Hamilton

DEVELOPMENT APPLICATION GUIDELINES

WIND STUDY

PURPOSE:

This document provides a guideline for the preparation of a Wind Study, which may be required for the submission of an application under the *Planning Act*. All Wind Studies shall follow the guidelines contained and referenced in this document. Failure to adhere to the guidelines may result in a submission being considered unsatisfactory and a submitted application being deemed incomplete.

A Wind Study is a technical document that may be required in support of a development application to predict, assess, and where necessary, mitigate the potential impacts of a proposed development on wind conditions in pedestrian areas. The objective is to maintain comfortable and safe wind conditions that are appropriate for pedestrian areas. Pedestrian areas include street frontages, pathways, building entrance areas, open spaces, amenity areas, outdoor sitting areas, and accessible rooftop, parks, and open spaces among others.

Buildings can have major impacts on the wind conditions in their surrounding context especially when a building is considerably taller than surrounding buildings. It is important to consider the potential impacts of a proposed development on the local microclimate early in the planning and design process as this allows sufficient time to consider appropriate wind control and mitigation strategies, including changes to site and building designs.

The requirement for a Wind Study will be identified at the Formal Consultation stage of an application. The following types of development may trigger the need for a Wind Study:

1. Building Height

    - A proposed development 20 m in height or more requires a **Qualitative Wind Study** and a **Quantitative Wind Tunnel Study** may be required at the discretion of the Planning and Economic Department.

    - A proposed development 20 m in height or more and up to two times the height of surrounding buildings requires a **Quantitative Wind Tunnel Study.**

    - A proposed development 44 m in height or more requires a **Quantitative Wind Tunnel Study.**

2. Number of Buildings

    - A proposed development with two or more buildings that are 20 m in height or more requires a **Quantitative Wind Tunnel Study.**

3. Site Area (size)

    - A proposed development with a site area of 3 hectares or more, and a building that is 20 m in height or more, requires a **Quantitative Wind Tunnel Study**.

Where a Quantitative Wind Tunnel Study is required, prior to application submission, the applicant and/or agent must submit an image displaying the proposed “test locations” to Urban Design staff for approval prior to the simulation testing (refer to **Figure 1**).

PREPARED BY:

A qualified microclimate specialist or a certified wind tunnel specialist. These studies are to be signed and sealed by a Professional Engineer. If a Wind Study is prepared by an individual or company who does not have extensive experience in pedestrian level wind evaluation, an independent peer review may be required at the expense of the proponent.

CONTENTS:

A pre-study consultation with staff may be required to confirm a terms of reference prior to initiating the Wind Study. A Wind Study will contain and address the below contents for wind studies and analysis criteria.

1. General Submission Information

- Type of application.
- Municipal address.
- Name of the individual and company who has prepared the study.
- Digital copy of study should include the development massing.
- **NOTE -** The wind model shall be no smaller than a 1:500 representation of the proposed development and will include all buildings within a minimum of 400 metres of the site, in keeping with the industry standard.

2. Existing Context

- The most objective way to assess the impact of a proposed development on wind conditions around it, is to compare it to existing conditions. Provide the meteorological data used to confirm the existing wind conditions.

- Provide images which display the prevailing wind directions inset within the current site conditions for each required test date. Highlight the location of the proposed site (refer to **Figure 1**).

3. **Effects of the Proposal**

- Provide an image which displays the existing and proposed pedestrian and amenity area(s) within the proposed development and immediate adjacent area(s) which form part of the “test locations” used to evaluate wind conditions in the analysis area (refer to **Figures 1**).

- Where a wind tunnel test was completed, provide statistical text information of the resulting wind conditions at the test locations (e.g. prevailing wind directions and speeds) as a result of the proposed development.

4. **Explanation and Assessment**

- Provide a written summary of the wind impacts, which include the locations of the impact and type of wind sensitive use where the impact occurs for each test date.

- The pedestrian wind comfort level and safety exceedance are determined by the predicted wind speeds for respective exceeding frequencies as specified in **Section 8.0** Pedestrian Level Wind Study Criteria. The assessment will give consideration to the predicted comfort level and intended pedestrian usage. In addition, a comparison to existing, and if appropriate future, wind conditions, shall be considered.

- The proposed development shall achieve wind comfort conditions that are considered appropriate for the intended usage (i.e. walking on sidewalks, standing at building entrance areas, and sitting or standing in amenity areas where more passive use is anticipated). If the proposed development produces pedestrian comfort conditions that prove to be less than desirable based on the intended use of unsafe (as per the definitions in **Table 1**) then the developer shall proposed mitigation strategies and/or investigate alternative to the proposed design with the microclimate specialty.

- If applicable, detail the proposed mitigation measures to be adjusted in the development proposal which will minimize or eliminate the resulting wind impacts and describe any mitigating features that have been incorporated into the site and building design. This may require confirmation through submission of a revised site plan and/or building elevations. A condition of Site Plan Approval will be placed to ensure that the mitigation recommendations of the wind study are fully implemented, prior to the City releasing any associated securities.

- Overall, the proposed development shall improve on existing wind conditions where possible, and as a minimum, shall not significantly degrade wind conditions especially when considering the safety criteria. Some allowance for degradation of wind comfort levels during the winter months may be deemed to be acceptable due to reduced pedestrian usage of outdoor spaces.

5. Confirmation of Proper Implementation

Prior to Site Plan approval for any Building Permit clearance, the following clause shall be included on the Site Plan and all relevant drawings:

The microclimate specialist shall confirm, to the satisfaction of the Planning and Economic Development Department that the 'as constructed' buildings and wind mitigation measures are in compliance with the recommendations of the Pedestrian Level Wind Study.

NOTE - Prior to the final site works inspection by the Planning and Economic Development Department, the microclimate specialist shall issue a letter confirming that the wind mitigation measures have been installed in accordance with the recommendations of the pedestrian level wind study.

TECHNICAL REQUIREMENTS INCLUDE:

1. Type of Study

A. Qualitative Study:

A Qualitative Study relies on professional observation and interpretation. A Qualitative Study may be conducted either as a **Qualitative Desktop Study** or using **Computational Fluid Dynamics (CFD).**

i) Requirements for a Qualitative Desktop Study

- Predict and estimate the wind speeds at critical locations around the proposed development while considering the frequency of occurrence of wind speeds.
- Study should be based on the standard wind comfort criteria described in this document in Section 5.0 of the Technical Study Requirements.
- Where conditions are considered to be unacceptable for the intended usage, provide mitigation concepts to improve the wind comfort to acceptable levels or suggest appropriate adjustments to pedestrian usage.

ii) Requirements for Computational Fluid Dynamics (CFD)

- It shall be acceptable to simulate only the prevailing wind directions as a basis of assessment using CFD.

- The CFD simulation shall appropriately represent the atmospheric boundary layer for winds approaching the computational model.

- Presentation of the wind speeds shall include horizontal planes at pedestrian level (i.e. 1.5 m above local grade) and vertical slices to understand flow conditions in critical areas.

- The actual assessment of wind conditions at critical pedestrian locations must account for the probability of all wind directions that can occur based on the wind data from the appropriate airport.

- The potential wind comfort and safety categories should be assessed for areas of interest.

- If problematic wind conditions are predicted, design alternatives and wind mitigation measures shall be recommended and described in the final report.

B. Quantitative Wind Tunnel Study:

A Quantitative Wind Tunnel Study is based on measured data from physical scale model testing. A Quantitative Wind Tunnel Study shall be conducted in a boundary layer wind simulation facility.

Requirements for Quantitative Wind Tunnel Testing

- 36 wind directions shall be tested.

- The wind simulation facility must be capable of simulating the earth's atmospheric boundary layer and appropriate profiles for each of the wind directions tested.

- Wind speeds shall be presented in km/h.

- Wind speed sensors used to measure local wind speeds shall be omni-directional and represent the horizontal wind speed at a full scale height of approximately 1.5 m above local grade. These sensors should be capable of measuring mean wind speed and wind speed fluctuations with time, including peak gusts of three to ten second duration. Sampling time in the wind tunnel shall represent a minimum of one hour of full scale time.

- The model scale should be selected to allow representation of sufficient architectural detail on the proposed development while including the surrounding context within approximately 400 m of the centre of the proposed development site (typically scales of 1:300 or 1:400 have proven to be effective). Structures and natural features beyond the modelled surroundings shall be appropriately represented in the wind tunnel upwind of the scale model.

- Sensors shall be placed at least every 10 m along a street frontage of the study buildings and at all locations where pedestrians will travel or gather. A typical development project would require a minimum of 50 sensor locations on and around the proposed development to provide adequate coverage.

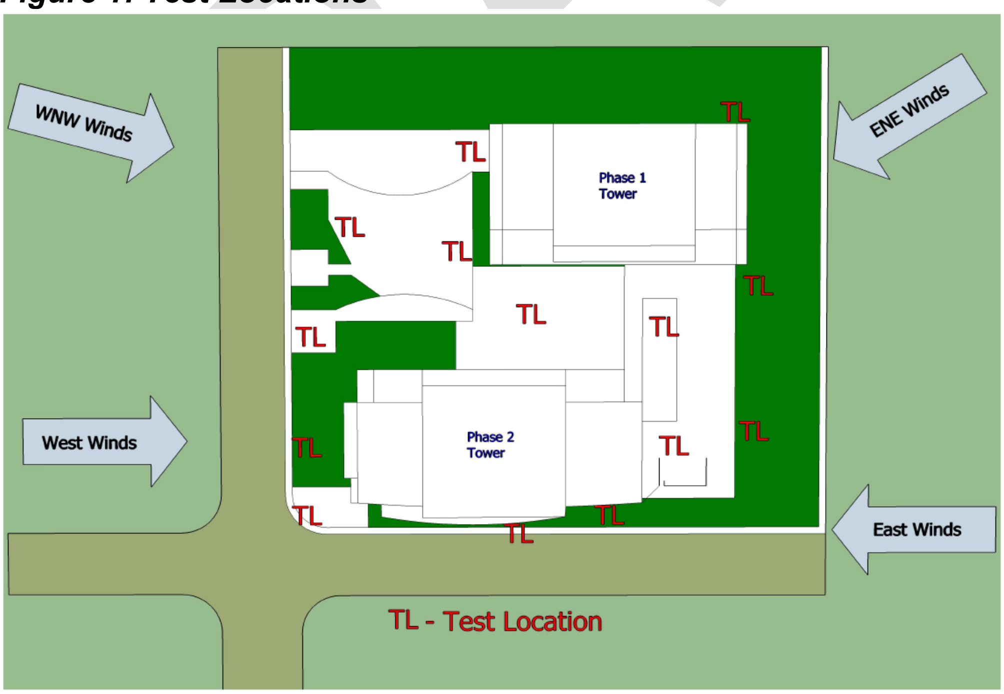
- The results shall be presented in both tabular and graphic forms for all the test configurations, with seasonal comfort data and annual safety data.

2. Test Locations

Test locations will be identified through an image in the application submission (refer to **Figures 1**). Test locations include:

- Major building entrances.
- Sidewalks (adjacent to the proposed building(s).
- Parking lots (adjacent to the proposed building(s).
- Public amenity spaces (e.g. parks, plazas, courtyards, trails, public pools, restaurant patios, etc.).
- Private amenity space (e.g. balconies, rooftop patios, private pools).

Figure 1: Test Locations



3. Test Dates

A minimum of 30 years of hourly wind data from John C. Munro Hamilton International Airport should be used and presented on a four-season basis as follows:

- Summer: Hourly winds occurring the period of May through October.
- Winter: Hourly winds occurring the period of November through April.

Appropriate hours of pedestrian usage for a typical project (i.e. 6:00 am and 11:00 pm) should be considered for wind comfort, while data for 24 hours should be used to assess wind safety.

4. Configurations

When conducting a wind study the most objective way to assess the impact of a proposed development is to compare it to the existing wind conditions. In some parts of the City it may be prudent to consider a future cumulative configuration.

The following is a description of the configurations that typically need to be considered:

a. Existing
Include all existing buildings, significant topographic features, and developments under construction within a 400 m radius of the site.

b. Proposed
Include the proposed development being studies, as well as all existing buildings, significant topographic features, and developments under construction within a 400m radius of the site.

c. Future (only if warranted)
Add any buildings that are part of a future development identified by the City, and deemed by the wind consultant to have a potential impact on winds at the subject site.

d. Mitigation
Where mitigation is required to achieve acceptable pedestrian wind comfort levels, evaluate the proposed configuration with all recommended mitigation measures in order to demonstrate the benefits of the mitigation strategies under the proposed and/or future configurations.

5.0 Wind Comfort Criteria

The criteria to be used for assessment of pedestrian wind conditions and comfort includes both mean and gust wind speeds, therefore their combined effect is used as the basis of the criteria and defined as a Gust Equivalent Mean (GEM) wind speed. The GEM is defined as the maximum mean wind speed or the gust wind speed divided by 1.85.

A 20% exceedance is used in these criteria to determine the comfort category, which suggests that wind speeds would be comfortable for the corresponding activity at least 80% of the time or four out of five days. Only gust winds are considered in the safety criterion. These criteria for wind forces represent average wind tolerances.

There are four measuring points to evaluate the comfort of the wind speed:

1. Sitting,
2. Standing,
3. Strolling, and
4. Walking.

These measuring points are to be evaluated at different locations/areas on the development site and immediate adjacent area to ensure that they meet the criteria. Should a proposed development not be able to meet the comfort evaluation criteria, mitigation measures (e.g. building design, and/or site design measures) are to be included into the design of the building and/or site.

Table 1: Pedestrian Wind Comfort Criteria

Wind Comfort Category	**GEM Speed (km/h)**	**Description**
Sitting	≤ 10	Calm or light breezes for outdoor restaurants and seating areas where one can read a paper without having it blown away.
Standing	≤ 14	Gentle breezes suitable for main building entrances and bus stops.
Strolling	≤ 17	Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza, or park.
Walking	≤ 20	Relative high speeds that can be tolerated if ones objective is to walk, run, or cycle without lingering.
Uncomfortable	> 20	Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation measures are recommended.
Notes: (1) Gust Equivalent Mean (GEM) speed = *max*(mean speed, gust speed/1.85); and **(2)** GEM speeds listed above are based on a seasonal exceedance of 20% of the time between 6:00 and 23:00. The criterion has been met if the wind speeds occur at least 80% of the time or four out of five days.		

6.0 Wind Safety Criteria

Wind gusts will be used to measure the safety of the wind on all test locations. Should a proposed development not be able to meet the wind safety criteria, appropriate mitigation measures (e.g. redesign of the site, reduction in height, etc.) will be required to eliminate the safety issue.

Table 2: Pedestrian Wind Safety Criteria

Wind Safety Criterion	Gust Speed (km/h)	Description
Exceeded	$\geq$ 90	Excessive gusts that can adversely affect a pedestrian's balance and footing. Wind mitigation is required.
Note: the GEM is based on an annual exceedance of 9 hours or 0.1% of the time for a 24 hour day.		

7.0 Mitigation Measures

In areas where wind conditions are considered to be unacceptable for the intended pedestrian use or unsafe (as defined in **Table 1**) and will be accessible to pedestrians, wind control mitigation strategies shall be developed and tested to demonstrate efficacy. In more extreme cases, the developer in consultation with the microclimate specialist may need to investigate and prepare design alternatives that can achieve more acceptable wind conditions.

Wind Control Mitigation Strategies may include the following:

- Building massing changes or alternative designs that are more responsive to the local wind climate.
- Incorporating podiums, tower setbacks, balconies, curved or stepped corners, notches and/or colonnades.
- Strategic use of canopies, parapet walls and wind screens, landscaping, planters, public art and/or other features that prove to be effective for mitigating problematic wind conditions.
- Modifications to the pedestrian usage.

Landscaping Principles to Mitigate Wind Effects

The use of landscaping as part of a mitigation strategy is acceptable but must be selected and sized to be effective at the time of installation. Landscaping can only be recommended as a mitigation measure where the wind conditions are suitable for it to thrive and for its maintenance.

High branching deciduous trees can reduce down washing wind flows in the summer months when they have full foliage. However, they generally do not provide ground level protection from horizontal wind flows. Coniferous trees can provide additional wind protection during the winter months.

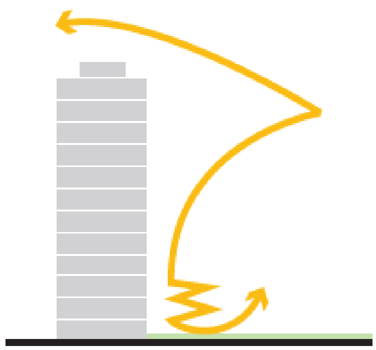
The type of trees (i.e., deciduous, coniferous or marcescent), approximate size and location required for wind control shall be specified in the wind study. The landscape architect shall select the species appropriate for the site and which will achieve the stated wind mitigation benefits.

Where extreme wind conditions such as safety exceedances are predicted, hard landscaping (e.g., architectural features, screens, etc.) is strongly recommended over soft landscaping (e.g. trees, shrubs, etc.), as trees may not be able to survive in extreme wind environments.

Massing Principles to Mitigate Wind Effects

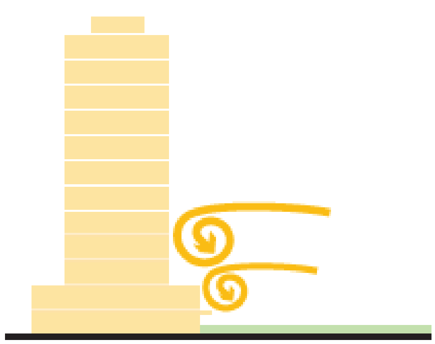
Massing details can affect the wind flow around a site and the following considerations should be made:

WIND AT STREET LEVEL



When wind hits the windward face of a tall building, the building tends to deflect wind downwards, causing accelerated wind speeds at pedestrian level and around the windward corners of the building.

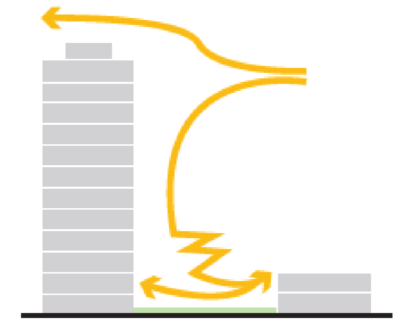
Tall and wide building facades are generally undesirable.



When introducing a base building or podium with step back, and setting back a tower relative to the base building, the downward wind flow can be deflected, resulting in reduced wind speed at pedestrian level.

The proportions of the base building and tower step backs and their influence on the wind conditions is affected by the heights of surrounding buildings.

WIND BETWEEN BUILDINGS



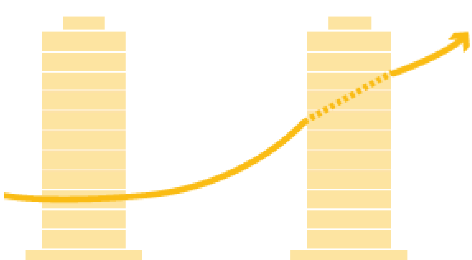
When the leeward face of a low building faces the windward face of a tall building, it causes an increase in the downward flow of wind on the windward face of the tall building.

This results in accelerated winds at pedestrian level in the space between the two buildings and around the windward corners of the tall building.

By landscaping the base building roof and providing a tower step back, wind speed at grade can further be reduced, and wind conditions on the base building roof can improve.

Also, a horizontal canopy on the windward face of a base building can improve pedestrian level wind conditions.

DISTANCE BETWEEN BUILDINGS



Wind speed is accelerated when wind is funnelled between two buildings located close to one another causing a “wins canyon effect”.

The intensity of the acceleration is further influenced by the building heights, size of the facades, and building orientation.

Spacing towers further apart allows for wind to move through more easily.

REVIEWED AND APPROVED BY:

Development Planning staff, Planning and Economic Development Department
Urban Design staff, Planning and Economic Development Department

CONTACT:

pdgeninq@hamilton.ca

Last updated October 2022