23-47 VILLIERS STREET

NORTH MELBOURNE, VIC

PEDESTRIAN WIND ASSESSMENT

PROJECT # 2402470

28 AUGUST 2024

SUBMITTED TO

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RWDI

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QUALITY ASSURANCE

RWDI Australia Pty Ltd operates a Quality Management System which complies with the requirements of AS/NZS ISO 9001:2015. This management system has been externally certified by SAI Global and Licence No. QEC 13457 has been issued for the following scope: The provision of consultancy services in acoustic engineering, air quality and wind engineering; and the sale, service, support and installation of acoustic monitoring and related systems and technologies.

1. INTRODUCTION

RWDI Australia Pty Ltd (RWDI) was retained to undertake a pedestrian wind assessment of the proposed development located at 23-47 Villiers Street in North Melbourne, VIC. The project site is bound by Villiers Street to the south, Little George Street to the east, Harcourt Street to the north, and Mary Street to the west. Mid-rise residential buildings and approved hotel are situated on the opposite site of Little George Street, while the rest of the surrounding context consists primarily of low-rise residential, commercial or school buildings. The overall site context, indicating the project site and the surrounding buildings, is shown in Image 1.

The proposed development is comprised of two connected towers with an overall height of 12-storeys, with Building A facing Villiers Street, and Building B facing Harcourt Street (Image 2). The key outdoor pedestrian accessible areas of interest associated with the development include the pedestrian footpaths around the site, the entrances to the development, the communal open spaces on the ground floor and upper levels, and the private balconies.

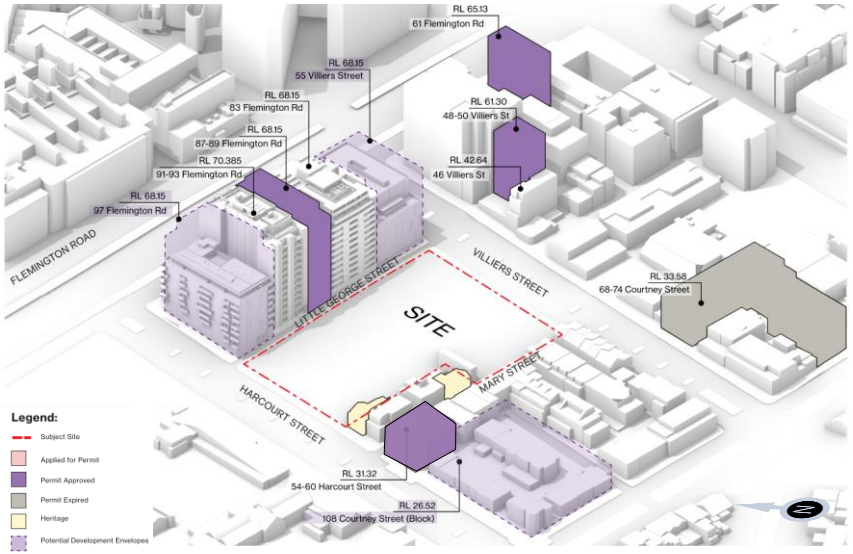

Image 1: Site Context

Source: Urban Context Report – 23 – 47 Villiers St North Melbourne

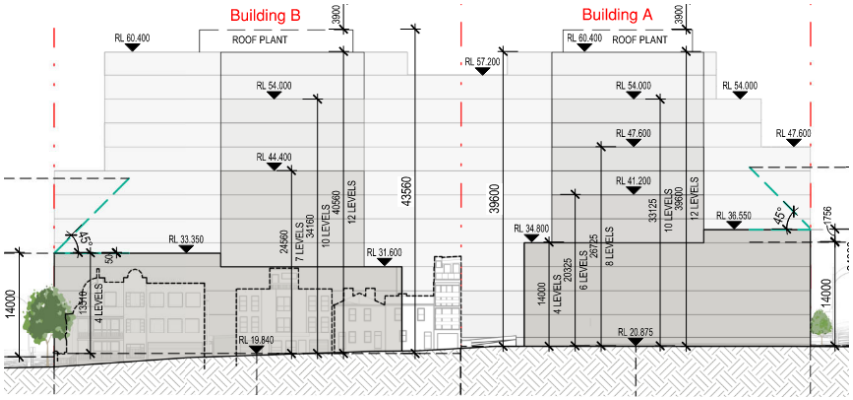

Image 2: Proposed Development West Elevation

2. METHODOLOGY

Predicting wind speeds and occurrence frequencies around a building is a complex process, encompassing an assessment of factors such as building geometry, orientation, surrounding building heights and positions, terrain upstream, and the local wind climate. RWDI has amassed extensive expertise through conducting numerous wind-tunnel model studies and Computational Fluid Dynamics (CFD) assessments specifically focused on pedestrian wind conditions around buildings. This wealth of experience, complemented by comprehensive literature, facilitates a reliable and efficient desktop estimation of pedestrian wind conditions for concept designs without the need for wind-tunnel testing or detailed CFD studies.

This qualitative approach provides a preliminary assessment of potential wind conditions around the site and offers a conceptual framework for wind control measures aimed at enhancing wind comfort, if and where necessary. To further validate and refine the predicted conditions discussed in this report or to refine the suggested wind control measures, physical scale model tests in a boundary-layer wind tunnel or CFD simulations will be required. These detailed studies offer a quantitative validation and enable a more detailed assessment, ensuring the accuracy and effectiveness of proposed wind control strategies.

RWDI's assessment is based on the following:

- A review of the regional long-term meteorological data;
- Drawings and information received by RWDI in April 2024.
- Wind-tunnel studies, CFD simulations, and desktop assessments undertaken by the microclimate team for projects in the region;
- Our engineering judgement, experience, and expert knowledge of wind flows around buildings[1, 2]; and,
- Pedestrian Wind Comfort Criteria as set out in the Melbourne Planning Scheme (Clause 58.04-4).

Note that other microclimate issues such as those relating to cladding and structural wind loads, door operability, building air quality, noise, vibration, etc. are not part of the scope of this assessment.

1. H. Wu and F. Kriksic (2012). "Designing for Pedestrian Comfort in Response to Local Climate", Journal of Wind Engineering and Industrial Aerodynamics, vol.104-106, pp.397-407.
2. C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999), "Experience with Remedial Solutions to Control Pedestrian Wind Problems", 10th International Conference on Wind Engineering, Copenhagen, Denmark.

3. METEOROLOGICAL DATA

Meteorological data recorded at Melbourne Airport for the period from 2000 to 2022 were used as a reference for wind conditions in the study area. Image 3 graphically depicts the directional distributions of wind frequencies and speeds recorded at the station during the summer (Nov-Apr) and winter (May-Oct) seasons. The records indicate that winds are most frequent from the north and south directions during the summer with secondary winds from the southwest. During the winters, winds from the north are more dominant with secondary winds from the westerly directions.

Long-term meteorological data recorded at other airports in the region (e.g., Moorabbin Airport) were also examined to determine the local wind directionality, as indicated in Image 3. The analysis confirmed the dominance of the northerly winds in the region throughout the year, with the secondary winds from the westerly directions. The intensity of the northerly winds observed to the south of the Melbourne CBD is, however, generally less severe than the winds noted at the Melbourne International Airport. This is primarily due to these winds traversing over the urban terrain of Melbourne and due to a local shift in the wind climate towards a westerly dominant wind. The southerly winds in the summer are also more spread-out from the south half of the compass since the measurement site is closer to the Bay area and is, therefore, influenced by the effect of sea/land breezes. The current analysis method has accounted for the north and all wind directions.

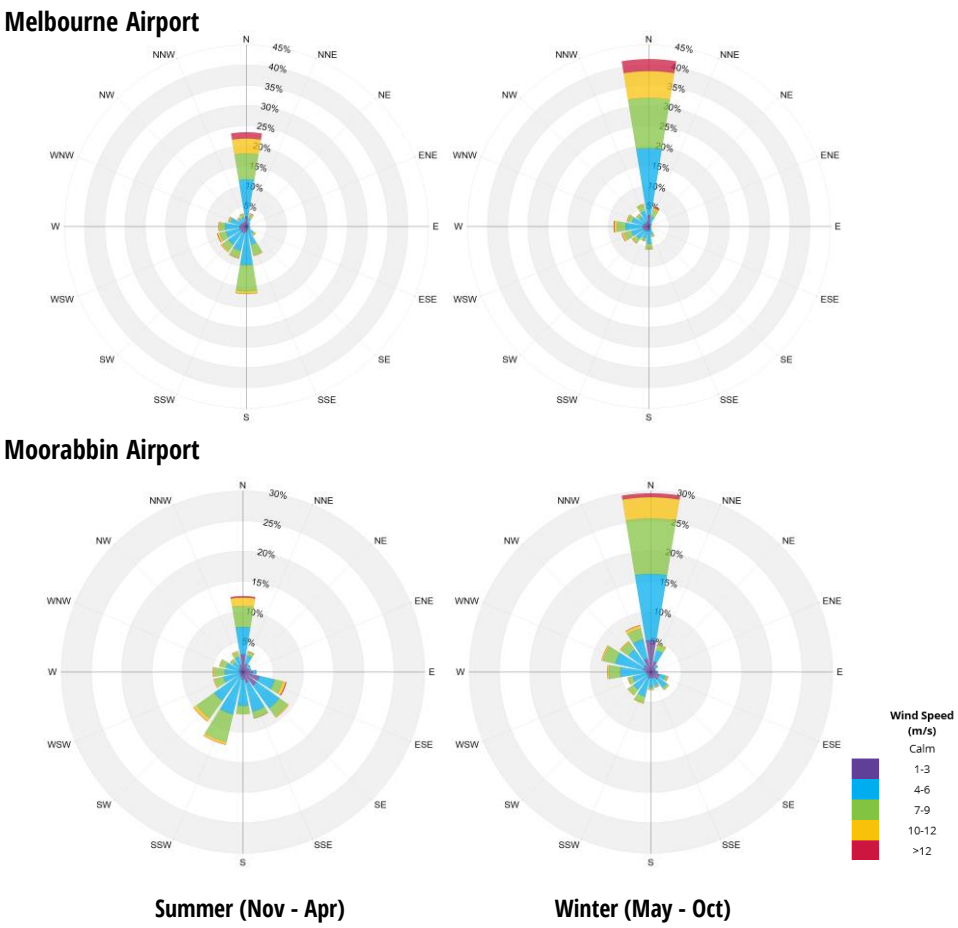

Image 3: Directional Distribution of Winds Approaching Melbourne and Moorabbin Airports (2000-2022)

4. PEDESTRIAN WIND CRITERIA

4.1 Safety Criterion

Pedestrian safety is associated with excessive gusts that can adversely affect a pedestrian's balance and footing. If strong winds, greater than 20 m/s occur for more than nine hours per year (or 0.1% of the time), the wind conditions are considered severe. These are assessed qualitatively in the assessment and are usually coincident with areas of high wind activity as noted in the report.

4.2 Pedestrian Comfort Criteria

The Pedestrian Wind Criteria as specified in the Melbourne Planning Scheme (Clause 58.04-4) sets out standards for compliance to facilitate a comfortable environment for designated pedestrian activities, as indicated in Image 4. The standards detail the requirements related to pedestrian wind comfort and safety, with the objective of mitigating adverse wind effects generated by buildings.

The wind comfort levels are categorised based on typical/intended pedestrian activity and are expressed in terms of their suitability for various levels of human activity. The categorisation is based on conservative wind speeds; higher the activity level, higher the wind speed one can typically tolerate while engaged in the activity. Wind conditions are assessed at a typical pedestrian chest height and are considered suitable for the intended use of the space if the associated mean winds are not expected to exceed the specified criterion for more than 20% of the time during the year.

These criteria for wind forces represent average wind tolerance and can be subjective with regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. also impacting and individual's perception of the wind climate. Wind control measures are typically required at locations where the occurrence frequencies of wind speeds exceed the threshold values for specific pedestrian activities.

It should be noted that there is an alterative criteria presented in DDO61 Table 2 (last updated 15/10/2015), however, this comfort criteria (based on the peak gust) is no longer considered best practice. This criteria has since been superseded by the gust equivalent mean criteria (outlined in Clause 58.04-4 Standard D17, last updated 04/05/2022) as it is a better predictor of wind comfort in an urban environment, and is therefore the current standard and best practice in wind engineering.

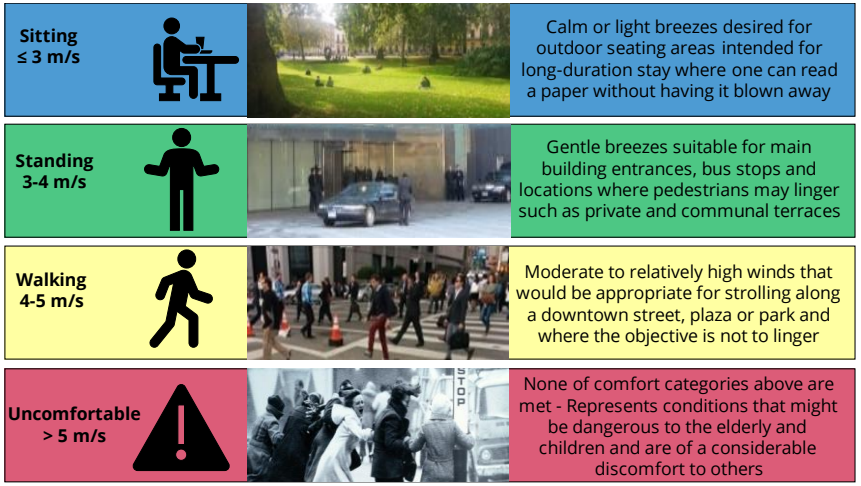

Image 4: Pedestrian Wind Comfort Criteria

5. RESULTS AND DISCUSSION

5.1 General Wind Flow around Buildings

In our discussion of wind conditions on and around the proposed development, reference may be made to the following generalised wind flows (see Image 5). If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable or potentially unsafe conditions. Design details such as setting back a tower from the edges of a podium for a prevailing wind direction, deep canopies close to ground level, wind screens / tall trees with dense landscaping, etc. can help reduce high wind activity. The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.

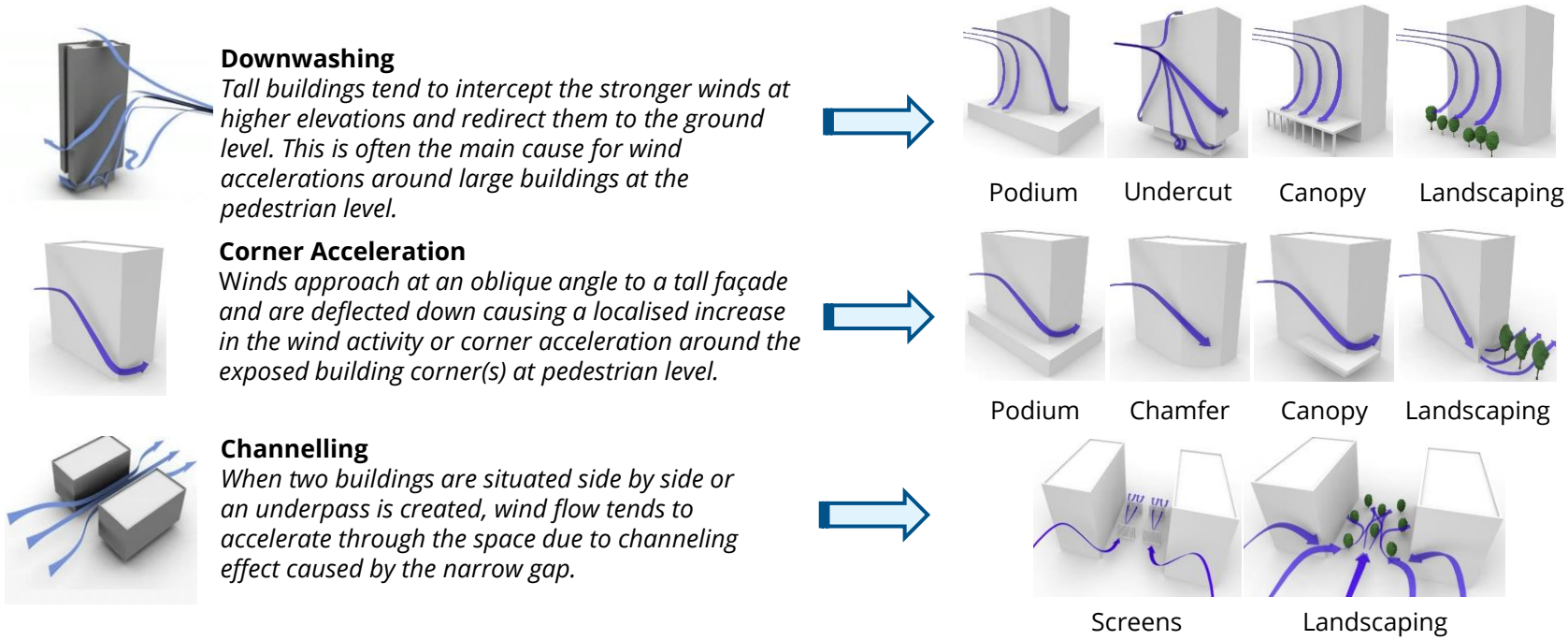

Image 5: General Wind Flow around Buildings with Examples of Common Wind Measures

5.2 Site Exposure and Existing Site Conditions

Notably, the site benefits from shielding against prevailing winds from the north due to the neighboring buildings along Flemington Road. Additionally, winds originating from the south are expected to be somewhat buffered by the presence of the Melbourne CBD further to the south. However, the site is relatively exposed to westerly winter winds with low-rise buildings in this direction.

The local wind environment surrounding the project site is expected to be influenced predominantly by the neighboring mid-rise buildings along Flemington Road, primarily due to the low-rise nature of the existing structure. Considering the local wind climate and site exposure, it is expected that wind conditions across the majority of the site will typically be suitable for passive sitting to standing use throughout the year.

However, higher winds exceeding the wind comfort or safety criteria are likely to occur at the corner of Harcourt Street and Little George Street due to massing of the neighbouring buildings redirecting the northerly and southerly winds towards this corner. Similarly, wind conditions suitable for active walking use are likely to occur at the corner of Villiers Street and Little George Street due to the westerly winds being redirected by the existing buildings towards this corner.

Image 6: Exposure of Site to Regional Prevailing Winds
Left: Summer | Right: Winter

5.3 Proposed Site Conditions

5.3.1 Ground Level Areas

The proposed development takes advantage of several positive design features that are likely to reduce the overall wind activity around the site. These include the incorporation of stepped volumes in the proposed massing of both Buildings A and B, alongside strategic canopies and landscaping features. Additionally, the primary lobby entrances are recessed into the buildings and positioned away from corners. Furthermore, similar to the existing site, most areas within and surrounding the proposed development are shielded from prevailing northerly winds. Therefore, overall wind conditions on the ground level are typically expected to be comfortable for passive standing use to active walking use.

However, the northerly and westerly winds are anticipated to channel near the northeast corner of the site, with conditions expected to surpass wind comfort and safety limits. Nevertheless, overall conditions are projected to be comparable to those of the existing site. The awning incorporated in the design and the recess at the corner is likely to reduce impacts of the westerly winds.

Similarly, southerly winds are expected to impact the southeast corner of the site, with the elevation increase along Villiers Street likely intensifying overall effects. It's worth noting that the awning along the southern corner includes gaps, which may diminish its effectiveness in wind reduction. Nonetheless, the space is now shielded from westerly winds due to the proposed development. Consequently, overall wind impacts are expected to resemble those of the existing site, rendering the area suitable for active walking use at the corner.

Wind impacts within the proposed Boardwalk and the communal space on ground level are likely to be comfortable for passive sitting to standing use due to the shielding afforded by the subject development from prevailing winds. However, areas in proximity to the intersection of Harcourt Street and the Boardwalk are likely to offer comfortable conditions ranging from passive standing use to active walking use during winters. This is due to the likely channelling of northerly and westerly winds. This generally aligns with the intended use of the space as a pedestrian thoroughfare.

5.3.2 Upper-Level Communal Spaces

- **Level 1:** The external terrace on Level 1 is situated between the two proposed buildings and is, hence, shielded from prevailing regional winds. Wind conditions are, therefore, likely to be suitable for long-duration sitting use within the space.
- **Level 2:** The Level 2 terrace is situated along Harcourt Street within Building B. The space is relatively exposed to regional winds that can impact outdoor comfort. Review of the Landscape Drawings (received by RWDI in April 2024) shows 1 m raised planters along the perimeter and canopies that will likely assist with conditions. However, the winds can accelerate around the corners of the terrace with the more open areas exposed to stronger wind effects. Wind conditions are likely to be comfortable for active walking use within the space.

5. RESULTS AND DISCUSSION

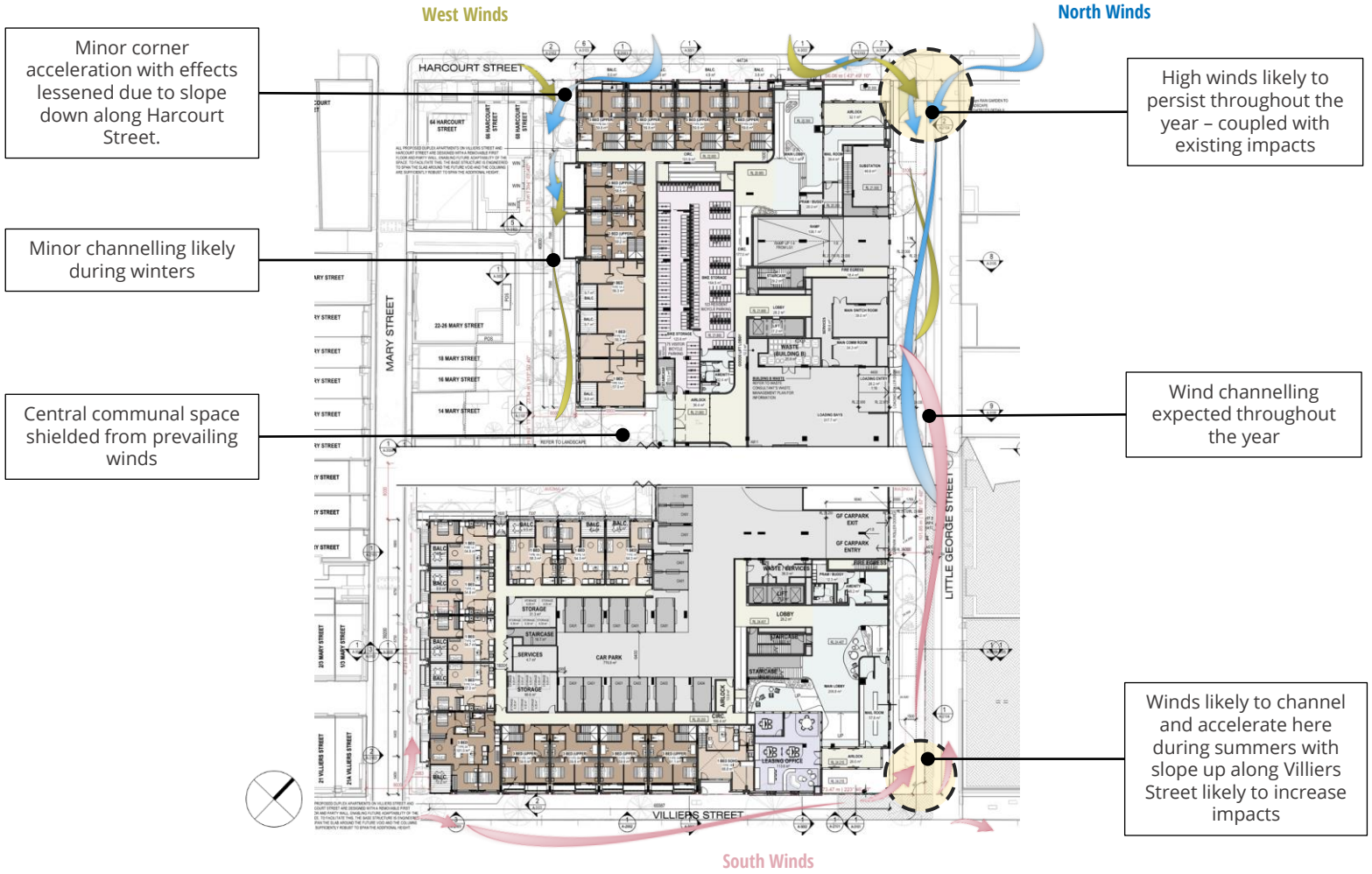

Image 7: Expected Wind Flow on Local Ground

5.3.3 Private Balconies

Balconies that are inset / recessed within the planform of the buildings benefit from a single aspect design, and as such, these spaces are expected to have comfortable wind conditions suitable for short to long-duration sitting use throughout the year.

Corner balconies tend to be exposed to stronger wind effects due to the high likelihood of regional winds accelerating around building corners. For this development, higher winds that could potentially exceed the comfort and safety thresholds can occur for corner balconies, particularly if they are located along the northern aspect of Building B along Harcourt Street and along the southern aspect of Building A along Villiers Street.

Note that wind conditions within balconies can vary substantially depending on the position of an individual with respect to railings, screens etc. Furthermore, the utilisation of balcony space is discretionary with occupants having the option to retreat indoors during periods of high winds and generally developing an understanding of their balcony's usability based on seasonal variability. Potential safety issues for corner balconies, however, should be proactively addressed through mitigation. Further wind tunnel testing will be undertaken to confirm the extents of these measures.

5.5 Implemented Mitigations and Further Studies

Based on the appraisal of the site wind conditions and the likely risks, some areas where the proposed design implements wind mitigation measures are noted below and are recommended to be investigated further:

- The wind conditions near the northeast and southeast corners on the ground level are anticipated to be primarily influenced by the existing buildings. However, with the inclusion of the proposed development, stronger wind effects may arise due to corner acceleration of regional winds. The entryways of the proposed design are slightly recessed into the building form which has the potential to improve local wind conditions in close proximity to the entry. Wind tunnel testing is recommended to be undertaken to quantify the wind conditions in this area and to define any additional mitigation strategies, if required.
- The southern awning is anticipated to assist in improving wind conditions by reducing the risk of winds reattaching on the ground floor. Wind tunnel testing is recommended to be undertaken to verify its effectiveness in wind mitigation.
- The Level 2 terrace benefits from the various screens, canopies and proposed landscaping that have been incorporated in the design. To confirm the levels of wind comfort achieved through the implementation of these measures in this space, wind tunnel testing is recommended to be undertaken to quantify their effect and refine these mitigation measures.

6. SUMMARY

Wind conditions on and around the proposed development located at 23-47 Villiers Street, North Melbourne, VIC are discussed in this report. The qualitative assessment is based on the review of local wind climate and the current design of the proposed development. The impact of the surrounding buildings and the local land topography has also been considered. The assessment is based on our experience with wind tunnel testing and CFD analysis of similar buildings within the region.

Conceptual wind flows around the proposed development have been assessed for the prevailing wind directions to identify key wind sensitive areas. Design advice in the form of conceptual mitigation measures and built-form response are also provided for design coordination. It is to be noted that the mitigations discussed in this report are qualitative in nature and based on the assumptions and flow activity noted.

Wind tunnel testing is planned to quantify and confirm the predicted conditions discussed in the report. The wind control measures will also be refined as part of these wind tunnel tests.

7. APPLICABILITY OF ASSESSMENT

The assessment discussed in this report pertains to the proposed development in accordance with the drawings and information received in April 2024. In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact on the wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.

Statement of Limitations

This report entitled '*23-47 Villiers Street North Melbourne Pedestrian Wind Assessment*', dated 28 August 2024, was prepared by RWDI Australia Pty Ltd ("RWDI"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.