FINAL REPORT

PANDORA 1468 VANCOUVER STREET

Victoria, British Columbia

PEDESTRIAN WIND ASSESSMENT

PROJECT # 1901838

FEBRUARY 7, 2020

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the pedestrian wind conditions for the proposed Pandora 1468 Vancouver Street development in Victoria, British Columbia. (see **Image 1**). This qualitative assessment is based on the following:

- a review of the regional long-term meteorological data from Victoria Harbour Seaplane Airport;
- design drawings and documents received by RWDI;
- Wind-tunnel studies and desktop assessments undertaken by RWDI for similar and nearby projects in Victoria;
- our engineering judgement and knowledge of wind flows around buildings[1-3]; and,
- use of 3D software developed by RWDI (Windestimator[2]) for estimating the potential wind conditions around generalized building forms.

This qualitative approach provides a screening-level estimation of potential wind conditions. Conceptual wind control measures to improve wind comfort are recommended, where necessary. To quantify these conditions or refine any conceptual wind control measures, physical scale model tests in a boundary-layer wind tunnel would typically be required.

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

Image 1: Rendering of Proposed Pandora 1468 Vancouver Street Development

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. 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.
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.

2. BUILDING AND SITE INFORMATION

The proposed project site is between Pandora Avenue to the north, Johnson Street to the south and Vancouver Street to the east (see aerial view of site and site plan in **Images 2 and 3**).

Key pedestrian areas on and around the site include main entrances, the podium roof terrace, sidewalks and park spaces adjacent to the site.

The project site is generally surrounded by low to mid-rise buildings. There are tall buildings to the south and east of the project site. Further away, downtown Victoria is located southwest of the site. Harris Green park is located to the north east of the site. Victoria Harbour is approximately 1.5 km to the west of the project site.

The proposed development consists of one 16-storey building (see **Image 3**). The proposed project will be a mixed-use development consisting of residential apartments and commercial spaces. Pedestrian accessible areas on and around the site include building entrances, grade level outdoor amenity areas, surrounding sidewalks, central courtyard and rooftop terraces at a number of levels.

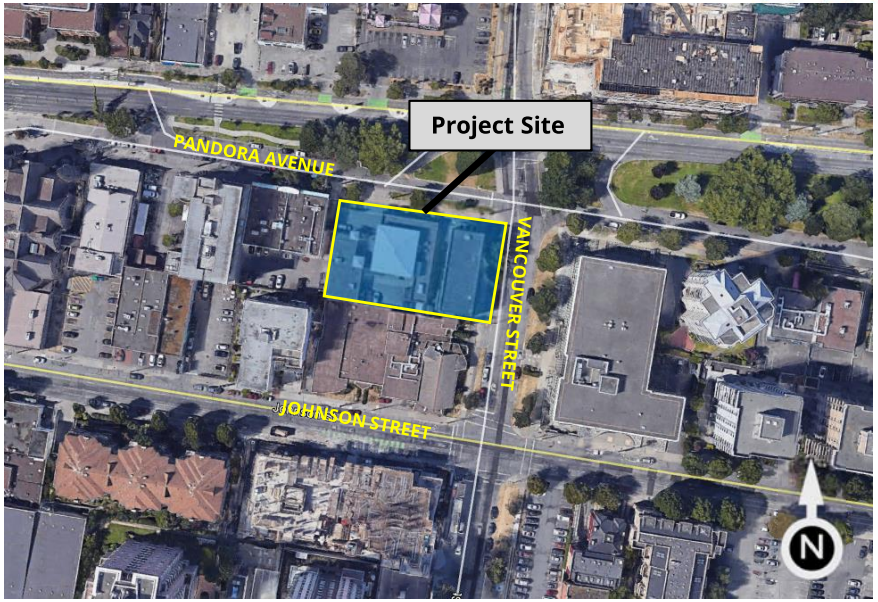


Image 2: Aerial View of Site And Surroundings (Credit: Google™ Earth))

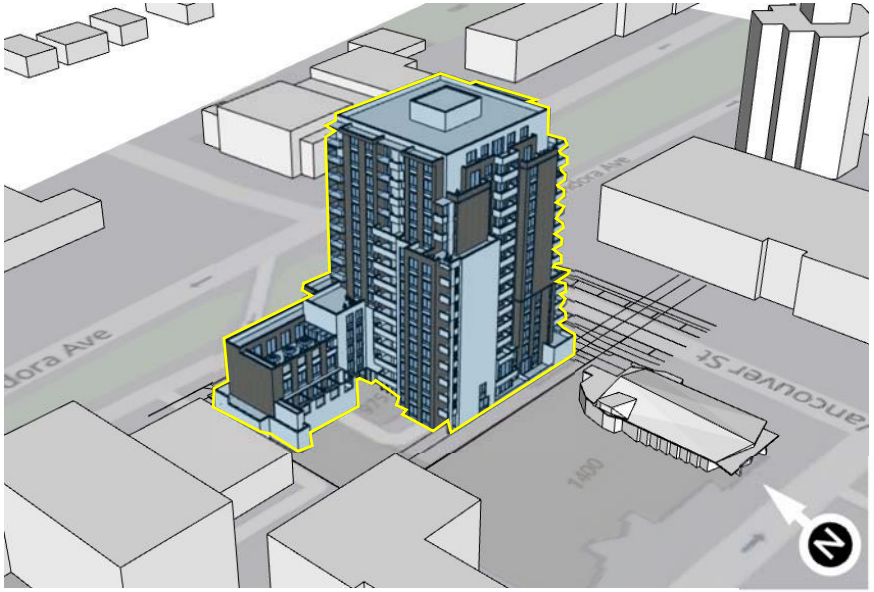


Image 3: Rendering of Proposed Pandora 1468 Vancouver Street Development from Southwest

3. METEOROLOGICAL DATA

Meteorological data from Victoria Harbour Seaplane Airport recorded between 1994 and 2015 was used as reference for wind conditions.

The distributions of wind frequency and directionality for the summer (May through October) and winter (November through April) seasons are shown in the wind roses in **Image 4.** When all winds are considered (regardless of speed), winds from the southwest are predominant during the summer. During the winter, winds are predominant from the west, east and north directions.

Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) occur more often in the winter than in the summer. They are most frequent from the west-southwest, north and southeast directions, as shown in the winter wind rose.

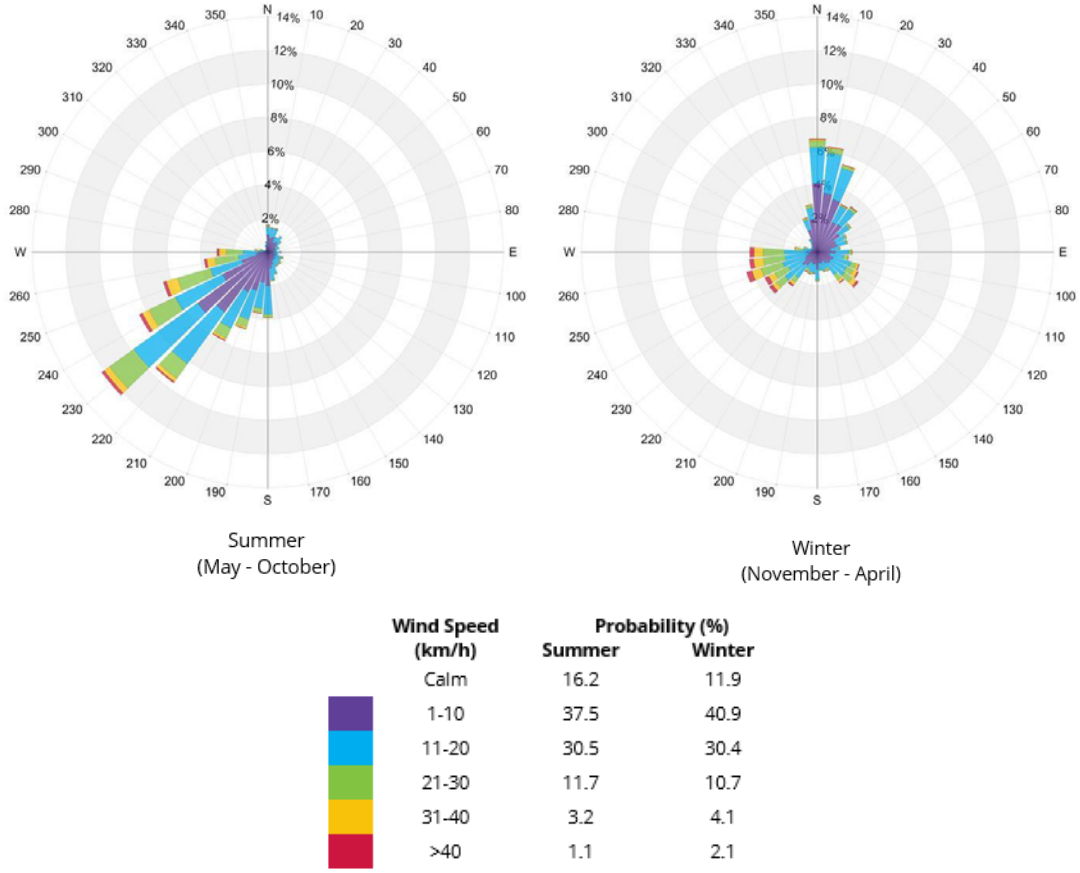


Image 4: Directional Distribution of Winds Approaching Victoria Harbour Seaplane Airport (1994 – 2015)

4. PEDESTRIAN 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 and by the building design and city planning community.

4.1 Pedestrian Safety

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 (**90 km/h**) occur more than 0.1% of the time or 9 hours per year, the wind conditions are considered severe.

4.2 Pedestrian Comfort

Wind comfort levels 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; and
- **Uncomfortable**: None of the comfort categories are 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 pedestrian height (i.e., 1.5 m above grade or the concerned floor level), and are 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; and lower wind speeds comfortable for standing are required for building entrances where pedestrians may linger. Wind speeds comfortable for sitting are appropriate for outdoor amenity areas during the summer, when these areas will be frequented.

5. PEDESTRIAN WIND CONDITIONS

5.1 Background

Predicting wind speeds and occurrence frequencies is complicated. 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. This knowledge has been incorporated into RWDI's proprietary software that allows, in many situations, for a qualitative, screening-level numerical estimation of pedestrian wind conditions without wind tunnel testing.

Overall, the geometry of the proposed development and location of the site offer several benefits for wind control, as follows;

- The central courtyard is protected by the surrounding building
- Canopies and overhangs have been included in the design
- Above grade terrace areas include tall parapet walls
- Potential wind channels include movable doors (breezeway)

The following is a detailed discussion of wind comfort conditions for key pedestrian areas of the development.

Image 5: North Elevation

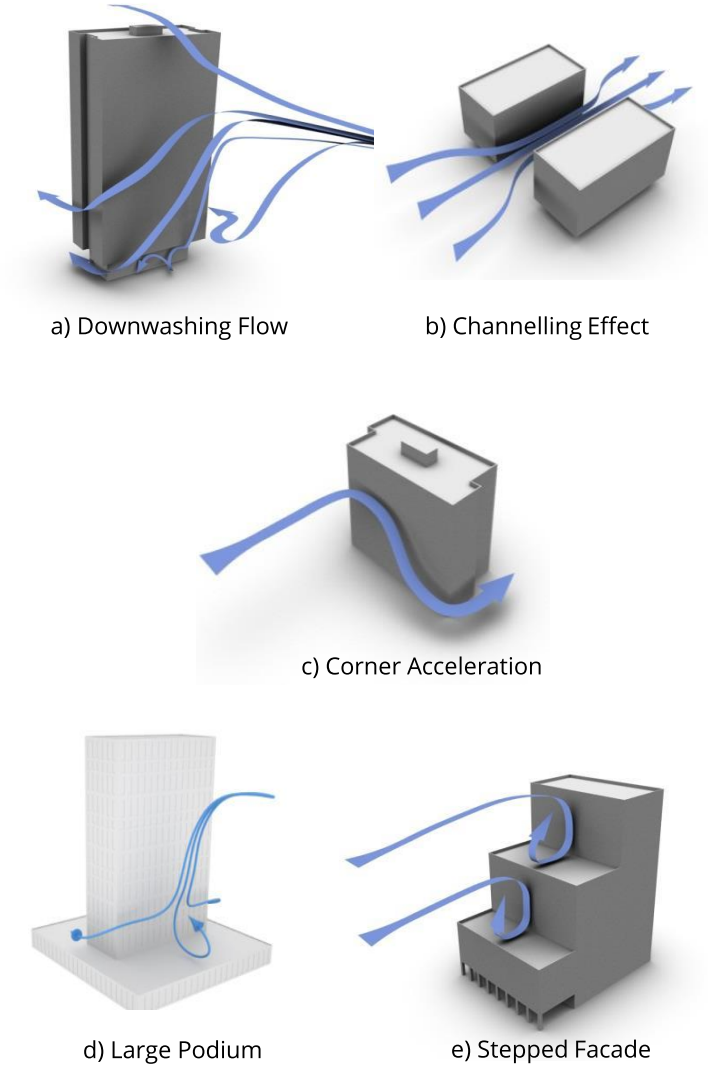
Image 6: South Elevation

5. PEDESTRIAN WIND CONDITIONS

5.1 Background

Tall buildings tend to intercept stronger winds at higher elevations and redirect them to the ground level. Such a Downwashing Flow (**Image 7a**) is the main cause for increased wind activity around tall buildings at the pedestrian level. When two buildings are situated side by side, wind flows tend to accelerate through the space between the buildings due to the Channelling Effect (**Image 7b**). Oblique winds also cause wind accelerations around the exposed building corners (**Image 7c**). If these building/wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable conditions.

Podium structures under towers are beneficial for wind control, as they reduce the direct impact of any downwashing winds from the towers to the grade (**Image 7d**). Stepping the windward façade (**Image 7e**) is also a positive design strategy that can be used for wind control. However, increased wind activity will be created on the podium terraces.



a) Downwashing Flow

b) Channelling Effect

c) Corner Acceleration

d) Large Podium

e) Stepped Facade

Image 7: Typical Wind Flow Patterns

5. PEDESTRIAN WIND CONDITIONS

5.2 Existing Wind Conditions

Due to the presence of mid and low-rise surroundings, the existing wind conditions on site and at surrounding sidewalks along Pandora Avenue and Vancouver Street are likely comfortable for sitting or standing throughout the year. These wind conditions are considered appropriate for the intended use.

5.3 Proposed Wind Conditions

The proposed Pandora 1468 Vancouver Street building, which is approximately 45 m tall (see **Image 8 and 9**), will be taller than the surrounding buildings and will therefore be exposed to the prevailing winds. This condition is expected to cause an increase in wind speeds around the perimeter of the site in some areas, particularly building corners. However, given the wind climate in the Victoria area, wind conditions are still expected to be generally suitable for the intended use of the spaces throughout the year.

Image 8: Existing site at1468 Vancouver Street Development (Credit: Google™)

Image 9: Rendering of Proposed Pandora 1468 Vancouver Street Development from the Northwest

5. PEDESTRIAN WIND CONDITIONS

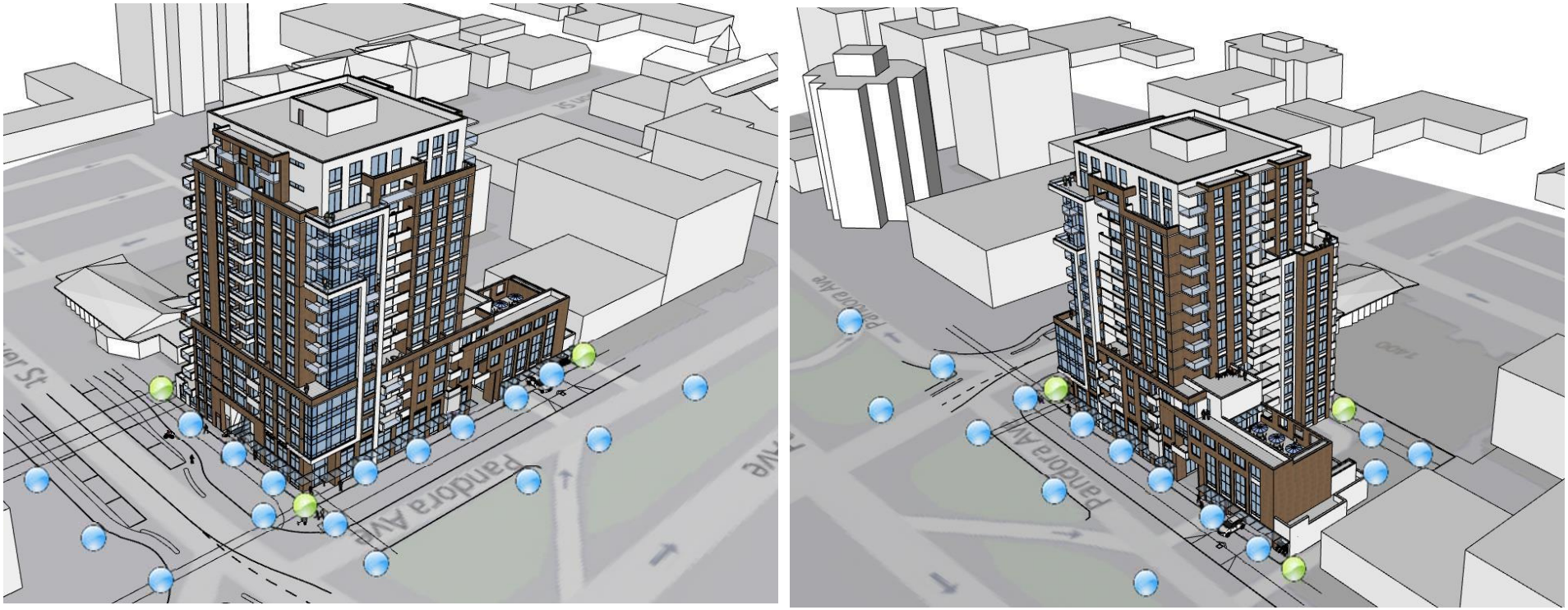


Image 10: Predicted Wind Comfort Conditions (Ground Level) – View from Northeast (left) and Northwest (right)

Predicted *ANNUAL*
Mean Wind Conditions

- Sitting / Standing
- Walking
- Uncomfortable

5. PEDESTRIAN WIND CONDITIONS

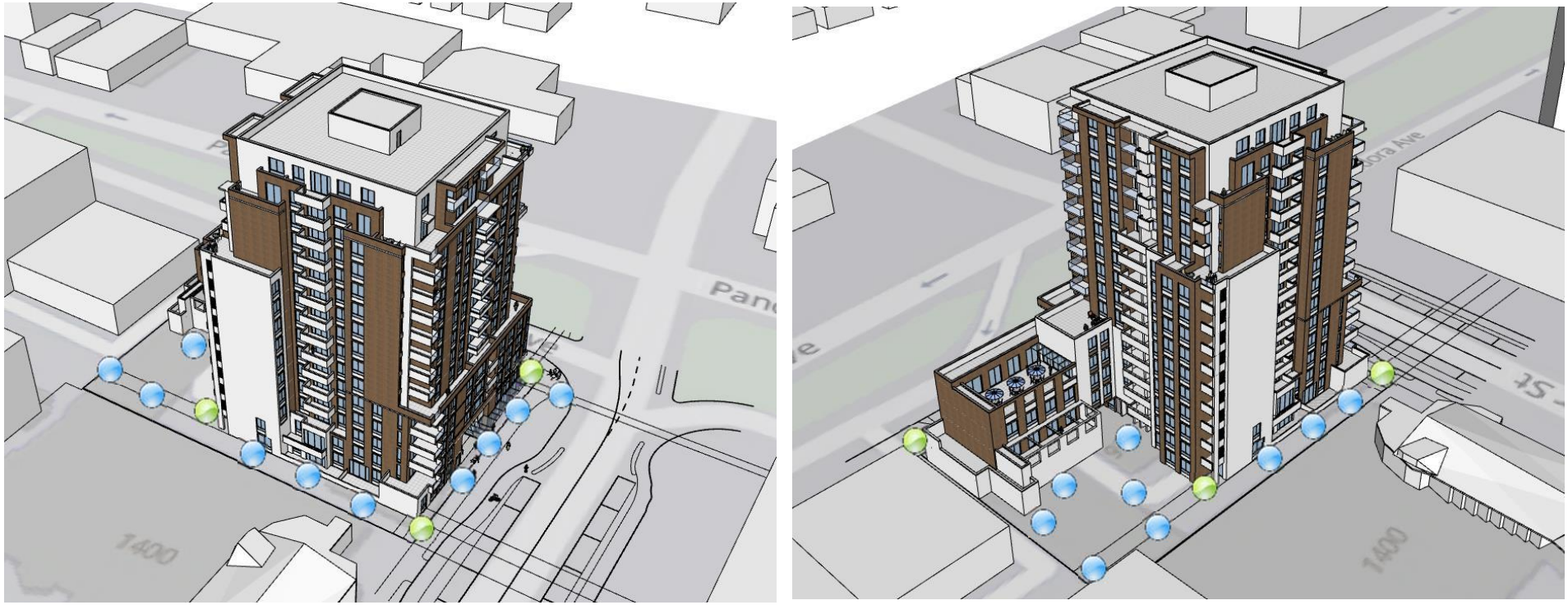


Image 11: Predicted Wind Comfort Conditions (Ground Levels) – View from Southeast (right) and Southwest (left)

Predicted *ANNUAL*
Mean Wind Conditions

- Sitting / Standing
- Walking
- Uncomfortable

5. PEDESTRIAN WIND CONDITIONS

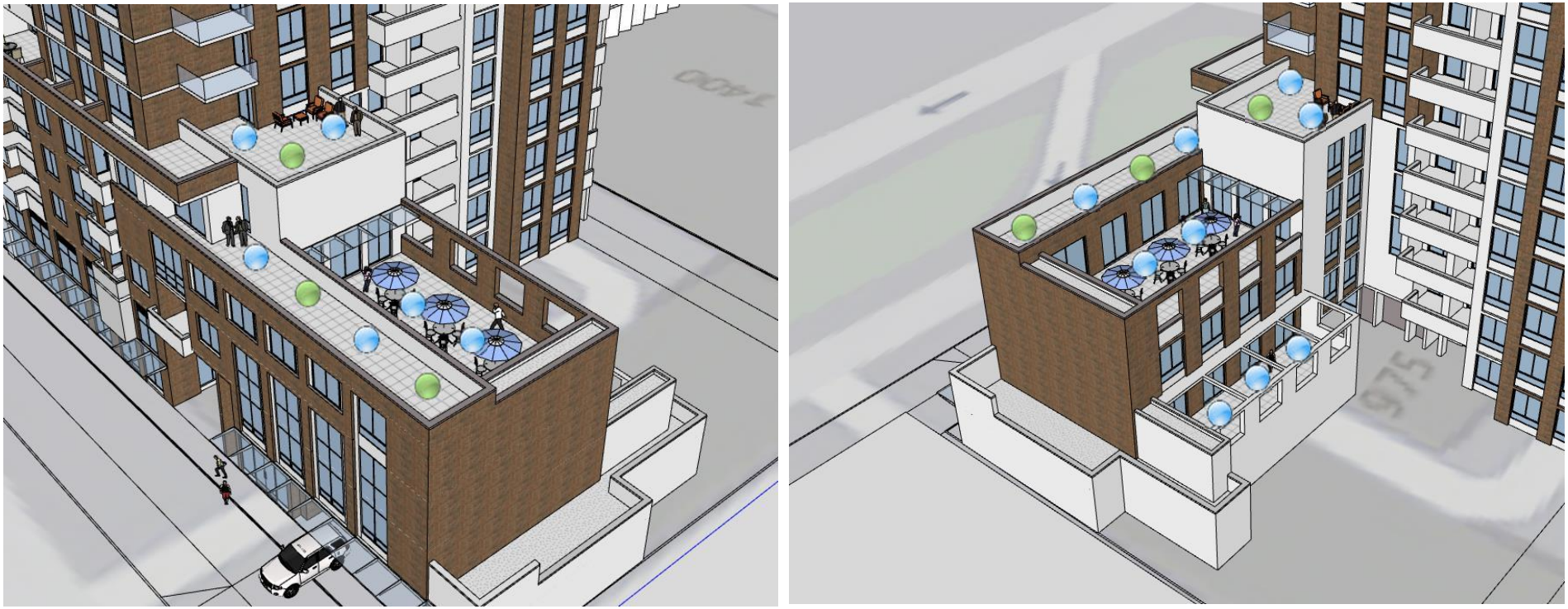


Image 12: Predicted Wind Comfort Conditions (Lower Terrace Levels) – View from Northwest (right) and Southwest (left)

Predicted *ANNUAL*
Mean Wind Conditions

- Sitting / Standing
- Walking
- Uncomfortable

5. PEDESTRIAN WIND CONDITIONS

Image 13: Predicted Wind Comfort Conditions (Upper Terrace Levels) – View from Northeast (right) and Southwest (left)

Predicted *ANNUAL*
Mean Wind Conditions

- Sitting / Standing
- Walking
- Uncomfortable

5. PEDESTRIAN WIND CONDITIONS

5.3.1 Building Entrances

The primary entrances to the development are marked by the black arrows in **Image 14**.

The entrances are located on the north and east sides of the development as well as in the central courtyard area. These locations are well sheltered from strongest prevailing winds directions in either season. In addition, all entrances are located underneath canopies/overhangs or are located inside a recessed area which are expected to offer additional protection and sheltering from prevailing winds that are expected to downwash from the tower façade or wrap around building corners.

As a result, appropriate wind conditions (i.e. suitable for sitting/standing) are anticipated at all entrances.

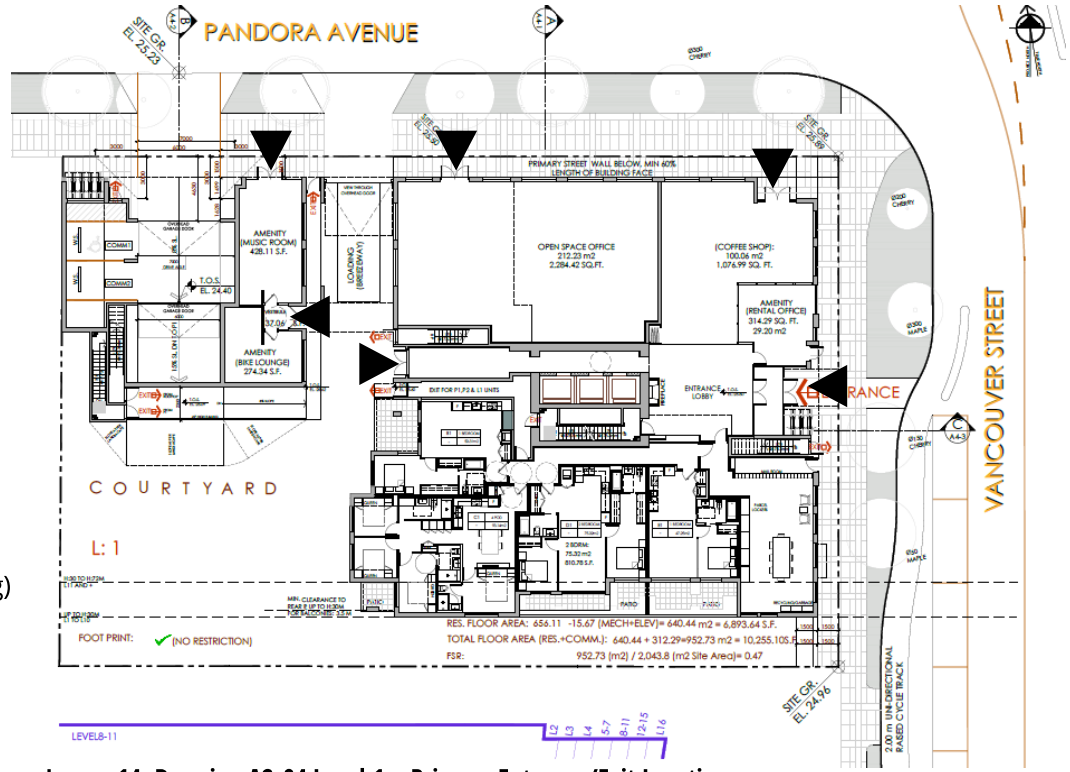


Image 14: Drawing A2-04 Level 1 – Primary Entrance/Exit Locations

5.3.2 Perimeter Sidewalks

With the addition of the proposed development, wind conditions on the sidewalks areas around the site (particularly those on Pandora Avenue and Vancouver Street) are expected to increase slightly when compared to the existing configuration. Conditions are expected to be suitable for standing in most areas throughout the year. These wind conditions are considered desirable for the intended use of the area.

Building corner locations, such as at the intersection of Vancouver Street and Pandora Avenue, are expected to experience wind speeds that are suitable for walking. This is caused by corner accelerated wind flows. These wind conditions are still considered acceptable for the use of the sidewalks.

No uncomfortable or dangerous wind conditions are anticipated at these locations. However, any landscaping such as trees or potted plants are encouraged as they are helpful in providing localized blockages for the wind.

5.3.3 Central Courtyard

Wind conditions in the central courtyard area on the southwest side of the site are expected to be mostly suitable for sitting and standing throughout the year. Significant sheltering exists at this location from existing structures along Johnson Street (932 & 954 Johnson Street) as well as by the proposed building itself. These wind conditions are desirable for the area. Any additional landscaping that can be incorporated into the area is expected to further improve conditions.

5.3.4 Lower Level Terraces (L2, L4, L5, L6)

In general, due to the above grade terrace level's height above the surrounding buildings, exposure to stronger winds throughout the year are expected to result in slightly higher wind speeds than would be expected at grade level. However, due to a number of positive design features that have been included on terrace levels 2 and 4, problematic winds are expected to be mitigated. These features should be maintained in the final design, and include tall perimeter walls (3.25m), overhead trellis structures and canopies.

Because of the inclusion of these features in the design, wind conditions on the level 2 and 4 terraces located on the west side of the development are predicted to be appropriate for passive pedestrian uses (e.g. lounging, sitting, etc.) as it is well sheltered from prevailing winds. The level 5 and 6 terraces are expected to experience slightly higher than desired wind speeds in certain areas during some periods throughout the year due to their open exposure to the prevailing directions. It is recommended that perimeter windscreens be installed, particularly on the south side. Windscreens can typically offer a protected area with a width that is 3x to 10x it's height, as shown in **Image 15**. If additional improvement in wind conditions is desired, planters with soft landscaping elements at least 2m tall can be considered.

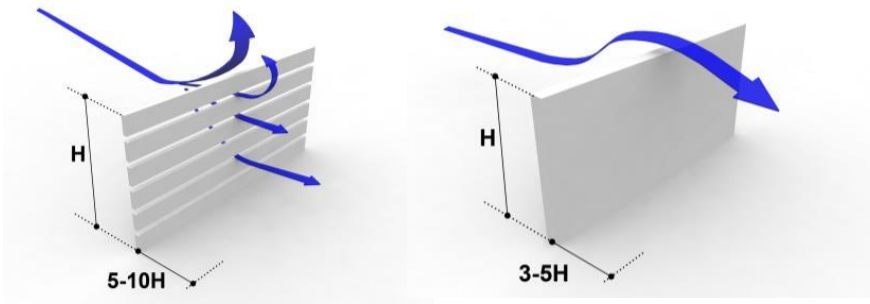


Image 15: Conceptual windscreen performance, 30% open (left) and solid (right)

5. PEDESTRIAN WIND CONDITIONS

5.3.5 Upper Level Terraces

Because of the height of the upper level terraces (shown in **Image 13**) above grade and the surrounding structures, they are particularly exposed to the prevailing wind directions. Additionally, these terraces are commonly located at building corners, where corner wrapping wind flows are anticipated to be prevalent. It is expected that wind speeds in some areas on these terraces may be higher than desired for the intended use of the spaces, with conditions likely comfortable for walking. It is recommended that taller parapet walls and localized wind mitigation features be implanted. These parapet walls and landscaping features should be approx. 1.5m to 2m tall.

5.3.6 Breezeway

The loading area located adjacent to Vancouver Street (known as the Breezeway, shown in **Image 16 and 17**) is expected to experience slightly higher wind speeds throughout the year due to a channeling effect (especially during the winter months where the prevailing winds better align with the space). Although the wind conditions are not expected to be uncomfortable or dangerous it is recommended that when higher wind speeds are observed the retractable overhead door be closed so as to create a blockage from winds travelling through the open area.

5.3.7 Off Site

Wind conditions in the off site surrounding areas are not expected to be significantly impacted by this development. The effect of the proposed building is expected to be limited to the sidewalks and roadways immediately around the property.

Image 16: Rendering of the Loading Area (Breezeway) adjacent to Vancouver Street

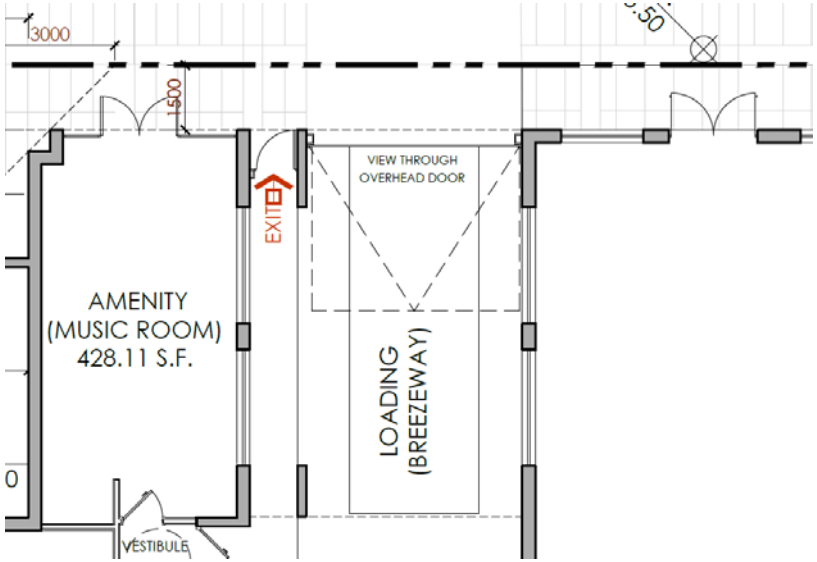


Image 17: Drawing A2-04 Level 1 – Loading Area (Breezeway) detail

5. PEDESTRIAN WIND CONDITIONS

5.4 Future Wind Conditions

It is our understanding that an approximately 45m tall building is anticipated to be built directly to the southwest of the proposed Pandora 1468 Vancouver Street Development sometime in the future (**shown in Image 18**).

This building is expected to provide localized sheltering to the central courtyard area as well as most spaces along the south perimeter of the proposed development, by providing a blockage of the prevailing winds from the south and southwest. Additionally, this future building is expected to include a podium level terrace which may prevent downwashing winds from reaching grade and impacting wind conditions on 1468 Vancouver Street.

Some building corner areas may be susceptible to corner accelerating wind flows, and it is recommended that a more detailed assessment be performed when this future building is confirmed.

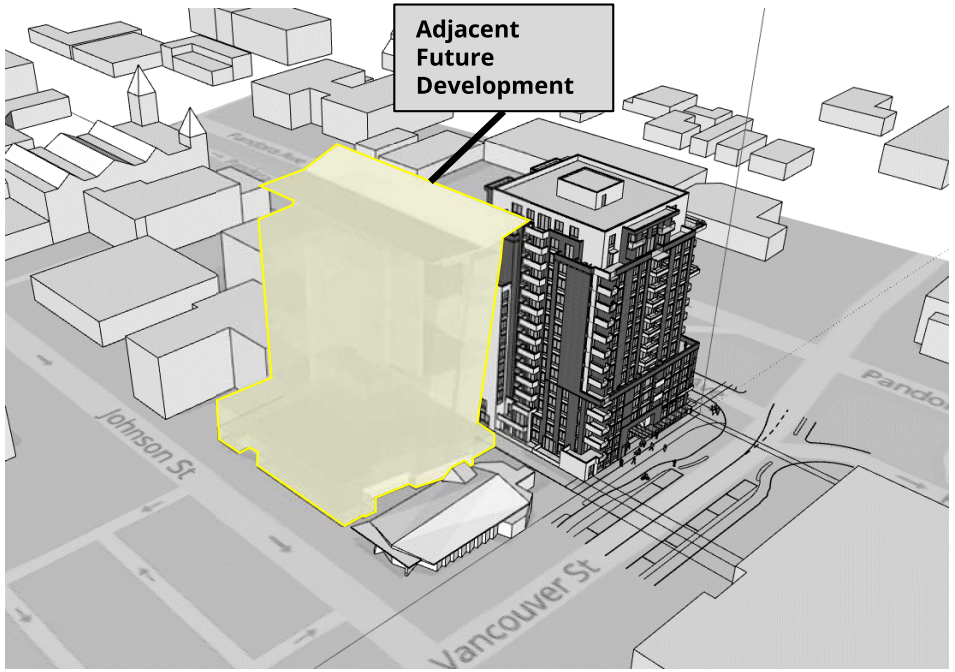


Image 18: Rendering of Proposed Pandora 1468 Vancouver Street Development Including the Adjacent Future Development on Johnson Street (highlighted yellow)

6. SUMMARY

RWDI was retained to conduct a pedestrian wind assessment for the proposed building at 1468 Vancouver Street in Victoria, British Columbia.

Our assessment was based on the local wind climate, the current design of the proposed development, the existing surrounding buildings, our experience with wind tunnel testing of similar buildings in Victoria, and screening-level modelling.

Wind conditions can be summarized as follows:

- Existing wind conditions around the site are expected to be suitable for sitting or standing throughout the year.
- With the addition of the proposed development, wind speeds are expected to slightly increase, although conditions are still expected to be suitable for the intended use of the areas in both seasons. Some accelerated wind conditions are expected at building corners (i.e. suitable for walking), although these are still considered acceptable for active pedestrian use.
- Appropriate wind conditions (i.e. suitable for sitting/standing) are anticipated at the proposed building entrances. Positive design features have been included and no modifications are required.
- Wind conditions on the second and fourth floor terrace are expected to be suitable for sitting or standing, which is considered adequate for the intended use of the space. Positive design features have been included, such as a tall parapet wall, overhead canopy and trellis structures which are expected to mitigate any stronger winds.
- Wind speeds on the fourth and fifth level as well as the upper level terraces, are expected to be slightly higher than desired during some times throughout the year. It is recommended that a taller parapet wall, and local landscaping features be implanted at these levels.
- The addition of the future development to the southwest of the site on Johnson Street is expected to alter the wind conditions on the property of the proposed development.
- Additional optional wind control measures that can further improve wind conditions at certain areas have been suggested in Section 5.

7. APPLICABILITY OF RESULTS

The assessment presented in this report are for the proposed Pandora 1468 Vancouver Street Development development in Victoria, British Columbia. The drawings and information listed below were used for our assessment.

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 (dd/mm/yyyy)
20181217 - 1468 VANCOUVER ST	PDF	16/01/2020
18-57 Massing Model	SketchUp	21/01/2020