ATTACHMENT I

FINAL REPORT

TELUS OCEAN

Victoria, British Columbia

PEDESTRIAN WIND ASSESSMENT

PROJECT # 2004582

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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 TELUS Ocean 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 on July 2nd, 2020;
- 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.

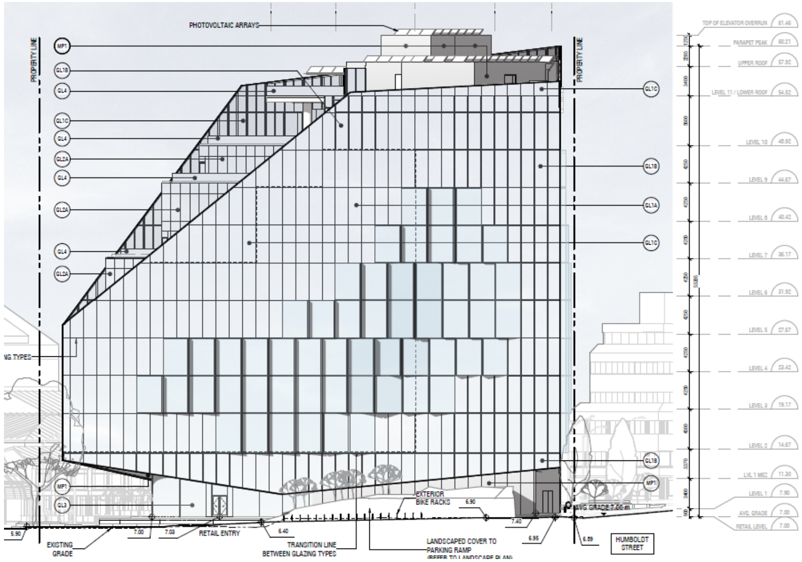


Image 1: South Elevation of the Proposed Project

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 located at 767 Douglas Street, between Humboldt Street and Douglas Street, to the south of Burdett Avenue (see aerial view of site and surroundings in **Image 2)**. The site is located at the south end of Downtown Victoria.

The project site is generally surrounded by low-rise buildings to the south and west and mid-rise buildings to the north and east. Victoria Harbour is approximately 200 m to the west of the project site.

The proposed development consists of one 10-storey building (see **Image 1**). The proposed project will be a mixed-use development that will act as an innovation and employment hub for 250 TELUS employees. Key pedestrian areas on and around the site include main entrances, public open space on-site at grade level, terraces at Levels 5, 7, 9, 10 and 11 and sidewalks adjacent to the site.

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

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 3.** 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 southwest through west, southeast 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.

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	16.2	11.9
1-10	37.5	40.9
11-20	30.5	30.4
21-30	11.7	10.7
31-40	3.2	4.1
>40	1.1	2.1

Image 3: 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

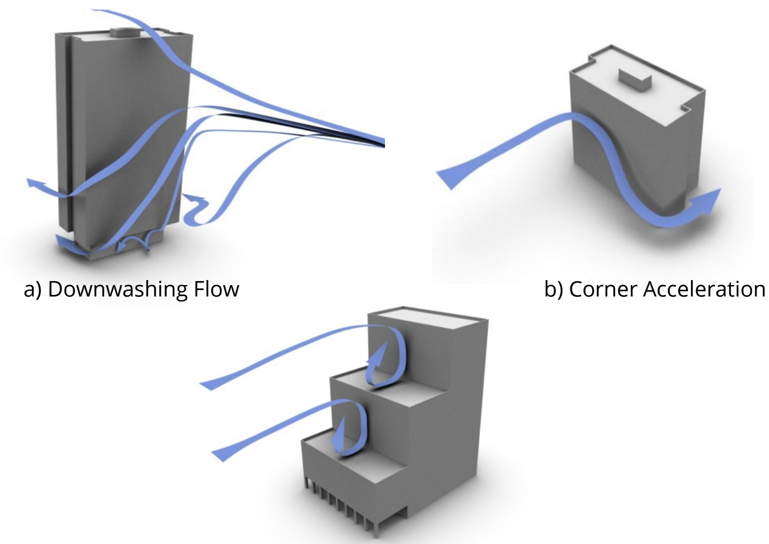
5.1 Background

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.

Tall buildings tend to intercept stronger winds at higher elevations and redirect them to the ground level. Such a Downwashing Flow (**Image 4a**) is the main cause for increased wind activity around tall buildings at the pedestrian level. In addition, oblique winds also cause wind accelerations around the exposed building corners (**Image 4b**). If these building/wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable conditions. Stepping the windward façade (**Image 4c**) is a positive design strategy that can be used for wind control. However, increased wind activity will be created on the podium terraces.

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

- The grade level is recessed into the building façade, providing overhead protection to the areas close to building perimeter including the entrances
- The triangular face is aligned with the predominant southwest direction, which will be beneficial to reduce the impact of downwashing wind flows;
- Stepped building façade on the southwest side, which will help reduce the impact of downwashing wind flows at grade level.
- Proposed deciduous landscaping on-site will be beneficial for wind comfort during the summer



a) Downwashing Flow

b) Corner Acceleration

c) Stepped Facade

Image 4: Typical Wind Flow Patterns

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

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 Burdett Avenue, Humboldt Street, Powell Street and Douglas Street are likely comfortable for sitting or standing throughout the year. These wind conditions are considered appropriate for the intended use.

5.3 Potential Wind Conditions

The proposed project will be of similar height compared to the surroundings to the north and east. The surroundings on the west side are much lower compared to the proposed development. The lower density surroundings on the west side and the exposure to the southwesterly and westerly winds are expected to cause an increase in wind speeds around the perimeter of the site in some areas, particularly at building corners. However, given the wind climate in the Victoria area, wind comfort conditions are still expected to be generally suitable for the intended use of the spaces throughout the year. Occasional strong wind gusts are experienced in Victoria, these are rare events but deserve special attention due to the severe impact on pedestrians. Predicted wind comfort and safety conditions at grade level are shown in Images 6a and 6b respectively. For the above-grade level terraces, predicted wind comfort and safety conditions are shown in Images 8a and 8b respectively. Detailed discussion of these areas are presented in next few pages.

<u>Grade Level:</u>

As mentioned previously, the first floor of the proposed project is recessed into the building façade. In addition, the triangular face with stepped façade on the southwest side is aligned with the predominant wind direction. These features are favorable for wind comfort, as they reduce the impact of downwashing wind flows at grade level. With these features in place, wind conditions around most of the project perimeter, including the building entrances and open spaces / adjacent sidewalks are generally predicted to be comfortable for sitting or standing throughout the year (Image 6a). Due to the predominant winds from the southwest and northeast accelerating at building corners, higher wind speeds comfortable for strolling or walking are expected at building corners, particularly the north and south corners of the building (Image 6a). These conditions are suitable for the intended pedestrian use.

Due to the occurrence of occasional strong gusts accelerating at the building corner (Image 5b) , winds at the north building corner may exceed the wind safety criterion (Image 6b). Reduced wind speeds can be achieved by adding vertical porous wind screens or coniferous/ marcescent landscaping, as shown in Image 6b. These features should be at least 2m tall to maintain good wind control efficacy. Examples of these wind control measures are shown in Image 7. It is recommended that wind tunnel tests be conducted to quantify the wind conditions and to refine the wind control measures.

5. PEDESTRIAN WIND CONDITIONS

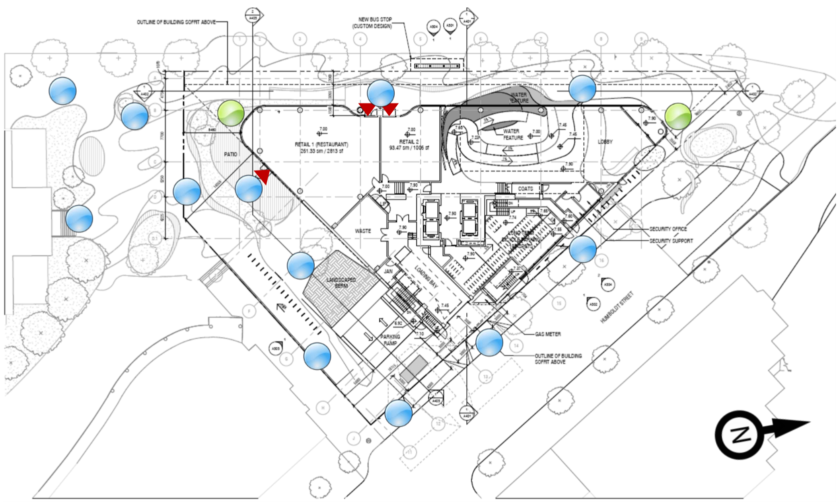


Image 6a: Predicted Wind Comfort Conditions (Annual)

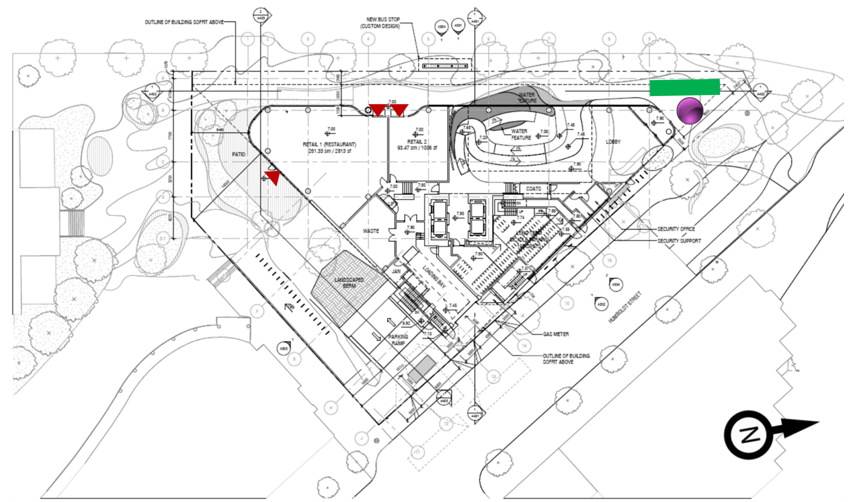


Image 6b: Predicted Wind Safety Conditions (Annual)

WIND CATEGORIES

- Sitting / Standing
- Strolling / Walking
- Uncomfortable
- Exceeds Safety Criterion

LEGEND:

- Building Entrances
- Suggested locations for wind screens/ coniferous landscaping

5. PEDESTRIAN WIND CONDITIONS

Examples of coniferous landscaping

Examples of porous wind screens

Image 7: Examples of wind Control Measures at Grade Level

5. PEDESTRIAN WIND CONDITIONS

Terraces:

As mentioned previously, buildings with stepped façades are beneficial to reduce the impact of downwashing wind flows at grade level. However, this would likely result in windy conditions on the stepped surfaces (i.e., terraces). The proposed project will include amenity terraces at Levels 5, 7, 9, 10 and 11. All of these terraces will be exposed to the predominant northerly and southwesterly winds. Due to this exposure and the impact of downwashing wind flows, high wind activity is expected on most of these terraces. As shown in Image 8a, wind conditions comfortable for sitting or standing are predicted on the terraces at Levels 5 and 7. Higher wind speeds, comfortable for strolling or walking are expected at Levels 9 through 11. Wind speeds comfortable for strolling or walking are considered higher than desired for passive activities. Due to exposure to the strong northerly and southwesterly gusts, winds at the roof terrace of Level 11 are predicted to exceed the safety criterion (Image 8b).

Lower wind speeds can be achieved by introducing tall porous screens (i.e. 2m tall and 20- 40% porous) along the terrace perimeters. Landscaping of similar heights along the terrace perimeter or near seating areas can also be considered. In addition, overhead protection such as trellises or canopies would be beneficial to reduce the impact of downwashing wind flows. Examples of these features are shown in Image 9.

Image 8a: Predicted Wind Comfort Conditions (Annual)

WIND CATEGORIES

- Sitting / Standing
- Strolling / Walking
- Uncomfortable
- Exceeds Safety Criterion

Image 8b: Predicted Wind Safety Conditions Annual)

5. PEDESTRIAN WIND CONDITIONS

Image 9: Examples of wind control measures at terrace levels

6. SUMMARY

RWDI was retained to conduct a pedestrian wind assessment for the proposed TELUS Ocean at 767 Douglas 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 in most areas. Some accelerated wind conditions are expected to occur at building corners.
- 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 Levels 5 and 7 terraces are predicted to be suitable for pedestrian use throughout the year. Wind speeds that are higher than desired for passive activities are predicted on terrace Levels 9 through 11 of the proposed development throughout the year.
- Wind control measures are recommended for identified windy areas.
- Wind tunnel testing of a scale model is recommended to confirm and quantify the predicted wind conditions and refine the wind control features.

7. APPLICABILITY OF RESULTS

The assessment presented in this report are for the proposed TELUS Ocean 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)
ARCH 1911-200630_Rezoning_Pre-application	PDF	07/02/2020