20 BERRY STREET

NORTH SYDNEY, NSW

PEDESTRIAN WIND ASSESSMENT

PROJECT #2101025
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SUBMITTED TO

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1. INTRODUCTION

RWDI Australia Pty Ltd (RWDI) was retained to conduct a qualitative assessment of the pedestrian wind conditions expected around the proposed development at 20 Berry Street in North Sydney. This report is intended to inform good design and has been conducted in support of the Stage 1 Development Application.

The development site is located north of Berry Street between the Pacific Highway and Angelo Street (Image 1). The existing site is occupied by a 14-storey office building and neighboured by buildings that are either similar in height or taller (Image 2). The nearfield surroundings to the east, south and west comprise tall buildings and low-rise suburban residential areas make up the extended surroundings.

The proposed development is a 25-storey office tower that will replace the existing 14 storey office building on the site. The tower design is unique in its massing with a stepped form that is widest at mid-height, and a podium with a saw-toothed façade. Pedestrian areas include the ground level perimeter, plaza proposed at the southeast corner, terrace on the podium and nearby sidewalks. Key plans and renderings are provided in Image 3.

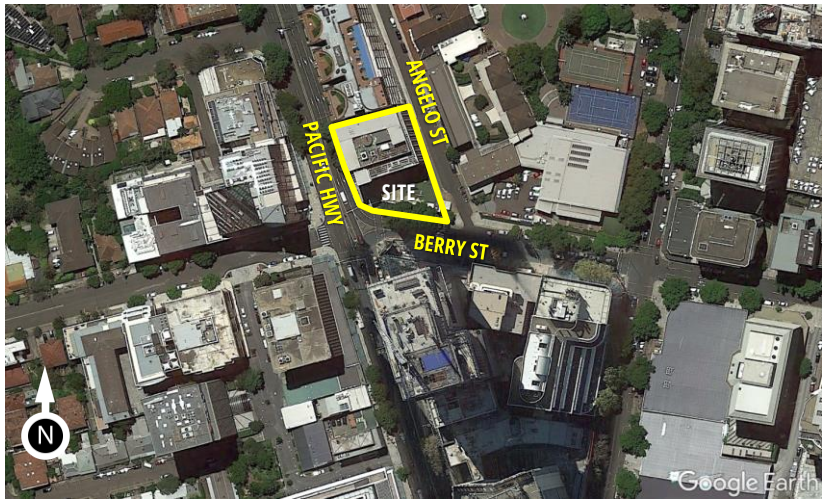


Image 1: Aerial View of the Existing Site and Surroundings
(Credit: Google Earth)

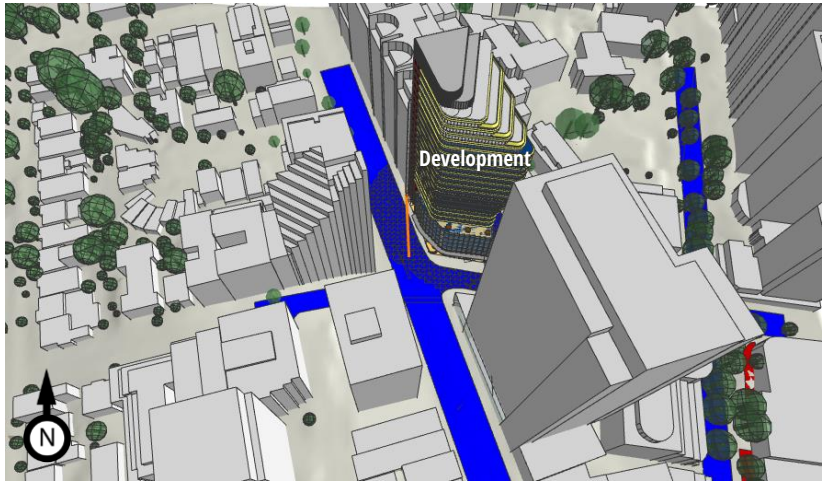
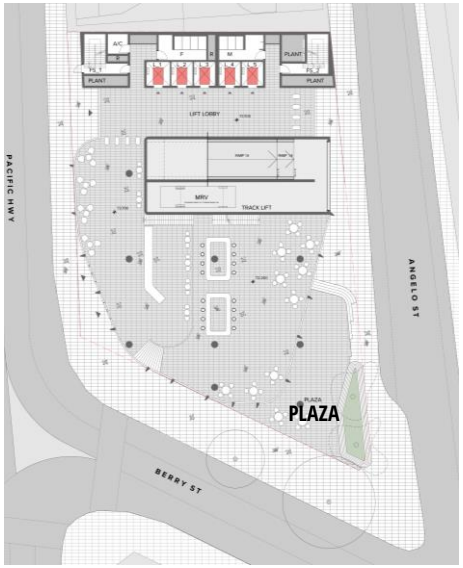
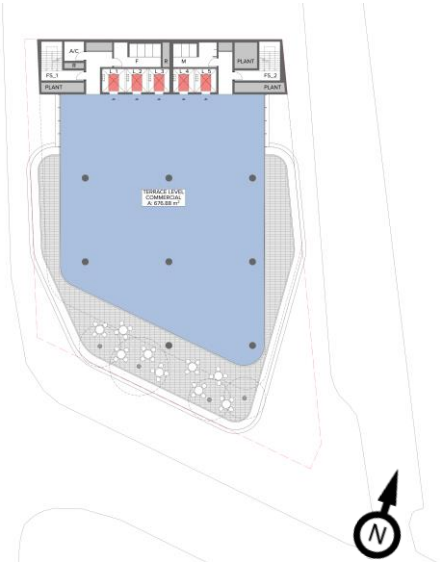


Image 2: Rendering of the development in the Surrounding Context

1. INTRODUCTION



GROUND FLOOR PLAN



TERRACE LEVEL PLAN

VIEW FROM BERRY STREET

VIEW OF TERRACE FROM EAST

VIEW OF DEVELOPMENT FROM SOUTH ON PACIFIC HIGHWAY

Image 3: Key Plans and Development Renderings

2. METHODOLOGY

Predicting wind speeds and occurrence frequencies is complex. It involves the combined assessment of building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate.

Over the years, RWDI has conducted thousands of wind-tunnel model studies on pedestrian wind conditions around buildings, yielding a broad knowledge base. In some situations, this knowledge and experience, together with literature, allow for a reliable, consistent and efficient desktop estimation of pedestrian wind conditions without wind-tunnel testing. This approach provides a screening-level estimation of potential wind conditions and offers conceptual wind control measures for improved wind comfort, where necessary.

In order to quantify and confirm the predicted conditions or refine any of the suggested conceptual wind control measures, physical scale model tests in a boundary-layer wind tunnel would be required.

RWDI's assessment is based on the following:

- Design drawings and renderings of the development provided by Turner on November 24, 2020;
- A review of the regional long-term meteorological data;
- Use of RWDI's proprietary software (*WindEstimator*[1]) for providing a screening-level numerical estimation of potential wind conditions around generalized building forms;
- Wind-tunnel studies and desktop assessments undertaken by RWDI for projects in Sydney;
- RWDI's engineering judgement and knowledge of wind flows around buildings[2, 3]; and,
- RWDI Criteria for pedestrian wind comfort and safety.

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, C.J. Williams, H.A. Baker and W.F. Waechter (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", *ASCE Structure Congress 2004,* Nashville, Tennessee.
2. 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.
3. 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 Sydney Kingsford Smith International Airport, for the period from 1995 to 2018, were used as a reference for wind conditions in the area. The distributions of wind frequency and directionality for summer (November through April) and winter (May through October) seasons are shown in Image 4.

When all wind data is considered, winds are frequent from the north-northeast, northeast, south-southeast and south directions during the summer months. During the winter, winds from the west-southwest through northwest and the southerly directions are most common.

Strong winds of a mean speed greater than 30 km/h measured at the airports (at an anemometer height of 10 m) occur more often in the summer (10.6%) than in the winter (8.0%). During both seasons, strong winds from the southerly directions are predominant. Winds from these directions could potentially be the source of uncomfortable or even severe wind conditions, depending on the site exposure or development design. The analysis methods have accounted for this and all winds directions.

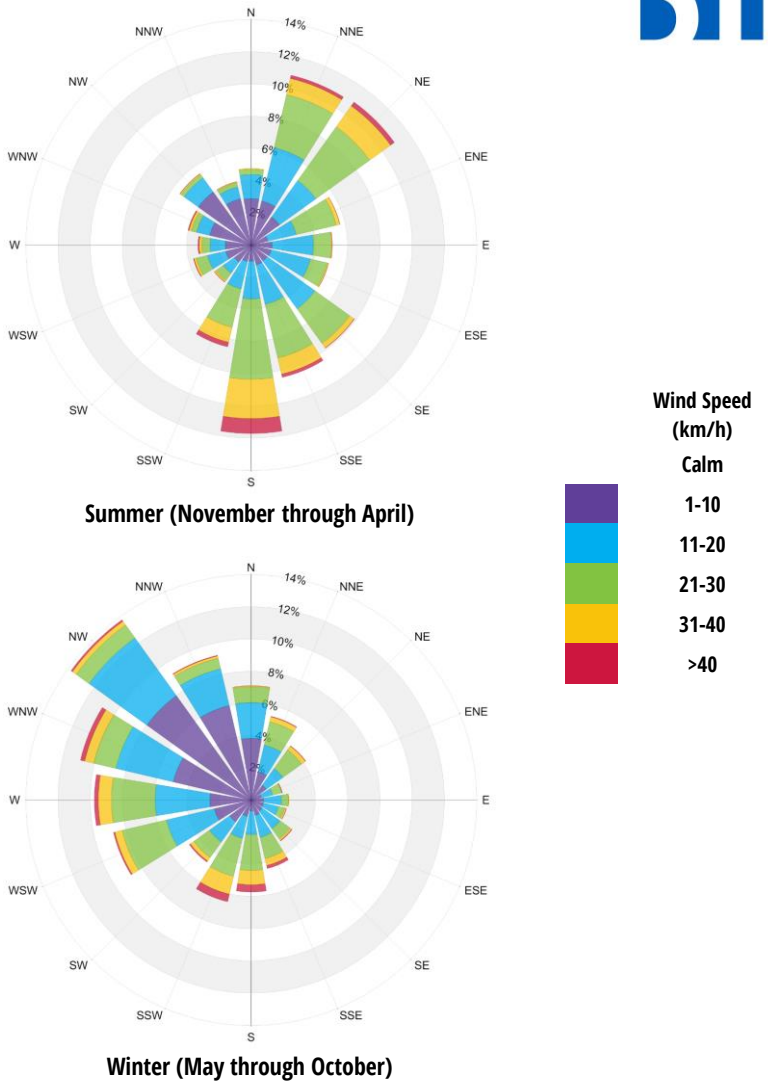


Image 4: Directional Distribution of Winds Approaching Sydney Kingsford Smith International Airport (1995 to 2018)

4. WIND CRITERIA

The RWDI pedestrian wind criteria are used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities, building designers and the city planning community. The criteria are as follows:

4.1 Safety Criterion

Pedestrian safety is associated with excessive gust wind speeds that can adversely affect a pedestrian's balance and footing. If strong winds that can affect a person's balance (**83 km/h**) occur more than **0.1%** of the time or **9 hours per year**, the wind conditions are considered severe.

4.2 Comfort Criteria

Wind comfort can be categorized by typical pedestrian activities:

Sitting (≤ 10 km/h): Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away.

Standing (≤ 14 km/h): Gentle breezes suitable for main building entrances and bus stops.

Strolling (≤ 17 km/h): Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park.

Walking (≤ 20 km/h): Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.

Uncomfortable: The comfort category for walking is not met.

Wind conditions are considered suitable for sitting, standing, strolling or walking if the associated mean wind speeds are expected for at least four out of five days (**80% of the time**). Wind control measures are typically required at locations where winds are rated as uncomfortable or they exceed the wind safety criterion.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5 m above grade or the concerned floor level), typically lower than those recorded in the airport (10 m height and open terrain).

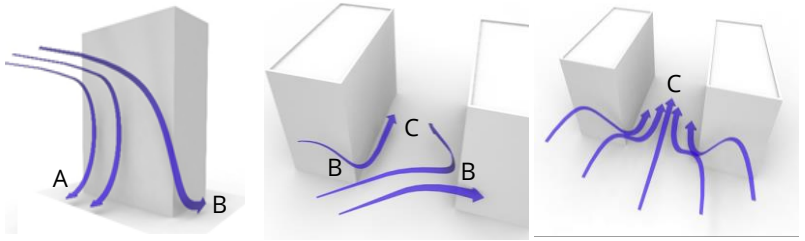
These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks; lower wind speeds comfortable for standing are required for building entrances and bus-stops where pedestrians may linger, and calm wind speeds suitable for sitting are desired in areas where passive activities are anticipated, such as the outdoor terrace.

5. RESULTS AND DISCUSSION

5.1 General Wind Flow around Buildings

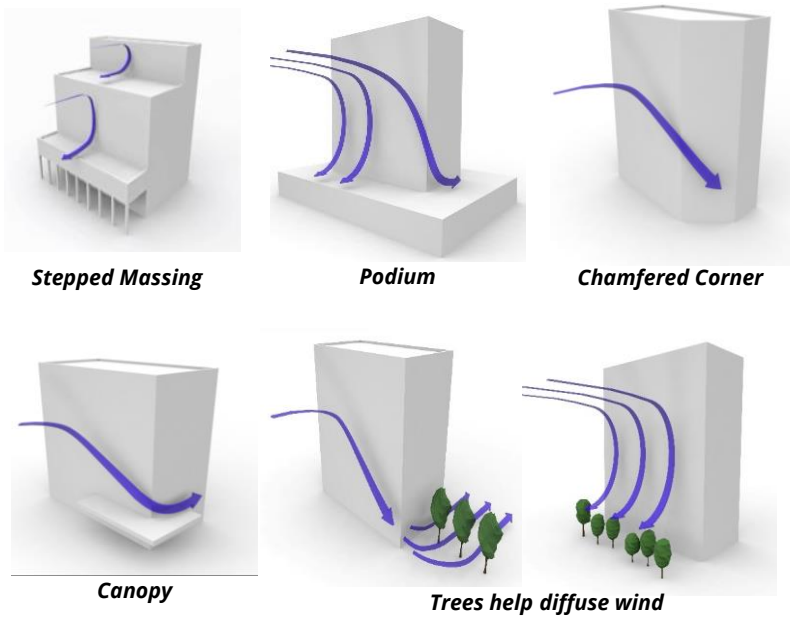
Wind speed increases with elevation; often in densely built suburbs the built forms shelter each other from wind exposure, particularly when most buildings are of similar heights or very tall. Buildings that are taller than its surrounding structures tend to intercept the stronger winds at higher elevations and redirect them to the ground level. (Downwashing). These winds subsequently move around exposed building corners, causing a localized increase in wind activity due to Corner Acceleration. Wind at ground level may also accelerate in canyons or gaps formed by tall buildings such as narrow streets (Channelling flows). These flow mechanisms are illustrated in Image 5. If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and *uncomfortable* conditions.



A. Downwashing ***B. Corner Acceleration*** ***C. Channelling***

Image 5: General Wind Flow Mechanisms

Design details such as stepped massing, significant façade and corner massing articulations, tower step-back from a podium edge, deep canopies close to ground level, wind screens / tall trees with dense underplanting, etc. can help reduce wind speeds around them (Image 6). 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.



Stepped Massing ***Podium*** ***Chamfered Corner***

Canopy ***Trees help diffuse wind***

Image 6: Examples of Common Wind Control Measures

5.2 Existing Wind Conditions

The existing site is occupied by a 14-storey office building and the site is sheltered from the prevailing winds to a large extent by the tall buildings that exist in the surroundings. However, the taller buildings in the area would interact with winds to create localised areas of wind accelerations at street-level near them. Southerly winds would be channelled along the Pacific Highway and accelerate around the base of the buildings at Berry Street. In the summer, winds from the northeast are also likely to cause elevated speeds on Berry Street at the southeast corner of the site.

Wind speeds around the development site are expected to be comfortable for sitting or standing most of the time during the year. Higher wind speeds comfortable for strolling or walking are expected at the intersections of Berry Street at the Pacific Highway and Angelo Street; these conditions are appropriate for footpaths.

5.3 Future Wind Conditions

The proposed development, at 25 storeys, is comparable in height to the taller buildings that exist in the surrounding area. The wind flow patterns described in Section 5.2 will continue to prevail (Image 7); however, the proposed tower design incorporates several features that are favourable for wind control, such as the following.

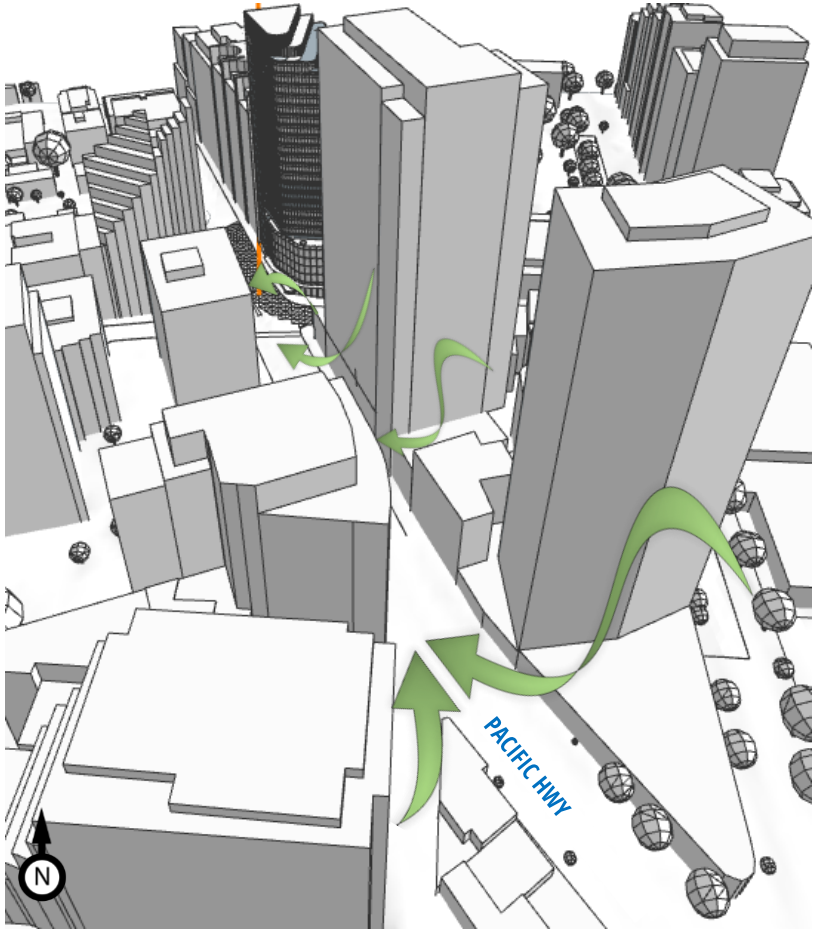
- The tower step-back on the podium and the deep canopy above the first floor that will help disrupt downwashing flows.
- The stepped tower massing that is narrowest at the podium widening with height will encourage westerly winds that would be redirected by the wide west façade to flow around the tower well above street level.
- Tall balustrades on the podium terrace for reduced wind exposure.
- The saw-toothed articulation of the podium façade as well as the massing offset at every level on the tower, which will disturb wind flows and reduce acceleration of winds travelling along the façade
- The recessed first floor that will be protected from downwashing flows by the overhang above.
- The recessed main entrance area will be well protected from ambient wind flows.

Owing to the benefits of these features on wind flows around the development, wind conditions around the base of the development are expected to be comfortable for sitting or standing through most of the year. Higher wind speeds comfortable for walking may be expected occasionally at the intersections of Berry Street at Pacific Highway and Angelo Street, and in the proposed Plaza area due to the westerly and north-easterly winds. The inclusion of the stepped façade form and recessed terrace level is expected to ensure conditions are similar to the existing conditions. The noted tree planting at the corner of Angelo and Berry Streets will further help to reduce wind activity in this area.

Wind speeds on the podium terrace are also generally expected to be appropriate for passive use with the protection of the tall balustrades. The area will benefit from high-canopied trees, trellises or other overhead features, particularly at the east end where the northeasterly winds may influence comfort from time to time in the summer.

5. RESULTS AND DISCUSSION

SOUTH WINDS (SUMMER AND WINTER)



NORTHEAST WINDS (SUMMER)

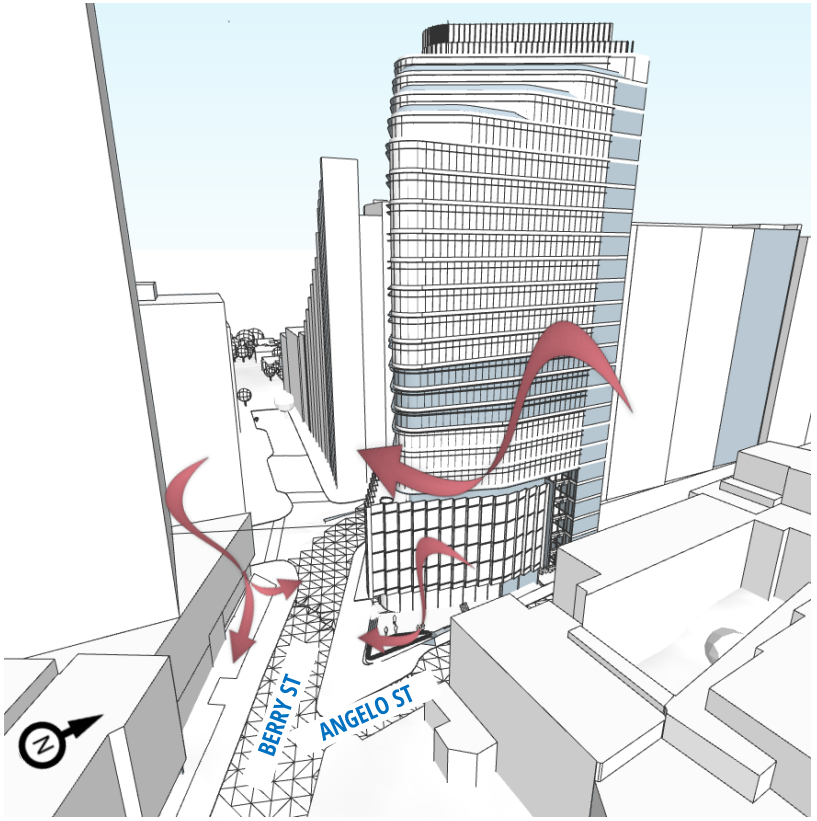


Image 7: Movement of Prevailing Winds around the Development

6. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed development at 20 Berry Street in North Sydney, Australia. Our assessment was based on the local wind climate, the current design of the proposed development, information on the existing surrounding buildings, our experience with wind tunnel testing of similar buildings, and screening-level modelling.

Our findings are summarized as follows:

- The development site is fairly sheltered from prevailing winds by the existing surroundings but is influenced by the strong southerly winds and exposure to the northeast winds in the summer.
- The proposed building is significantly taller than the existing building on the site, but comparable in height to the taller buildings in the surrounding area.
- The proposed building design incorporates several wind-responsive features, including massing and façade articulations, a wide canopy above street level, recessed main level, tall balustrades on the terrace, etc. which will moderate the potential wind impacts on the surroundings.
- Wind conditions on and around the development site are not expected to exceed the recommended criteria for pedestrian safety; conditions are likely to remain similar to the existing conditions post completion.
- Wind conditions are expected to be appropriate for pedestrian use in most areas; slightly higher wind speeds than desired may occur in the proposed plaza and can be mitigated using landscape elements.
- The terrace on the podium will also benefit from overhead features like a trellis, high-canopied trees or a canopy, particularly at the east end.
- Wind tunnel testing can be conducted at a later design stage to quantify these wind conditions and to determine the need and extent of wind control solutions.

7. APPLICABILITY OF RESULTS

The assessment presented in this report are for the proposed development at 20 Berry Street based on the information provided by Turner, listed in the table below. 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 pedestrian wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.

File Name	File Type	Date Received (mm/dd/yyyy)
20008–Model_201119	SKP	11/24/2020
20008_-201118_Plans	PDF	11/24/2020