Pedestrian Level Wind Studies Terms of Reference

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Introduction

As growth and intensification occur within the city it is important to maintain comfortable and safe conditions for pedestrians and to evaluate impacts of new development on surrounding areas. The City of Guelph, through documents such as the Urban Design Brief Terms of Reference and the City's Official Plan, places emphasis on the design of the built environment and ensuring spaces are comfortable to the public.

New buildings may cause increased wind activity affecting pedestrian areas and surrounding neighbourhoods. Generally, as part of the pre-consultation process, requirements for a pedestrian level wind study will be identified. Pedestrian level wind studies may be required for proposed mid-rise or high-rise buildings in order to assess the potential wind comfort and, where necessary, to mitigate predicted, negative wind impacts on and around the proposed development site.

This Terms of Reference will assist development proponents when completing a pedestrian level wind study to determine the potential impacts of mid-rise and high-rise buildings to the surrounding neighbourhoods.

When is a wind study required?

Buildings taller than their immediate surroundings are exposed to stronger winds at higher elevations. These winds downwash off building facades and subsequently accelerate around building corners and along the gaps between buildings, resulting in higher wind activity in pedestrian areas (**Figure 1**). When there is a proposed development application, a pedestrian wind study may be required and **Table 1** can be used to determine the appropriate approach based on the proposed building height.

Figure 1: Typical Wind Flow Patterns around Buildings

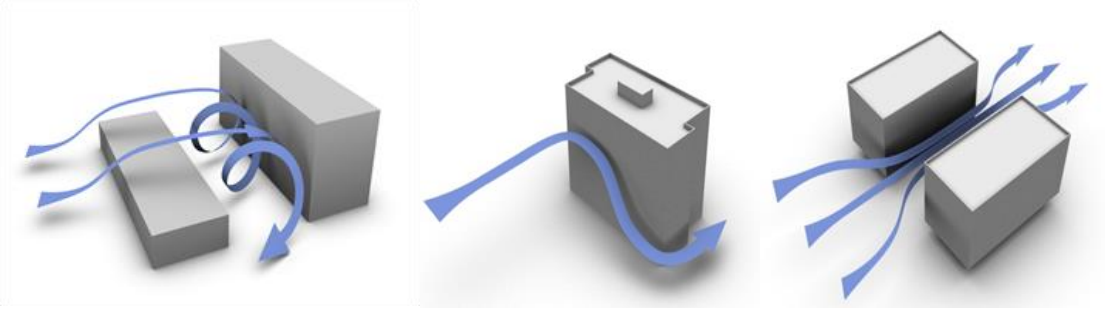


Table 1: Wind Study Approach Based on the Proposed Building Height

Building Height	Wind Study Approach
6 to 8 storeys	A **letter of opinion** is generally sufficient for all mid-rise buildings to identify any building design issues and to provide conceptual solutions for wind control, where needed.
9 to 10 storeys	An experienced-based **desktop analysis** using numerical tools, including computational fluid dynamics (CFD), is typically appropriate for a qualitative assessment and wind mitigation. For some cases (e.g. multiple buildings, an open wind exposure, a large continuous building façade, and/or special pedestrian uses), a **quantitative wind tunnel study** may be required by city staff.
11 storeys and up	A **quantitative wind tunnel study** using physical scale modelling in a boundary-layer wind tunnel is required to predict and assess the potential wind conditions and, if needed, to develop and confirm the effectiveness of wind mitigation measures.

Table 1 is intended as a guide to determine what type of study may be required for a proposed development; however, the decision as to what type of study is needed will be made at the sole discretion of Planning Services. For instance, Planning Staff may request that a wind study be completed for buildings less than 6 storeys in more sensitive cases or in cases where there may be a risk of hazard winds.

The study for pedestrian level wind conditions should be conducted as early as possible in the development application process when building massing can still be altered for wind control, if necessary. Based on this, the need for a wind tunnel study will generally be identified through the pre-consultation process.

A wind study will typically only be required through the site plan process:

- where significant changes are made to the building design since the previous wind study completed during rezoning; or,
- on sites where a contemporary planning application has not been completed (e.g. where a site contains legacy zoning).

Who is qualified to do the study?

A pedestrian wind study shall be prepared and stamped by a Professional Engineer with adequate experience in pedestrian wind evaluation. If Planning Services is uncertain about the level of experience demonstrated or the quality of the report submitted by a wind consultant, a peer review will be performed, the cost of which will be borne by the applicant.

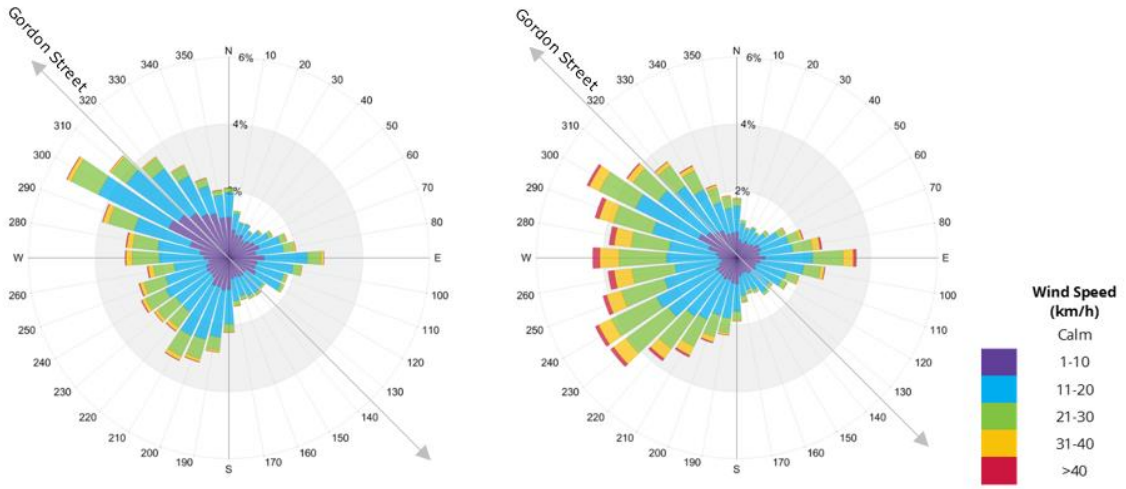
What are the technical requirements?

As specified in **Table 1**, a wind study can take the form of wind tunnel testing, desktop analysis and letter of opinion. The following technical contents should be included in a wind study.

Local Wind Data

Long-term data from Region of Waterloo International Airport (**Figure 2**) should be used as a reference for the wind assessment. The data can be grouped into two seasons: Summer (May through October) and Winter (November through April), for their distinct differences in pedestrian outdoor behaviours during these two periods.

Figure 2: Seasonal Distribution of Winds Approaching Region of Waterloo International Airport (1988-2017) - the angle of Gordon St is noted for reference



Summer (May - October) Winter (November - April)

Study Approach

A qualitative assessment of wind conditions, including a letter of opinion and a desktop analysis, is largely based on wind consultants' knowledge of wind flows around buildings and experience with wind tunnel tests on similar building projects. Qualitative assessments may use CFD tools to visualize the flow patterns for select (or all) wind directions (see **Figure 3a** for example). However, quantitative wind speeds and exceeding frequencies can only be obtained through wind tunnel testing.

Quantitative wind tunnel testing should be conducted in a boundary-layer wind tunnel where wind and turbulence profiles are adequately simulated for 36 wind directions (**Figure 3b**). Both mean and gust wind speeds should be measured at 1.5 m above local grade for the existing surroundings with and without the proposed development. A building configuration with future surroundings may be warranted when there is a significant development or demolition planned for the surrounding area in the future. If needed, mitigation configuration(s) should also be included in wind tunnel testing to demonstrate the effectiveness of the mitigation. Measurement locations (to be determined in consultation with the planning department) should cover key pedestrian areas on the development site and in the surrounding areas. The results should be presented in both tabular and graphic forms for all test configurations.

Figure 3a: An Example of Computer Simulation of Wind Flows around Buildings

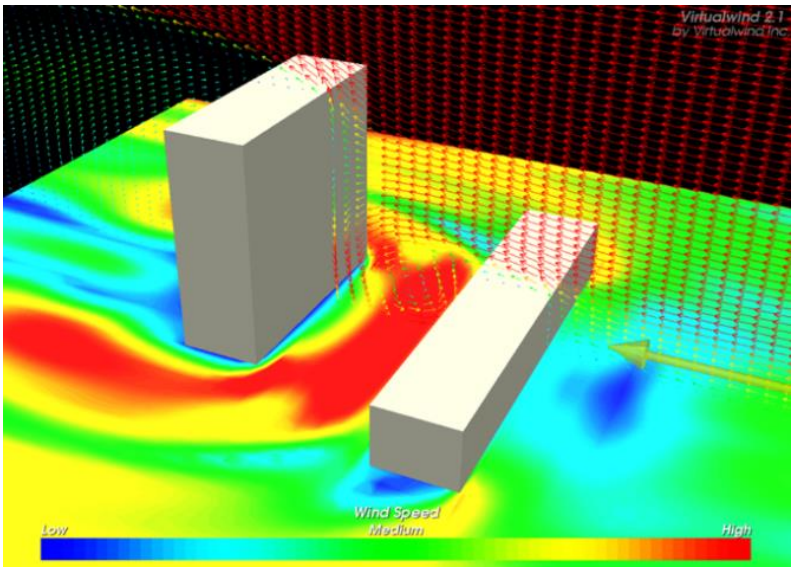


Figure 3b: Photo of Modelled Buildings in a Boundary-layer Wind Tunnel

Wind comfort levels must be assessed in public spaces on the proposed site and adjacent land. Of particular importance are public spaces such as parks, public courtyards, building entrances, and sidewalks, bike lanes or multi-use paths. Private outdoor spaces within the development, such as private amenity terraces, are not required to be assessed for wind comfort; however, ensuring that the users of the private space will not be exposed to dangerous wind conditions is recommended.

When assessing future wind conditions, the effect of existing and proposed landscaping must not be considered. This is common practice to establish baseline conditions. However, when considering mitigation strategies, the effect of landscaping on wind conditions may be considered (see Mitigation Strategies).

Wind Criteria and Results

The predicted wind speeds and frequencies should be compared to the following wind comfort and safety criteria (**Table 2**). Wind comfort may be affected by both mean and gust speeds and their combined effect should be quantified as a Gust Equivalent Mean (GEM), while only gust speeds are to be considered in the wind safety criterion.

Table 2: Wind Comfort and Safety Criteria

Comfort Category	GEM Speed (km/h)	Description
Sitting	≤ 10	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away
Standing	≤ 15	Gentle breezes suitable for main building entrances, bus stops, plazas, and other places where pedestrians may linger
Walking	≤ 20	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	> 20	Strong winds of this magnitude are considered a nuisance for all pedestrian activities, and wind mitigation is typically recommended

Notes:

(1) GEM speeds are equal to the gust speed divided by 1.85, or the mean speed (whichever is larger); and,
(2) GEM speeds listed above are based on a seasonal exceedance of 20% of the time between 6:00 and 23:00. Nightly hours between 0:00 and 5:00 are excluded from the wind analysis for comfort since limited usage of outdoor spaces is anticipated.

Safety Criterion	Gust Speed (km/h)	Description
Exceeded	> 90	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is required.

Notes:

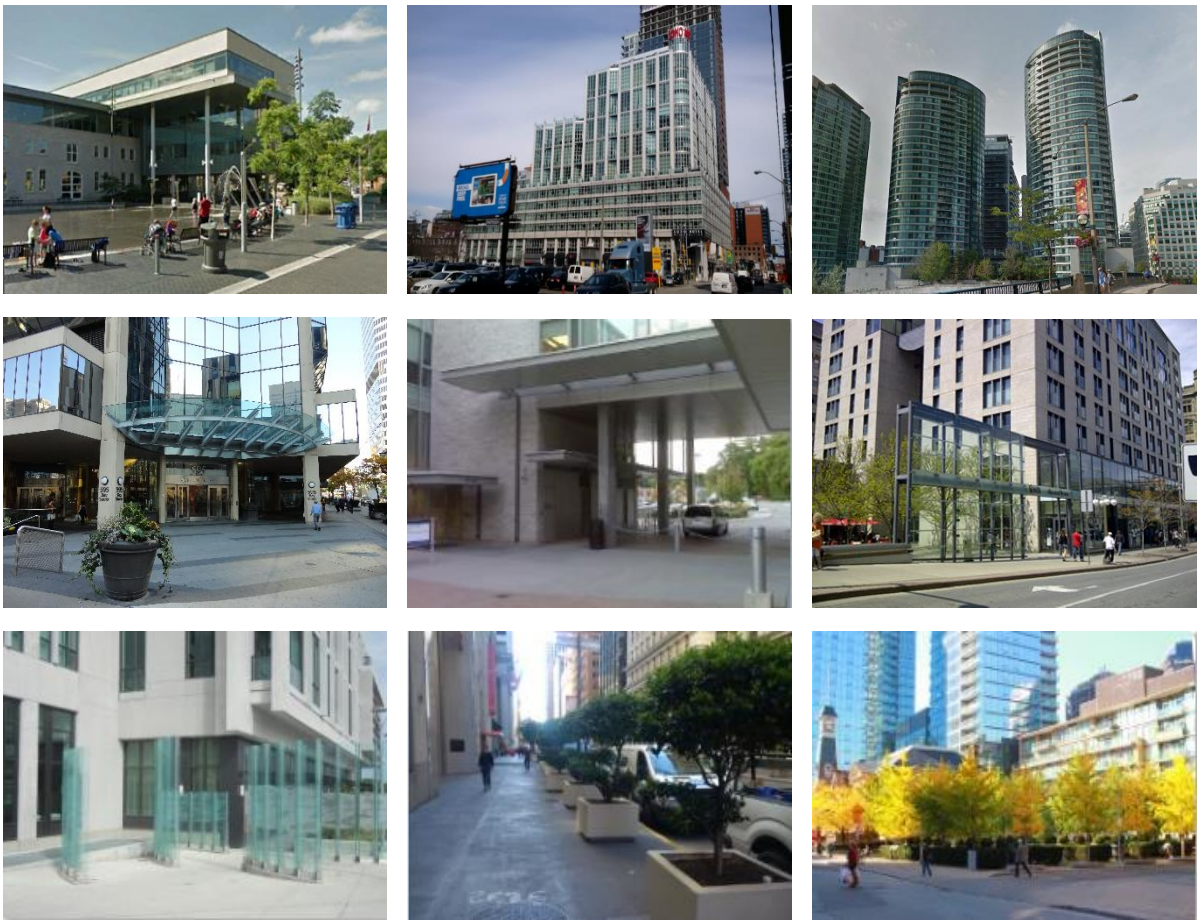
(3) Based on an annual exceedance of 9 hours or 0.1% of the time for 24 hours a day.

Mitigation Strategies

Wind mitigation *may* be required for areas where wind conditions are uncomfortable or not suitable for the intended pedestrian uses. Wind mitigation *is* required where wind conditions are predicted to be unsafe and additional wind tunnel modelling of proposed mitigation should be conducted to demonstrate the resultant conditions meet the safety criterion.

The most effective wind control measures involve adjustments to the building early in the design process (e.g., massing, shape and orientation changes) that are more responsive to the local wind climate. These can be assisted by tower setbacks, low podiums, colonnades/arcades, corner articulations and so on. Smaller-scale measures such as canopies, trellises, wind screens and street art are also often used for local wind control. Landscaping elements, especially coniferous and marcescent species, are commonly used to improve wind conditions to appropriate levels. The use of landscaping for wind control requires consideration to the species, size and viability in the predicted local microclimate (e.g., sustainable in a wind environment). **Figure 4** shows several examples of positive building design and landscaping features for wind control.

Figure 4: Examples of Wind Control Solutions



1	2	3
4	5	6
7	8	9

1. Massing and Landscaping **2.** Stepped Massing
3. Curved Towers **4.** Recessed Entrance with Canopy
5. Canopy above Passageway **6.** Screen along Sidewalk
7. Screen at Building Corner **8.** Landscaping along Sidewalk **9.** Landscaping at Park

Report Structure and Format

Upon the completion of wind study, a technical report shall be prepared to describe the proposed project and existing surroundings in detail. A Pedestrian Level Wind Study should use the following format:

1.1 Physical Context

a. Building information

- What is the height of the proposed development?
- Where is it located?
- Are there existing structures to remain?
- Identify any key pedestrian areas on the site.

b. Surroundings

- Describe topography.
- Is the surrounding area developed?
- What are the heights of surrounding buildings or developments?
- Identify any key pedestrian areas in immediate surroundings.

1.2 Study Approach

a. Type of Study

- State type of study being conducted, per Table 1.
- Explain reasoning, referencing Table 1, for using this type of study.
- Present the meteorological data and criteria used in the assessment of wind conditions.

1.3 Results of Assessment

a. Present wind data used for study

- Discuss wind conditions at key pedestrian areas on and around the development. Conditions in existing and proposed configurations for summer and winter seasons must be described.
- Provide statement to indicate frequency that comfort and/or safety wind conditions may be exceeded.
- Provide recommendations for mitigation where wind safety conditions are exceeded and to bring wind conditions to appropriate levels.