source: GHD)

There are many different ways of measuring heat, including air temperature, surface temperature and Human Thermal Comfort (similar to what is referred to as a “feels like” temperature). Human Thermal Comfort takes into account air temperature, sunlight, humidity and wind, to consider how hot a person would likely feel in a given circumstance. As investigations of urban heat are often most interested in the human experience, and related impacts on active transport, time spent outdoors, productivity and human health, these studies typically use a Human Thermal Comfort indicator. This study has used the Universal Thermal Comfort Index (UTCI), as shown in Figure 6.

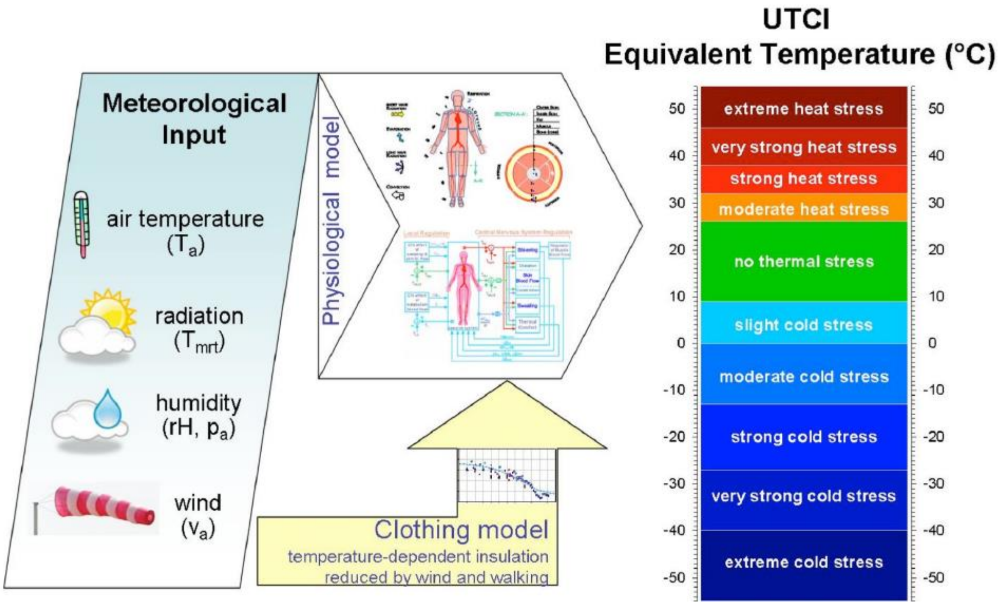

Figure 6 Human Thermal Comfort model utilised in this study (Source: Lindberg et al 2018)

The objective of the technical component of this theme was to generate a body of evidence in regards to the locations that are likely to be have the highest heat, and from this provide design guidance in regards to the placement and sizing of vegetation (particularly tree canopies).

2.2.2 Method

The assessment for this theme involved analysing three scenarios with a consistent number of trees but varying canopy width/height (low, median and high), across six case study areas, as shown in Figure 7. The case study areas were selected during the Modelling Approaches Workshop (2) as:

1. Around Westgate Park
2. Employment Precinct and proposed metro station
3. Lorimer Precinct, shows key strategic cycling corridor and active transport links
4. Wirraway Precinct, interface between Williamstown Road and proposed community hub, relationship between the open public space and the built form
5. Sandridge Precinct, mix of building typologies and road typologies.
6. Montague Precinct, proposed arts and cultural hub, proposed sports and recreation hub

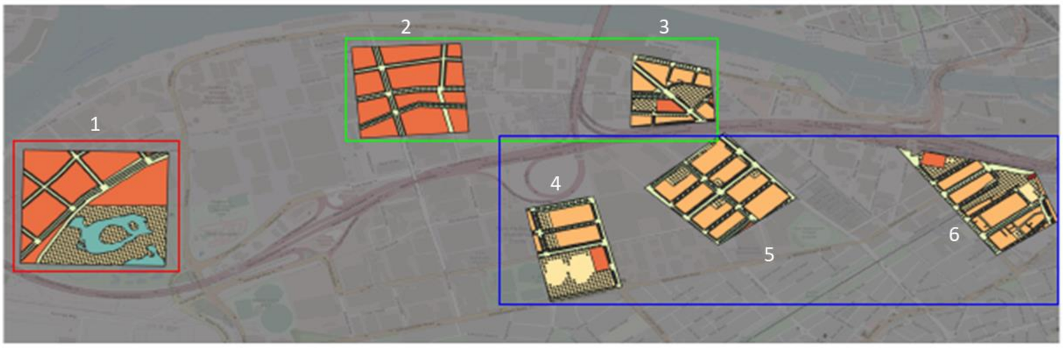

Figure 7 Heat case study areas

These case study areas were modelled using the Urban Multi-scale Environmental Predictor (UMEP) model, previously known as The Solar LongWave Environmental Irradiance Geometry model (SOLWEIG). The modelling was performed for 2 pm on February 12 of a typical hot summer day in 2050.

Table 4 Conditions used in heat modelling

Parameter	Value
Air temperature	37.4°C
Relative humidity	29.6%
Global radiation	833.0 Wm^{-2}
Diffuse radiation	92.0 Wm^{-2}
Direct radiation	925.0 Wm^{-2}
Wind speed	2.5 ms^{-1}

Scenario	Paved	Trees	Grass	Water
1	20.6%	9.5%	16.7%	3.6%
2	16.9%	17.5%	13.6%	3.5%
3	12.4%	28.6%	8.7%	3.4%

2.2.3 Results

Micro-climate results

An example modelling output from UMEP is shown in Figure 8 and Figure 9. This modelling takes into account building heights, tree width and height, as well as surface materials to calculate the thermal comfort that a human would experience if they were standing in a particular location. As tree canopy width and height is increased, the amount of shade provided is increased, resulting in improved thermal comfort (on this hot day).

This modelling illustrates many lessons in regards to streetscape and public space design, including:

- Southern sides of East West streets experience more sun, with Northern sidewalk shaded by buildings to North. Eastern sides of North South streets experience more afternoon sun, with Western sidewalk shaded by buildings to the West
- Wide streets with active transport objectives are the highest priorities for planting, particularly wide East-West streets such as Turner St shown in Figure 8
- Thin streets, particularly thin North South streets, are the lowest priority for planting
- Irrigated grass performs moderately well, but higher tree canopy cools public spaces substantially
- Street intersections are unshaded and hot, but do not experience pedestrian traffic

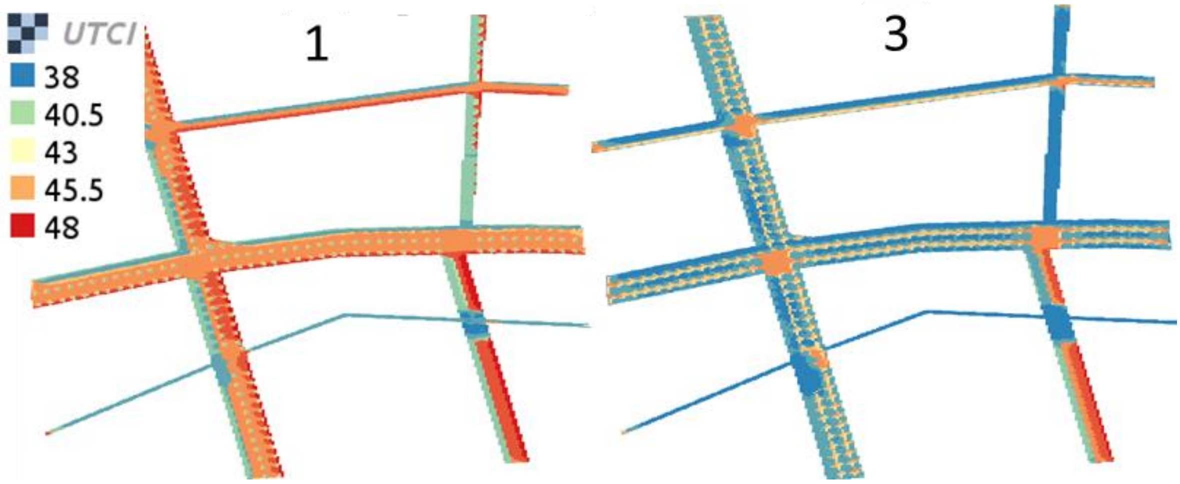

Figure 8 Illustrative example 1 – difference between heat results for Employment precinct (case study areas 2) between low canopy scenario (scenario 1), and high canopy scenario (scenario 3)

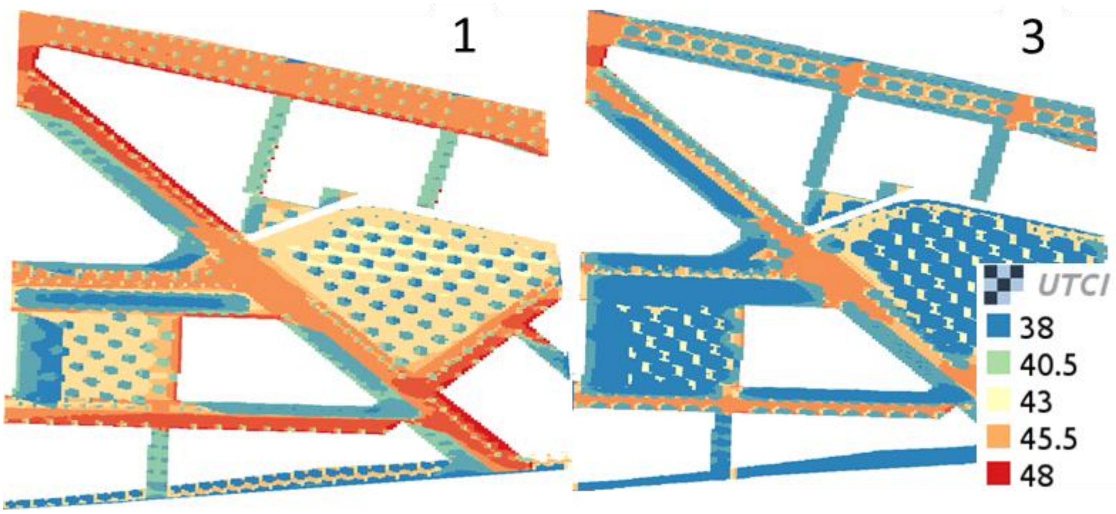

Figure 9 Illustrative example 2 – difference between heat results for Lorimer precinct (case study area 3) between low canopy scenario (scenario 1), and high canopy scenario (scenario 3)

Overall results

On this hot day, all the outdoor areas can be categorised as either strong (32-38°), very strong (38-46°), or extreme heat stress (>46°). Distributions of temperatures in the three scenarios (for modelled areas only) show a strong shift of percentages of areas in scenarios 2 and 3 away from the highest UTCI temperatures towards those with medium and lower temperatures.

Breaking down the distribution of heat stress categories shows a small shift between scenarios 1, 2, and 3 in percentages of extreme heat stress, but shows a large percentage of the modelled areas that move down from the very strong to strong heat stress category (approximately 45%). Can be attributed to increased canopy shading (9.5% -> 17.5% -> 28.6%), reductions in paved surfaces (20.6% -> 16.9% -> 12.4%). Large amount of cooling can be seen along the tree lined streets in scenarios 2 and 3 in all case study areas, as shown in the below figures.

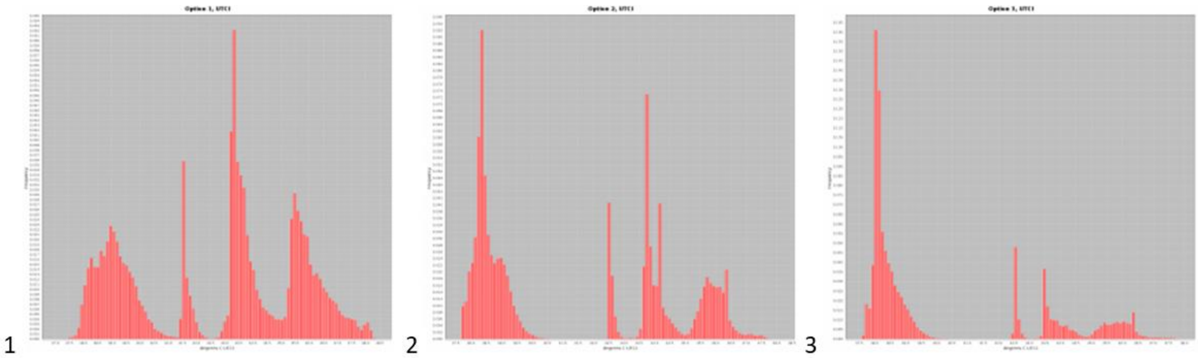

Figure 10 Shifting temperature distribution across the three scenarios (percentage of area with extreme temperatures dropping as canopy increases)

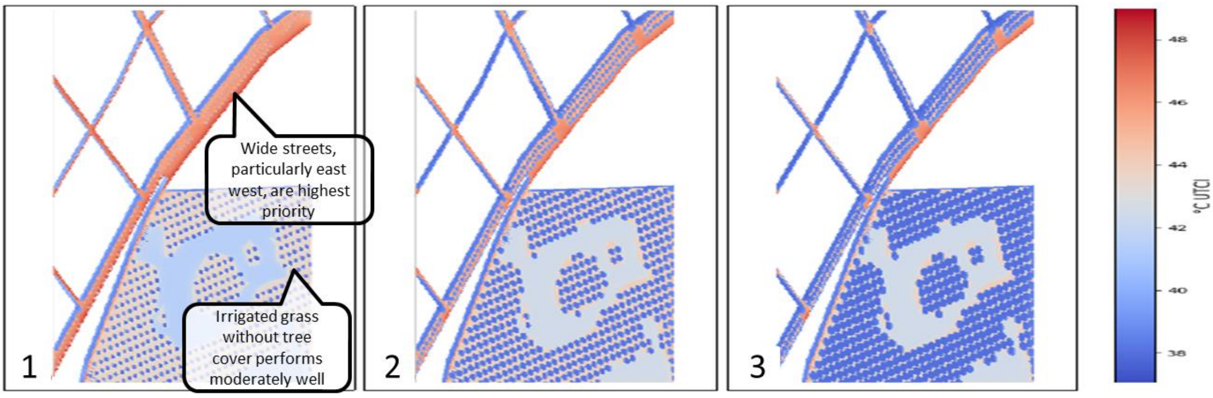

Figure 11 Heat case study 1 – Westgate Park

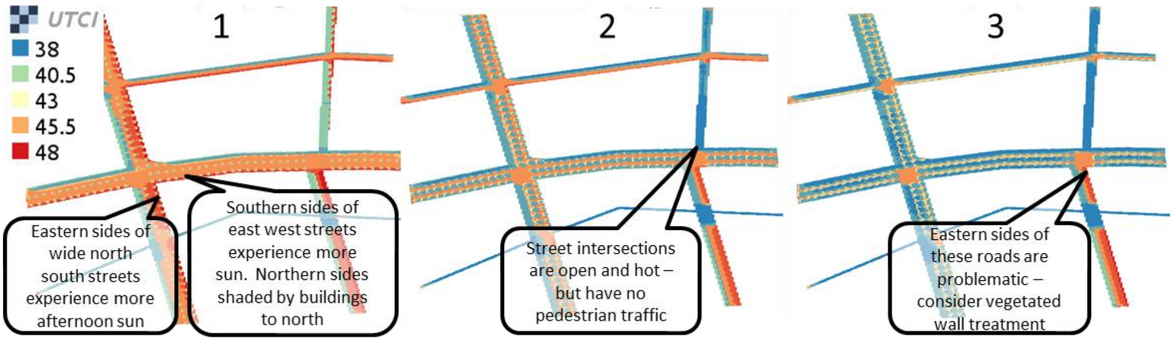

Figure 12 Heat case study 2 – Employment Precinct

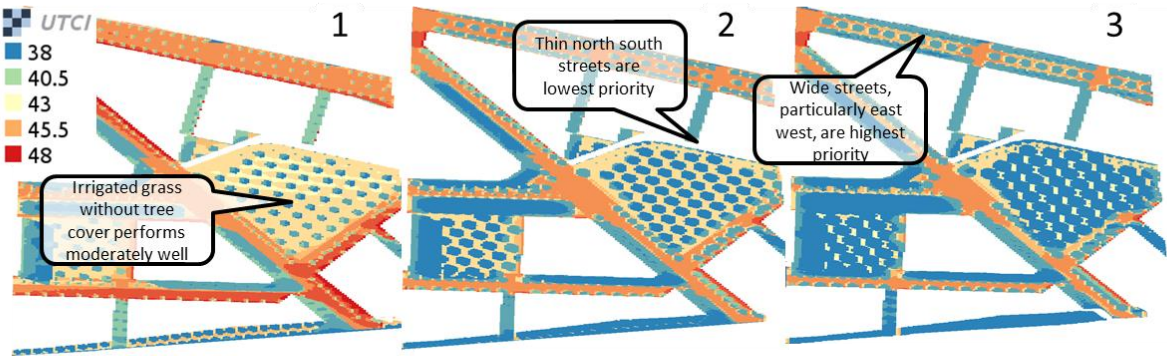

Figure 13 Heat case study 3 – Lorimer Precinct

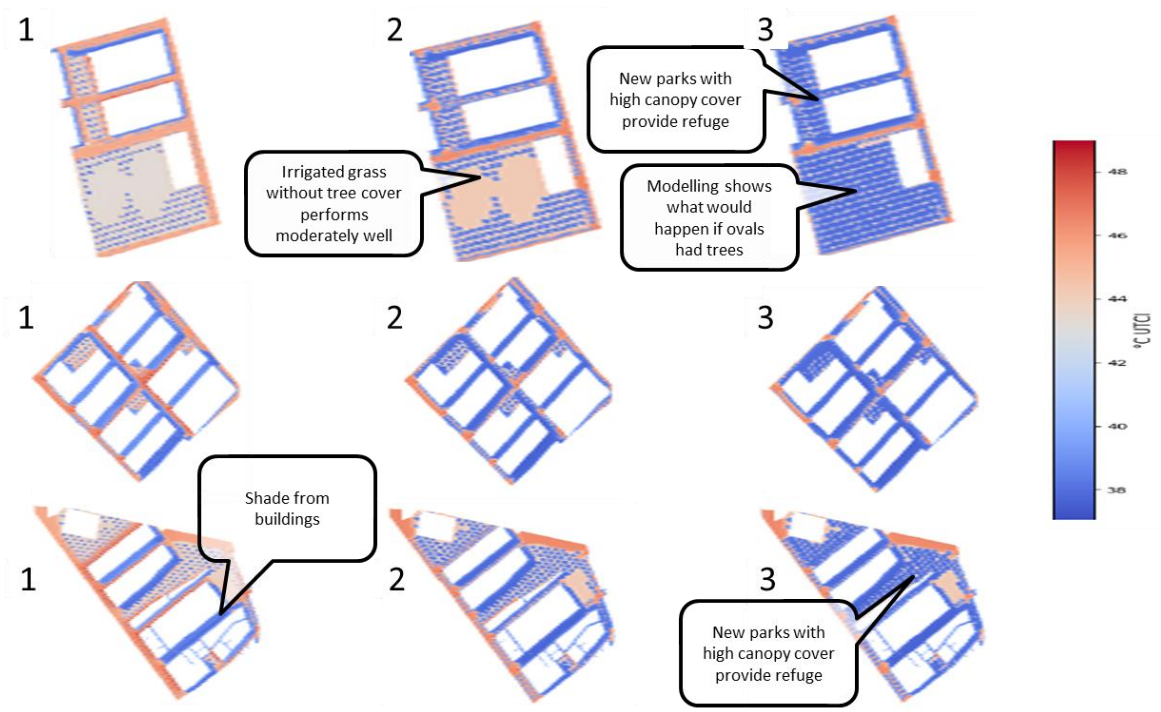

Figure 14 Heat case studies 4, 5 and 6

2.2.4 Recommendations

Technical recommendations emerging from this theme were as follows:

- Public realm:
  - Largest cooling benefits are through shading effect from a dense and wide tree canopy
  - This should be targeted to active transport streets, wide streets, and in particular wide east-west streets (see Figure 15)
  - Public spaces should have as high a canopy cover as possible (noting this will be limited by intended uses). Unirrigated grass has temperatures as hot as concrete/asphalt during the day, but cool quickly at night. Irrigated grass can have large surface temperature cooling impact during the day so these areas must be irrigated
  - Irrigation and/or passive watering will be important for tree health. Stormwater and recycling water sources could be directed to tree pits
  - Cooling effects are highly localised, so trees should be spread widely across the precinct, but also close enough to each other so they can shade each other and create a cooling zone (clustering)
  - Impervious surfaces should be converted to pervious surfaces to encourage soil water infiltration to provide evaporative cooling and to support deep rooted vegetation
- Tree cover is just as important on private property as on public, so should be encouraged
  - Although not included in our scenario modelling, choice of building materials can also help mitigate urban heat (i.e. cool roofs, cool surfaces)
  - In addition, all types of green space should be integrated widely (green roofs, walls and podiums) to reduce energy usage in buildings, but will have limited impact on pedestrian comfort
  - Green roofs/podiums and walls are particularly important on western and southern sides of wide streets

c) Prioristation: Street Trees

Canyon Width											Canyon Orientation
Very Wide	40 m	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	E-W
		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	N-S
Wide	30 m	0.13	0.27	0.40	0.53	0.67	0.80	0.93	1.07	1.20	E-W
		0.13	0.27	0.40	0.53	0.67	0.80	0.93	1.07	1.20	N-S
Medium	20 m	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	E-W
		0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	N-S
Narrow	10 m	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	E-W
		0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	N-S
	Metres	4	8	12	16	20	24	28	32	36	Metres
	Storeys	1	2	3	4	5	6	7	8	9	Storeys
		Low			Medium			Tall			
		Canyon Height									

High priority · Moderate priority · Lower priority · Not a priority

Figure 15 Relative priority of street trees in different street widths and orientations (Source: Norton et al 2015)

2.3 Wind

2.3.1 Introduction

Strong wind gusts can be unpleasant and impact on human experience, in winter they contribute negatively to human thermal comfort, and they can also pose a safety issue, particularly for children and the elderly.

Wind investigations can occur at multiple different scales including mesoscale (under 200 km), mircoscale (under 2 km), building scale (under 100 m) and indoor (under 10 m). This wind investigation fits approximately within the microscale, and is useful for determining which streets are particularly problematic for various wind directions.

2.3.2 Method

Wind studies are generally conducted through wind tunnels (physical) or Computational Fluid Dynamics (CFD) which is using computer modelling. There are two major commercial CFD analysis suites: Star CCM+ and ANSYS FLUENT. This investigation was undertaken using Star CCM+, which has unique capabilities with regards to the efficient simulation of terrain with high geometric complexity.

CFD Modelling requires a three-dimensional model of the terrain and all of the surrounding buildings. For this study, the three-dimensional terrain and building geometry data was supplied by the Taskforce in the form of an Urban Circus model, and then processed in order to generate a model that was appropriate for CFD. Then a computational mesh was created for everywhere air flow occurs, and it was this mesh that the CFD model uses to predict the wind field.

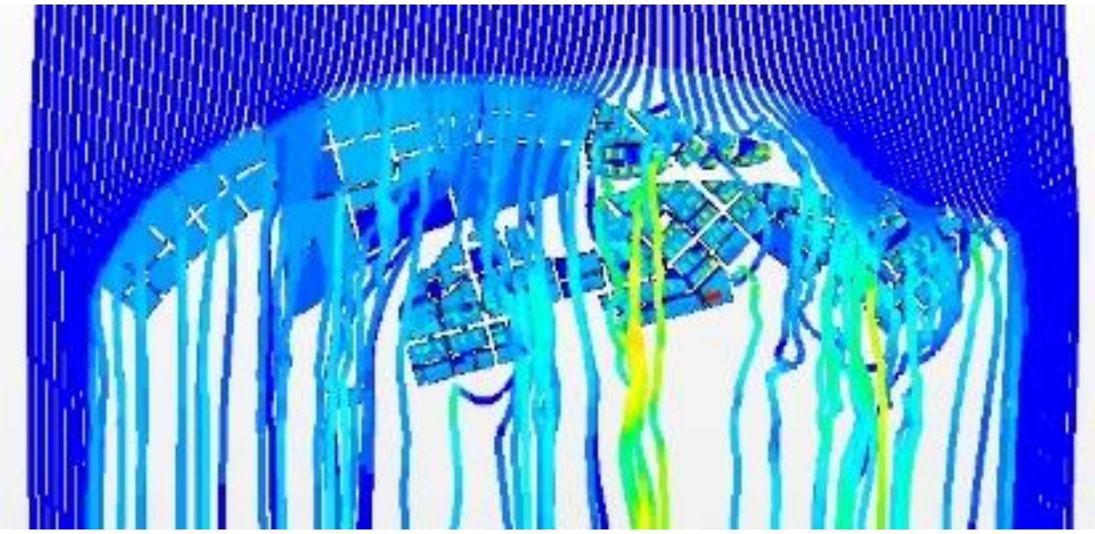

Figure 16 How northerly winds will traverse through Fishermans Bend

8 wind speeds and directions were simulated, see below figures. The 'Old Harbour Control' centre was used to measure winds. This is the best available data close to precinct (essentially southern approach to Bolte Bridge), despite being discontinued in 1995.

Two street layouts were tested for the Employment Precinct (see Figure 17), to test whether angling streets away from North-South towards the North-West would improve wind results.

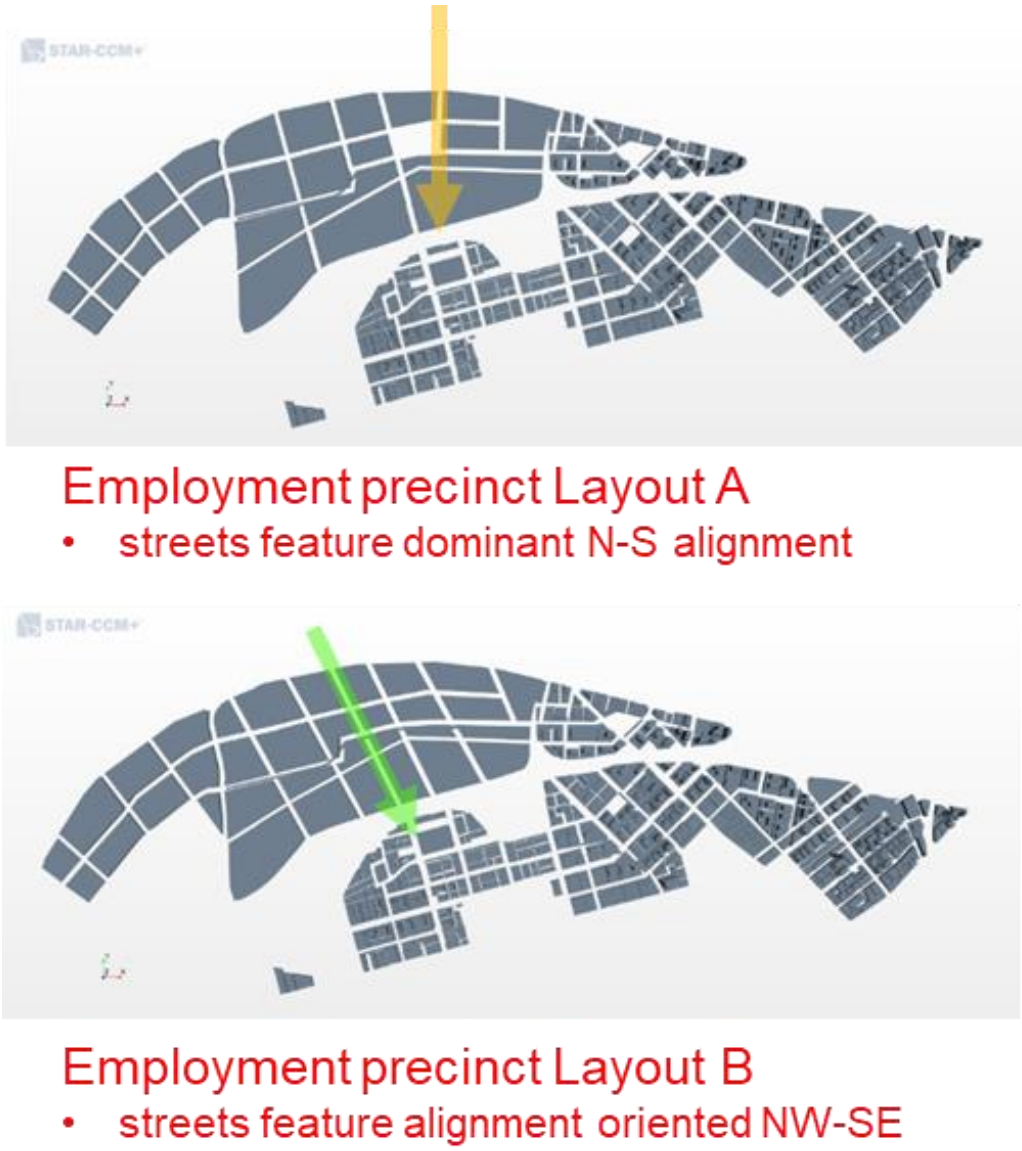

Figure 17 Two street layouts for Employment Precinct

This assessment has focused on using exceedance analysis to determine where thresholds are exceeded for comfort and safety. There are multiple variations of exceedance criteria, with no universally accepted standards. The criteria used in this study were based on a well-known Lawson criteria for 95th percentile (i.e. 5% chance of occurrence) as follows:

- >4 m/s - sitting exceedance – uncomfortable to sit for extended periods
- >6 m/s - standing exceedance – uncomfortable to stand for extended periods
- >10 m/s – safety exceedance – difficult to walk fast

2.3.3 Results

Wind meteorology results are shown in Figure 18. These results show that the North winds dominate in all cases. The Southwest quadrant is shown to be important for gusts and wind driven rain, and there are natural ‘impact shadows’ from east and (lesser extent) northwest. Interestingly in winter, despite conventional wisdom, the coldest winds (in terms of “feels like temperature”) come from the North due to the intensity of these winds.

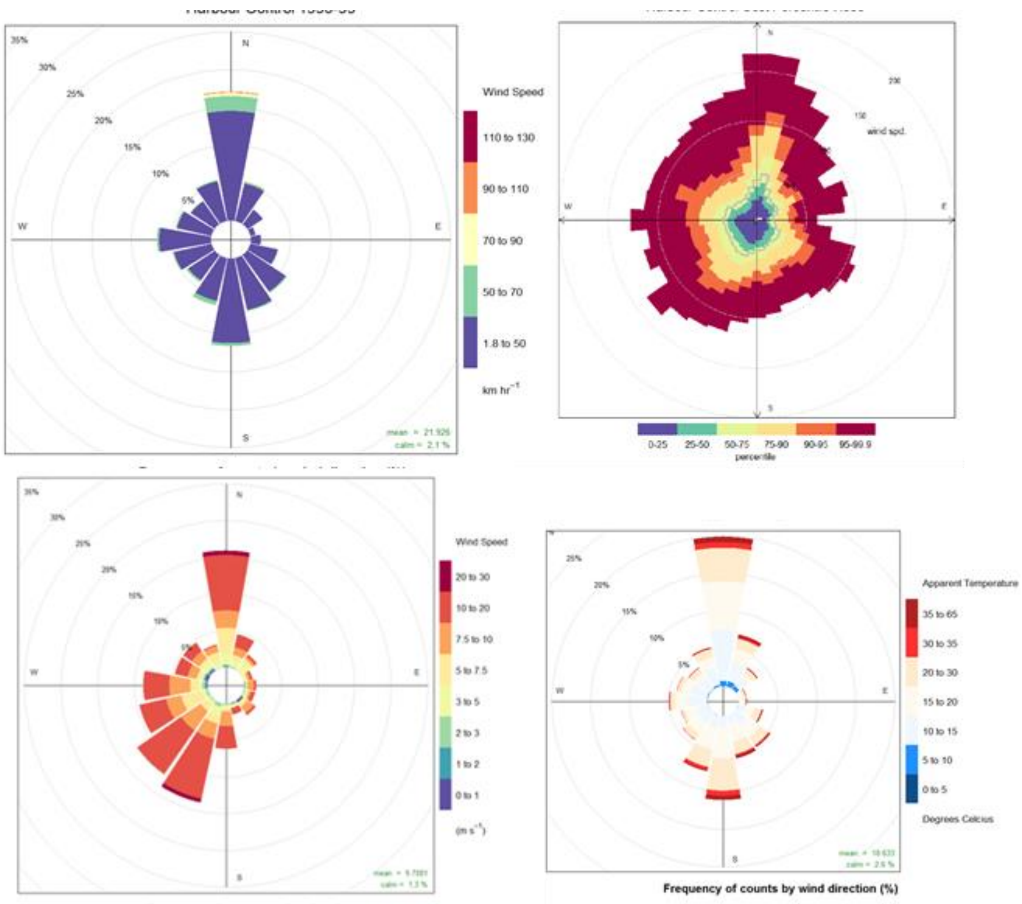

Figure 18 Frequency of wind counts per direction (%) (top left), Frequency and intensity of wind gusts per direction (top right), frequency and intensity of wind-driven rain (bottom left), apparent temperature (bottom left)

Analysis of two potential street alignments for the Employment Precinct found that Street canyon funnelling occurs for both layouts, and changing the alignment does not make a large difference to amount of area affected, see Figure 19. There were isolated areas of lower velocities when alignments are tilted towards the North West, but not enough to justify the effort required to alter these streets. The remainder of the study only considered the original street layout.

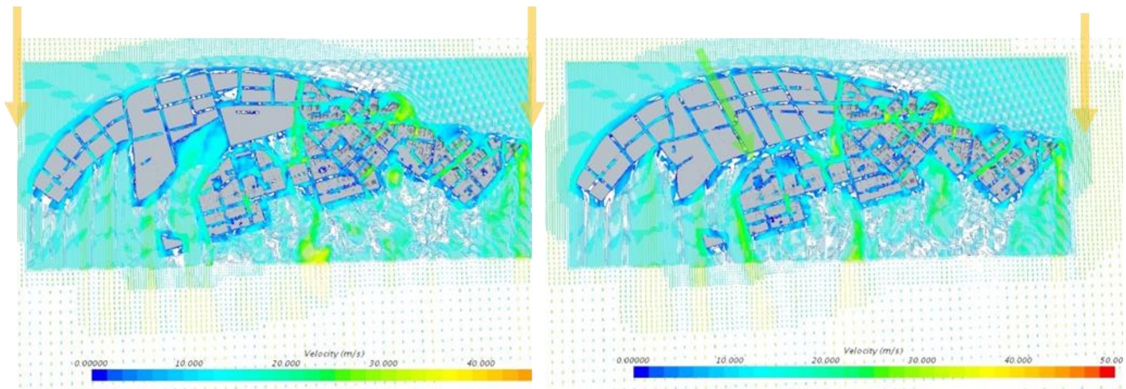

Figure 19 Comparison of results for two Employment Precinct street layouts

The exceedance plots shown below indicate areas that exceed the safety exceedance factor for 10 m/s. All public spaces are found to be vulnerable to winds from the North as shown in Figure 20. This shows that Lorimer will experience intense winds from the North.

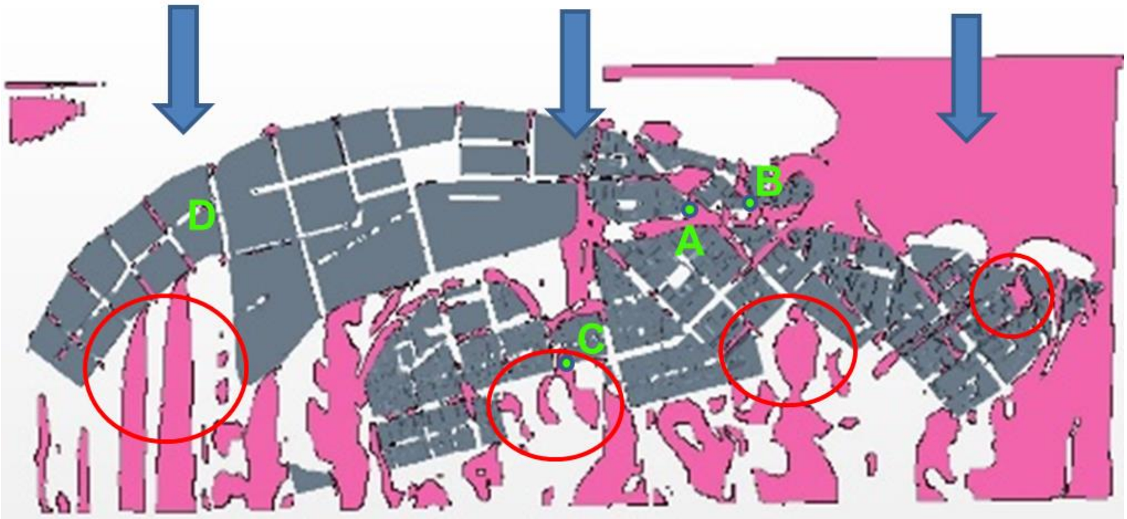

Figure 20 10 m/s exceedance plots for wind from North at z = 2 m (ground level) (green text shows case study areas described in more detail below, red circles indicate high winds in public spaces)

Southerly winds are found to be far less problematic than northerly winds, but there are some streets and public spaces in Sandridge and Montague that are vulnerable, as shown in Figure 21.

Figure 21 10 m/s exceedance plots for wind from South at z = 2 m (ground level) (green text shows case study areas described in more detail below, red circles indicate high winds in public spaces)

Westerly winds are less problematic than northerly winds, but create some interesting localised wind canyons, as shown in Figure 22 and Figure 25.

Figure 22 10 m/s exceedance plots for wind from West at z = 2 m (ground level) (green text shows case study areas described in more detail below, red circles indicate high winds in public spaces)

The Westgate Freeway will be a major wind canyon from multiple directions including the North and West, but will be particularly intense from the North. Further investigation may be warranted to determine the impact, and possible advantages and disadvantages from creation of any new noise/amenity walls, as shown in Figure 23.

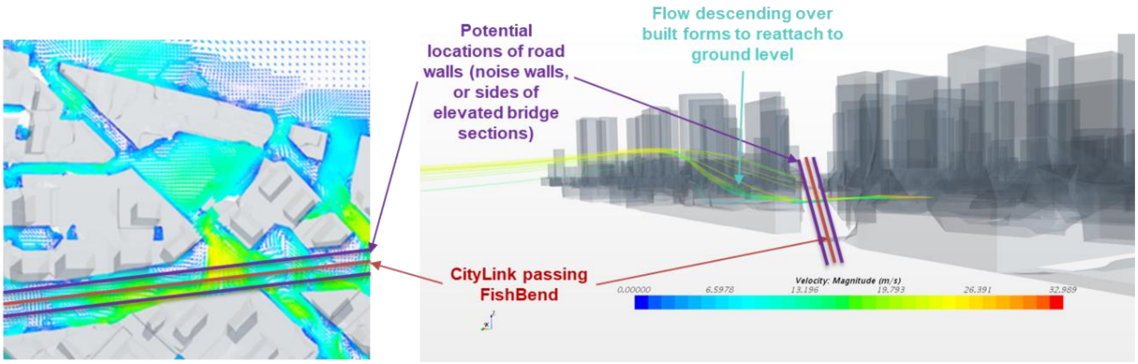

Figure 23 "Street Canyon A" wind from North

Street alignment twisting from North South to a 45 degree bend can create a wind tunnel, as shown in Figure 24.

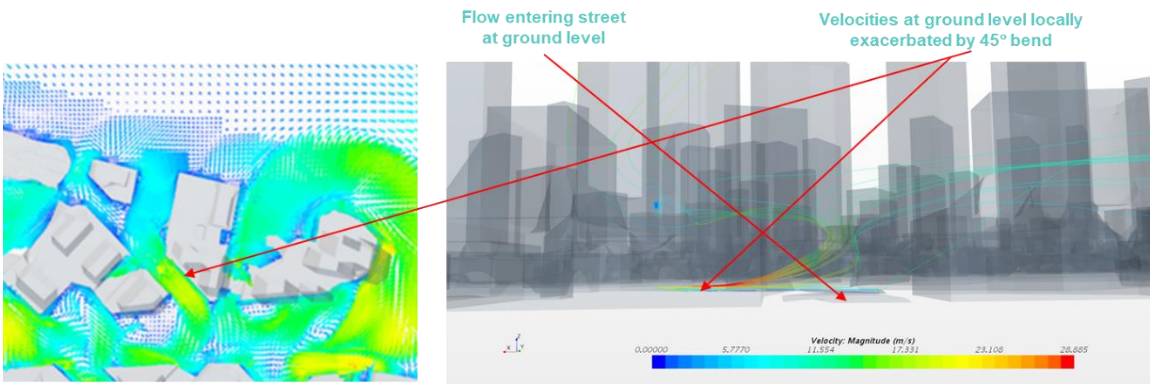

Figure 24 "Street Canyon B" wind from North

Flow reattachment from building tops back down to ground level is the primary observed mechanism of street canyon formation, as shown in Figure 25.

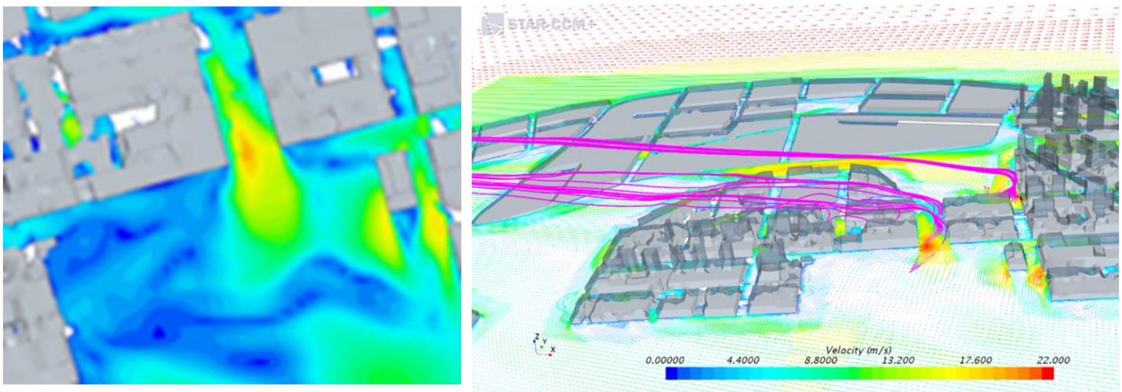

Figure 25 "Street Canyon C" wind from West

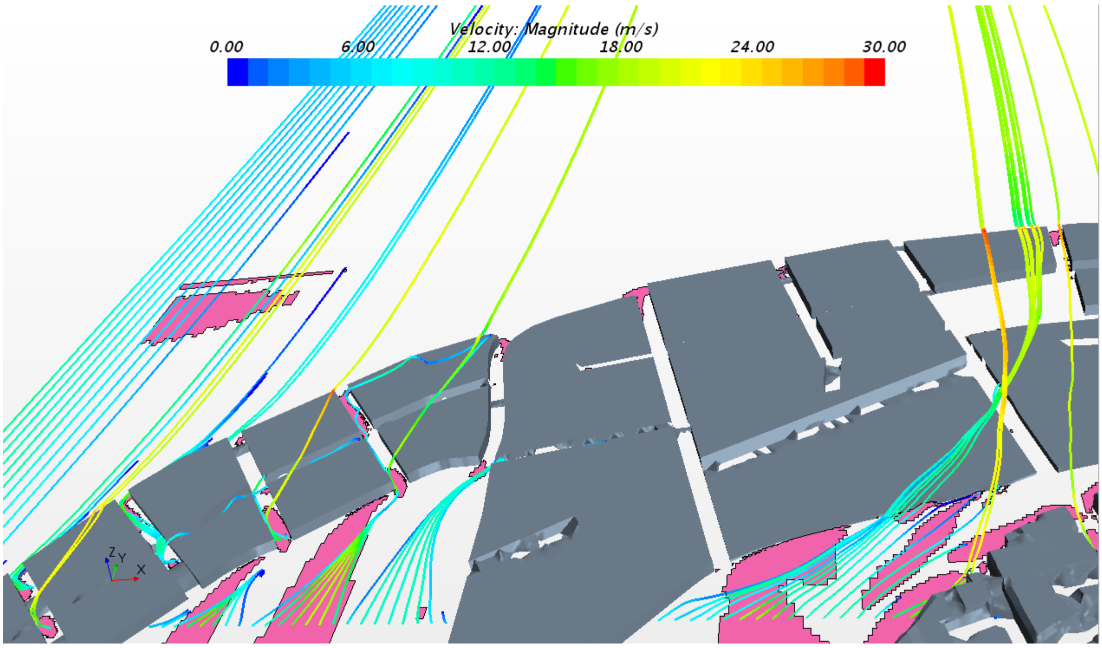

Figure 26 "Street Canyon D" wind from North into Westgate Park

2.3.4 Recommendations

Technical recommendations emerging from this theme were as follows:

- Requirement for testing new building designs through centralised model
  - This scale of analysis (given the available resources for this project) provide high-level guidance, but all new buildings should have building-scale analysis conducted to refine building design. It is inefficient for each developer to generate its own wind model from scratch. If building scale analysis is done using the centralised Fishermans Bend-scale model created for this analysis, it would be possible to update this model as new designs are proposed, and test the impact on Fishermans Bend as a whole, providing mutual benefit for developers (through reduced study cost), and government (through testing large scale impacts)
- Recommendations for all buildings:
  - Balconies on southern faces will be less exposed to wind. Balconies on other faces will require additional shielding. More modelling is required to do case studies on different building shapes/heights, in different parts of Fishermans Bend (testing the impact of the proximity of other buildings), to refine this guidance further
  - Shielding with secondary operable facades should be considered for all balconies (needs to be considered on a building by building basis)

- Generally avoid ground-floor openings (e.g. Arcades without doors that extend the length of the building) in tall buildings, as these can create wind canyons. There may be some specific buildings were this is not a problem (due to proximity of other buildings), but this needs to be specifically tested through the CFD model

- Other general guidance for buildings:
  - For tall buildings with rectangular footprints, it is undesirable to have the wide face towards the north (prevailing wind)
  - It is generally undesirable to place short buildings directly upwind of tall buildings (which causes wind acceleration)
  - Differing building heights and offsetting large towers (horizontally) may improve wind outcomes in some locations. However more modelling is required to test this, as this is substantially context specific
- In streets identified as wind canyons (refer to Volume 1 corridor design guidance):
  - Require podiums and/or
  - Structural canopies (on building façade) to protect sidewalks and entrances
- Recommendations for public space
  - Windbreaks should be included on edges of public spaces, particularly Northern edges of large spaces (e.g. Westgate Park and JL Murphey Reserve)
- Recommendations for communal spaces exposed to wind (cafes, restaurants, courtyards, gardens etc.)
  - Consider use of porous or impervious screens and awnings to blocks winds. Porous screens can work better than non-porous walls for wind protection, because they can largely avoid generating significant wind acceleration and turbulence
- Propositions without sufficient justification
  - There is insufficient justification to realign streets in the Employment Precinct, as modelling did not reveal a significant improvement
- Propositions that are worthy of further investigations
  - Case studies on tall buildings in different parts of Fishermans Bend (with different surrounding buildings) to refine balcony placement guidance
  - Case studies on specific wind canyons to test the effectiveness of varying tower location and shape, and varying wind heights, in regards wind canyon amelioration
  - There is currently insufficient analysis to test the impact of placement of buildings at the northern ends of streets to block wind entrance into street. The primary cause of wind canyon creation was the “downwash effect” (when wind is sucked down gradually towards ground level after passing over a building, or wind hits a tall building and is diverted directly towards ground level). It was found that “street level ingress” (when wind enters the street directly), was less of a factor, but still occurred in some locations. What this means is that there may be some select streets where this may provide a benefit
  - Related to the above, further analysis is warranted to look for and resolve occurrences of the “Venturi Effect” which occurs when a wider canyon narrows into a narrower canyon (and causes wind to accelerate). In some specific locations it may be possible to ameliorate this effect by widening canyons in key locations. Further analysis is required to identify these

2.4 Biodiversity

2.4.1 Introduction

The inclusion of biodiversity in urban areas provides intrinsic benefits for nature, as well as providing many benefits for humans (as discussed in Volume 1 Introduction). The City of Melbourne and City of Port Phillip both have policies in place to deal with the protection and restoration of biodiversity, with CoM more progressed in their planning, and CoPP beginning more detailed investigation shortly.

Seven Key Objectives were agreed during the biodiversity workshop for this study. These objectives were based on shared themes for how Fishermans Bend will look sound and feel in the future, with a focus on liveability and everyday nature experiences. These Seven Key Objectives were as follows:

- **A place that honours Indigenous culture**

  The habitats of this area reflect Indigenous knowledge and stories, in their design, naming and function. This objective guides the rest.

- **A place with seven seasons**

  Constant seasonal change is reflected in our flora and fauna, how we use places, and how water appears in the landscape.

- **A place known by its diverse ecosystems**

  Local ecosystems and species are a core part of each precinct's identity and function. Local habitat helps you know where you are and where you're going.

- **A place for the senses**

  Habitat areas offer scents, colours and sensations, which bring daily delight but also opportunities to feel relief and escape from the 'concrete jungle'.

- **A place of shifting waters**

  Water is part of the landscape – both freshwater and brackish, ephemeral and permanent.

- **A place that's comfortable and beautiful in any weather**

  Habitat offers a range of microclimates – from shaded to open, from wet to dry and from breezy to sheltered. Species and landscape designs are selected to correspond to microclimates, so every area teems with life.

2.4.2 Method

The method used in biodiversity assessment for this study included:

- An initial workshop (1) to identify key biodiversity objectives and co-select relevant target species. These species were chosen by consensus during the workshop as umbrella species with diverse resource requirements. Should these species return to and persist in Fishermans Bend then the stated Key Objectives would have been fulfilled
- The target species selected were: Superb fairy-wren, Growling grass frog, Blue-banded bee, Blue-tongued lizard, Brolga, Fungi, White mangrove.
- Selection of two focal species for the detailed connectivity modelling: Superb fairy-wren and Growling grass frog. These species reflect a wide range of habitat requirements
- Identification of key habitat resources for the modelled species that are required for the persistence within the connectivity of these species

- Development of current, base-case and best-case habitat maps (to reflect the future worst and best cases). The biodiversity recommendations reflect all the key proposals that were modelled in the best-case scenario.
- Modelling of species connectivity for the species to quantitatively compare the performance of the two scenarios. Connectivity was modelled by developing resistance maps for each species in each scenario, then quantifying the 'flow' of these species across Fishermans Bend using circuit theory.

Figure 27 Existing habitat scenario

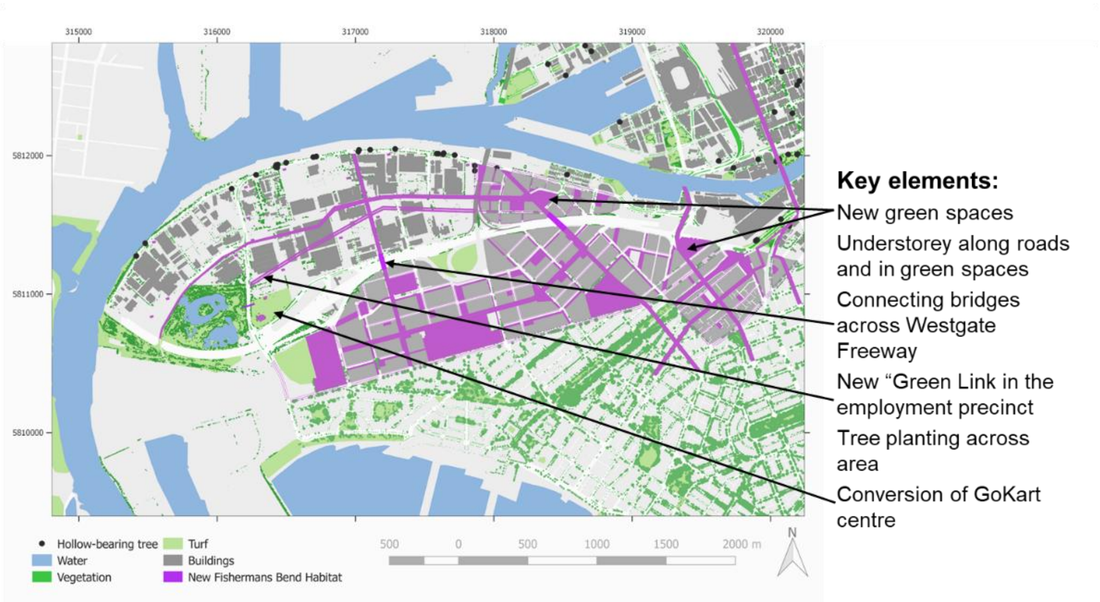

Figure 28 Best case habitat scenario

2.4.3 Results

This analysis found that connectivity was greatly improved by the inclusion of new green spaces, understory vegetation in linear public spaces, local streets and in green spaces, green elements on pedestrian bridges over freeway, a proposed car-free green link/spine through the

Employment Precinct, and the inclusion of new water features in key public spaces. This is shown in Figure 29.

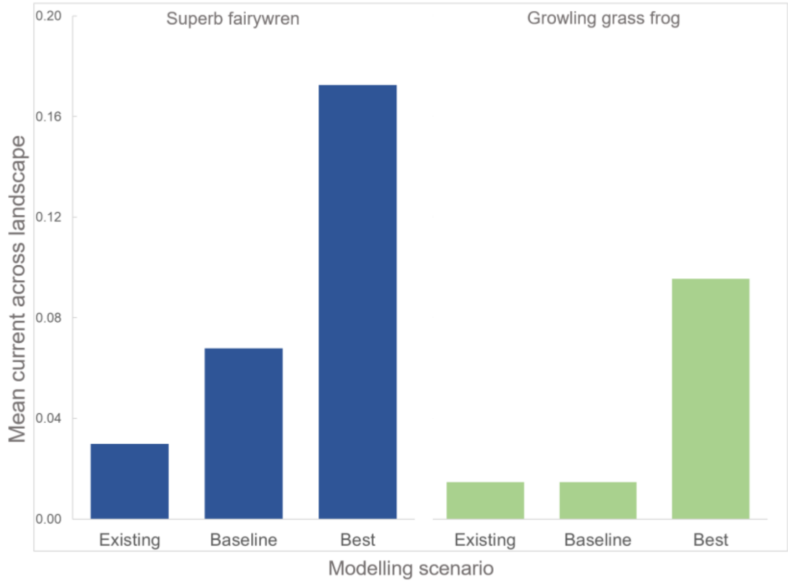

Figure 29 Comparison of existing, base and best-case connectivity for the two focal species

This was true for the Superb fairy-wren (see Figure 30), Growling Grass Frog (see Figure 31), and would also result in improved ecological connectivity for the other target species.

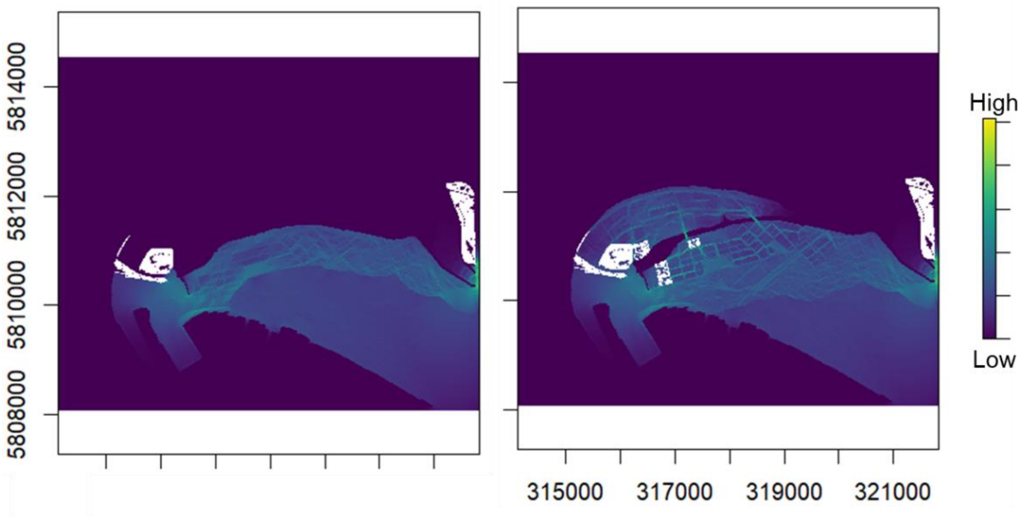

Figure 30 Base and best case scenario results for Superb fairy-wren connectivity

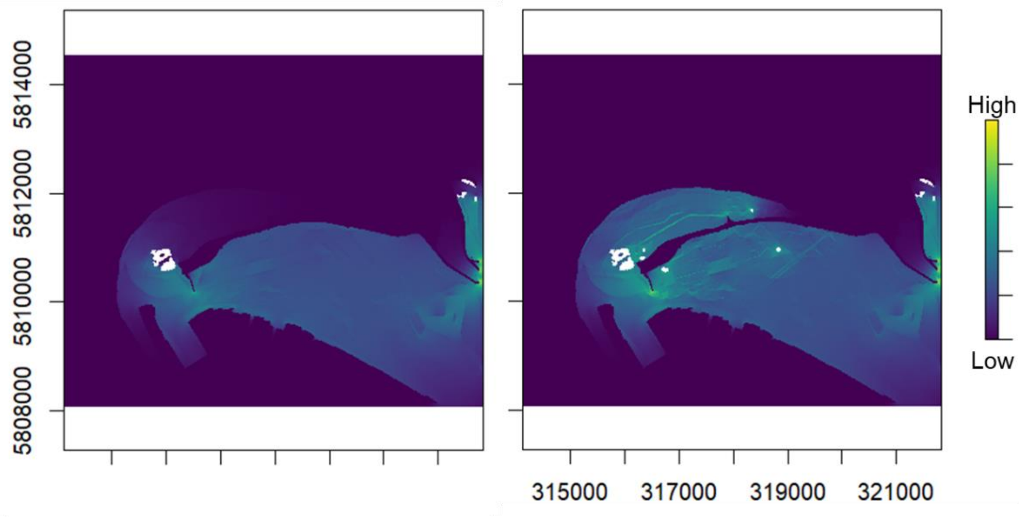

Figure 31 Base and best case scenario results for Growling Grass Frog connectivity

2.4.4 Recommendations

Technical recommendations emerging from this theme were as follows:

- Inclusion of water within the landscape
  - Permanent water bodies or “billabongs” in all new public spaces
  - Ephemeral waterways, rain gardens or “wet areas” along all relevant streets
  - Ephemeral water along the “green link”
  - Soft edges and vegetation within water body and at edges
  - Mixture of salinity levels and temperature moderation
- Diverse native understorey vegetation
  - Added as garden beds in ALL new public spaces, gardens, parklets & podiums
  - Added to all linear public spaces along roads
  - Added along all “Local streets”
  - Flowering native plants should be used
  - Should include grasses (0-0.8m height) and shrubs (0.5-2m height)
- Canopy trees
  - Should not cover public spaces by more than 50%
  - Spacing of street trees < 10m ideally
  - Should not completely shade permanent water features
  - Should be predominantly native
  - Mixture of vegetation structures and service provision (e.g. nectar, shelter & nest sites)
  - Prioritise the preservation of hollow-bearing trees
- Green bridges over Westgate Freeway (along cycle paths)
  - Separate bike path with a lawn/grass buffer before vegetation
  - Have dense understorey vegetation (0.5-2m height)
  - Include tall grasses and flowering plants
- Animal underpass below Todd Road

- Gridded to allow light to penetrate
  - Should be able to be kept moist/wet
  - Funnel/fence for directing terrestrial species and prevent road casualties
  - Open onto understorey vegetation on either side
- New public space in the GoKart centre area
  - Two new permanent water features
  - Animal underpass connection with Westgate Park
  - Native woodland stands
  - Large contiguous understorey areas (natural feel)
  - Walking paths and boardwalks
  - Information boards
- Built form and other infrastructure
  - Anti bird-strike glass
  - Work with urban designers and architects to incorporate novel habitat analogues (e.g. artificial cavities)
  - Consider green walls and roofs/roof top parks on all buildings
  - Street lighting (LED long wavelength)
  - Speed restrictions to reduce noise
  - Diverse landscaping types – consider hills, rockeries, shrubs, grasses
  - Use native mistletoe to increase canopy structure
  - Increase opportunities for positive interaction & stewardship of nature.
  - Prioritise mid-rise architecture and semi-private courtyards
- Employment Precinct
  - Provision of podium gardens containing both canopy and understorey habitat (follow guidance)
  - All built form and green space recommendations match those within the public realm
  - Parking space conversion, in lots of 10+ spaces → at least two spaces converted to garden beds, kerb outstands (parklets) along all roads
  - Green Link (as below)
- Green Link in the Employment Precinct
  - Lawn buffer between shared path and understorey vegetation
  - Dense native understorey with flowering species
  - Native tree canopy
  - Water in small permanent pools
  - Ephemeral waterway across entire length (storm water drainage)
- Residential areas
  - Native vegetation to be prioritised at all times, unless vegetable gardens
  - Planter pot provision for all residences: containing least two small native flowering trees/shrubs per balcony
  - Where gardens are being built, provision of several heights of understorey vegetation (0-2m height) in beds (same as public realm)
  - Consider creation of water features in non-enclosed courtyards
  - Biodiversity information boards inside residential blocks

  - Mid-rise buildings prioritised at all times
- Threat mitigation
  - Mandatory control of cats. All domestic cats to be kept indoors. Council control of feral cats and legislation domestic cats
  - No use of herbicides and/or pesticides on gardens
  - Slow speed limit along all streets, especially “local” streets
  - Avoid public spaces with just trees and lawn, which would encourage Noisy miner bird invasion

3. Appendix C: Developing the recommendations

3.1 Process for developing integrated recommendations

After the technical assessments were conducted multiple stages of assessment and collaboration were employed to move from recommendations aimed at individual themes, towards integrated recommendations for total community outcomes. This process is described in Figure 32.

Figure 32 Method for moving from technical recommendations to consolidated integrated recommendations

3.2 Responses from stakeholders at workshops

The final recommendations were developed with consideration of stakeholder opinions at the workshops. These stakeholder opinions are summarised in the below sections.

3.2.1 Propositions with general support

Heat

- Ambitious canopy targets (particularly in priority hot spots, wide streets, east west streets), example of 34% achieved in inner Sydney was given

Wind

- Wind recommendation to have a centralised CFD model used consistently by all developments was supported by multiple stakeholders
- Wind recommendation to have podiums under tall buildings to break up wind gusts was noted as already encouraged in Fishermans Bend controls, and provides multiple other benefits

Biodiversity

- Encouraging biodiversity in the private realm was supported
- Green link/spine through employment precinct was generally supported (but alignment and implementation mechanisms was unresolved)

- Biodiversity connectivity across the freeway (e.g. green bridge overpasses) was supported to some degree, as bridges will be needed regardless (but further investigation is required to explore potential designs and constraints)
- Altering the wavelength of street lights to be insect friendly was generally supported

Urban forest/other

- Green space opportunities should be looked for in the Employment Precinct (and CoM intend to do so)
- Keeping water in the landscape was supported, with tentative agreement that water should be directed to vegetated elements (tree pits, above ground storages etc.) before pipes
- It was agreed that all planning needs to take into account future climate scenarios, and that consideration should be given to staging (where to plant first)

3.2.2 Propositions without general support

Heat

- Suggestion of “white” or “cool” roofs instead of green roofs from a heat perspective was not supported by many attendees, who thought the focus should be on green roofs as they provide multiple benefits

Wind

- Adjusting alignment of employment precinct is too hard and without sufficient justification (the project team agrees)

Biodiversity

- It was suggested by some stakeholders that residents don’t like possums, but others disagreed with this strongly

Urban Forest/other

- Unnecessarily removing existing trees (there was some concern around the trees that GHD has mapped not taking into account existing trees that will remain, but this level of detail was beyond the scope of this project)
- 50% tree canopy target may not be achievable (as indicated by the urban forest mapping)
- Water bodies in public spaces should not be too expansive (because this stops other uses)
- Trees should not be shown in ovals in any modelling scenario

3.2.3 Propositions from individual themes that appear synergistic

- Trees/vegetation provide multiple benefits (heat, wind, biodiversity)
- Water in the landscape (floodable public spaces and linear public spaces) provides multiple benefits (flooding, amenity, heat and biodiversity). Key question is where the water should go first (i.e. send to the drain first or to the streetscape first for passive irrigation)
- Needing a diversity of spaces (e.g. some shaded and some not, some native species and some exotic species) means that different objectives can be met in different locations (e.g. a hierarchy or streetscapes and public spaces)
- Requirements for “roughness elements” to mitigate wind, lining up with a diversity of canopy and understory vegetation for biodiversity

- Living Levee and riverside walk could provide multiple benefits (biodiversity, liveability, active transport)
- Green roofs/walls provide multiple benefits (biodiversity, mental health), the benefits for heat was questioned by some

3.2.4 Potential trade-offs or conflicts between themes

- Some stakeholders seemed supportive of turning the Go Kart track into another public space, but then after hearing from the Westgate Park Biodiversity group, many changed their mind and preferred the idea of "offsetting". For example, selling this land for development and investing in biodiversity elsewhere (either another public space in the Employment Precinct or a Living Levee, mangrove and waterfront area at some point in the future)
- Biodiversity objectives suggest 50% canopy cover in public spaces as an absolute maximum, likewise recreation objectives likely require an even lower canopy cover, and solar access is important in winter. However heat modelling recommends as much canopy as possible. These competing objectives must be balanced against each other
- Some thought there is conflict in species selection between natives and exotics, but many others felt that due to species diversity objectives, and a desire for a diversity of spaces and micro-climates, that this is not a conflict
- Some thought fauna in an area with large population was unrealistic. Likewise some thought aquatic fauna (frogs) were not compatible with the stormwater quality available
- There was some suggestion of locating buildings at North and South ends of streets to block wind, which could have negative implications for amenity/function/solar access
- Some concerns around water in landscape for mosquitos and tripping hazards
- Some concerns around the impact of wind on vegetation (tree health and green podiums/roofs/walls)

4. Appendix D: Fishermans Bend Tree Audit

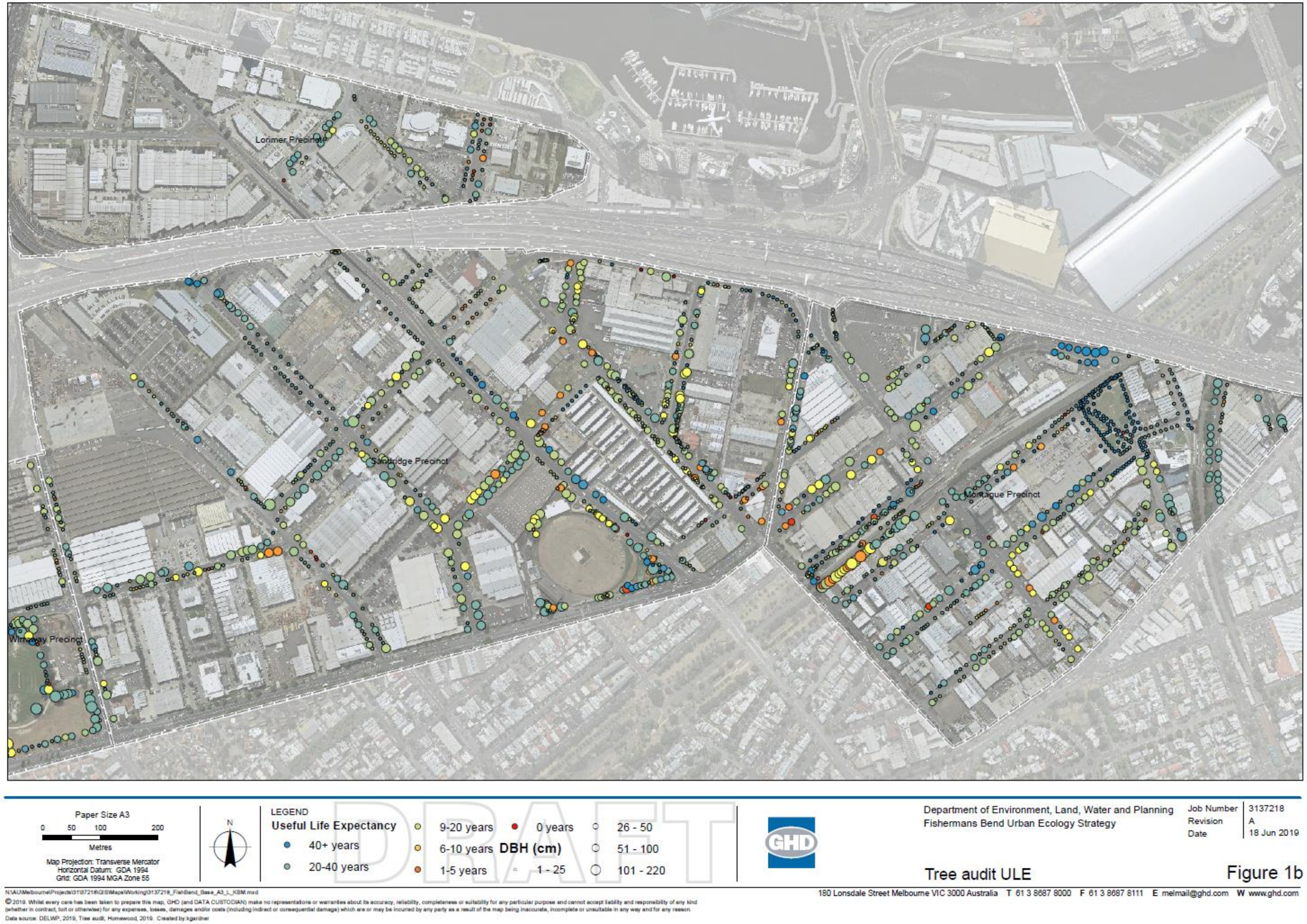

Figure 33 Tree audit for useful life expectancy in Sandridge and Montague

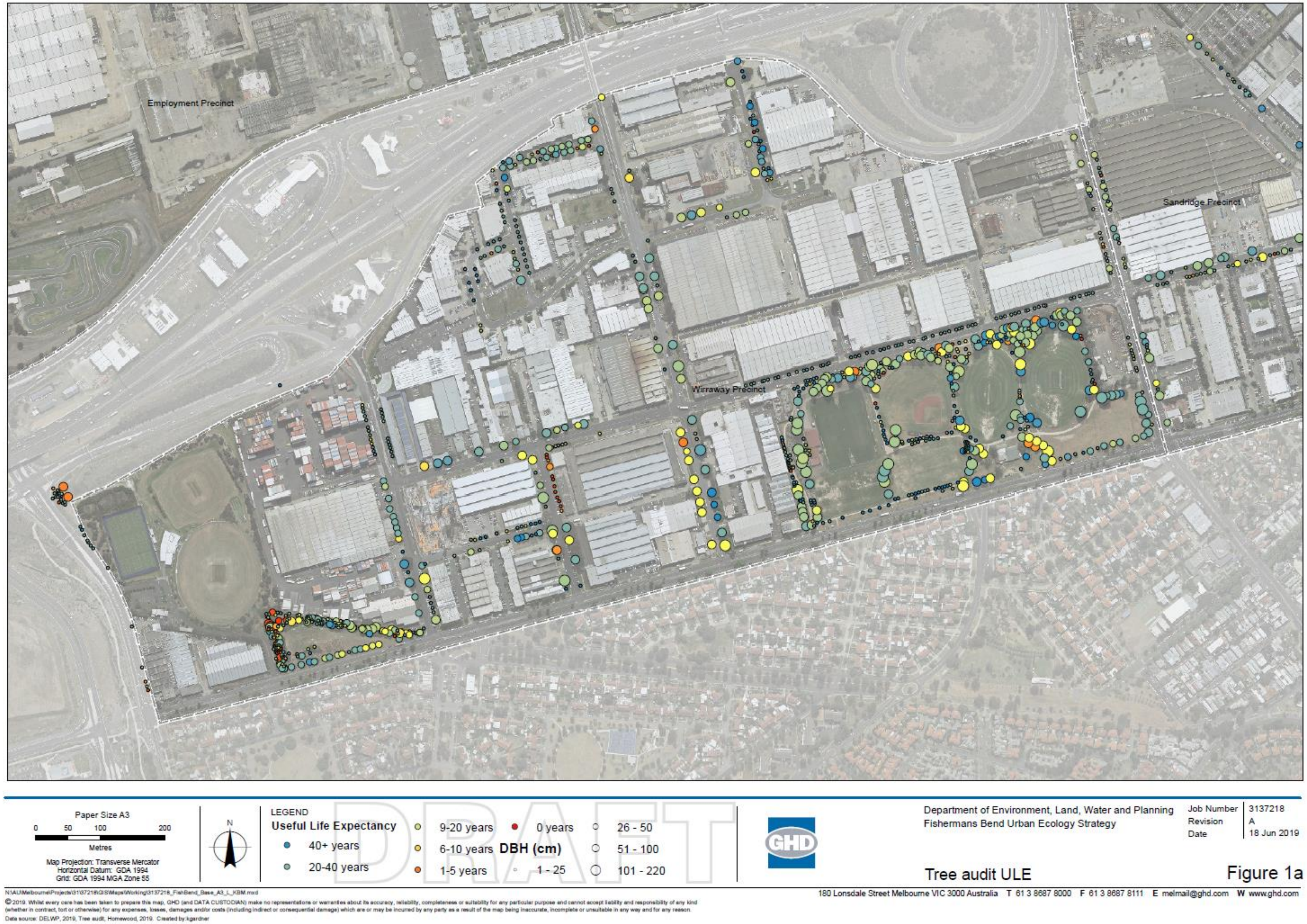

Figure 34 Tree audit for useful life expectancy in Wirraway

5. Appendix E: Background report from ICON Science

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3137218-89324/Draft Fishermans Bend Urban Ecology Study

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		Name	Signature	Name	Signature	Date
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