SUBURBAN RAIL LOOP EAST

SRL East Draft Structure Plan

# Wind Technical Report

More Homes For Victorians

VICTORIA State Government

# Suburban Rail Loop

## PREPARED FOR SUBURBAN RAIL LOOP AUTHORITY

## SRL EAST DRAFT STRUCTURE PLAN – WIND TECHNICAL REPORT

FEBRUARY 2025

REVISION 01

AJM Joint Venture

# Document Control Record

AJM Joint Venture

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| DOCUMENT CONTROL | | | |
|---|---|---|---|
| Project Title | **Suburban Rail Loop East** | | |
| Document Title | **SRL East Draft Structure Plan – Wind Technical Report** | | |
| Document ID | **Technical Report T.1** | | |

| Rev | Date | Revision details/status | Author |
|---|---|---|---|
| 01 | February 2025 | For exhibition | B. Malin |
| Current revision | | 01 | |

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# Executive summary

As part of the Suburban Rail Loop (SRL) East project, Draft Structure Plans (Structure Plans) are being prepared for the neighbourhoods surrounding the new underground stations at Cheltenham, Clayton, Monash, Glen Waverley, Burwood and Box Hill.

The Structure Plans will set a vision and framework to guide growth and change in each neighbourhood, while protecting and preserving the character and features people love about them now.

This SRL East Structure Plan – Wind Technical Report will inform the development of the Structure Plans.

This report is based on computational fluid dynamic (CFD) simulations which modelled existing conditions in the Structure Plan Areas and conditions in the future highly developed scenarios.

## FINDINGS

The main findings of the technical assessment are:

- Existing conditions for all SRL East Structure Plan Areas mostly meet the criteria for sitting or standing, with the exception of some open areas (parklands), where they meet the walking criteria, and some localised spots and tall buildings, where uncomfortable conditions are present.
- Wind comfort conditions will improve as the SRL East Structure Plan Areas develop because the higher density of buildings will reduce wind speeds.
- Some localised areas around tall buildings or in street canyons aligned with northerly winds will experience high (uncomfortable) wind speeds, particularly in the Clayton, Burwood and Box Hill Structure Plan Areas.
- Wind safety exceedances are found in scattered locations in all six SRL East Structure Plan Areas. These safety exceedances are due to downwash, corner acceleration and channelling, and will require mitigation.

## RECOMMENDATIONS

Recommendations to improve wind conditions across all SRL East Structure Plan Areas are made, followed by recommendations specific to each Structure Plan Area.

Recommendations focus on areas where Clause 58.04-4 of the Victoria Planning Provisions (relating to wind impacts of developments of five or more storeys) may not apply, because they are non-residential areas.

Further wind assessment is required at planning permit application stage. Proposed planning controls should incorporate a wind effect analysis within the SRL East Structure Plan Areas in specific areas as identified in the recommendations for each Structure Plan Area below and at various height thresholds.

### All SRL East Structure Plan Areas

The threshold for further wind assessment:

1. A pedestrian-level wind tunnel study is required for developments that meet any of the following criteria:
    a) The building height exceeds 60 metres.
    b) The building height exceeds 40 metres and is exposed to an open area from the north, west, or south. Open areas typically include major arterial roads, highways, parks, large water bodies, or parcels of open land larger than 40 by 40 metres.

c) The development includes a tower-and-podium design with a height exceeding 40 metres and more than one tower.

2. Developments between 20 and 60 metres in height that do not meet criteria 1(b) or 1(c) require a pedestrian-level CFD study.

The recommendations for wind mitigation are:

3. Setbacks and podiums are recommended for tall buildings and large building compounds to reduce downwash.
4. Breaking up large continuous north-facing façades in buildings that are considerably higher than their surroundings is recommended to reduce downwash and channelling effects.
5. Gradually increasing the height of buildings in the direction of the predominant winds (in this case, increasing height from north to south) is recommended to help reduce the effects of downwash, as taller buildings are partially shielded by the smaller buildings upstream.
6. Chamfered (sloping) or rounded building corners are recommended to reduce wind acceleration around corners.
7. Wide streets are recommended to reduce wind channelling and increase air dispersion.
8. Awnings, canopies or screens are recommended in areas with uncomfortable wind conditions to reduce wind speeds to acceptable levels.
9. Trees and landscaping should not be used to mitigate wind impacts, except in sitting areas (as a supplementary measure) where trees with dense foliage and street furniture can assist in reducing wind speeds.

### Cheltenham Structure Plan Area

The modelling found no uncomfortable wind conditions in the future scenario of the Cheltenham Structure Plan Area. Some regions of walking conditions might require mitigation depending on their intended use. Safety exceedances are created mainly by cornering and channelling effects, therefore:

10. Breaking up large continuous north-facing facades is recommended to reduce downwash and channelling.
11. Chamfered or rounded building corners are recommended to reduce wind acceleration around corners.
12. Awnings, canopies or screens are recommended to shield and reduce wind speeds in seating areas if required.

### Clayton Structure Plan Area

The modelling found uncomfortable and unsafe wind conditions in the future scenario around the SRL station at Clayton with tall buildings causing significant downwash, and along Wellington Road (North Road) where tall buildings on the western side of the Structure Plan Area presenting a large façade to the north and the laneways between them are aligned with the northerly winds, creating a channelling effect; therefore:

13. Breaking up the large façade is recommended to reduce downwash and channelling.
14. Gradually increasing the height of buildings in the direction of the predominant winds (in this case, increasing height from north to south) is recommended to reduce the effects of downwash.
15. Podiums, setbacks and awnings are recommended to reduce downwash on the building above the SRL station at Clayton.

## Monash Structure Plan Area

The modelling found no uncomfortable wind conditions in the future scenario in the Monash Structure Plan Area. Walking conditions along the south side of Ferntree Gully Road and Wellington Road due to wind channelling through the narrow street were identified. Downwash and channelling are the main mechanisms causing unsafe conditions; therefore:

16. Setbacks and podiums on tall buildings are recommended to reduce downwash.
17. Chamfered or rounded corners are recommended on unshielded façades, particularly those which are north-facing and west-facing.

## Glen Waverley Structure Plan Area

The modelling found no uncomfortable wind conditions in the future scenario in the Glen Waverley Structure Plan Area. Walking criterion is met around The Glen Shopping Centre. Downwash and channelling are the main mechanisms causing unsafe conditions, therefore:

18. Setbacks and podiums on tall buildings are recommended to reduce downwash.
19. Chamfered or rounded corners are recommended on unshielded façades, particularly those which are north-facing and west-facing.
20. Trees or street furniture are recommended to reduce uncomfortable wind speeds to acceptable levels in seating areas where required.

## Burwood Structure Plan Area

The modelling found uncomfortable and unsafe wind regions scattered in the mixed-use region along Burwood Highway in the future scenario, particularly around building corners and laneways around large building compounds, therefore:

21. Setbacks and podiums are recommended on tall buildings to reduce downwash.
22. Chamfered or rounded corners are recommended on north-facing façades along Burwood Highway, particularly for those buildings on the eastern edge of the Burwood Structure Plan Area and for the building above the SRL station at Burwood.

## Box Hill Structure Plan Area

The modelling found wind safety exceedances around the Whitehorse Towers and ATO building on Whitehorse Road, and next to Sky One Tower on Station Street, caused by downwash and channelling; therefore:

23. Setbacks and podiums are recommended on tall buildings to reduce downwash.
24. Chamfered or rounded corners are recommended on north-facing facades to reduce cornering effects and wind channelling through narrow streets.
25. Screens and street furniture are recommended to shield seating areas from northerly winds.
26. Chamfered or rounded corners are recommended on north-facing facades of tall buildings along the northern side of Whitehorse Road close to Box Hill City Oval to reduce wind channelling and corner acceleration.

# 1. Introduction

Suburban Rail Loop (SRL) is a transformational project that will help shape Melbourne's growth in the decades ahead. It will better connect Victorians to jobs, retail, education, health services and each other – and help Melbourne evolve into a 'city of centres'.

SRL will deliver a 90-kilometre rail line linking every major train service from the Frankston Line to the Werribee Line via Melbourne Airport.

SRL East from Cheltenham to Box Hill will connect major employment, health, education and retail destinations in Melbourne's east and south east. Twin 26-kilometre tunnels will link priority growth suburbs in the municipalities of Bayside, Kingston, Monash and Whitehorse.

SRL East Draft Structure Plan (Structure Plan) Areas will surround the six new underground stations at Cheltenham, Clayton, Monash, Glen Waverley, Burwood and Box Hill.

## 1.1 Purpose of this report

This SRL East Structure Plan – Wind Technical Report will inform the development of the Structure Plans to guide land use planning and development in the SRL East Structure Plan Areas.

The report describes the existing pedestrian wind comfort conditions in each SRL East Structure Plan Area.

Issues and opportunities relating to pedestrian comfort and safety that impact planning for the development of each SRL East Structure Plan Area are identified.

Recommendations to consider when developing the Structure Plans are made, with the objective to avoid, minimise or manage potential negative impacts of change, and to maximise potential for positive change.

## 1.2 Project context

Construction of the SRL East underground stations is underway at Cheltenham, Clayton, Monash, Glen Waverley, Burwood and Box Hill. This provides an opportunity to enhance the surrounding neighbourhoods.

SRL East will support thriving and sustainable neighbourhoods and communities that offer diverse and affordable housing options, with easy access to jobs, transport networks, open space, and community facilities and services.

A vision for each SRL East Structure Plan Area and surrounds has been developed in consultation with the community and stakeholders. The visions set out the long-term aspirations for these areas, ensuring they are ready to meet the needs of the growing population.

Figure 1.1 shows SRL East in the context of the entire SRL project and Melbourne's rail network.

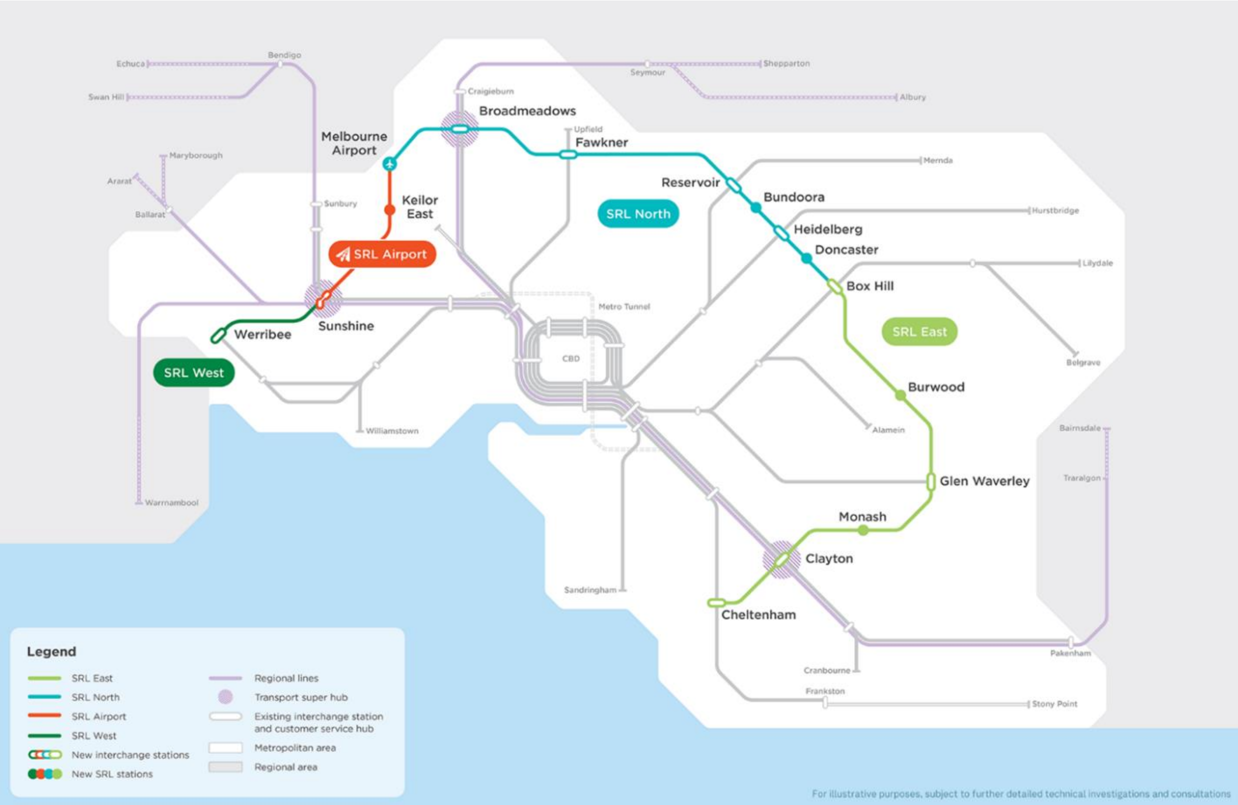



**FIGURE 1.1 SRL EAST CONTEXT IN MELBOURNE'S RAIL NETWORK**

## 1.3 Structure planning

Structure Plans are being prepared for defined areas surrounding the SRL East stations to help deliver the vision developed for each SRL East neighbourhood.

The Structure Plans cover defined SRL East Structure Plan Areas that can support the most growth and change. These areas cover a walkable catchment that extends from the SRL station entrances. Additional places are included within each Structure Plan Area as required to make planning guidance more robust and effective, and to align with each community's aspirations and current and future needs.

A Structure Plan is a blueprint to guide how an area develops and changes over a period of time. Structure Plans describe how future growth within the area will be managed in an appropriate and sustainable way to achieve social, economic and environmental objectives. The Structure Plans cover a wide range of matters, such as transport connections and car parking, housing and commercial development, community infrastructure, urban design, open space, water and energy management, climate resilience and sustainability.

By tailoring planning decisions to reflect the needs of a defined area, Structure Plans give effect to the policies and objectives set for these areas and cater for changing community needs. They also provide certainty for residents, businesses and developers by identifying the preferred locations and timing of future land uses, development and infrastructure provision.

Structure Plans take a flexible and responsive approach that enables places to evolve over time.

Planning scheme amendments will be required to implement the Structure Plans into the planning schemes of the cities of Bayside, Kingston, Monash and Whitehorse.

## 1.4 Structure of this report

- **Section 1** provides the background and context of the technical assessment.
- **Section 2** explains the methodology for the technical assessment and the terminology of major wind effects around buildings and developments, and summarises the principle of computational wind modelling.
- **Section 3** defines the six SRL East Structure Plan Areas.
- **Section 4** summarises legislation, policies and other documents relevant to the assessment.
- **Section 5** provides the assessment of existing wind conditions in each SRL East Structure Plan Area.
- **Section 6** provides the assessment of wind conditions for the future developed scenarios in each SRL East Structure Plan Area.
- **Section 7** sets out recommendations to consider when developing the Structure Plans.

# 2. Methodology

The methodology for this technical assessment involved:

- Study Areas for the technical assessment were identified. For this assessment the Study Areas are the same area as the SRL East Structure Plan Areas (see Section 3).
- Legislation, policies and documents relevant to the assessment, and to land use planning and development in the SRL East Structure Plan Areas were reviewed (see Section 4).
- Local wind environment of the SRL East Structure Plan Areas is discussed based on the historical 10-minute records of wind speed at Moorabbin Airport (see Section 5). This weather station provides the most accurate data available in the proximity of the SRL East Structure Plan Areas.
- Wind conditions for the existing conditions in the SRL East Structure Plan Area were identified (see Section 5).
- Wind conditions for the future scenarios in the SRL East Structure Plan Area were identified (see Section 6).
- Issues, challenges and opportunities relating to wind and land use planning and development in the SRL East Structure Plan Areas were identified (see Section 6).
- Based on the assessment, recommendations were developed to avoid, minimise or manage potential negative impacts of change relating to wind comfort and safety and to maximise potential for positive change in the SRL East Structure Plan Areas (see Section 7).

## 2.1 Local wind effects

A schematic illustration of the wind flow pattern around a single wide high-rise building is shown in Figure 2.1. As the wind flow approaches the building it gradually diverges. Part of the flow is deviated over the building (1) and part of it flows around the building (2). At the windward façade, a stagnation point with maximum pressure is situated at approximately 70 per cent of the building height. From this point, the flow is deviated to the lower pressure zones of the façade: upwards (3), side-wards (4) and downwards (5).

The considerable amount of air flowing downwards produces a vortex at the ground level (6) called a standing vortex, frontal vortex or horseshoe vortex. The main flow direction of the standing vortex near the ground level is opposite to the direction of the approach flow. Where both flows meet, a stagnation point with low wind speed values is created at the ground floor in front of the building (7). The standing vortex stretches out sideways and sweeps around the building corners where flow separation occurs and corner streams with high wind speed values are created (8). The corner streams subsequently merge into the general flow around the corners (9).

At the leeward side of the building, an under-pressure zone is created. As a result, backflow or recirculation flow occurs (10,13). A stagnation zone is marked downstream of the building at the ground level where the flow directions are opposite each other and low wind speeds exist (11; end of the recirculation zone). Beyond the stagnation zone, the flow resumes its normal direction, but wind speeds stay low for a considerable distance behind the building (that is, the far wake) (12).

The backflow is also responsible for creating slow rotating vortices behind the building (13). Between these vortices and the corner streams (9), a zone with a high velocity gradient exists (the shear layer) that comprises small, fast rotating vortices (16). The shear layers originate at the building corners where flow separation occurs (Blocken and Carmeliet, 2004).

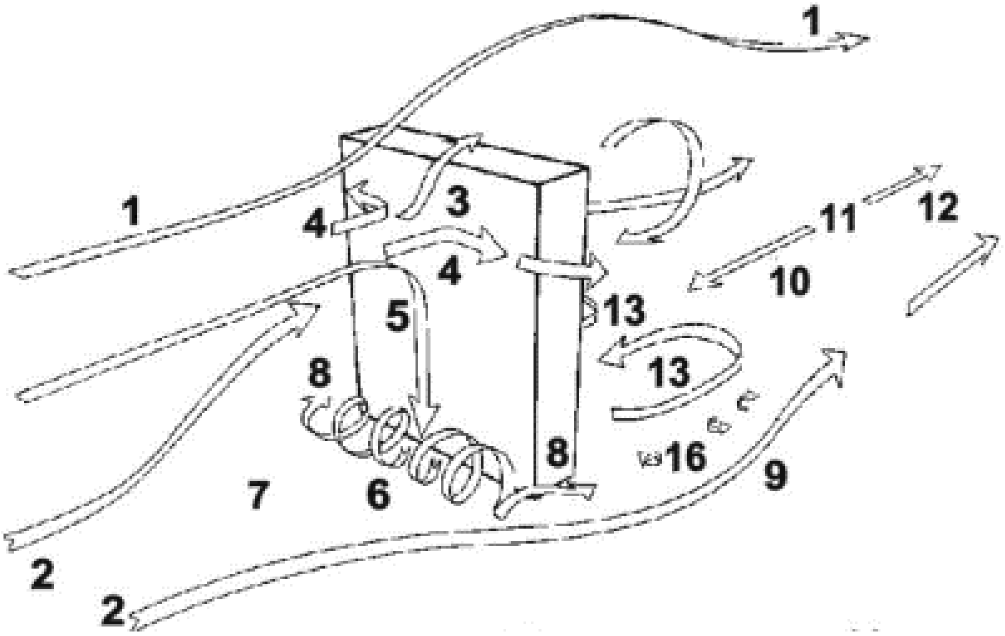



**FIGURE 2.1 WIND EFFECTS AROUND A BUILDING**
*Source: Blocken and Carmeliet, 2004*

Wind channelling occurs when wind is funnelled between buildings close to each other. The sudden reduction in cross section encountered by the wind forces it to accelerate, creating high speed wind corridors, as shown in Figure 2.2.

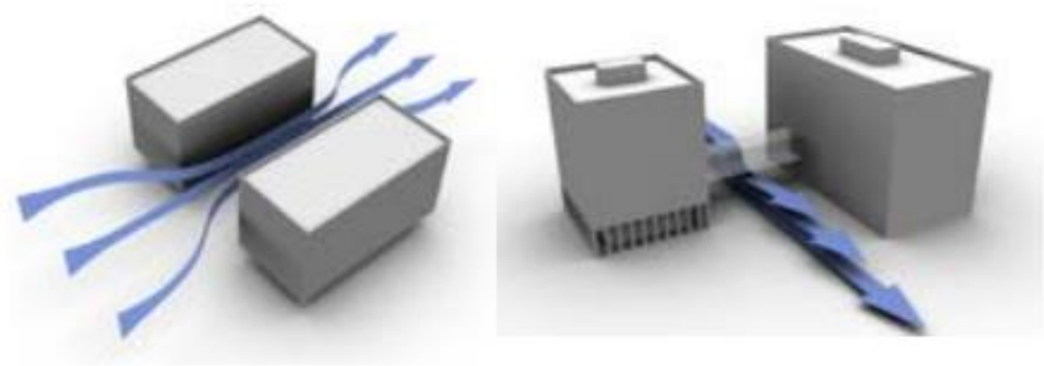


**FIGURE 2.2 WIND CHANNELLING EFFECT (CITY OF TORONTO, 2022)**

## 2.2 Wind climate

The wind climate of the SRL East Structure Plan Areas is adjusted based on the meteorological observations for the measurement station located at Moorabbin Airport, taking into account the terrain roughness of the observation site and the SRL East Structure Plan Areas. Detailed scaling information is provided in Appendix A.1. The data was obtained from the Bureau of Meteorology (BoM). Historical 10-minute records of wind speed data for the years 1997 to 2024 were utilised for analysis to understand the local wind environment.

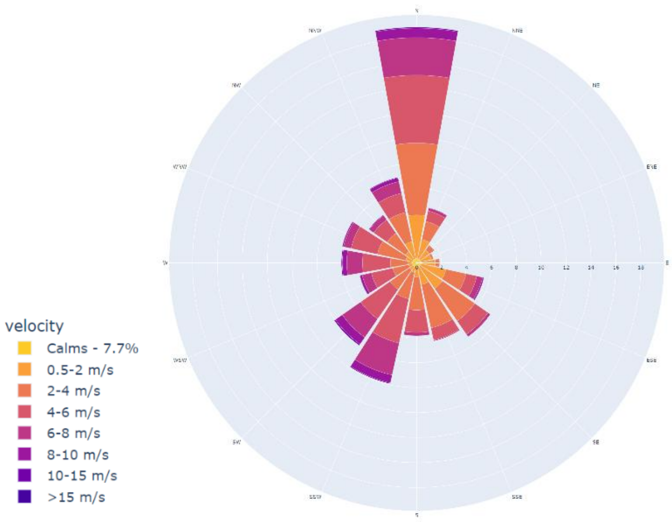
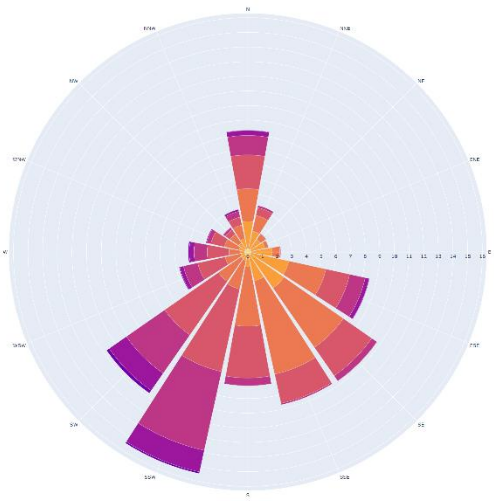
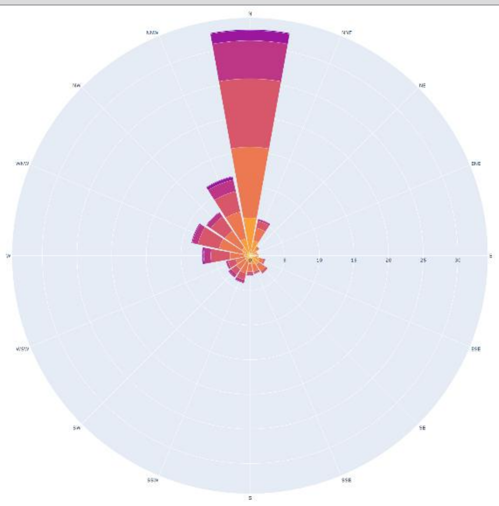
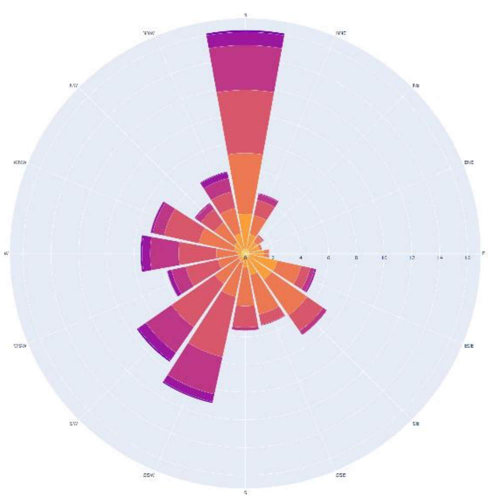
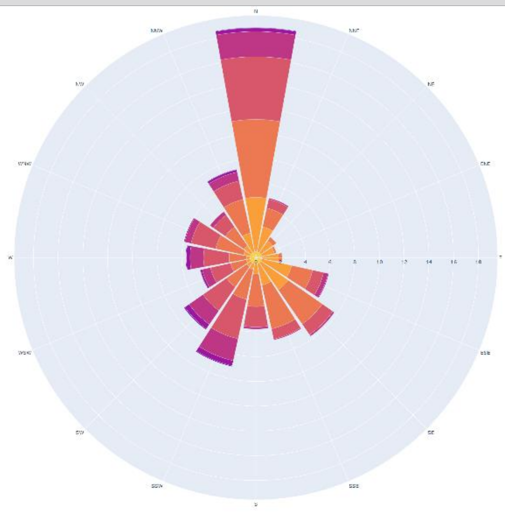
Yearly and seasonal wind-roses applicable to all SRL East Structure Plan Areas are provided in Table 2.1. The wind rose in the table shows the frequency and magnitude of wind speeds from different wind directions obtained from 27 years of wind data.

The prevailing winds across all SRL East Structure Plan Areas is from the north, with the second most frequent wind from the south. Easterly winds are rare by comparison. As shown by the seasonal wind roses, the northerly wind is particularly dominant during the cold winter months, while during the warm summer months, the frequency of southerlies increases, becoming more frequent than the northerlies. However, when considering wind strength, the westerly is the second-most important wind direction next to the northerlies.

The effect of these seasonal differences is that buildings in SRL East Structure Plan Areas should generally seek to mitigate against strong northerly and westerly winds, which are likely to cause discomfort due to their velocity and temperature. By contrast, mitigating southerly winds is less critical as they typically are lower velocity and tend to occur more often in summer.

During summer, a cooling breeze can be promoted through pedestrian areas to enhance thermal comfort. In addition, building orientation can be selected so as to optimise natural ventilation and reduce the heat island effect.

**TABLE 2.1 YEARLY AND SEASONAL WIND ROSES FOR THE SRL EAST STRUCTURE PLAN AREAS (BASED ON MOORABBIN AIRPORT CLIMATE DATA)**

| Yearly | |
|---|---|
|   | |
| **Summer** | **Winter** |
|  |  |
| **Spring** | **Autumn** |
|  |  |

## 2.3 Computational wind model

A computational fluid dynamic (CFD) simulation was performed to model existing wind conditions in each SRL East Structure Plan Area, and conditions in the future developed scenarios (see Section 2.2 for defined conditions).

Inflow wind conditions were generated based on the meteorological data in Section 2.2. Details of the simulation settings are provided in Appendix A.

CFD was used to determine the mean wind speed ($\overline{U}$) and turbulent kinetic energy ($k$) at a height of 1.5 metres for 16 wind directions relative to a reference wind speed of 10 metre per second (m/s).

Gust-equivalent mean wind speeds, $U_{GEM}$, were calculated using:

$$U_{GEM} = \frac{\overline{U} + 2.6\sqrt{k}}{1.85}$$

Where 2.6 is the peak factor corresponding to a 3-second gust relative to a 10-minute mean according to ESDU (Engineering Sciences Data Unit, 2008). The gust equivalent mean factor of 1.85 has been used based on the Melbourne City criteria. Wind speed for the criteria defined as the maximum of mean and gust equivalent mean wind speed:

$$U_{\text{criteria}} = \max(\overline{\text{U}}, U_{GEM})$$

Comfort wind speeds were calculated using a Weibull statistical analysis (see Appendix A.2) of the 10-minute mean wind speed results, with a probability of exceedance of 20 per cent from all directions.

Safety wind speeds were calculated using an Extreme Value statistical analysis (see Appendix A.2 of the 3-second gust wind speed results, with a probability of exceedance of 0.1% from all directions. It's assumed that the 3-second gust wind speed and the 10-minute mean wind speed have the same Gumbel distribution, as the historical record of the 3-second gust wind is not available. Gust wind speeds, $\widehat{U}$, were calculated from mean wind speed results using the same peak factor as gust-equivalent mean wind speeds:

$$\widehat{U} = \overline{U} + 2.6\sqrt{k}$$

## 2.4 Assumptions and limitations

The following assumptions and limitations apply to this technical assessment:

- The existing building geometry is based on the Digital Twin Victoria (DTV) Program (provided by SRLA) completed in 2023 and no site visits were conducted. While the model was updated using the latest Nearmap Aerial Imagery 2024 for this assessment, it cannot be guaranteed that all recent developments or all building features are included.
- The effects of vegetation and tree canopy are not considered.
- The assessment only considers the existing conditions and future conditions. The future conditions scenarios assume the SRL East Structure Plan Areas are fully developed according to the built form and land use frameworks outlined in the Structure Plans. The intermediate conditions between the existing conditions and future conditions are not considered in this assessment, and may differ significantly from the presented results.
- A separate study should be undertaken for individual high-rise buildings as they are developed to ensure comfort and safety criteria are met at each stage.

# 3. SRL East Structure Plan Areas

This section defines each SRL East Structure Plan Area.

## 3.1 Cheltenham Structure Plan Area

The Cheltenham Structure Plan Area surrounds the SRL East station at Cheltenham in the cities of Kingston and Bayside.

The Cheltenham Structure Plan Area is generally bordered by residential land north of Stayner Grove and Alison Street to the north, residential land east of Chesterville Road to the east, Park Road to the south and Middleton Street and Worthing Road to the west.

The Cheltenham Structure Plan Area is intersected by Nepean Highway and the Frankston Line.

The Cheltenham Structure Plan Area is shown in Figure 3.1.


**FIGURE 3.1 CHELTENHAM STRUCTURE PLAN AREA**

## 3.2 Clayton Structure Plan Area

The Clayton Structure Plan Area surrounds the SRL East station at Clayton in the cities of Monash and Kingston.

The Clayton Structure Plan Area is generally bordered by North Road / Wellington Road to the north, Ormond Road to the west, residential lots between Alward Avenue and Murdock Street, and parts of the Cranbourne / Pakenham Line to the south, and Kombi Road and Buckland Street to the east.

Dandenong Road is a major road, running in a north-west to south-east alignment through the edge of the Clayton Structure Plan Area. The existing Cranbourne / Pakenham Line intersects the Clayton Structure Plan Area in an east-west alignment.

The Clayton Structure Plan Area is shown in Figure 3.2.

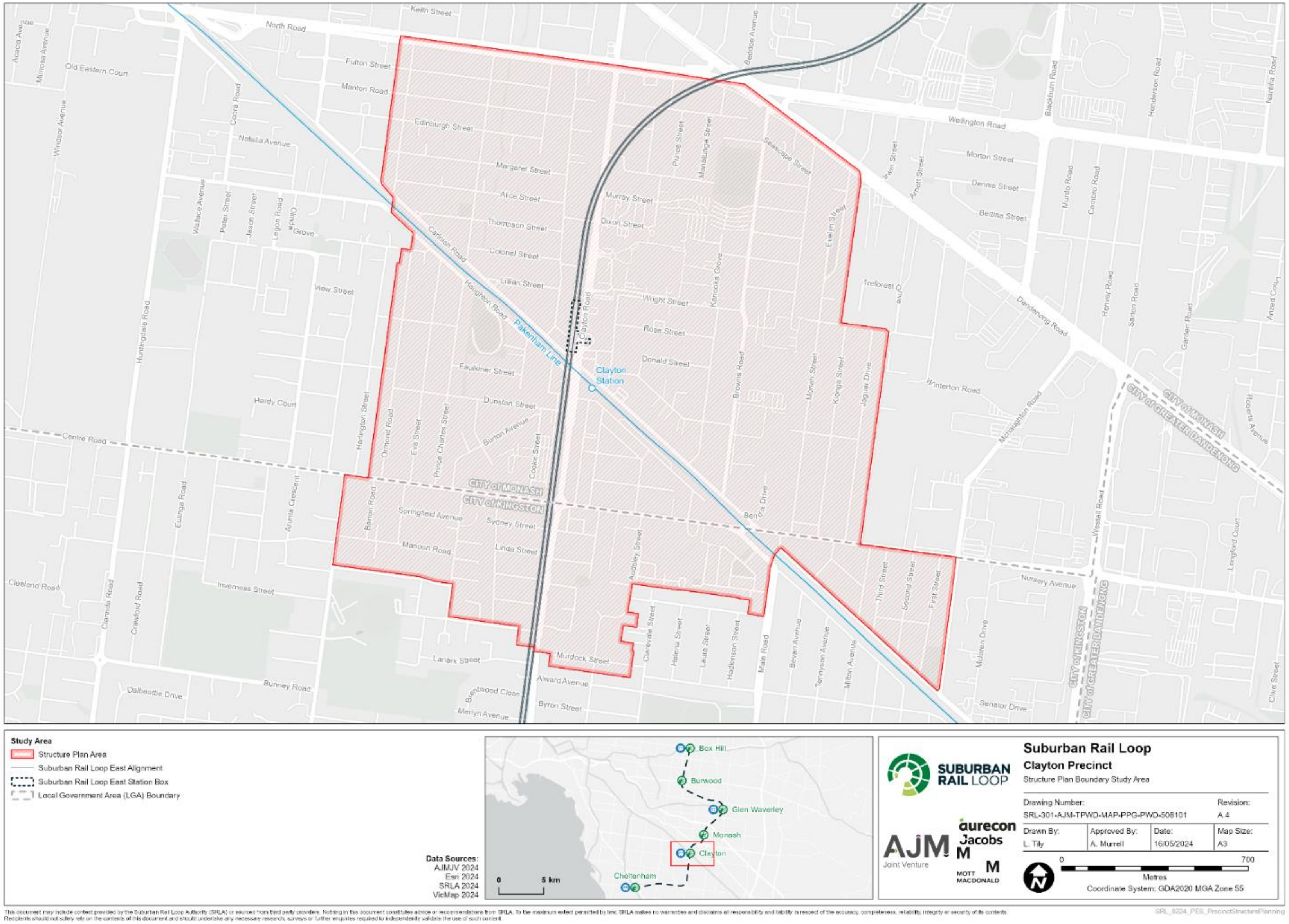



**FIGURE 3.2 CLAYTON STRUCTURE PLAN AREA**

## 3.3 Monash Structure Plan Area

The Monash Structure Plan Area surrounds the SRL East station at Monash in the City of Monash.

It is generally bordered by Wellington Road and Princes Highway to the south, Gardiner Road and residential properties between Clayton Road and Dover Street to the west, land north of Ferntree Gully Road to the north and a reservation for a future road, which forms a natural barrier to properties to the east.

Monash University Clayton campus is located in the Monash Structure Plan Area.

The Monash Structure Plan Area is shown in Figure 3.3.

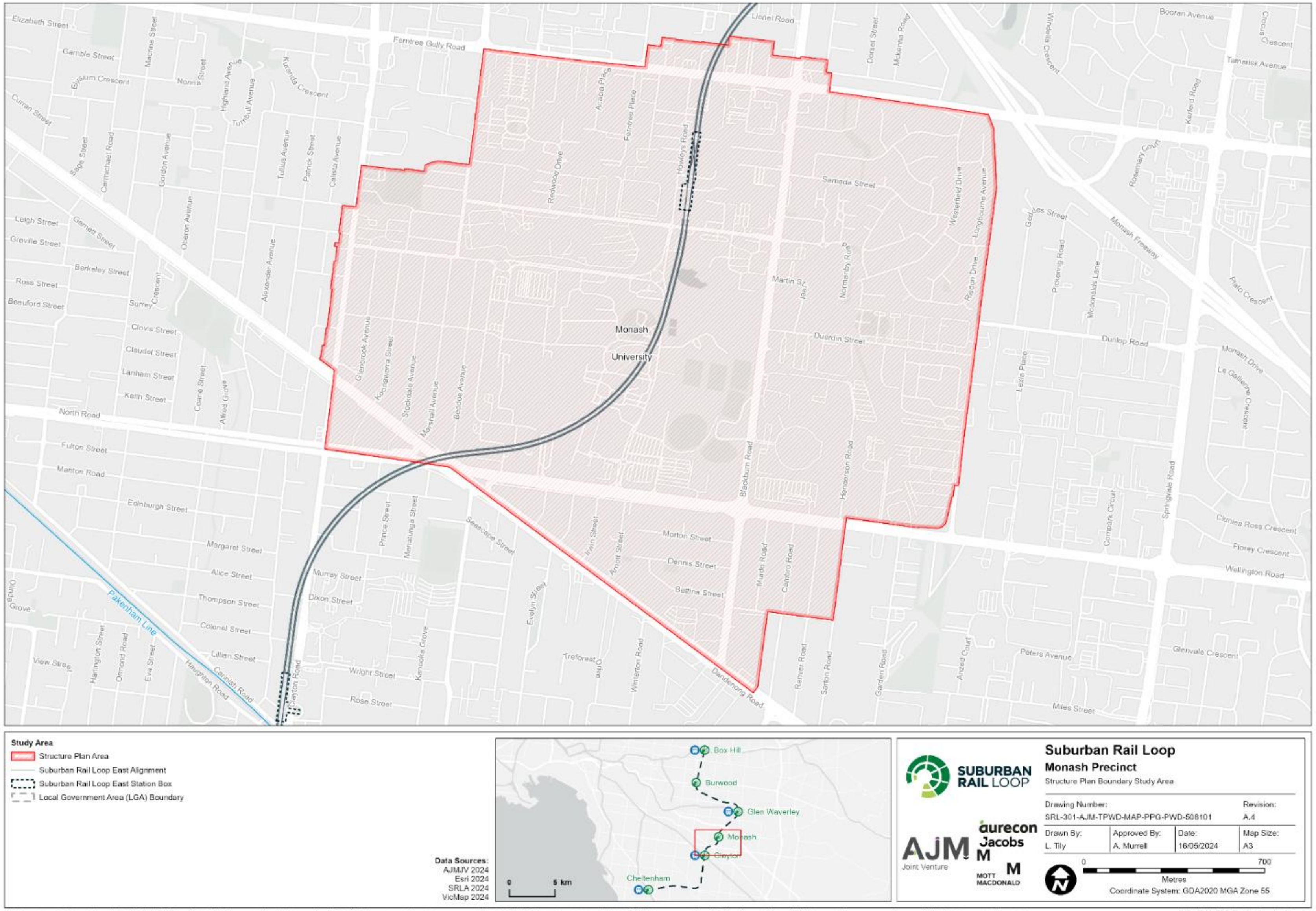



**FIGURE 3.3 MONASH STRUCTURE PLAN AREA**

## 3.4 Glen Waverley Structure Plan Area

The Glen Waverley Structure Plan Area surrounds the SRL East station at Glen Waverley in the City of Monash.

It is generally bordered by Madeline Street to the north, Danien Street and The Outlook to the east, Waverley Road to the south and Kinnoull Grove and Rose Avenue to the west.

Coleman Parade and the existing Glen Waverley Line intersect the centre of the Glen Waverley Structure Plan Area in an east-west alignment.

Key arterial roads include Springvale Road, which intersects the Glen Waverley Structure Plan Area in a north-south alignment, and High Street Road and Waverley Road.

The Glen Waverley Structure Plan Area is shown in Figure 3.4.

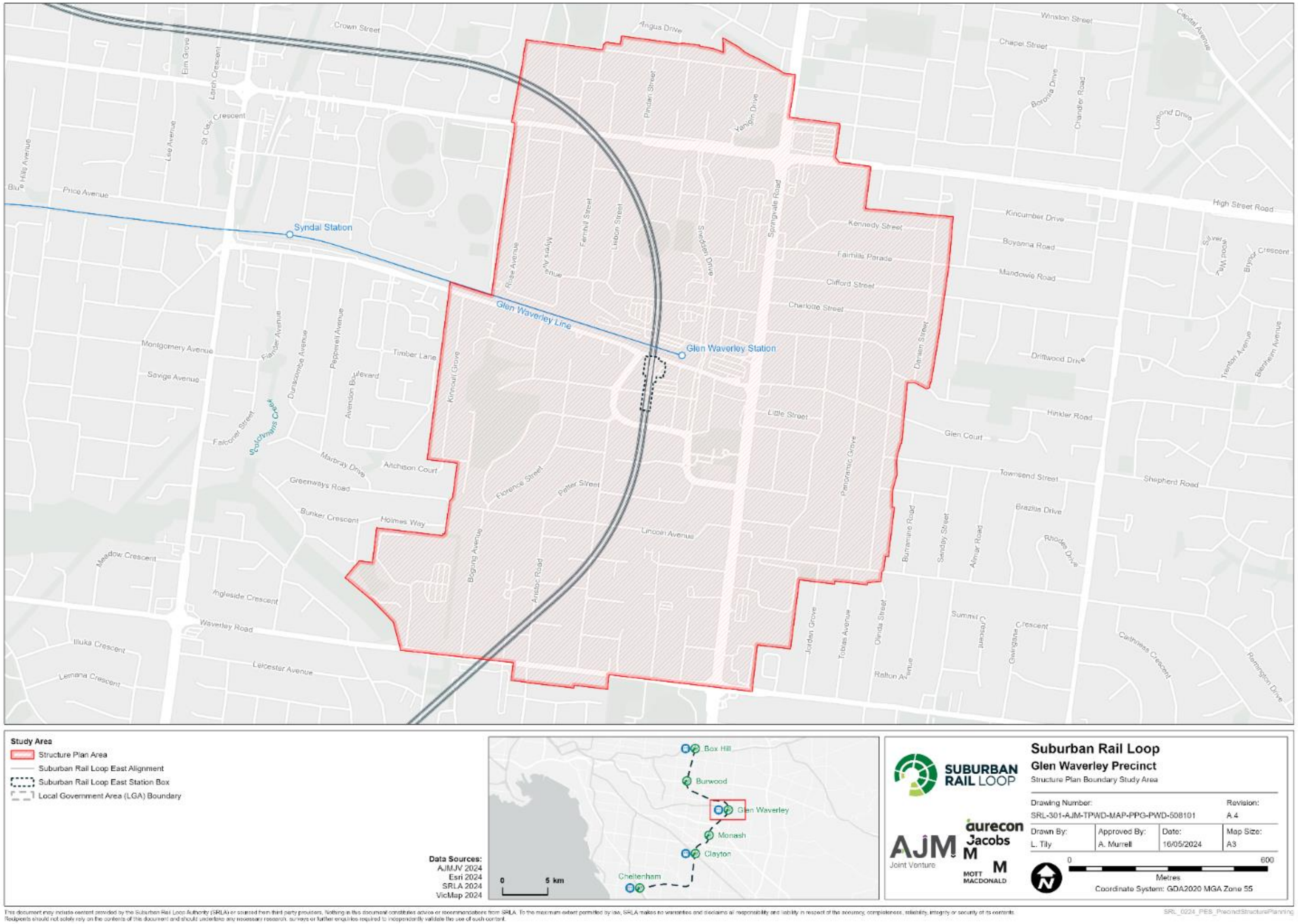



FIGURE 3.4 GLEN WAVERLEY STRUCTURE PLAN AREA

## 3.5 Burwood Structure Plan Area

The Burwood Structure Plan Area surrounds the SRL East station at Burwood. The Burwood Structure Plan Area is mainly located in the City of Whitehorse, with the southern portion south of Highbury Road extending into the City of Monash.

The Burwood Structure Plan Area is generally bounded by Uganda Street, Deakin University, Inverness Avenue, Bronte Avenue and Yarra Bing Crescent to the north, Andrews Street, Wridgway Avenue, Prospect Street and Huntingdale Road to the east, Zodiac Street, Ashwood Drive, Carmody Street and Barlyn Road to the south and Sixth Avenue, Evans Street, Warrigal Road, Parer Street and Meldan Street to the west.

Burwood Highway intersects the centre of the Burwood Structure Plan Area in an east-west alignment.

Deakin University Burwood campus is located in the Burwood Structure Plan Area.

The Burwood Structure Plan Area is shown in Figure 3.5.

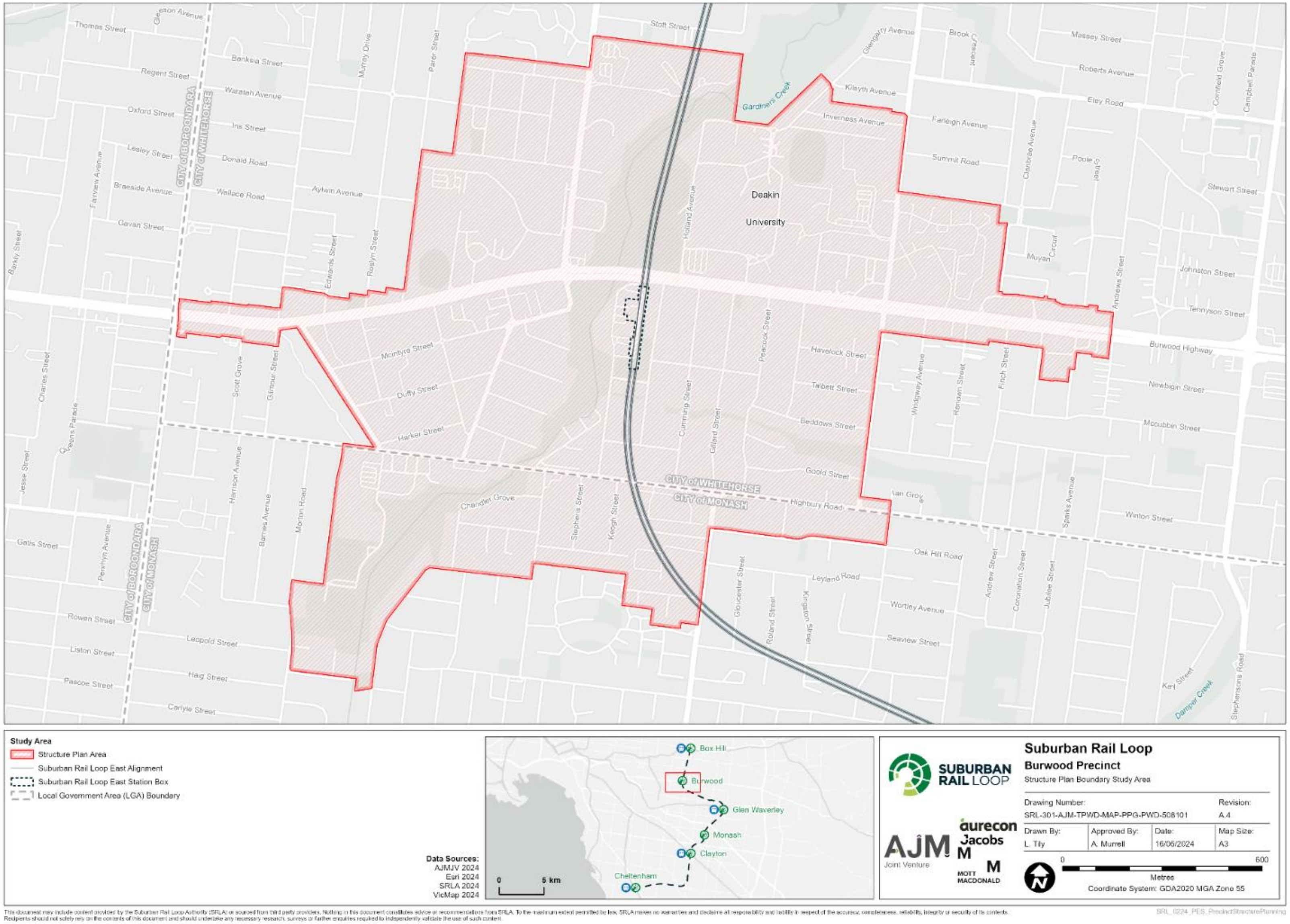



**FIGURE 3.5 BURWOOD STRUCTURE PLAN AREA**

## 3.6 Box Hill Structure Plan Area

The Box Hill Structure Plan Area surrounds the SRL East station at Box Hill in the City of Whitehorse.

It is generally bordered by Severn Street and McKean Street to the north, Clota Avenue and Laburnum Street to the east, slightly west of Elgar Road to the west and Canterbury Road to the south.

Whitehorse Road / Maroondah Highway and the existing Belgrave / Lilydale Line intersect the centre of the Box Hill Structure Plan Area in an east-west alignment. The main road corridors include Whitehorse Road, Elgar Road and Station Street.

The Box Hill Structure Plan Area is shown in Figure 3.6

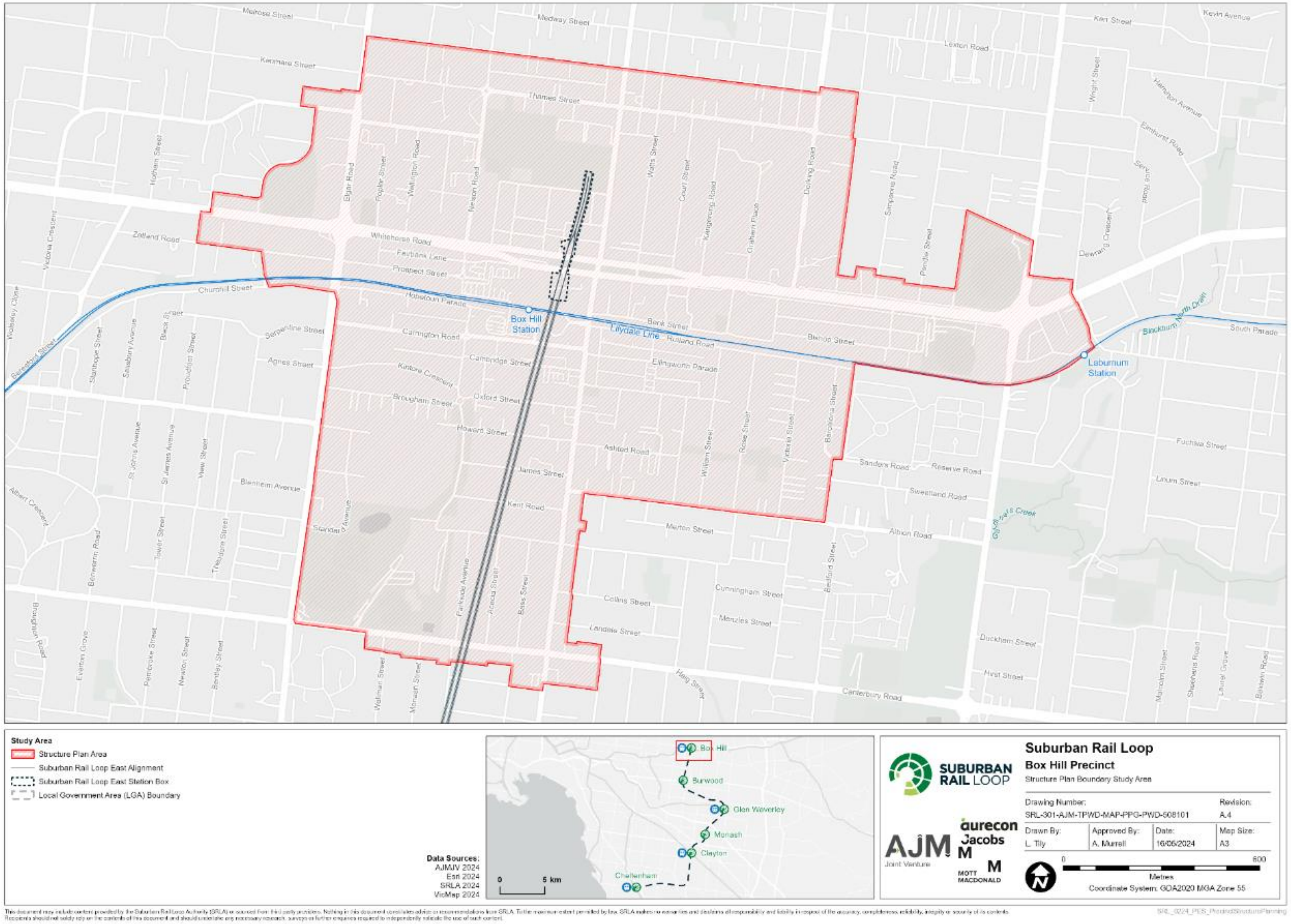



FIGURE 3.6 BOX HILL STRUCTURE PLAN AREA

# 4. Legislative and policy context

This section summarises legislation, polices and other documents relevant to the wind technical assessment, and to land use planning and development in the SRL East Structure Plan Areas.

## 4.1 State

### PLANNING AND ENVIRONMENT ACT 1987 (VIC)

The *Planning and Environment Act 1987* (Vic) establishes a framework for planning the use, development and protection of land in Victoria. It sets out procedures for preparing and amending the Victoria Planning Provisions (VPPs), which are the standard provisions that form the framework for all Victoria's planning schemes.

#### Planning practice notes

Planning practice notes provide technical advice on different aspects of the Victorian planning system.

Planning Practice Note 60 (PPN60) offers guidance on the preferred approach to the application of height and setback controls for activity centres. It outlines that during the structure planning process, built form outcomes should be supported by a comprehensive analysis, including an assessment of wind impacts.

PPN93 provides specific guidance related to wind impacts for an apartment development of five or more storeys. It defines safe conditions as those that allow a person to safely walk and stand in gusty winds. It also outlines that comfortable wind conditions are those that allow a person to comfortably sit, stand or walk without being unduly impacted by the wind.

As per PPN93, all public land, publicly accessible areas on private land, private open space and communal open space, within the assessment distance should achieve the 'safe' wind condition. However, private open spaces do not require an assessment against the 'comfortable' wind criteria.

#### Clause 58.04-4 Wind impacts

Clause 58.04-4 of the VPPs addresses wind impacts associated with development of five or more storeys (excluding a basement) and seeks to ensure the design and layout of development does not generate unaccepted wind impacts.

Standard D17 under Clause 58.04-4 requires an assessment of wind impacts and the level of wind speed to be achieved to ensure safety and comfort for pedestrians and people using outdoor areas.

Safe and comfortable wind conditions are defined by thresholds, as outlined in Table 4.1.

**TABLE 4.1 THERESHOLDS FOR SAFE AND COMFORTABLE WIND CONDITIONS UNDER CLAUSE 58.04-4**

| TABLE D6 WIND CONDITIONS | |
|---|---|
| UNSAFE | COMFORTABLE |
| Annual maximum 3-second gust wind speed exceeding 20 metres per second with a probability of exceedance of 0.1% considering at least 16 wind directions. | Hourly mean wind speed or gust equivalent mean speed (3-second gust wind speed divided by 1.85), from all wind directions combined with probability of exceedance less than 20% of the time, equal to or less than:<br>• 3 metres per second for sitting areas<br>• 4 metres per second for standing areas<br>• 5 metres per second for walking areas. |

*Source: Clause 58.04-4 (Wind impacts) of the Victoria Planning Provisions*

# 5. Existing conditions

This section describes the existing wind conditions in each SRL East Structure Plan Area.

Existing conditions for all SRL East Structure Plan Areas mostly meet the criteria for sitting or standing, except for some open areas (parklands), where they meet the walking criteria, and some localised places around tall buildings, where uncomfortable conditions are present. These criteria do not imply a ‘pass or fail’; rather, they indicate the suitability of a space for different activities.

Local wind climate effects around buildings that affect pedestrian comfort and safety are discussed in Section 2.1.

## 5.1 Cheltenham Structure Plan Area

Existing wind conditions meet the walking or the standing criteria for most of the Cheltenham Structure Plan Area (Figure 5.1), with some regions meeting the walking criterion in open areas and parklands. No areas of uncomfortable or unsafe conditions were identified (Figure 5.2 and Figure 5.3).

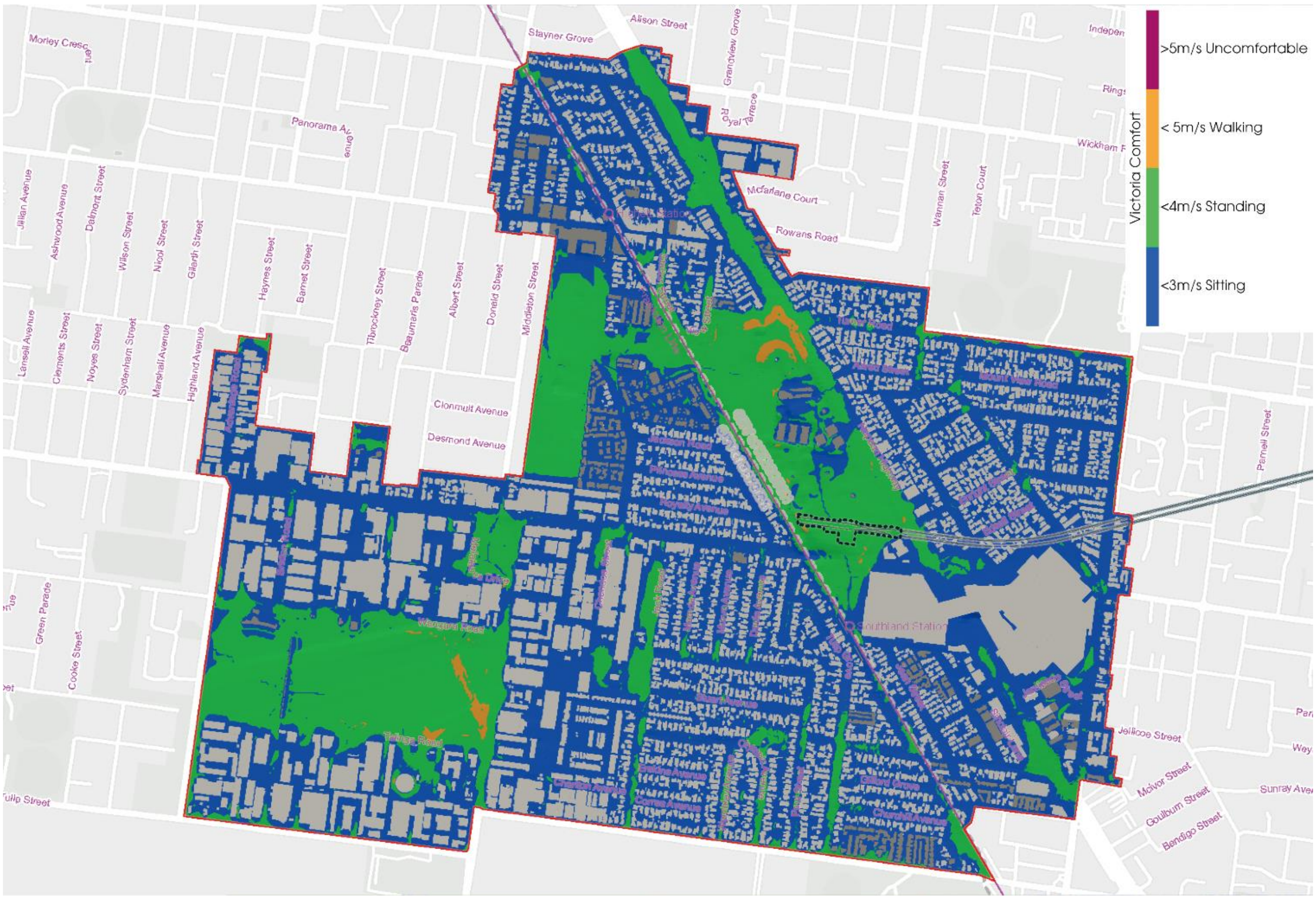



FIGURE 5.1 WIND COMFORT CONDITIONS FOR CHELTENHAM EXISTING BUILDINGS


**FIGURE 5.2 WIND COMFORT CONDITIONS FOR CHELTENHAM EXISTING BUILDINGS CLOSE UP**

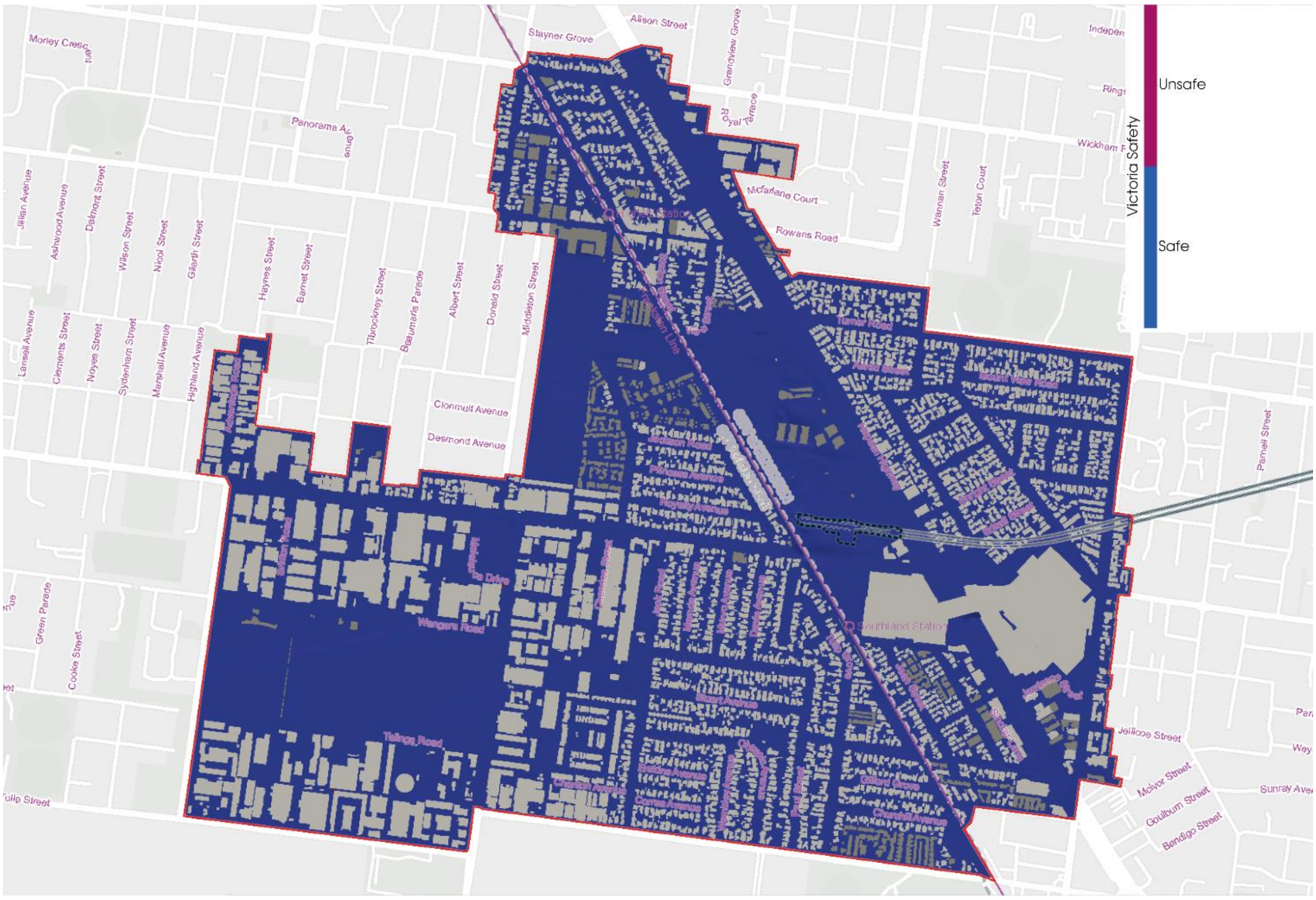



**FIGURE 5.3 WIND SAFETY CONDITIONS FOR CHELTENHAM EXISTING BUILDINGS**

## 5.2 Clayton Structure Plan Area

Buildings in the Clayton Structure Plan Area are predominantly low-rise suburban and commercial, creating walking and standing conditions (Figure 5.4). Walking conditions are predominantly found in open areas such as Fregon Reserve and North Road (Figure 5.5 and Figure 5.6). No uncomfortable or unsafe conditions were identified (Figure 5.7).

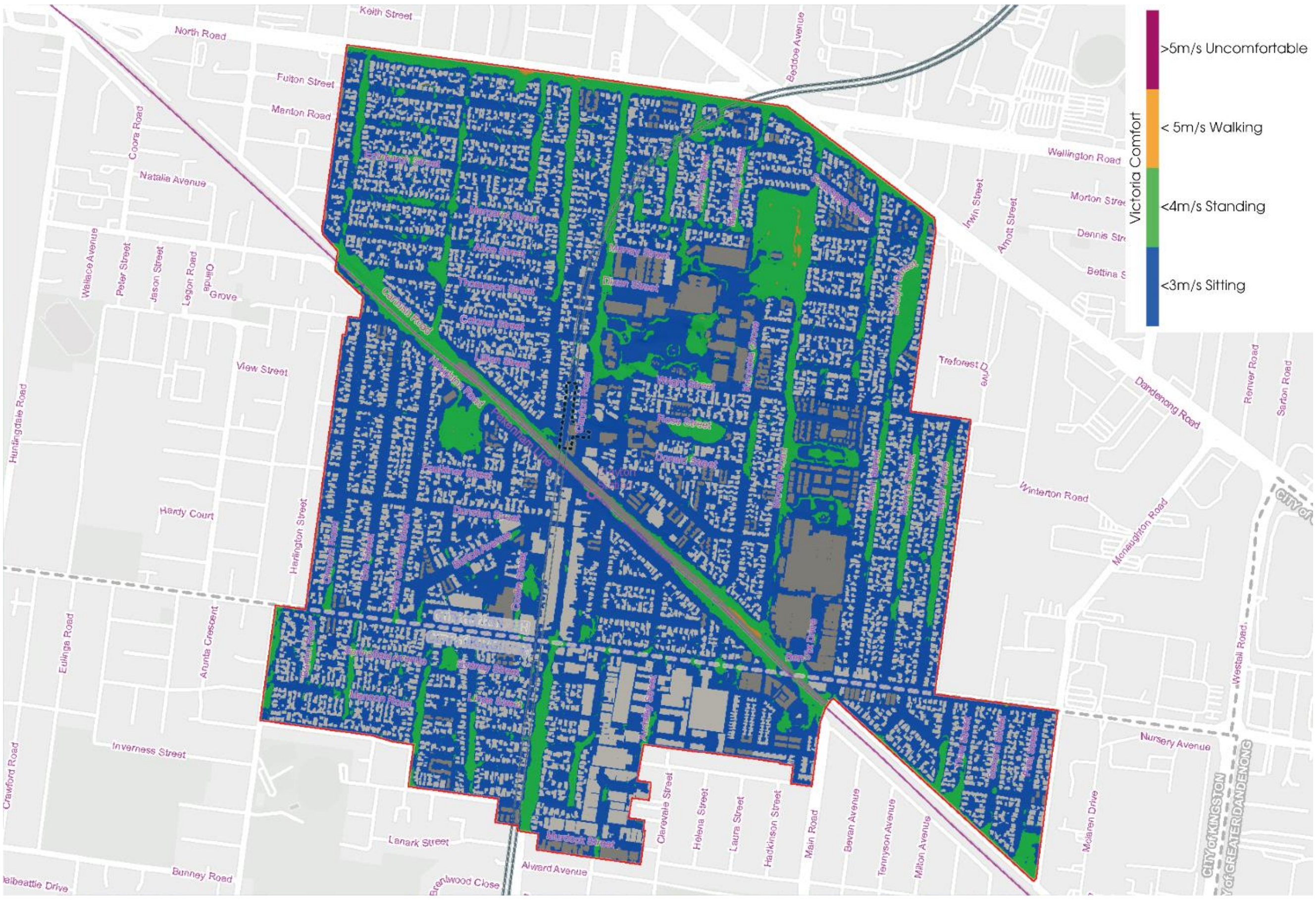



FIGURE 5.4 WIND COMFORT CONDITIONS FOR CLAYTON EXISTING BUILDINGS

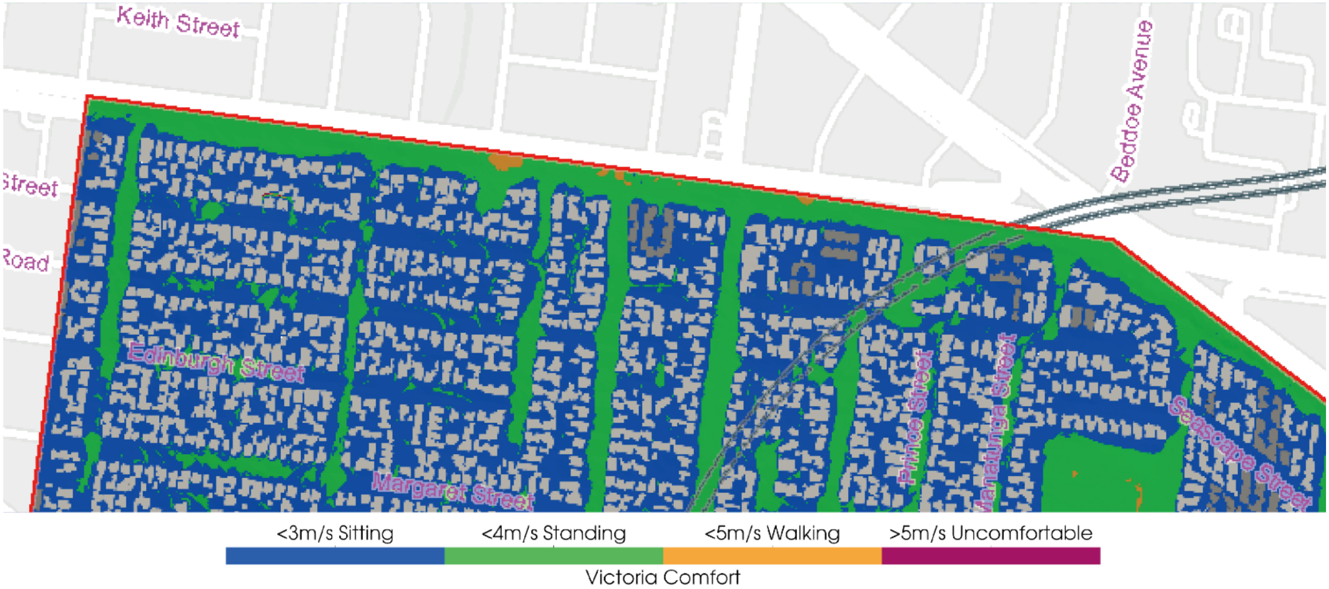



FIGURE 5.5 WIND COMFORT CONDITIONS FOR CLAYTON EXISTING BUILDINGS ALONG NORTH ROAD

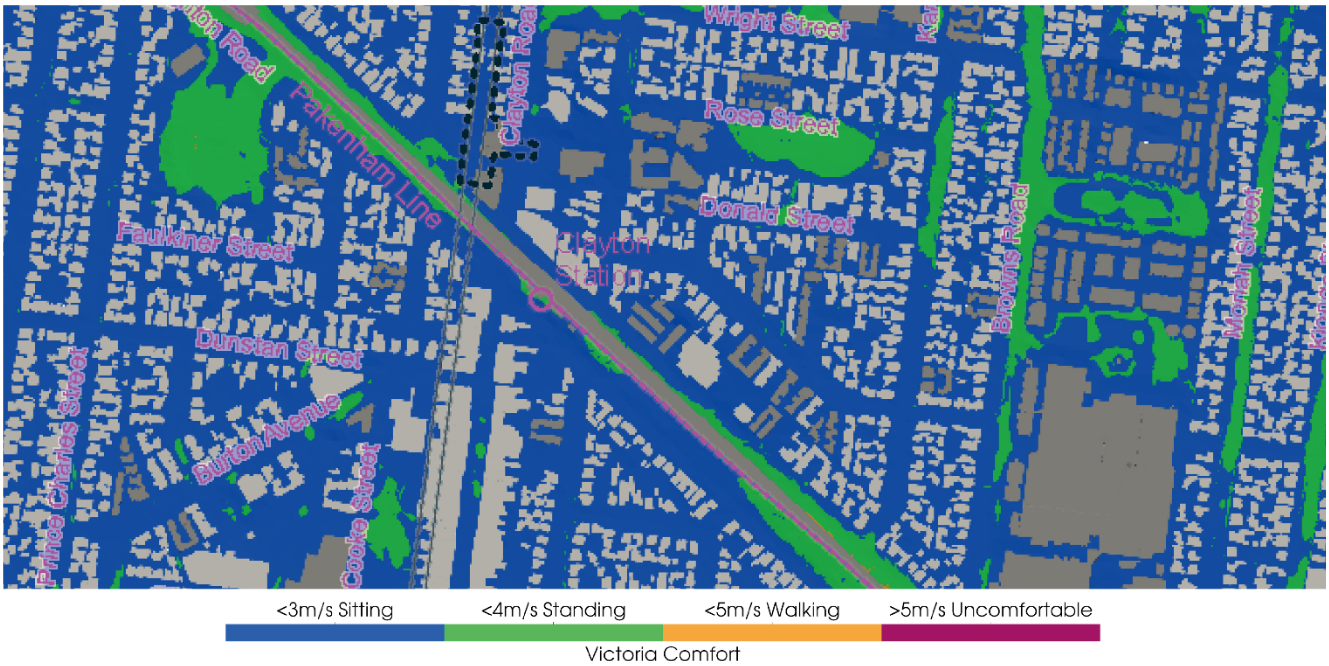



FIGURE 5.6 WIND COMFORT CONDITIONS FOR CLAYTON EXISTING BUILDINGS ALONG RAIL LINE

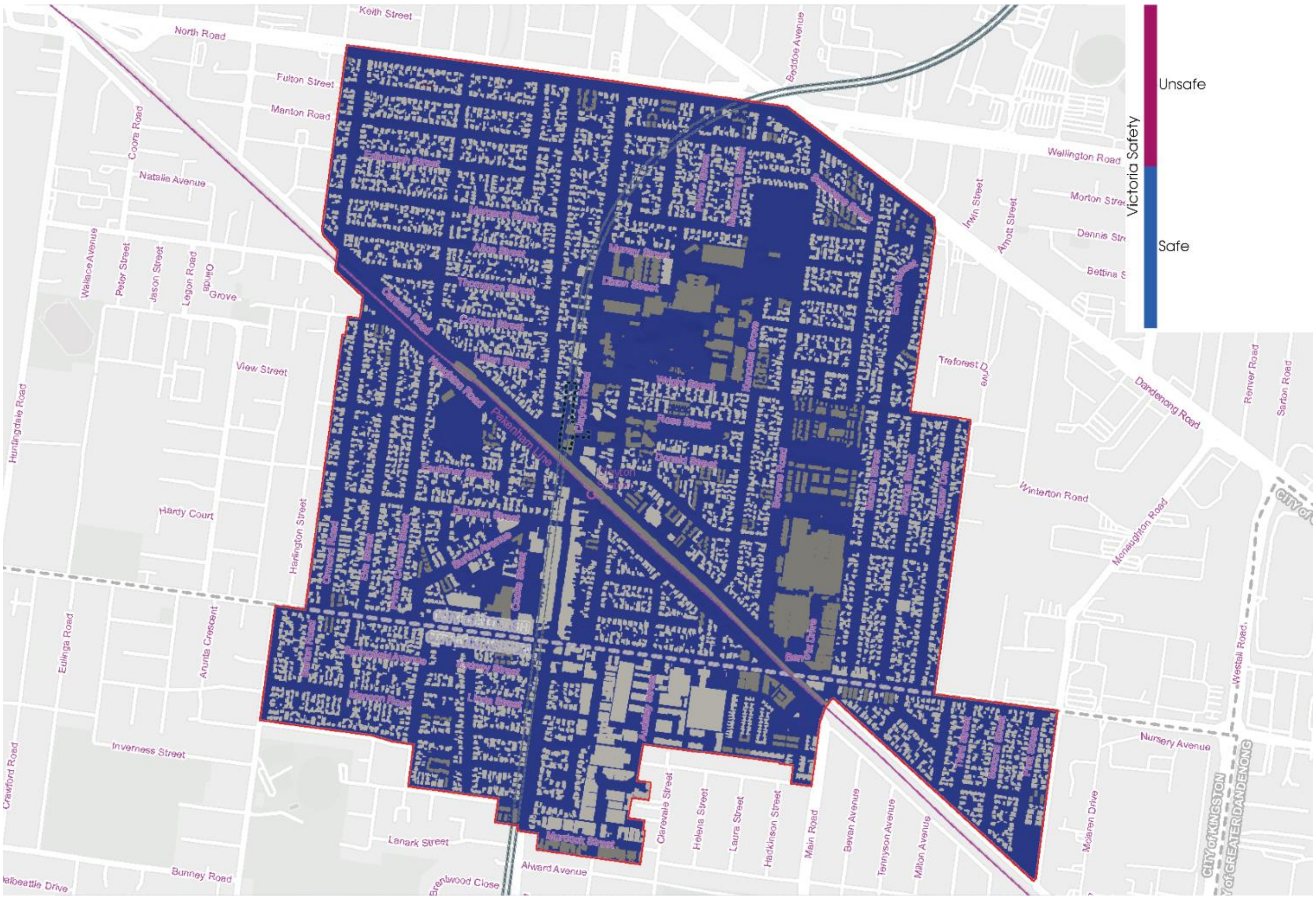



**FIGURE 5.7 WIND SAFETY CONDITIONS FOR CLAYTON EXISTING BUILDINGS**

## 5.3 Monash Structure Plan Area

Existing wind conditions meet the walking and standing criteria for most of the Monash Structure Plan Area (Figure 5.8, Figure 5.9, Figure 5.10), with regions meeting the walking criterion in open spaces and parklands. Even though the Monash University campus has some buildings of significant height and large north-facing façades (like the Menzies building at over 40 metres) the buildings on campus tend to increase in height gradually towards the south, providing some shielding against northerly winds. The campus buildings are also arranged so they don't create narrow channels between them, resulting in more favourable wind conditions than those found in the Box Hill area. No areas of uncomfortable conditions were identified.

Unsafe conditions are present at the intersection of Dandenong Road and Blackburn Road, around the M-City building, most likely caused by downwash and corner acceleration around the tower in southerly winds (Figure 5.11). The M-City building is over 45 metres high and is unshielded from every direction. However, it's important to note the M-City building compound consists of a podium, which was not modelled for this technical assessment. This unsafe condition may have been mitigated.

Unsafe conditions are also present on the Monash University campus around the corner of the residential services building (30 metres high) on College Walk, and around the Deakin Hall building (40 metres high). Both are consistent with downwash, corner acceleration and channelling of southerly winds. The buildings are unshielded from the south and create wind corridors between them and adjacent buildings.

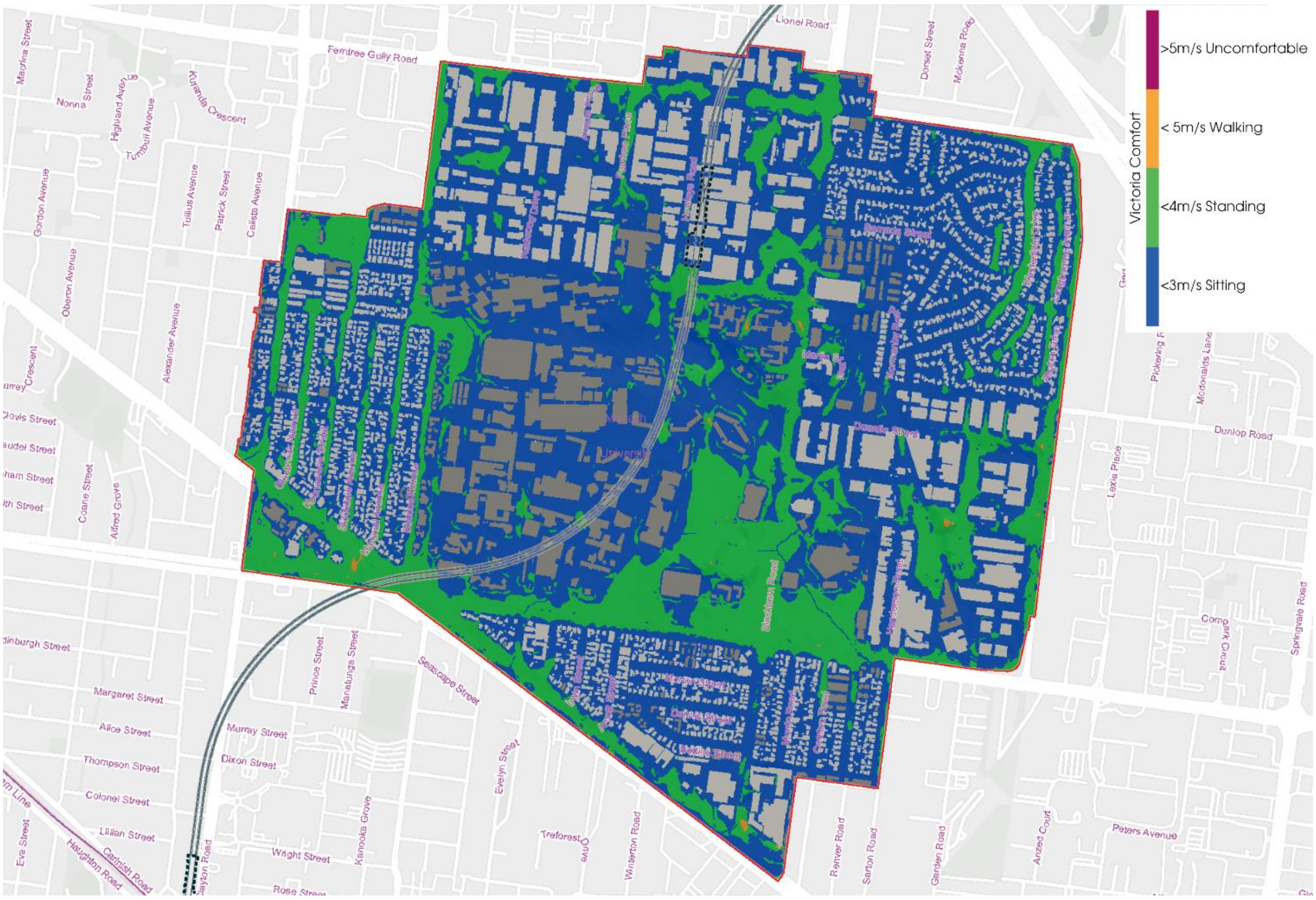



FIGURE 5.8 WIND COMFORT CONDITIONS FOR MONASH EXISTING BUILDINGS


FIGURE 5.9 WIND COMFORT CONDITIONS FOR MONASH EXISTING BUILDINGS ALONG FERNTREE GULLY ROAD


**FIGURE 5.10 WIND COMFORT CONDITIONS FOR MONASH EXISTING BUILDINGS ALONG WELLINGTON ROAD**


**FIGURE 5.11 WIND SAFETY CONDITIONS FOR MONASH EXISTING BUILDINGS**

## 5.4 Glen Waverley Structure Plan Area

Existing wind conditions meet the walking and standing criteria for most of the Glen Waverley Structure Plan Area (Figure 5.12), with open spaces and parklands meeting the walking criterion. The tall building next to the existing Glen Waverley Station at 39 Kingsway is surrounded by some areas of increased wind speed, creating walking conditions (Figure 5.13).

No areas of uncomfortable conditions were identified.

Wind safety exceedances are found around 39 Kingsway due to downwash, and south of The Glen Shopping Centre on O'Sullivan Road due to corner acceleration on the 52 O'Sullivan Road building (Figure 5.14).

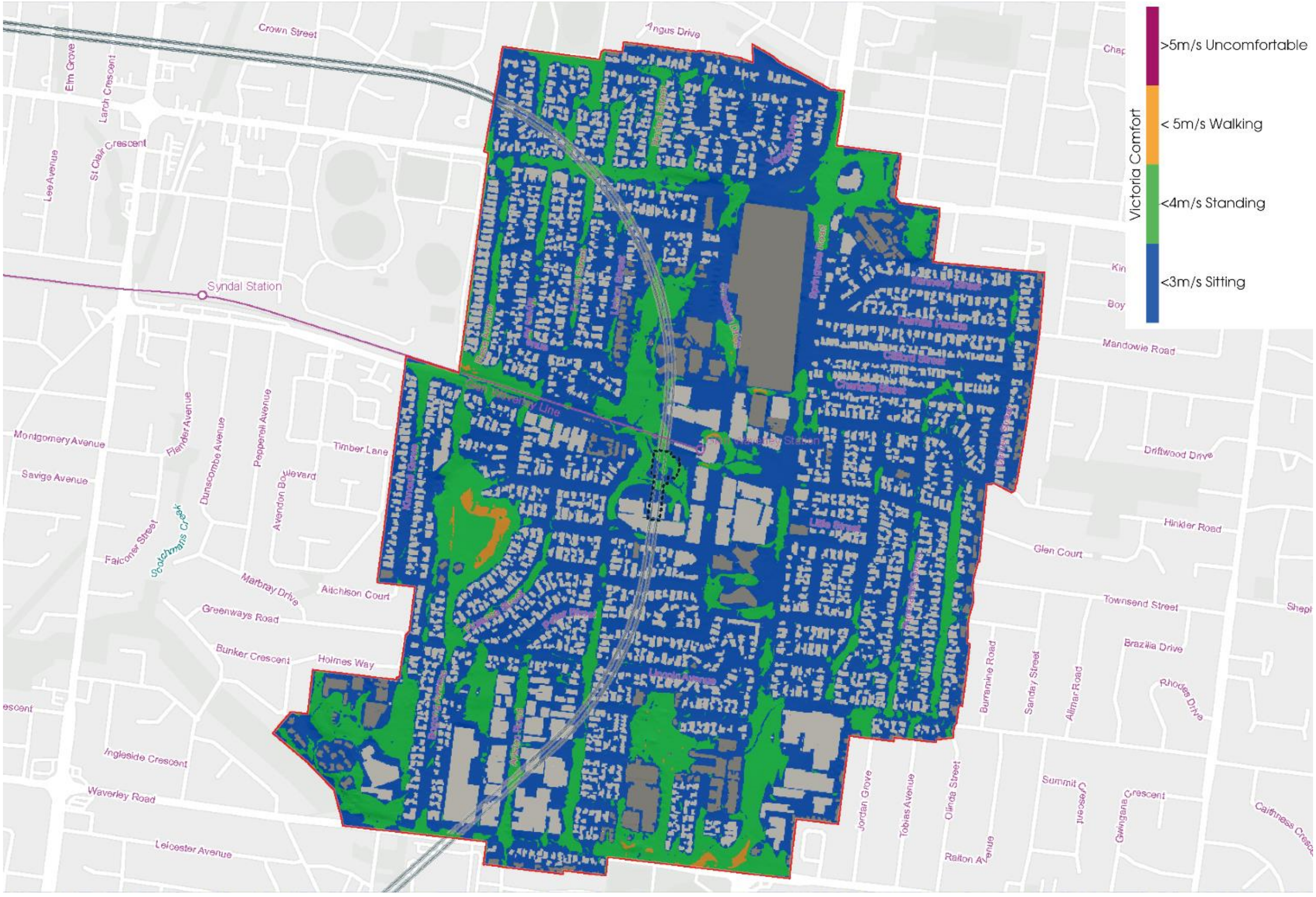



FIGURE 5.12 WIND COMFORT CONDITIONS FOR GLEN WAVERLEY EXISTING BUILDINGS

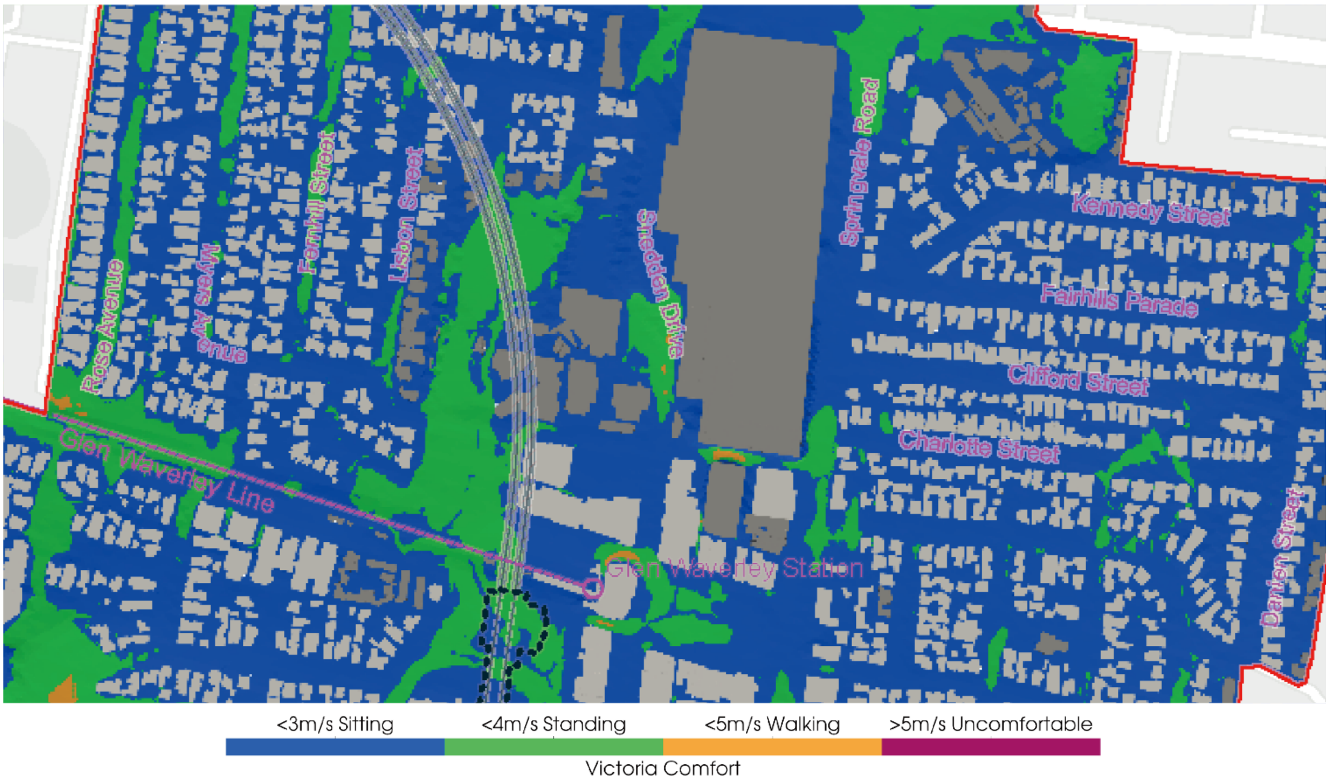



**FIGURE 5.13 WIND CONDITIONS FOR GLEN WAVERLEY EXISTING BUILDINGS CLOSE UP**

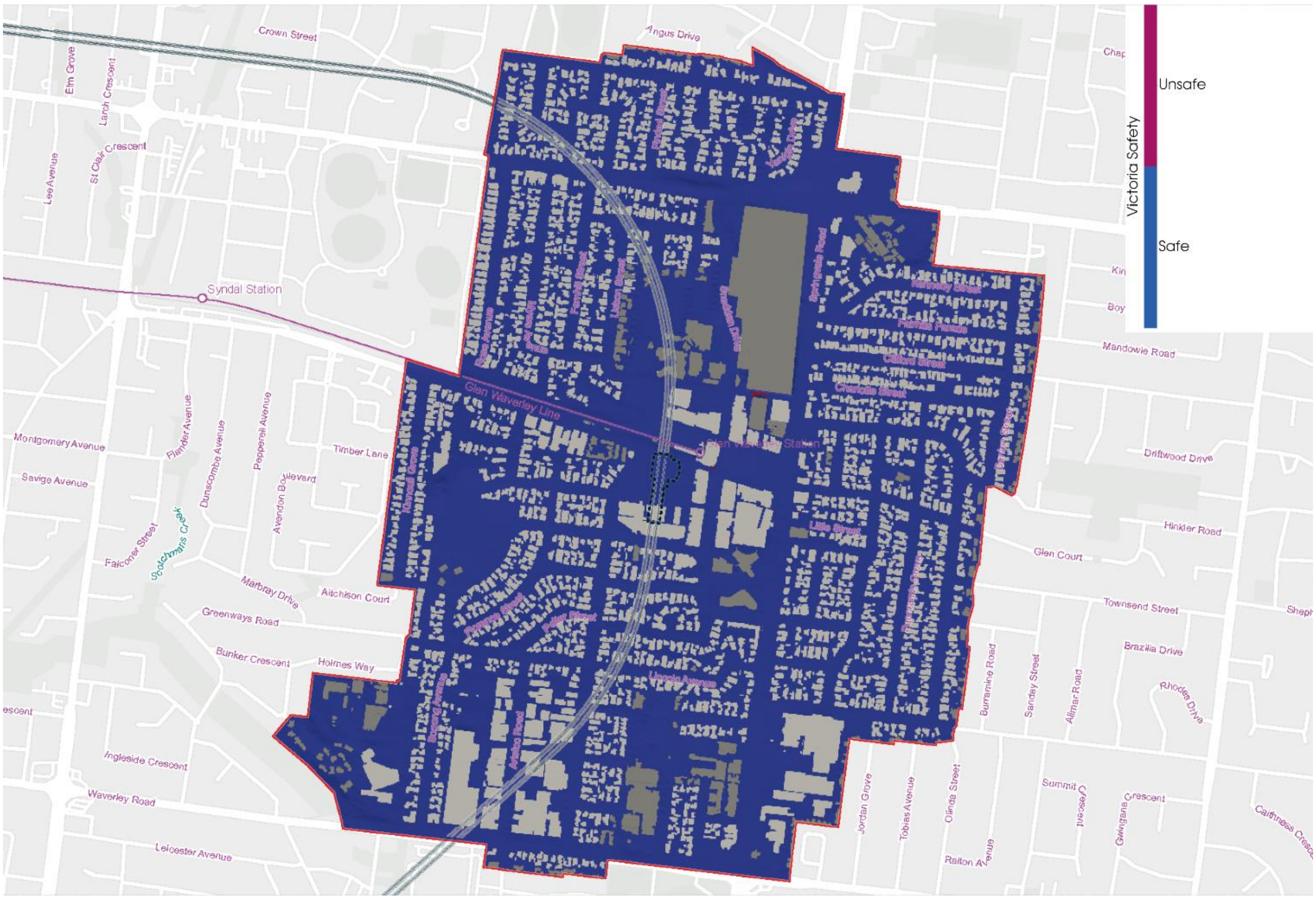



**FIGURE 5.14 WIND SAFETY CONDITIONS FOR GLEN WAVERLEY EXISTING BUILDINGS**

# 5.5 Burwood Structure Plan Area

Existing wind conditions meet the walking and standing criteria for most of the Burwood Structure Plan Area (Figure 5.15), with a very small region reaching the walking criterion near Presbyterian Ladies' College (Figure 5.16). No areas of uncomfortable conditions are present. This is due to the overall lower building height compared to Box Hill. Wind conditions meet the safety criterion throughout the Burwood Structure Plan Area (Figure 5.17).

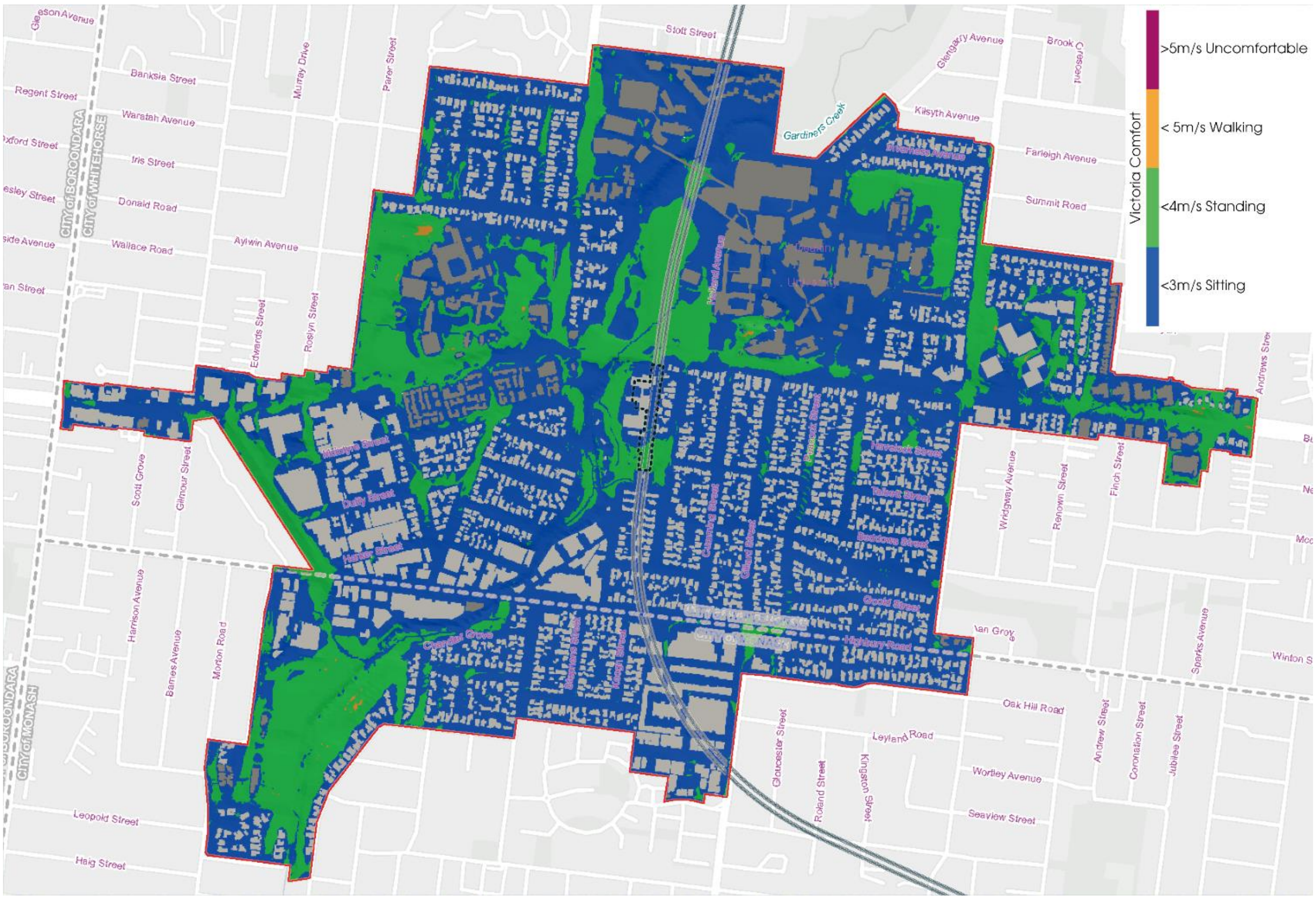



**FIGURE 5.15 WIND COMFORT CONDITIONS FOR BURWOOD EXISTING BUILDINGS**

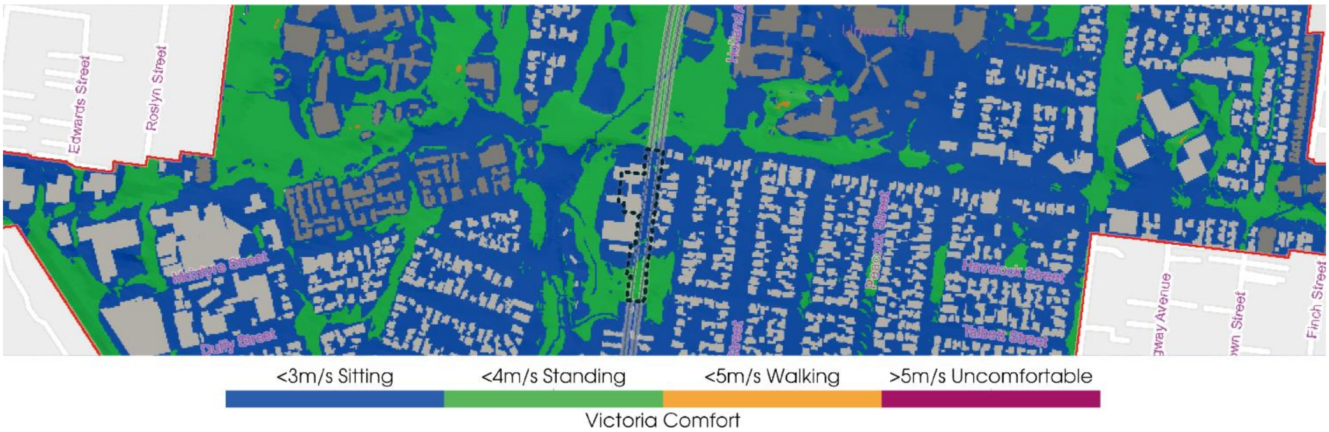



**FIGURE 5.16 WIND COMFORT CONDITIONS FOR BURWOOD EXISTING BUILDINGS ALONG BURWOOD HIGHWAY**


**FIGURE 5.17 WIND SAFETY CONDITIONS FOR BURWOOD EXISTING BUILDINGS**

## 5.6 Box Hill Structure Plan Area

Existing wind conditions meet the walking and standing criteria for most of the Box Hill Structure Plan Area (Figure 5.18). There are existing regions within the 'uncomfortable' classification, which is unsuitable for any usage according to the VPP criteria. These regions are around the Whitehorse Towers and ATO building on Whitehorse Road, and next to Sky One tower on Station Street. These buildings present a large northern façade and are of considerable height compared to surrounding buildings, creating significant downwash (Figure 5.19).

Future developments near these locations, in the worst case, should not worsen the level of wind comfort, and in the best-case should seek to ameliorate it. It should be noted that Whitehorse Towers and Sky One Tower feature podiums and awnings that were not included in the modelling, which would provide mitigation and likely result in more comfortable conditions.

Safety exceedances are present around the Whitehorse Towers and ATO building on Whitehorse Road, and next to Sky One Tower on Station Street, caused by downwash and channelling (Figure 5.20).

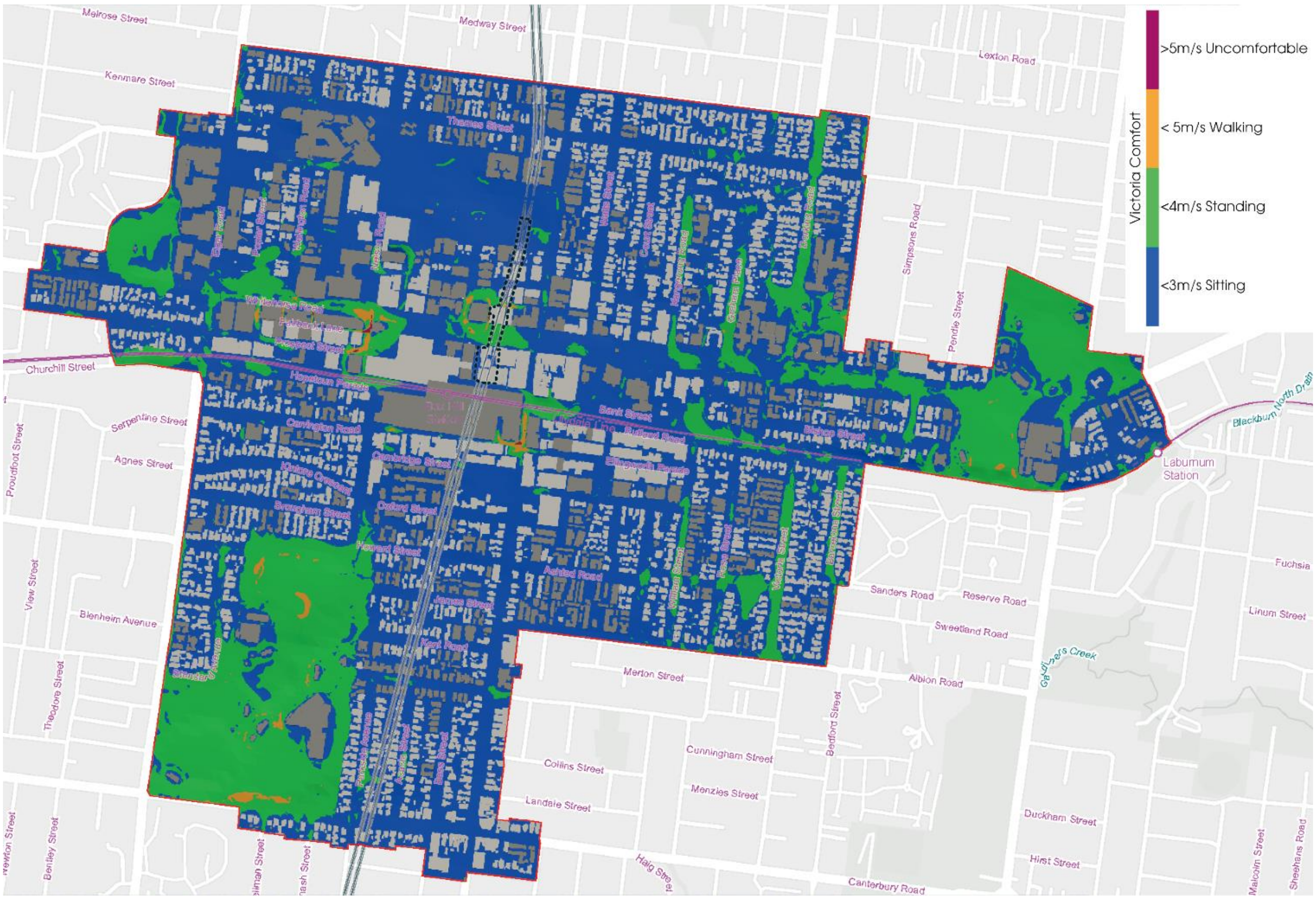



**FIGURE 5.18 WIND COMFORT CONDITIONS FOR BOX HILL EXISTING BUILDINGS**

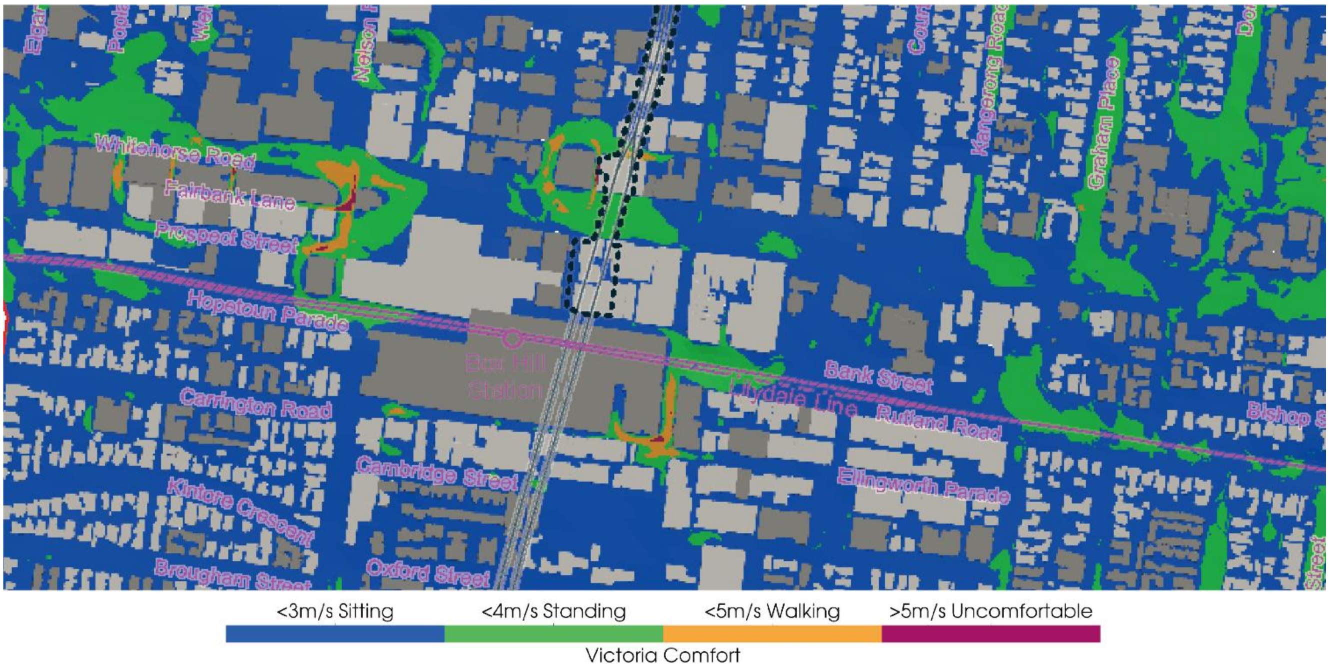



**FIGURE 5.19 WIND COMFORT CONDITIONS FOR BOX HILL EXISTING BUILDINGS ALONG WHITEHORSE ROAD**


FIGURE 5.20 WIND SAFETY CONDITIONS FOR BOX HILL EXISTING BUILDINGS

# 6. Findings

This section sets out the results relating to wind conditions in the future scenarios that impact land use planning and development in each SRL East Structure Plan Area.

## 6.1 Cheltenham Structure Plan Area

Figure 6.1 shows the proposed land use framework for the Cheltenham Structure Plan Area.

Wind conditions are within the sitting criterion for most of the Structure Plan Area (Figure 6.2 and Figure 6.3), with the exception of some areas along Nepean Highway and around Southland Shopping Centre, where conditions range from standing to walking. These areas are unlikely to require any mitigation, as the former is an intersection of two busy roads and the latter is the entrance to a carpark.

Safety exceedances are found at the intersections of Wickham Road and Nepean Highway, Sinclair Street and Nepean Highway, and Charman Road and Nepean Highway (Figure 6.4). All these locations are surrounded by buildings of 40 metres high with sharp corners, creating a combination of wind channelling and corner acceleration.

More safety exceedances are found along Nepean Highway, between Wickham Road and Highett Road. These are likely caused by the wind corridor created by the long, uninterrupted façades of the 40-metre high buildings on both sides of Nepean Highway.

Safety exceedances are also found on the western edge of the Cheltenham Structure Plan Area, along Bay Road and Park Road, and around the building immediately south of Cheltenham Cemetery. In all these cases, a combination of corner acceleration and channelling seems to be the cause, as the buildings are close together and present long continuous façades. These buildings range in height from 20 to 40 metres and are marked as ‘Employment’ in Figure 6.1.

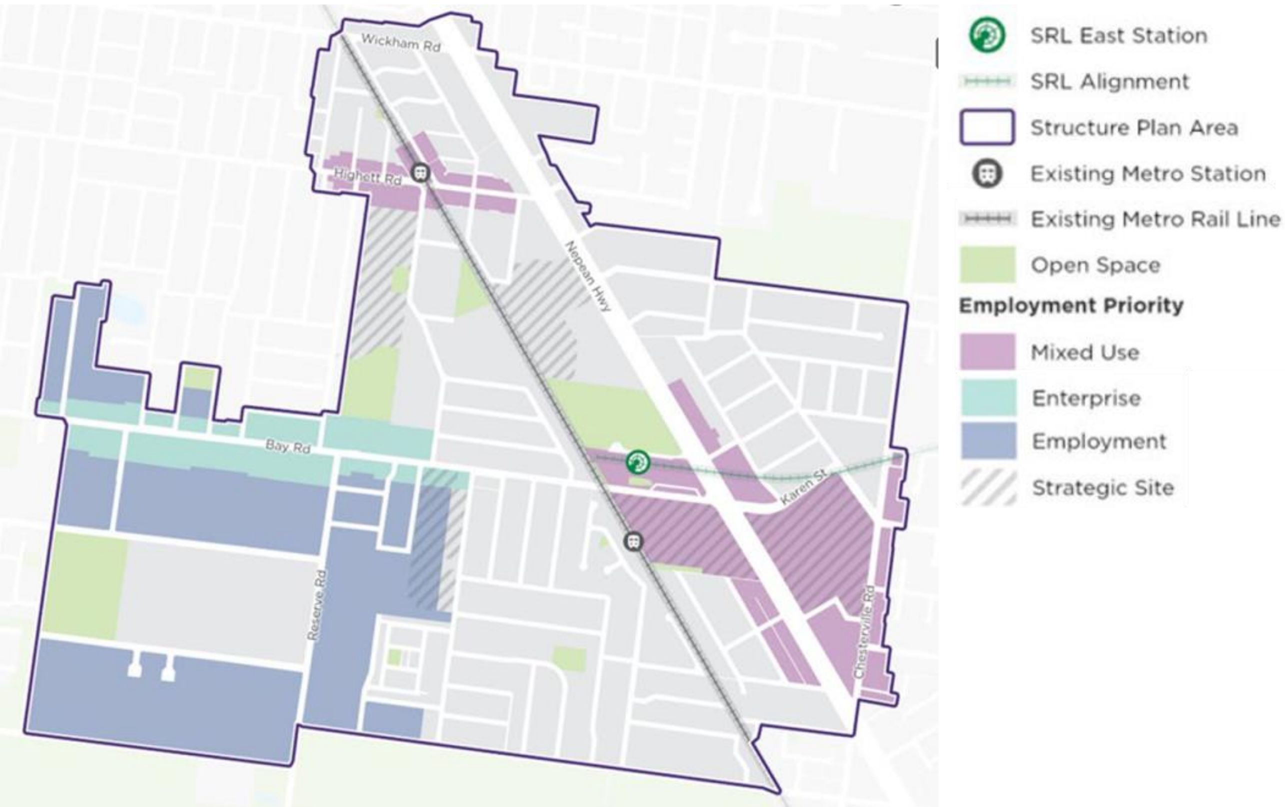



**FIGURE 6.1 PROPOSED LAND USE FRAMEWORK FOR CHELTENHAM STRUCTURE PLAN AREA**

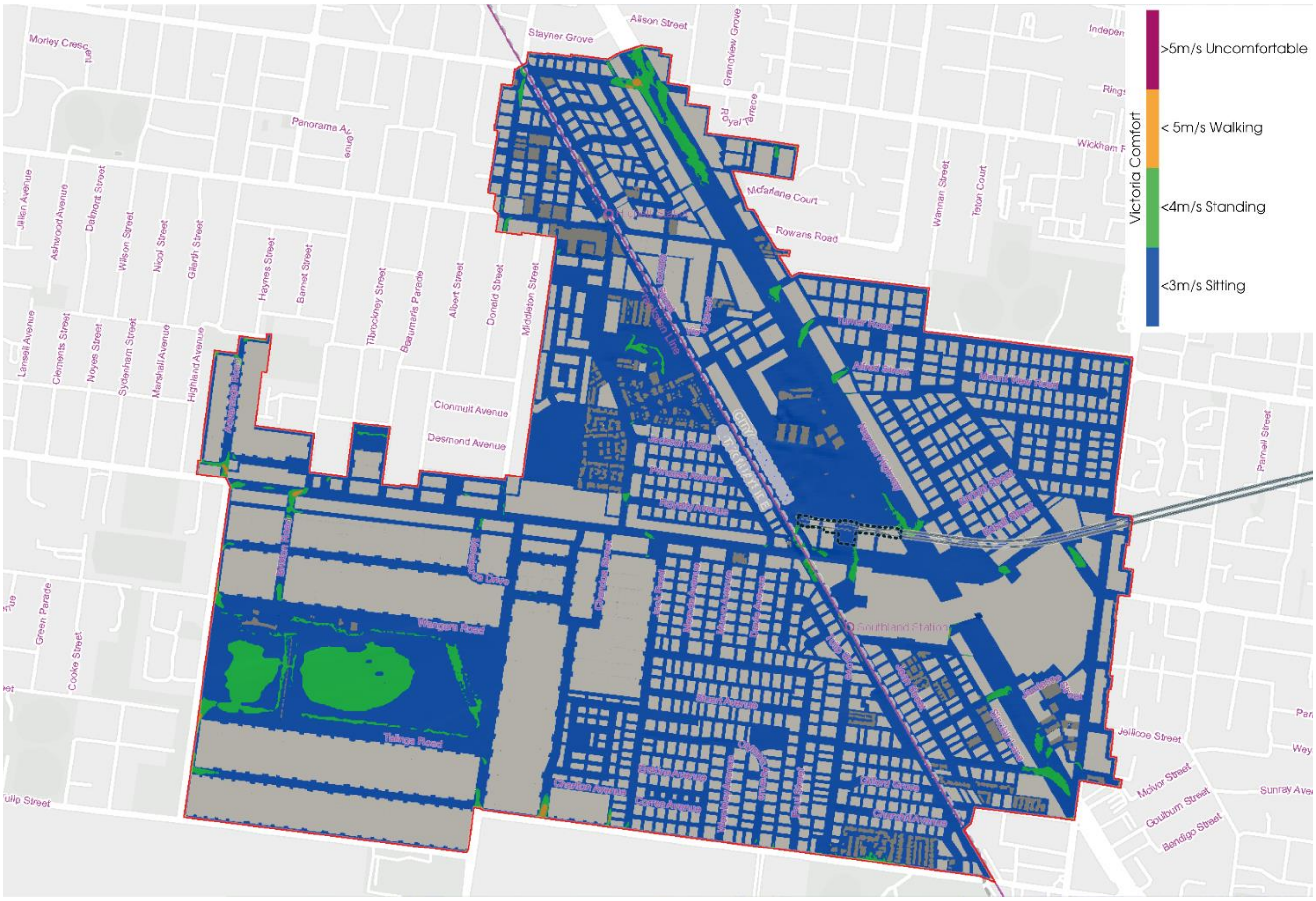



**FIGURE 6.2 WIND COMFORT CONDITIONS FOR CHELTENHAM FUTURE BUILDINGS**


**FIGURE 6.3 WIND COMFORT CONDITIONS FOR CHELTENHAM FUTURE BUILDINGS CLOSE UP**

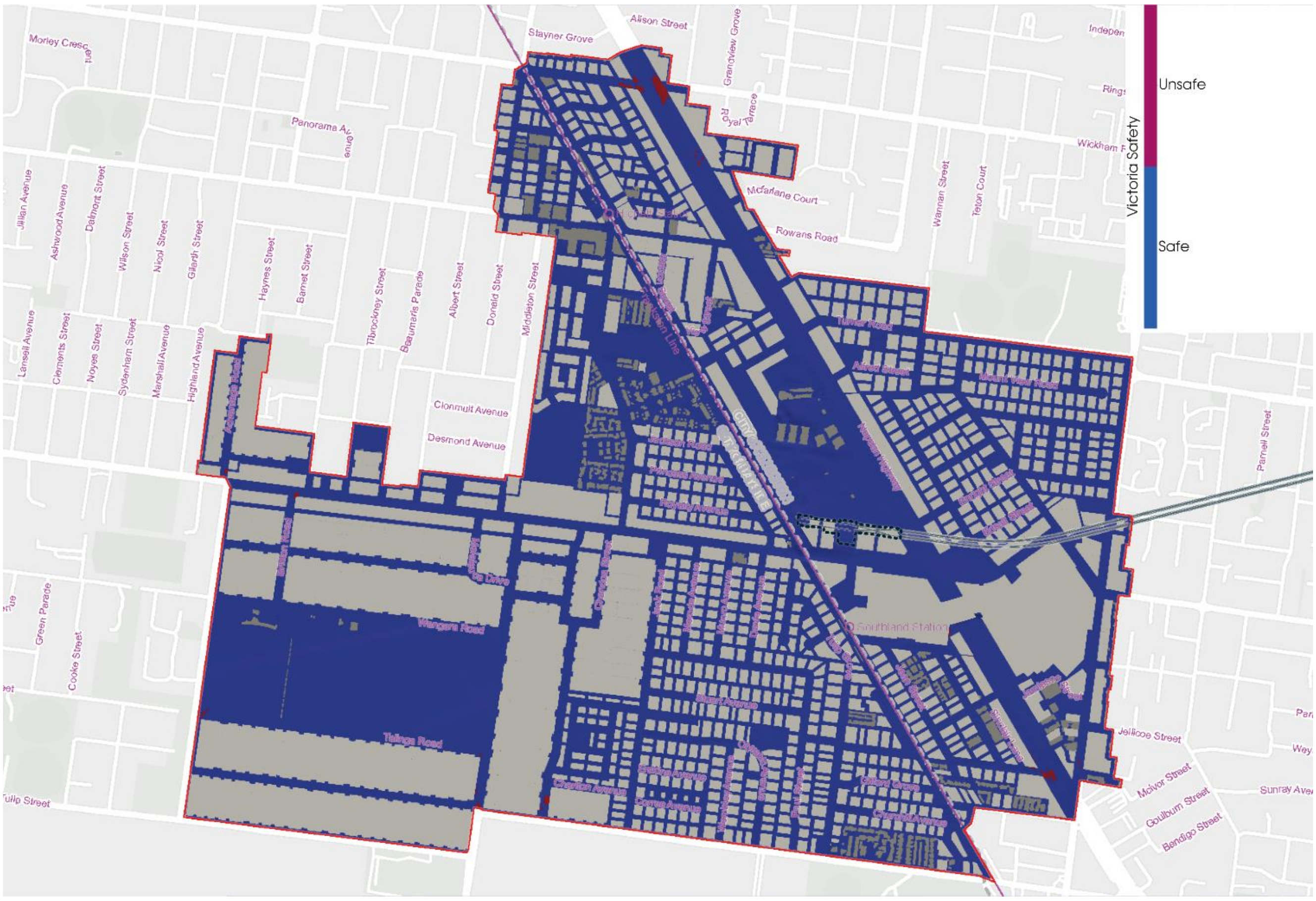



**FIGURE 6.4 WIND SAFETY CONDITIONS FOR CHELTENHAM FUTURE BUILDINGS**

## 6.2 Clayton Structure Plan Area

Figure 6.5 shows the proposed land use framework for the Clayton Structure Plan Area.

The CFD modelling for the Clayton Structure Plan included the future Monash development to its north because of the short distance between the SRL stations at Clayton and Monash.

Overall comfort conditions are improved by the higher density of buildings, with most areas going from meeting the standing to meeting the sitting criterion. Improvements are notable in open areas such as Monash University campus and Fregon Reserve (Figure 6.6).

Areas of uncomfortable conditions are found along Wellington Road (North Road) between the buildings on the western side of the Structure Plan Area (Figure 6.7). These buildings are 40 metres high, and present a large façade to the north, and the laneways between them are aligned with the northerly winds, creating a channelling effect. Breaking up the façade into smaller sections would likely reduce the channelling. A gradual increase in height of buildings in the direction of the predominant winds (in this case, increasing height from north to south) can reduce the effects of downwash, as taller buildings are partially shielded by the smaller buildings upstream. As an alternative to limiting the height of the buildings along North Road, channelling effects could be mitigated by reducing building heights only adjacent to the regions experiencing channelling. The land use in this area is not residential, as shown in Figure 6.5.

There is an area of increased wind speed around the SRL station at Clayton (Figure 6.8) but the conditions meet the walking criteria, which is likely sufficient depending on the intended use of the area; noting however, that the safety exceedance is identified in this area (Figure 6.9). The safety exceedance is caused by downwash from the tall tower (70 metres) located above. This area is area is marked as ‘Core’ in Figure 6.5.

Unsafe conditions are found between the buildings on the western side of the Structure Plan Area along North Road, matching the areas of uncomfortable conditions (Figure 5.9). The same reasons apply to safety and comfort.

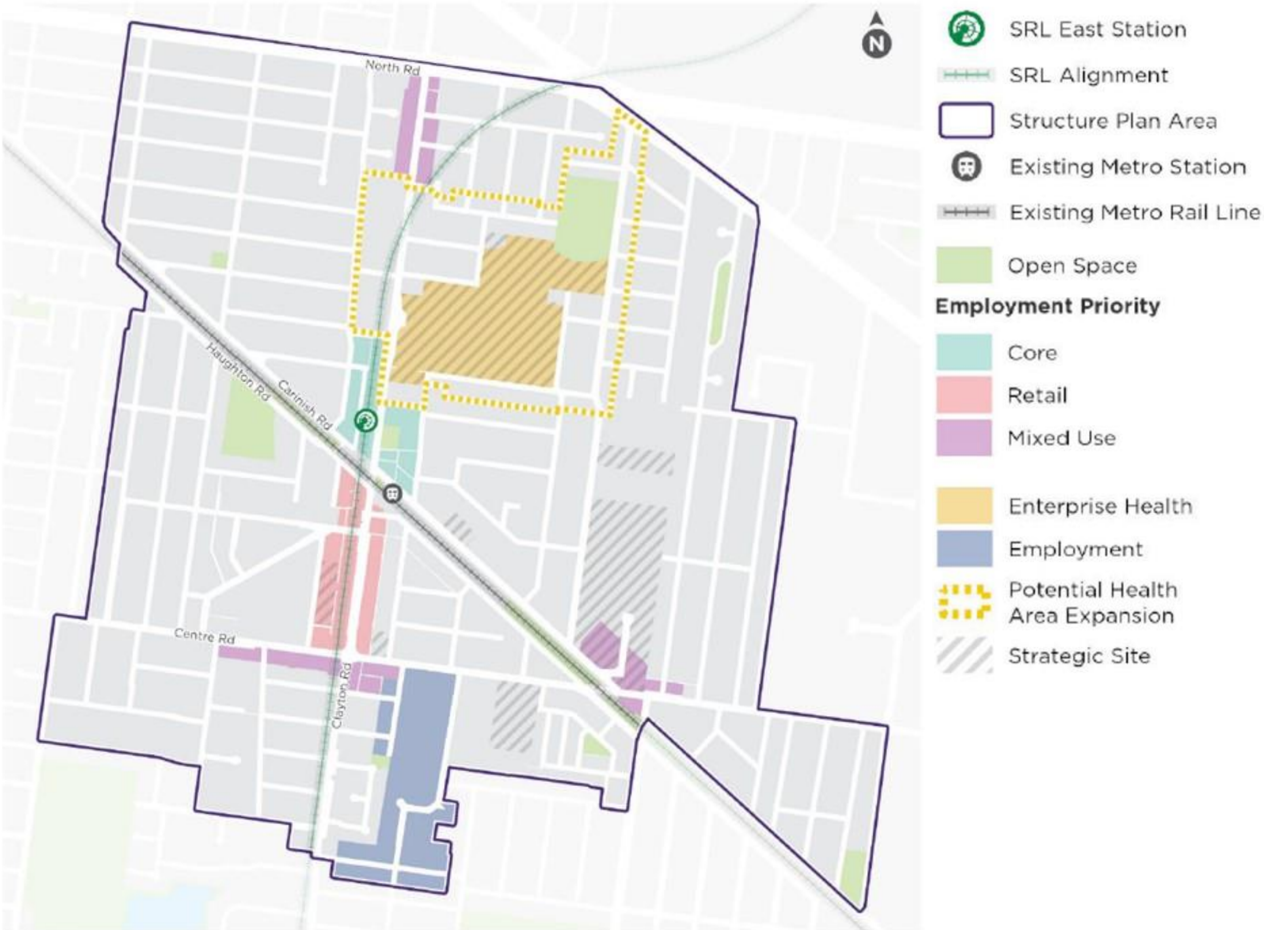



**FIGURE 6.5 PROPOSED LAND USE FRAMEWORK FOR CLAYTON STRUCTURE PLAN AREA**

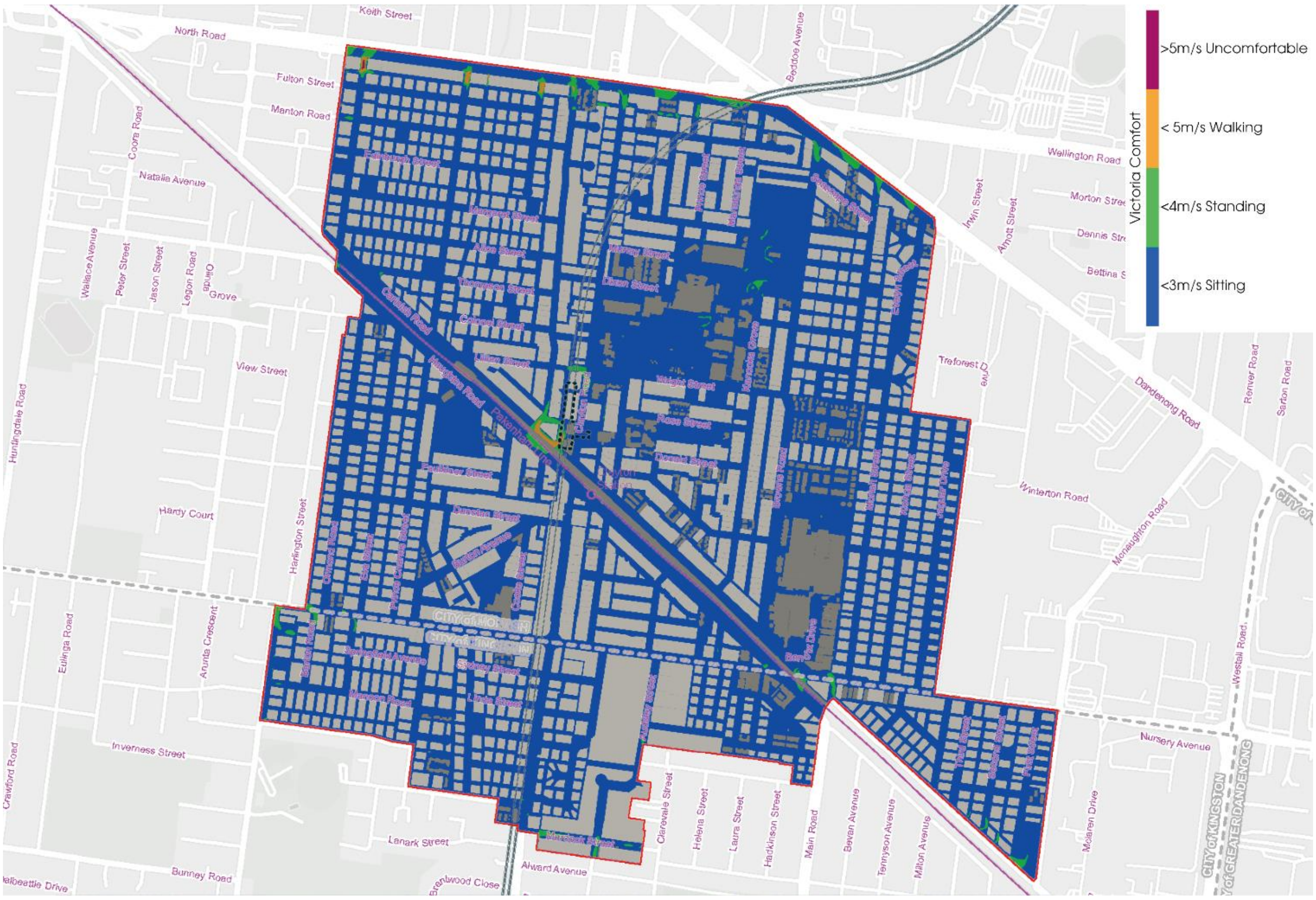



**FIGURE 6.6 WIND COMFORT CONDITIONS FOR CLAYTON FUTURE BUILDINGS**


**FIGURE 6.7 WIND COMFORT CONDITIONS FOR CLAYTON FUTURE BUILDINGS ALONG WELLLINGTON ROAD**

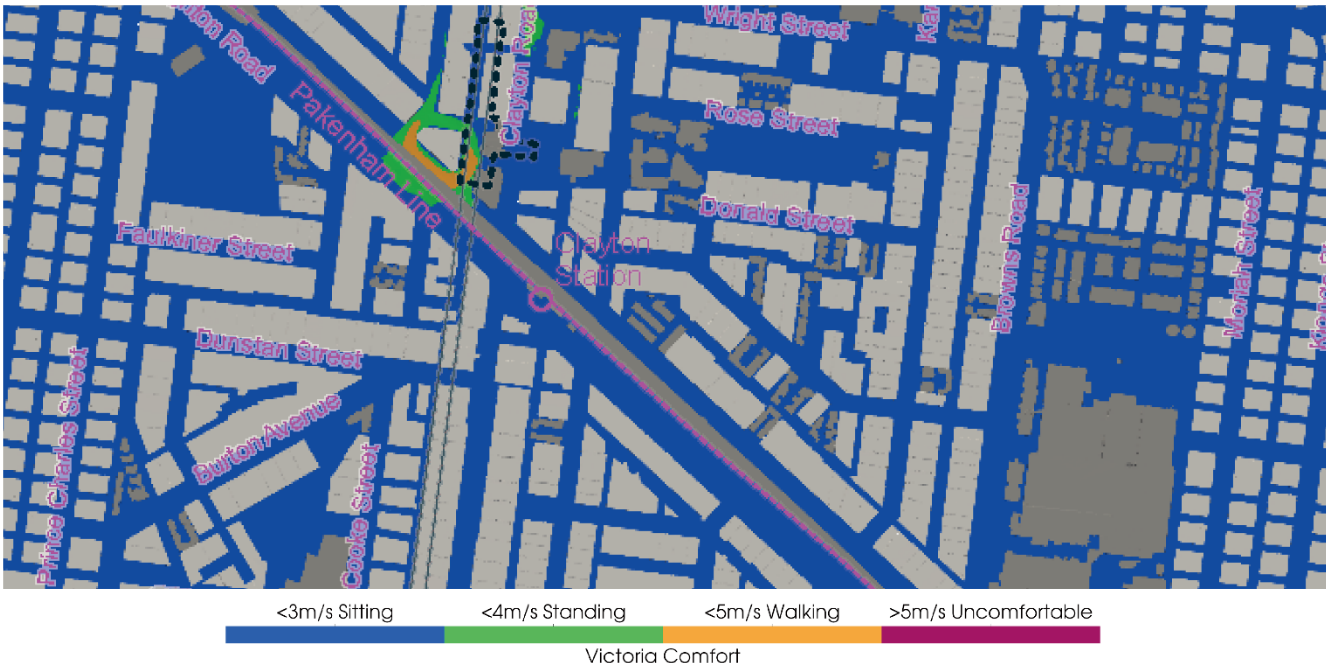



**FIGURE 6.8 WIND CONDITIONS FOR CLAYTON FUTURE BUILDINGS ALONG RAIL LINE**

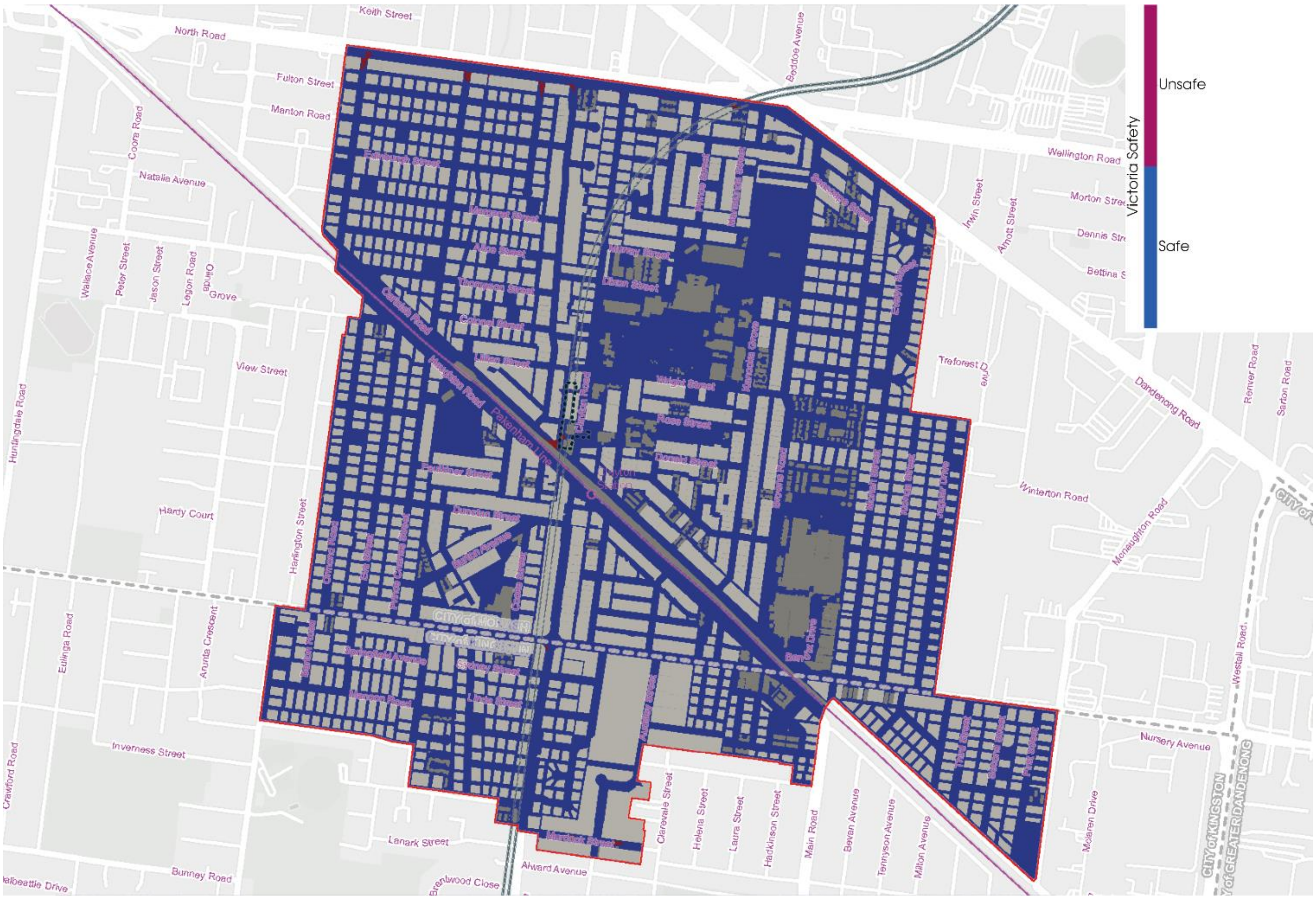



**FIGURE 6.9 WIND SAFETY CONDITIONS FOR CLAYTON FUTURE BUILDINGS**

## 6.3 Monash Structure Plan Area

The proposed land use framework for the Monash Structure Plan Area is shown in Figure 6.10.

The CFD modelling for the Monash Structure Plan includes the future Clayton development to its south because of the short distance between the SRL stations at Monash and Clayton.

Comfort conditions are mostly within the sitting criterion. Conditions at the Monash University campus are much improved by the higher density of buildings to the north of the campus, providing shielding from the northerly winds (Figure 6.11. Some areas of increased wind speeds are present between the buildings along Ferntree Gully Road (Figure 6.12) and along Wellington Road (Figure 6.13). However, the wind conditions meet the walking criteria and depending on the intended use, will probably not require mitigation.

Safety exceedances are found in multiple locations throughout the Monash Structure Plan Area (Figure 6.14). Most appear to be caused by channelling, as they appear between the first row of buildings on Ferntree Gully Road, Blackburn Road and Gardiner Road. All these buildings exceed 40 metres high. These areas are mostly mixed use, as shown in Figure 6.10.

There are safety exceedances on Dandenong Road (Princes Highway) at the intersection with Wellington Road, which are likely a combination of corner acceleration, downwash and wind channelling.

Another safety exceedance is found at the base of the tall building (100 metres high) at the intersection of Howleys Road and Normanby Road, likely due to downwash from southerly winds. This building is marked as town centre in Figure 6.10. Even though the predominant winds are the northerlies, exceedances are more likely to appear due to winds from other directions, as they don't need to happen frequently (only 9 hours per year).

Also on Wellington Road, between the buildings on the eastern end of the Monash Structure Plan Area, exceedances are found due to channelling. Note these buildings are 40 metres high and unshielded from the north.


**FIGURE 6.10 PROPOSED LAND USE FRAMEWORK FOR MONASH STRUCTURE PLAN AREA**

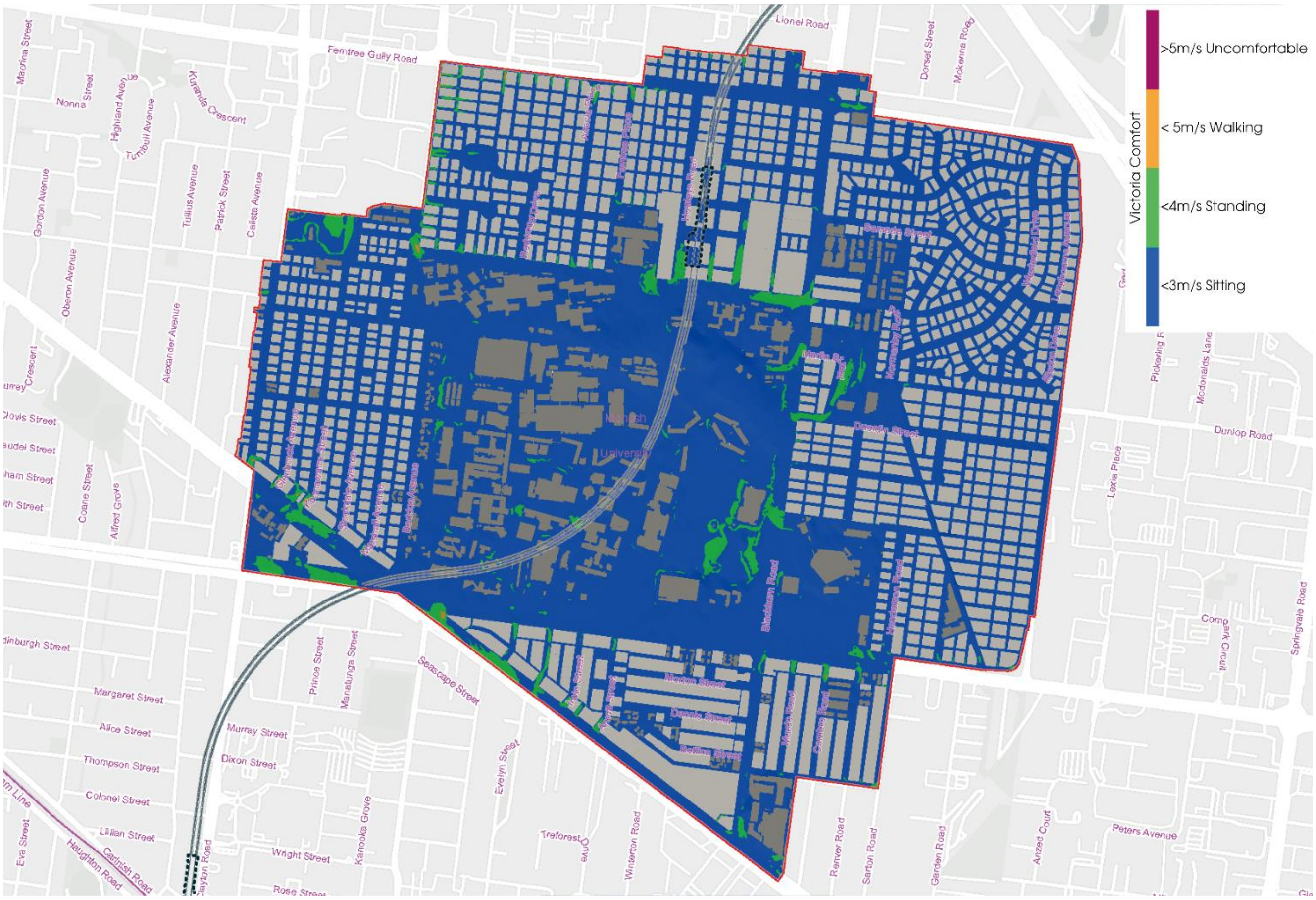



**FIGURE 6.11 WIND COMFORT CONDITIONS FOR MONASH FUTURE BUILDINGS**

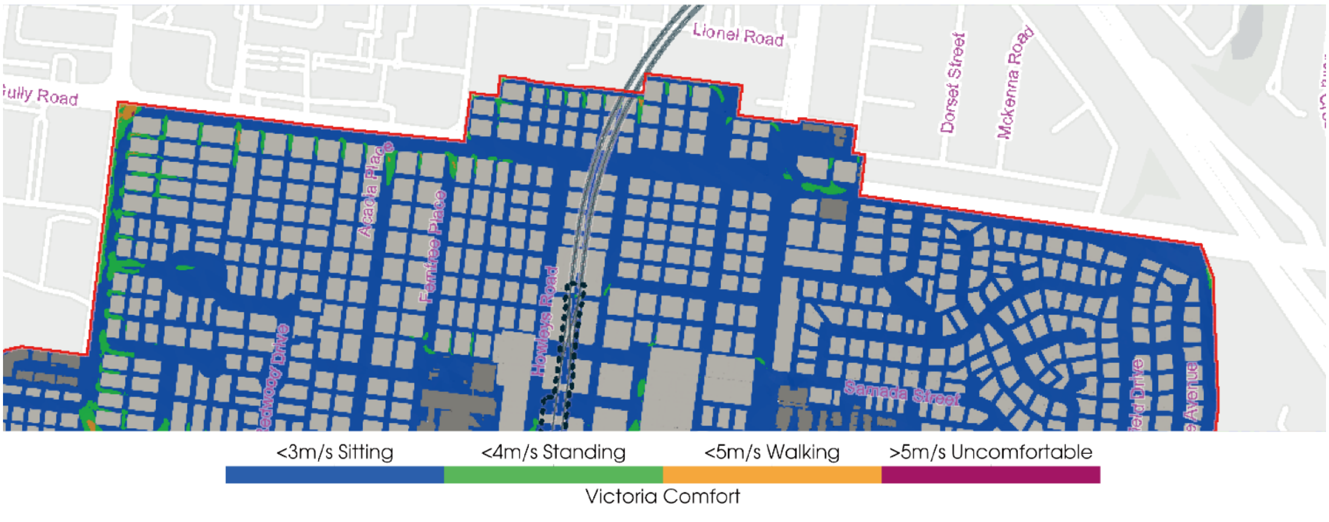



**FIGURE 6.12 WIND COMFORT CONDITIONS FOR MONASH FUTURE BUILDINGS ALONG FERNTREE GULLY ROAD**


FIGURE 6.13 WIND COMFORT CONDITIONS FOR MONASH FUTURE BUILDINGS ALONG WELLINGTON ROAD


FIGURE 6.14 WIND SAFETY CONDITIONS FOR MONASH FUTURE BUILDINGS

## 6.4 Glen Waverley Structure Plan Area

The proposed land use framework for the Glen Waverley Structure Plan Area is shown in Figure 6.15.

Comfort conditions in the Glen Waverley Structure Plan Area are mostly within the sitting criterion (Figure 6.16). Comfort conditions are improved by the higher density of buildings, particularly on open areas such as Bogong Reserve and the Glen Waverley College Oval. Some areas of higher wind speeds are visible around the buildings north-east and south-west of The Glen Shopping Centre (Figure 6.17). Wind conditions in these areas comply with the walking criterion and depending on their intended use will probably not require mitigation.

There are safety exceedances in various areas of the Structure Plan Area (Figure 6.18):

- Along the western edge of the Structure Plan Area, next to Wesley College and north of High Street Road – these exceedances are caused by channelling of the westerly winds, as the west-facing façades are unshielded.
- At the south-western corner of the Structure Plan Area, north of Waverley Road – these buildings are 40 metres high and are unshielded from the westerlies, as they are adjacent to a reserve (Ironbark Forest), creating channelling in the laneways, which have an east-west alignment.
- At the intersection of High Street Road and Springvale Road – the building on the north-eastern corner shows a pattern consistent with downwash of westerly winds. This building is 35 metres high with an unshielded western façade. There is also an area of unsafe conditions to the south of this building, which is consistent with channelling between the buildings on each side of High Street Road (35 metres and 40 metres high). This is a strategic site, as shown on Figure 6.15.
- On O’Sullivan Road around the buildings opposite the Glen Waverley Secondary College – the conditions are consistent with a large unshielded north-facing façade generating downwash. These buildings are 70 metres high and are marked as mixed use in Figure 6.15.
- Along Waverley Road west of Springvale Road – the pattern is consistent with downwash and channelling of winds from the south and south-south-westerly directions. There is a safety exceedance on the south-west corner or a building designated as retail in Figure 6.15.
- Between Kingsway and Springvale Road – channelling and downwash of winds from the south and south-south-west directions. These buildings are nearly 70 metres high and marked as mixed use in Figure 6.15.
- West side of Springvale Road, in front of the Ibis Hotel and Glen Waverley City Council building – the unsafe areas around the corner of the building are consistent with corner acceleration due to diversion of westerly winds impinging on the west façade. These buildings are marked as mixed use in Figure 6.15.


FIGURE 6.15 PROPOSED LAND USE FRAMEWORK FOR GLEN WAVERLEY STRUCTURE PLAN AREA

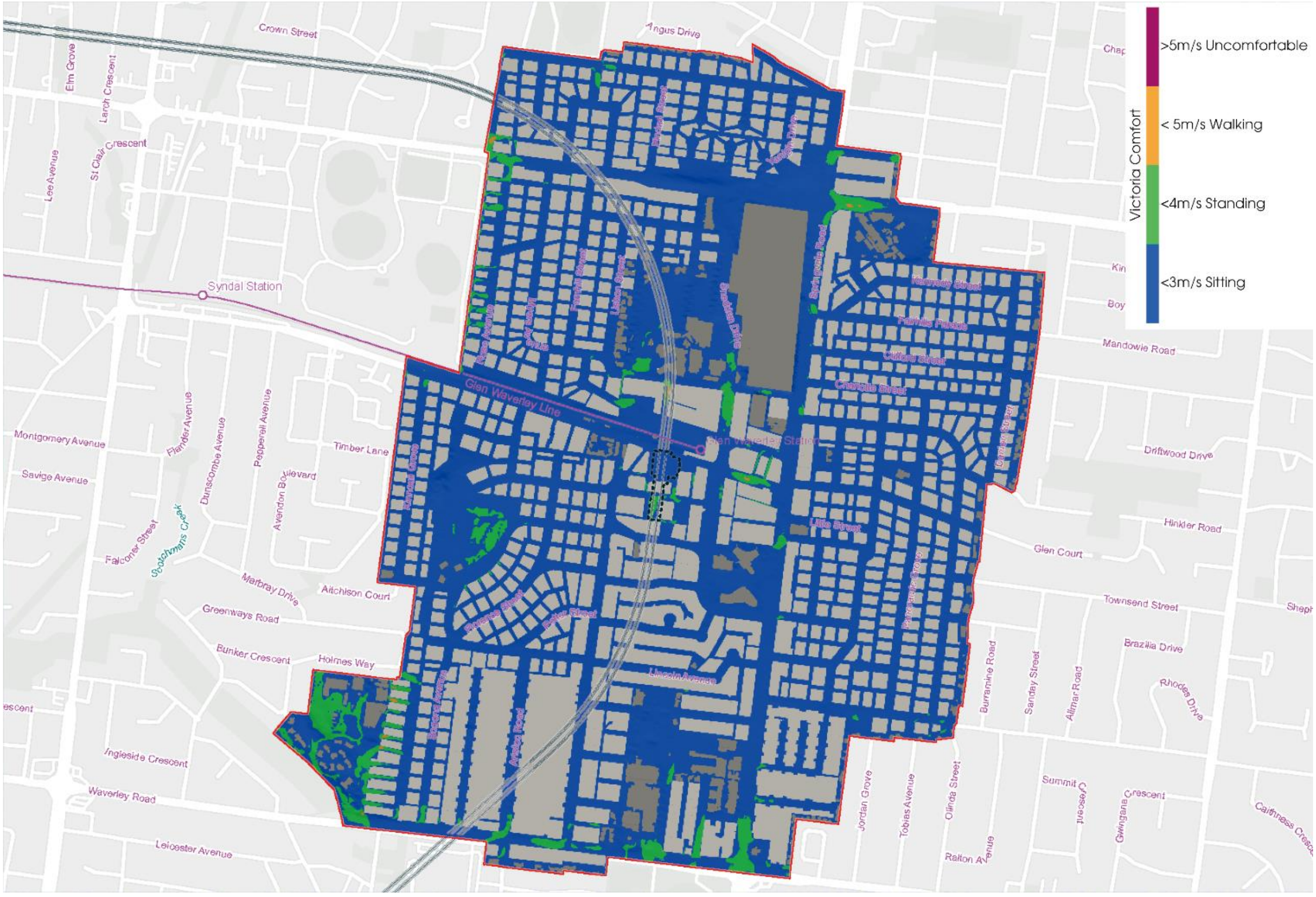



FIGURE 6.16 WIND COMFORT CONDITIONS FOR GLEN WAVERLEY FUTURE BUILDINGS

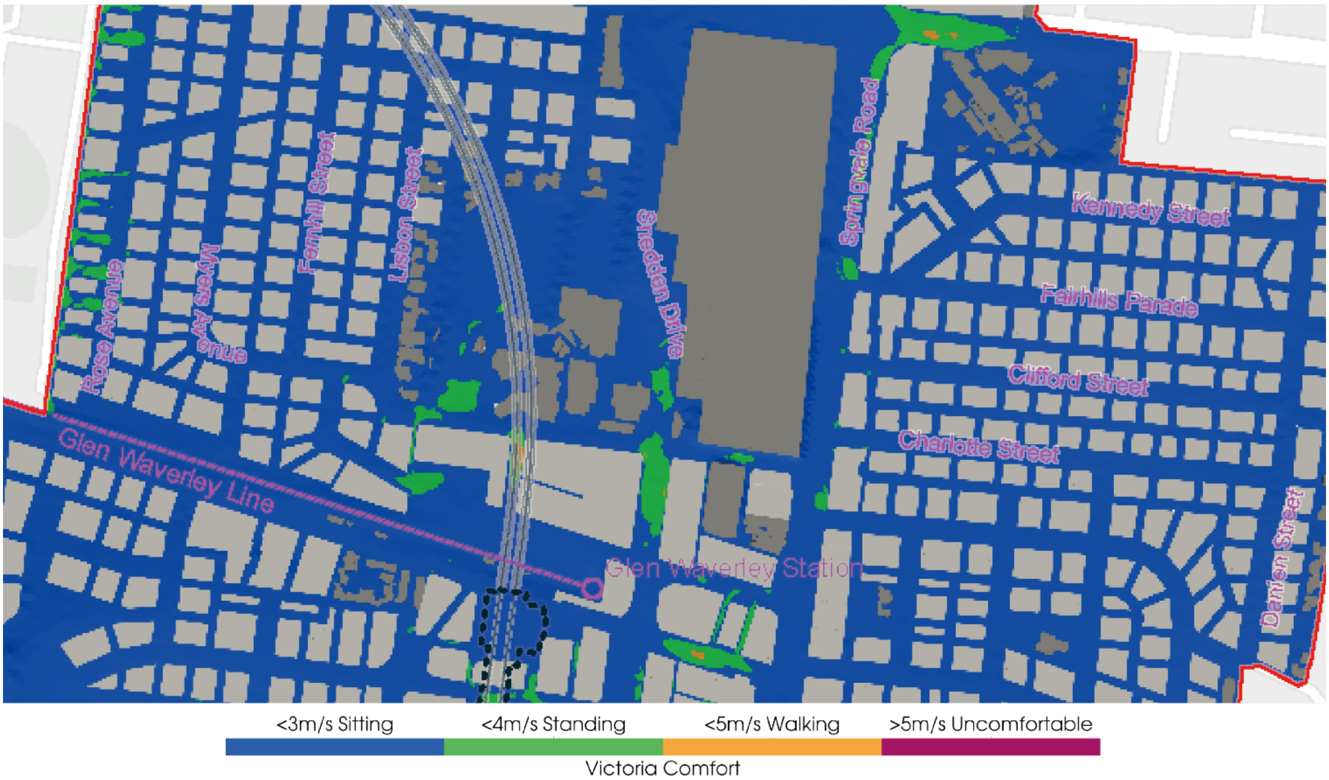



FIGURE 6.17 WIND COMFORT CONDITIONS FOR GLEN WAVERLEY FUTURE BUILDINGS CLOSE UP

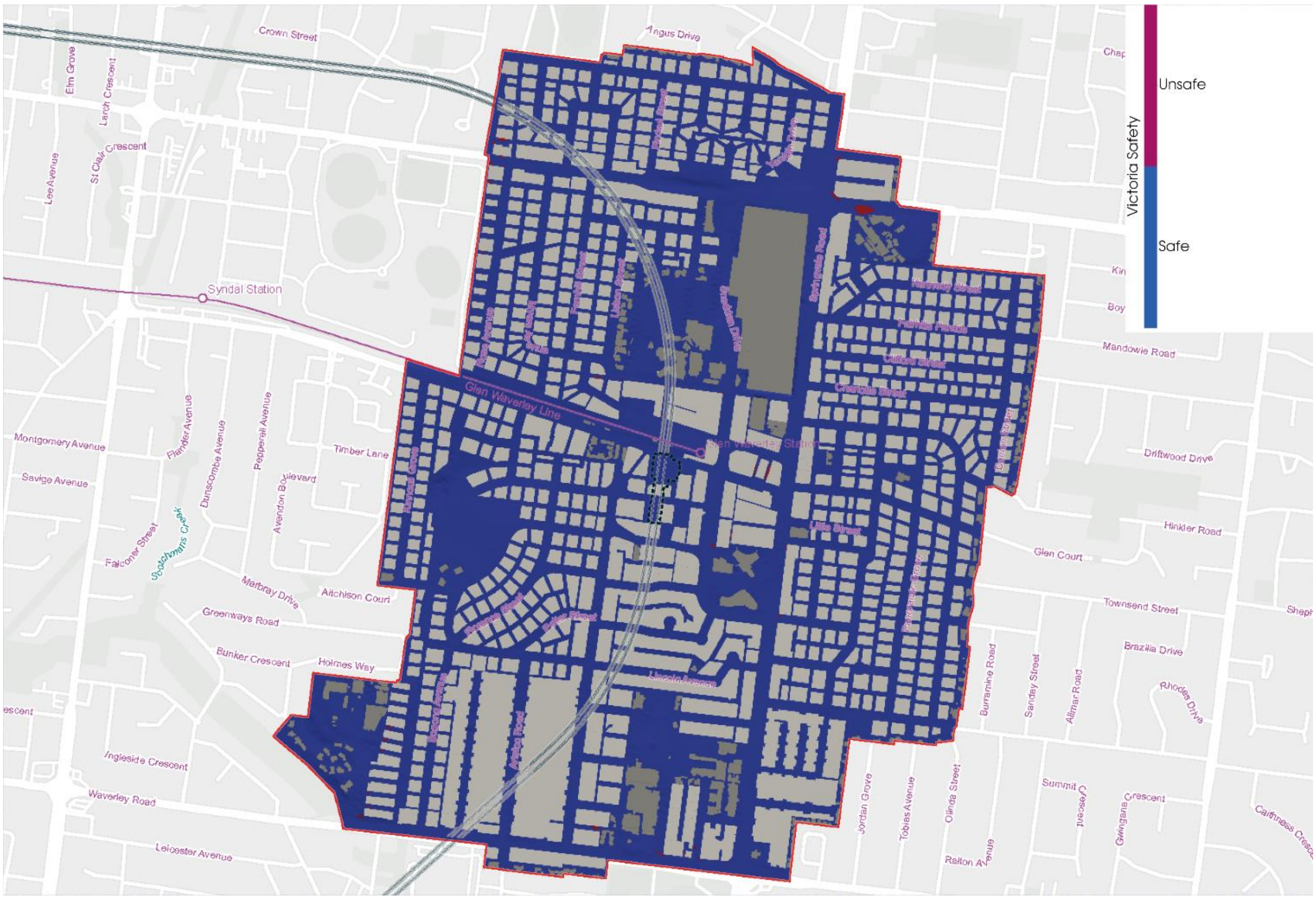



FIGURE 6.18 WIND SAFETY CONDITIONS FOR GLEN WAVERLEY FUTURE BUILDINGS

## 6.5 Burwood Structure Plan Area

The proposed land use framework for the Burwood Structure Pla Area is shown in Figure 6.19.

Overall comfort conditions are improved by the higher density of buildings, with most of the development meeting the sitting criterion (Figure 6.20). Some localised areas of uncomfortable conditions are found around tall buildings (30 to 40 metres high) along Burwood Highway (Figure 6.21) in the eastern and western edges of the development which will require some form of mitigation. These buildings have large unshielded north-facing façades, which divert the predominant northerly winds, causing significant downwash. The wind conditions are made worse by the channelling of the wind between the buildings, as the streets and laneways are aligned with the northerly winds.

Safety exceedances are found along Burwood Avenue, mostly coinciding with the locations of uncomfortable and walking conditions (Figure 6.22), for the same reasons listed above. Channelling of westerly winds along Burwood Avenue is also a contributing factor.

Unsafe conditions are also visible around the building south of the Deakin University campus, between Milford Avenue and Station Street. This building has a height of 38 metres and a large unshielded north-facing façade, which generates downwash and corner acceleration.

The safety exceedances occur in areas of mixed use, as shown in Figure 6.19.

Setbacks and podiums would be the most effective measures. Chamfered or rounded corners should be considered on north-facing façades along Burwood Highway, particularly for those buildings on the eastern edge of the Burwood Structure Plan Area and for the building above SRL station at Burwood. Awnings, canopies and screens might also provide sufficient mitigation.

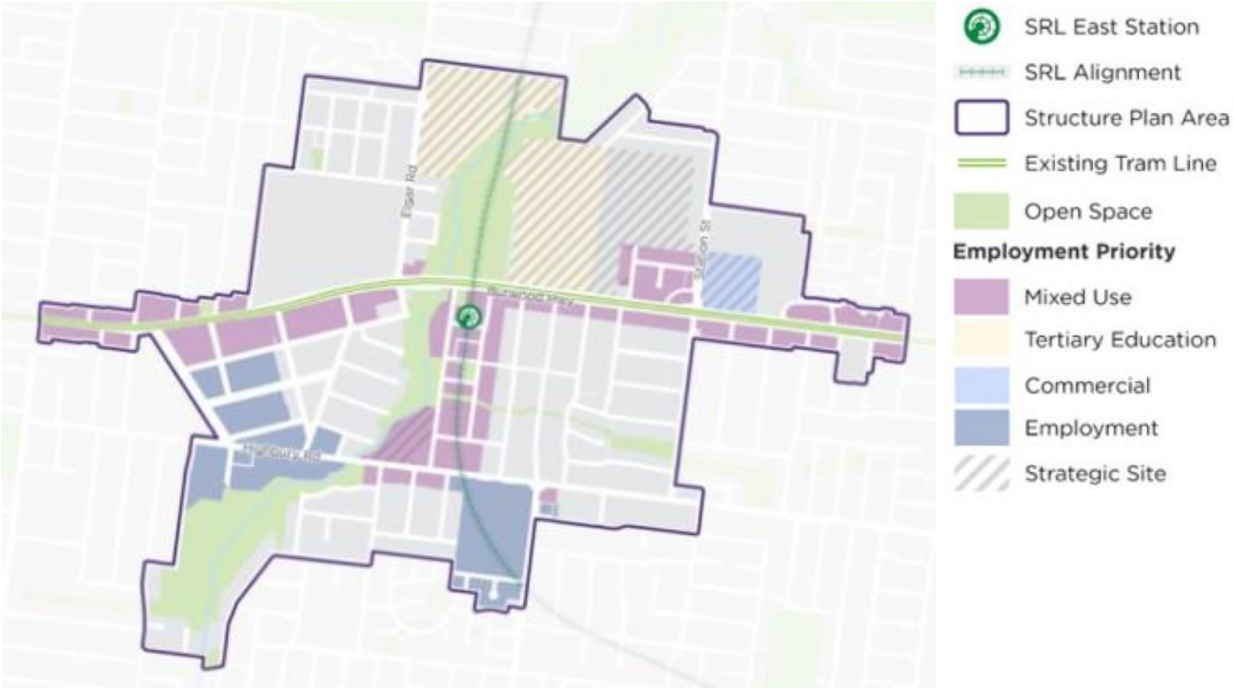



FIGURE 6.19 PROPOSED LAND USE FRAMEWORK FOR BURWOOD STRUCTURE PLAN AREA

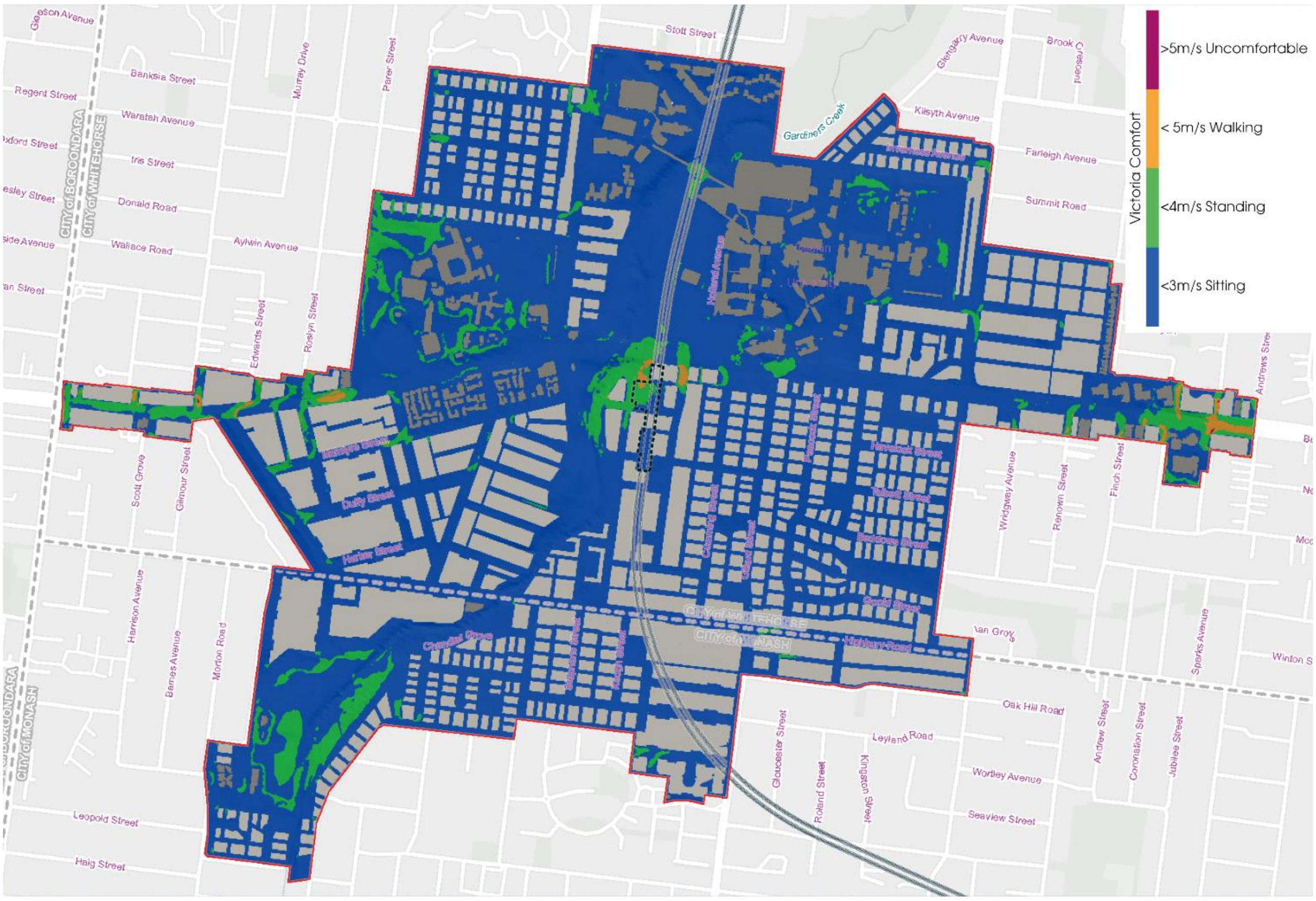



FIGURE 6.20 WIND COMFORT CONDITIONS FOR BURWOOD FUTURE BUILDINGS


FIGURE 6.21 WIND COMFORT CONDITIONS FOR BURWOOD FUTURE BUILDINGS CLOSE UP

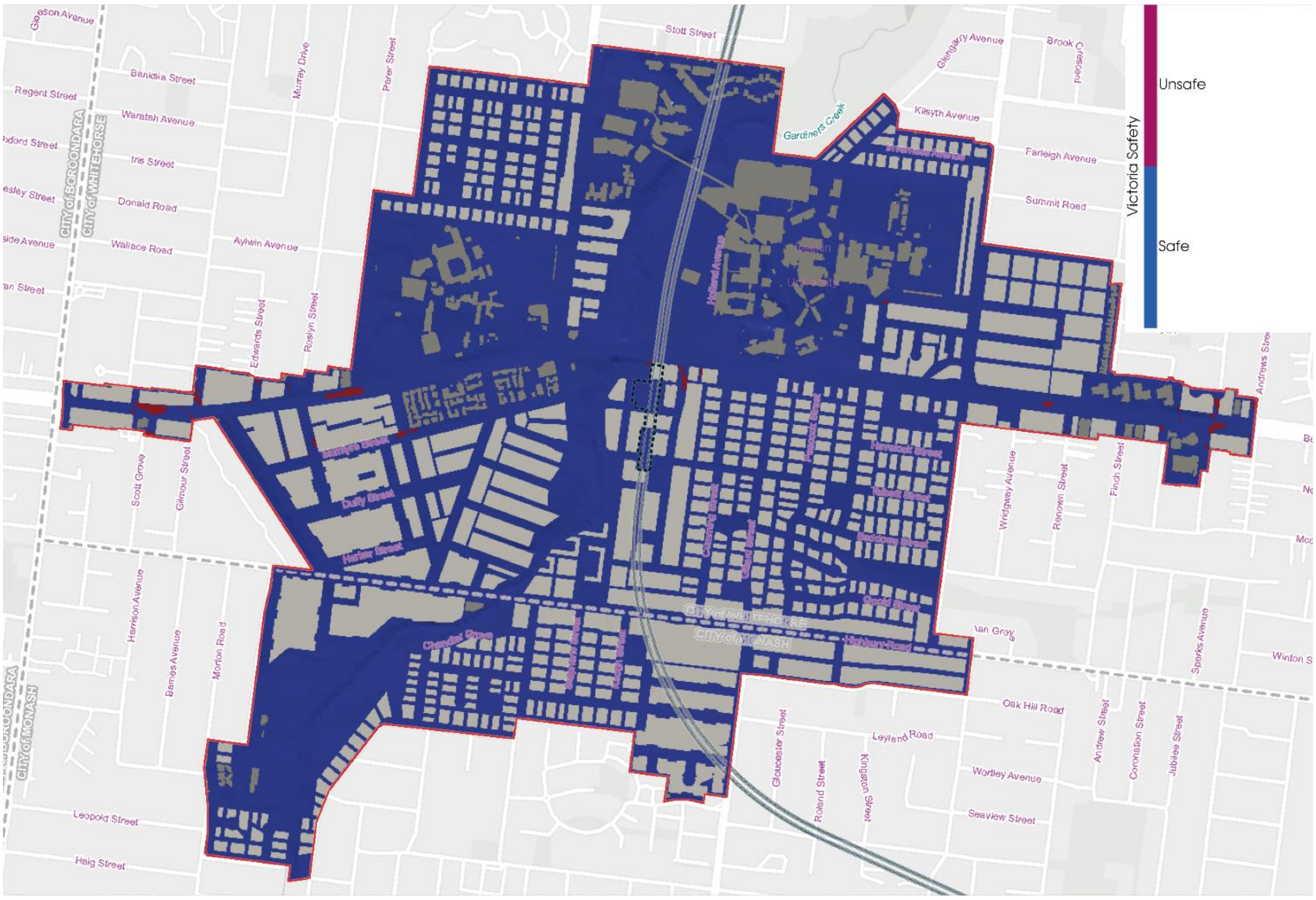



FIGURE 6.22 WIND SAFETY CONDITIONS FOR BURWOOD FUTURE BUILDINGS

## 6.6 Box Hill Structure Plan Area

The proposed land use framework for the Box Hill Structure Plan Area is show in in Figure 6.23.

The higher density of buildings improves the overall comfort conditions in the Box Hill Structure Plan Area, with most areas meeting the sitting criterion (Figure 6.24). Conditions around the ATO building and existing Box Hill Station are markedly improved due to the shielding provided by the buildings on the northern side of Whitehorse Road. Some small areas of uncomfortable conditions are present around the buildings east of Whitehorse Towers.

Some regions of accelerated flow are present around the buildings on the northern side of Maroondah Highway, close to the Box Hill City Oval (Figure 6.25), but conditions still comply with the walking criterion. These buildings are over 30 metres high and near each other, creating narrow wind corridors.

While the high density of buildings improves the comfort conditions, it deteriorates the safety conditions in the mixed-use area connecting to Whitehorse Road (Figure 6.26). There are safety exceedances around many of the high-rise buildings along Whitehorse Road and the intersecting laneways and streets, which are consistent with downwash and channelling. These buildings range from 30 to over 130 metres high.

Unsafe conditions are also found along Canterbury Road on the south end of the Box Hill Structure Plan Area, also consistent with channelling. Buildings in front of Surrey Park Oval are 30 metres high and largely unshielded. They are also arranged so that narrow corridors form between the buildings channelling the wind.

The unsafe conditions on Canterbury Road east of Station Street are caused by wind channelling. Buildings here are 30 metres high.

Most of the exceedances occur in areas of mixed use or retail, as shown in Figure 6.23.

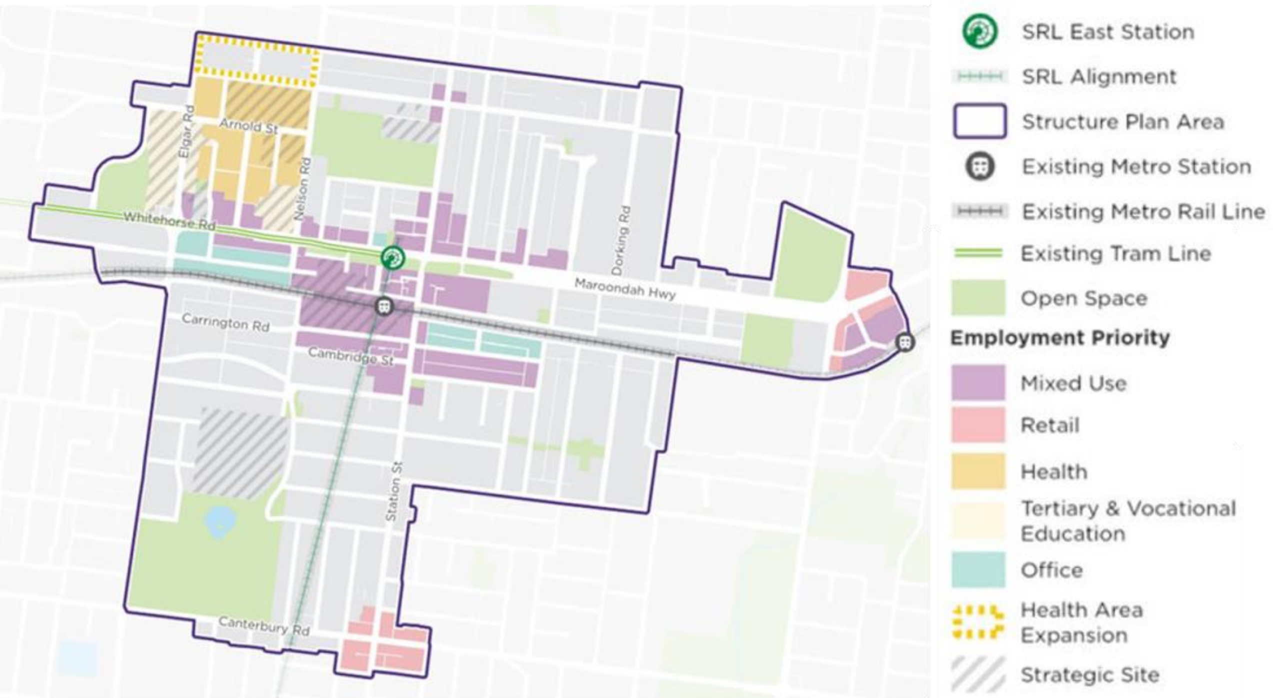



FIGURE 6.23 PROPOSED LAND USE FRAMEWORK FOR BOX HILL STRUCTURE PLAN AREA

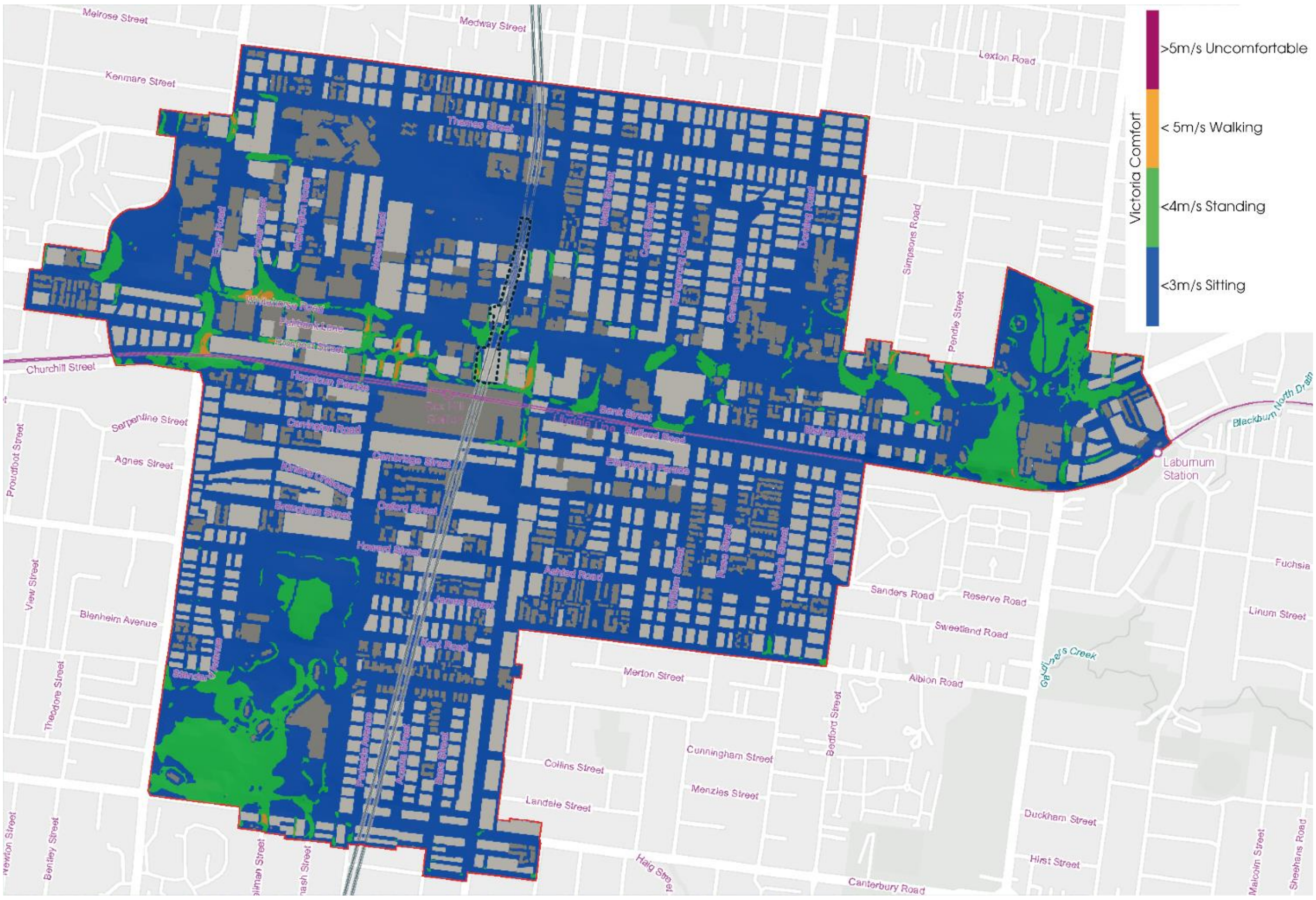



FIGURE 6.24 WIND COMFORT CONDITIONS FOR BOX HILL FUTURE BUILDINGS

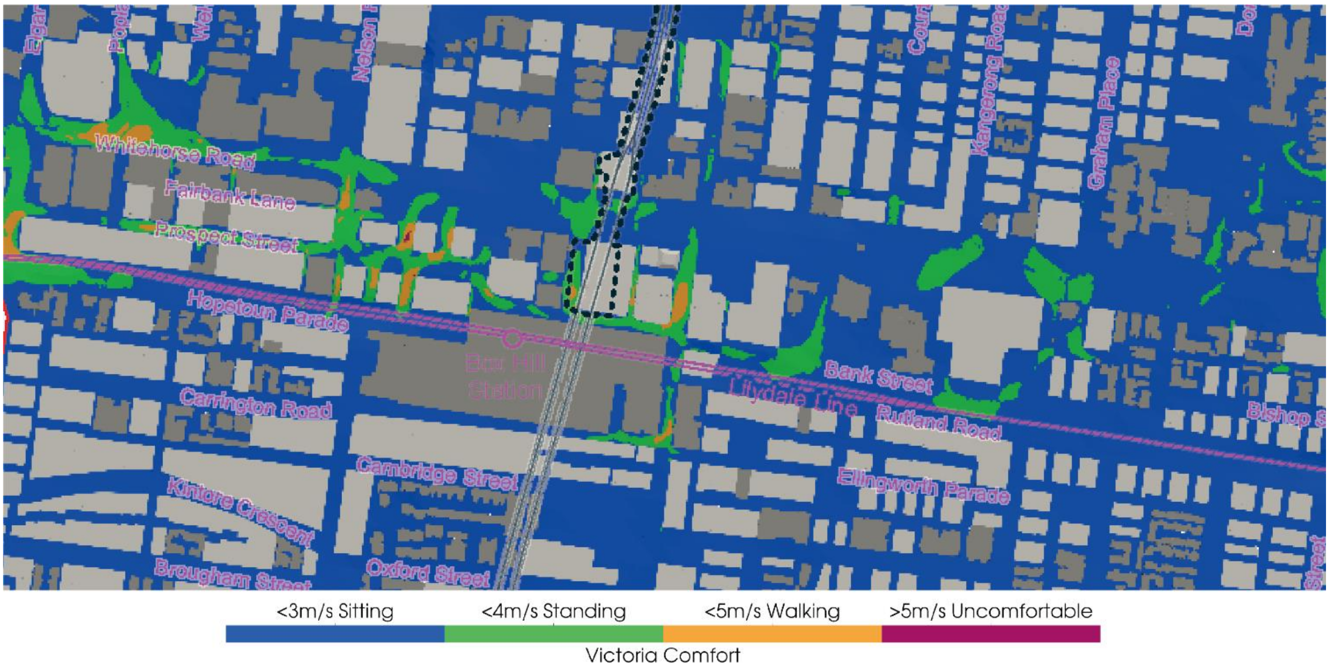



FIGURE 6.25 WIND COMFORT CONDITIONS FOR BOX HILL FUTURE BUILDINGS CLOSE UP


FIGURE 6.26 WIND SAFETY CONDITIONS FOR BOX HILL FUTURE BUILDINGS

## 6.7 Findings

The modelling of wind conditions for the future scenarios in the SRL Easts Structure Plan Areas found overall improvement because the high density and close spacing of buildings reduces wind speeds across the developments. Many locations shift from the current walking conditions to sitting conditions.

Some localised regions of increased wind velocity are found in streets and laneways between buildings when they align in the north-south direction, as they channel the predominant northerly winds. These regions are the western corner of the Clayton Structure Plan Area along Wellington Road, and the intersection of Somers Street and Burwood Highway in the Burwood Structure Plan Area, where the wind speeds reach uncomfortable levels.

Conditions are improved around the ATO Building and Whitehorse Towers in the Box Hill Structure Plan Area due to shielding by the buildings on the north side of Whitehorse Road.

Uncomfortable wind conditions are found around the buildings east of Whitehorse Towers, and around the buildings on the northern side of Whitehorse Road close to Box Hill City Oval.

The future scenarios create unsafe conditions in all SRL East Structure Plan Areas. This is due to the high-rise buildings, which create downwash and channelling.

# 7. Recommendations

This section provides recommendations to improve the wind condition when developing the Structure Plans and advise when further wind assessment is required. Recommendations are focused on non-residential areas that are not subject to existing planning provisions.

Recommendations to improve wind conditions across all SRL East Structure Plan Areas are made, followed by recommendations specific to each Structure Plan Area.

Recommendations focus on areas where Clause 58.04-4 of the Victoria Planning Provisions (relating to wind impacts of developments of five or more storeys) may not apply, because they are non-residential areas.

Further wind assessment is required at planning permit application stage. Proposed planning controls should incorporate a wind effect analysis within the SRL East Structure Plan Areas in specific areas as identified in the recommendations for each Structure Plan Area below and at various height thresholds.

## 7.1 All SRL East Structure Plan Areas

The threshold for further wind assessment:

1. A pedestrian-level wind tunnel study is required for developments that meet any of the following criteria:
    a) The building height exceeds 60 metres.
    b) The building height exceeds 40 metres and is exposed to an open area from the north, west, or south. Open areas typically include major arterial roads, highways, parks, large water bodies, or parcels of open land larger than 40 by 40 metres.
    c) The development includes a tower-and-podium design with a height exceeding 40 metres and more than one tower.
2. Developments between 20 and 60 metres in height that do not meet criteria 1(b) or 1(c) require a pedestrian-level CFD study.

The recommendations for wind mitigation are:

3. Setbacks and podiums are recommended for tall buildings and large building compounds to reduce downwash.
4. Breaking up large continuous north-facing façades in buildings that are considerably higher than their surroundings is recommended to reduce downwash and channelling effects.
5. Gradually increasing the height of buildings in the direction of the predominant winds (in this case, increasing height from north to south) is recommended to help reduce the effects of downwash, as taller buildings are partially shielded by the smaller buildings upstream.
6. Chamfered (sloping) or rounded building corners are recommended to reduce wind acceleration around corners.
7. Wide streets are recommended to reduce wind channelling and increase air dispersion.
8. Awnings, canopies or screens are recommended in areas with uncomfortable wind conditions to reduce wind speeds to acceptable levels.

9. Trees and landscaping should not be used to mitigate wind impacts, except in sitting areas (as a supplementary measure) where trees with dense foliage and street furniture can assist in reducing wind speeds.

## 7.2 Cheltenham Structure Plan Area

The modelling found no uncomfortable wind conditions in the future scenario of the Cheltenham Structure Plan Area. Some regions of walking conditions might require mitigation depending on their intended use. Safety exceedances are created mainly by cornering and channelling effects, therefore:

10. Breaking up large continuous north-facing facades is recommended to reduce downwash and channelling.
11. Chamfered or rounded building corners are recommended to reduce wind acceleration around corners.
12. Awnings, canopies or screens are recommended to shield and reduce wind speeds in seating areas if required.

## 7.3 Clayton Structure Plan Area

The modelling found uncomfortable and unsafe wind conditions in the future scenario around the SRL station at Clayton with tall buildings causing significant downwash, and along Wellington Road (North Road) where tall buildings on the western side of the Structure Plan Area presenting a large façade to the north and the laneways between them are aligned with the northerly winds, creating a channelling effect; therefore:

13. Breaking up the large façade is recommended to reduce downwash and channelling.
14. Gradually increasing the height of buildings in the direction of the predominant winds (in this case, increasing height from north to south) is recommended to reduce the effects of downwash.
15. Podiums, setbacks and awnings are recommended to reduce downwash on the building above the SRL station at Clayton.

## 7.4 Monash Structure Plan Area

The modelling found no uncomfortable wind conditions in the future scenario in the Monash Structure Plan Area. Walking conditions along the south side of Ferntree Gully Road and Wellington Road due to wind channelling through the narrow street were identified. Downwash and channelling are the main mechanisms causing unsafe conditions; therefore:

16. Setbacks and podiums on tall buildings are recommended to reduce downwash.
17. Chamfered or rounded corners are recommended on unshielded façades, particularly those which are north-facing and west-facing.

## 7.5 Glen Waverley Structure Plan Area

The modelling found no uncomfortable wind conditions in the future scenario in the Glen Waverley Structure Plan Area. Walking criterion is met around The Glen Shopping Centre. Downwash and channelling are the main mechanisms causing unsafe conditions, therefore:

18. Setbacks and podiums on tall buildings are recommended to reduce downwash.

19. Chamfered or rounded corners are recommended on unshielded façades, particularly those which are north-facing and west-facing.
20. Trees or street furniture are recommended to reduce uncomfortable wind speeds to acceptable levels in seating areas where required.

## 7.6 Burwood Structure Plan Area

The modelling found uncomfortable and unsafe wind regions scattered in the mixed-use region along Burwood Highway in the future scenario, particularly around building corners and laneways around large building compounds, therefore:

21. Setbacks and podiums are recommended on tall buildings to reduce downwash.
22. Chamfered or rounded corners are recommended on north-facing façades along Burwood Highway, particularly for those buildings on the eastern edge of the Burwood Structure Plan Area and for the building above the SRL station at Burwood.

## 7.7 Box Hill Structure Plan Area

The modelling found wind safety exceedances around the Whitehorse Towers and ATO building on Whitehorse Road, and next to Sky One Tower on Station Street, caused by downwash and channelling; therefore:

23. Setbacks and podiums are recommended on tall buildings to reduce downwash.
24. Chamfered or rounded corners are recommended on north-facing facades to reduce cornering effects and wind channelling through narrow streets.
25. Screens and street furniture are recommended to shield seating areas from northerly winds.
26. Chamfered or rounded corners are recommended on north-facing facades of tall buildings along the northern side of Whitehorse Road close to Box Hill City Oval to reduce wind channelling and corner acceleration.

# References

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Appendix A

# Computational fluid dynamics model

# A.1 – Detailed methodology

## Numerical methods

The analysis uses a computational fluid dynamics (CFD) model which predicts fluid flows by mathematically modelling the Reynolds Averaged Navier-Stokes equations; fundamental equations which describe fluid motion. Open FOAM software was used; its reliability for computational wind simulation has been well-validated by academic researchers and independent organisations.

The chosen CFD scheme simplifies estimates of turbulence, models average flow conditions well and random flow conditions with less accuracy. The turbulence closure scheme used for the modelling in this report was the realisable k-ε model. This model has been extensively validated for urban flows and has been shown to have superior performance for highly separated flows when compared with the standard k-ε model.

Second order discretisation was used for the gradient, divergence and Laplacian terms. Simulation residuals and flow properties were monitored for convergence to steady state.

## Computational domain and meshing

The computational domain for the wind technical assessment was taken as a cylindrical domain of 4800 metres diameter and 1000 metres high, sufficient to avoid any blockage effects (based on a blockage ratio much less than 10% per the AWES Quality Assurance Manual). The background mesh is an O-grid, allowing for cubic hexahedral elements at the geometry, while blending smoothly to the cylinder at the outer extents of the domain. Mesh refinement was used to ensure adequate resolution of the flow, with the smallest cells being of size 0.6 metres at the geometry. Inflation layers were added at the ground to better resolve the vertical velocity gradient and provide higher resolution at pedestrian height. Depending on the size of the SRL East Structure Plan Area, final mesh counts were between 100 and 150 million cells.

## Approach flow and boundary conditions

Accurate CFD simulations require appropriate modelling of conditions at the model boundaries. Of particular importance are the inlet velocity and turbulence conditions, which were modelled using a logarithmic wind profile, with roughness lengths taken from AS1170.2. For each SRL East Structure Plan Area, the surroundings from each direction were assessed as Terrain category 3, and so a roughness length of 0.2 metres was used. The ground plane roughness was modelled to ensure the boundary layer profile remained constant (neutrally stable) throughout the approach and far-field.

Additional boundary definitions were:

- The top boundary having a shear stress and vertical gradient in epsilon following the recommendations of Richards and Hoxey
- Outflow boundary with zero gradient in pressure
- Side boundaries based on a mixed inlet / outlet condition
- Bottom (ground) boundary as a no-slip wall with wall roughness function applied
- Building surfaces as no-slip walls.

Wall functions were used to model the viscous sublayer flows near no-slip walls to accurately model wall friction effects. Changes in wind speed with direction were accounted for in post-processing calculations using Weibull distribution parameters (see Appendix A.2).

# A.2– Statistical analysis of meteorological data

## Scaling methods

Modelling of local wind effects requires accurate representation of the surrounding terrain and built environment. The influence of terrain and built environment over the development length is incorporated into AS1170.2 (2021) as different terrain categories. Based on the terrain category, a suitable model of the atmospheric boundary layer (change in velocity and turbulence intensity with height) is given, which accounts for nearby structures and terrain (roughness). This model uses a logarithmic law to describe the mean wind speed profile in terms of roughness length.

Wind data from Moorabbin Airport was corrected to open terrain (category 2) using methods outlined in Holmes, 2021. To scale to the terrain roughness surrounding the site (category 3) scaling was applied using mean wind speed terrain / height multipliers from AS1170.2(2021) Weibull analysis

To accurately account for the relative contributions of wind events from different directions, comfort exceedance probabilities were defined using a Weibull distribution. The probability of the wind speed at a certain location, $U_i$, exceeding a speed, V, for any given direction, θ, is given by:

$$p(U_i > V, \theta) = A(\theta\,)e^{\left[-\left(\frac{V}{C(\theta)}\right)^{k(\theta)}\right]}$$

Here k(θ) and C(θ) are Weibull coefficients for the azimuth sector, θ , and A(θ) is the marginal probability of the wind direction being within the azimuth sector. Therefore, the sum of all the marginal probabilities will be equal to one and the following will hold true:

$$p(U_i > V, \theta) = A(\theta\,)e^{\left[-\left(\frac{V}{C(\theta)}\right)^{k(\theta)}\right]}$$

Consequently, the exceedance probability is given by:

$$p(U_i > V) = \sum_{all\ sectors} A(\theta)e^{\left[-\left(\frac{V}{C(\theta)}\right)^{k(\theta)}\right]}$$

The coefficients obtained from the Biggin Hill Airport BoM data are shown in the following table.

**TABLE A.1 WEIBULL COEFFICIENTS (TERRAIN CATEGORY SCALING BETWEEN WEATHER STATION AND SITE APPLIED)**

| Direction | A | C | k |
|---|---|---|---|
| N | 0.196 | 4.693 | 2.053 |
| NNE | 0.044 | 3.343 | 1.742 |
| NE | 0.015 | 2.084 | 1.805 |
| ENE | 0.011 | 1.639 | 2.163 |
| E | 0.016 | 1.840 | 1.920 |
| ESE | 0.055 | 3.481 | 1.619 |
| SE | 0.073 | 3.288 | 2.114 |
| SSE | 0.064 | 3.267 | 2.547 |
| S | 0.058 | 4.034 | 2.672 |
| SSW | 0.101 | 5.849 | 2.934 |
| SW | 0.082 | 5.867 | 2.737 |
| WSW | 0.046 | 5.273 | 2.653 |
| W | 0.060 | 5.654 | 2.697 |
| WNW | 0.061 | 4.639 | 2.624 |
| NW | 0.046 | 4.223 | 2.265 |
| NNW | 0.071 | 4.474 | 1.895 |

## Extreme value analysis

For analyses involving high return periods, such as pedestrian safety, infrequent wind events of high wind speed are considered. These wind events have been described using a Type 1 Extreme Value Distribution (or Gumbel Distribution) with Gringorten's modification, which models infrequent events more accurately than the Weibull distribution. The probability of the wind speed at a given location, $U_i$, exceeding a speed, $V$, for any given direction, $\theta$, is given by:

$$p(U_i > V, \theta) = 1 - \mathrm{e}^{-e^{\left[-\frac{V-u(\theta)}{a(\theta)}\right]}}$$

where $U(\theta)$ and $a(\theta)$ are the calculated coefficients for each azimuth sector. The return period for exceedance velocity $V$ for each sector is the inverse of the exceedance probability, that is:

$$R_\theta = \frac{1}{p(U_i > V, \theta)}$$

The overall exceedance probability for all wind directions is given by:

$$1 - \frac{1}{R} = \prod_\theta \left(1 - \frac{1}{R_\theta}\right)$$

$$= \prod_\theta \mathrm{e}^{-e^{\left[-\frac{V-u(\theta)}{a(\theta)}\right]}}$$

Therefore, the return period for winds from all directions is:

$$R = \frac{1}{1 - \prod_\theta \mathrm{e}^{-e^{\left[-\frac{V-u(\theta)}{a(\theta)}\right]}}}$$

The coefficients obtained Moorabbin Airport are shown in the following table.

**TABLE A.2 EXTREME VALUE COEFFICIENTS (TERRAIN CATEGORY SCALING BETWEEN WEATHER STATION AND SITE APPLIED)**

| Direction | u | A |
|---|---|---|
| N | 18.780 | 2.406 |
| NNE | 15.283 | 2.028 |
| NE | 10.454 | 2.060 |
| ENE | 8.661 | 2.270 |
| E | 10.051 | 2.124 |
| ESE | 14.522 | 2.620 |
| SE | 13.274 | 1.725 |
| SSE | 12.444 | 3.620 |
| S | 13.764 | 1.720 |
| SSW | 18.095 | 2.097 |
| SW | 19.377 | 2.168 |
| WSW | 19.420 | 2.290 |
| W | 20.217 | 2.036 |
| WNW | 17.494 | 2.259 |
| NW | 17.322 | 1.689 |
| NNW | 19.648 | 2.232 |

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