Pedestrian Level Wind Study

Terms of Reference

February 2023

Technical Update: June 2026







MARKHAM

Table of Contents

1.0 Introduction

1.1 Purpose

A Pedestrian Level Wind Study (PLW or wind analysis) is a technical assessment to evaluate the wind impacts of a proposed development. The study assesses the development's impact on pedestrian level wind conditions and evaluates seasonal wind comfort and safety against established criteria. The analysis also informs and supports the implementation of wind mitigation measures within the development application. Where necessary, it provides mitigation recommendations to ensure wind conditions remain appropriate for the intended pedestrian uses and meet acceptable wind level conditions year-round.

1.2 Why Do We Need the Pedestrian Level Wind Study?

To support the City of Markham's goals of fostering vibrant civic spaces, encouraging active use of the public realm, and ensuring a safe and comfortable pedestrian experience, it is essential to evaluate the wind-related impacts of new development early in the planning and design process. Considering microclimatic conditions at the outset allows adequate opportunity to shape built form in ways that promote comfortable wind conditions and appropriate air circulation along streets, open spaces, and other publicly accessible areas. This proactive approach also ensures that effective wind control and mitigation measures can be integrated to maintain the intended function, accessibility, and year-round usability of these spaces.

A Pedestrian Level Wind Study is needed to ensure that the development application conforms to applicable by-laws and policies from the City of Markham 2014 Official Plan, specifically Section 6.0 – Urban Design and Sustainable Development, including, but not limited to:

6.1.2 The Public Realm
6.1.4 Streetscapes
6.1.8 Built Form and Site Development

1.3 Types of Wind Study

The City of Markham accepts two types of wind analysis as part of the development application approval process:

1. **Computational Fluid Dynamics (CFD) Testing:** A quantitative computer-based study performed using wind speed simulations on a 3D model of the study site and surroundings. This study should illustrate pedestrian comfort over the site using comfort contours. Sensor locations are to be approved by City staff prior to commencement of the study.

2. **Wind Tunnel Testing:** Wind tunnel testing of a physical scale model of the study site and surroundings. This detailed quantitative study determines pedestrian comfort at discrete sensor locations. The number, placement and extent of the sensors should be sufficient to capture the influence of the new development on surrounding buildings. Typically, placing sensors to the distance equal to the height of the study building, in all directions surrounding the subject site, is sufficient to achieve this goal. The impact area may increase depending on context (e.g., parks, schools, other adjacent public open spaces, etc.).

1.4 When Is This Required?

The Pedestrian Level Wind Study may be required as part of a development application for a Zoning By-Law Amendment (ZBA or rezoning), and/or Site Plan Control (SPC or site plan) applications proposing significant changes in height or built form in key areas within the City (e.g. intensification areas, mixed-use nodes, sensitive infill development within established communities).

Zoning By-law Amendment (ZBA)

At the rezoning stage, a wind analysis is required for applications that pursue an increased building height in addition to meeting the following criteria:

- A proposed development greater than 10-storeys, regardless of the height of surrounding buildings;
- A proposed development in the range of 6 to 9-storeys that is more than twice the height of existing surrounding buildings; and/or,
- A proposed development where the subject site is located immediately adjacent to a sensitive use area (i.e., park, plaza, school, community centre, or other large public amenity area).

The purpose is to identify any built form or massing features that could create pedestrian comfort concerns to inform design at the initial stages of planning.

Type of Study Required:

All zoning applications meeting the criteria above require a **Computational Fluid Dynamics (CFD)** study.

Site Plan Control (SPC)

A wind analysis is required at the site plan stage for one of two scenarios:

1. An application that completed a wind analysis at the rezoning stage may require a subsequent analysis for the site plan stage to:
   a. identify any changes to the built form made following the rezoning stage that would influence pedestrian comfort; and
   b. reassess these changes as required based on the refined development massing.

2. An application that has not pursued an increase in height will require a wind analysis if the development is either:
   a. located in an intensification area;
   b. is taller than the existing surrounding development ; or
   c. is located immediately adjacent to a park, plaza, school, or other large public amenity area.

The purpose is to assess pedestrian comfort for applications within characteristically windier areas that did not require assessment at the rezoning stage.

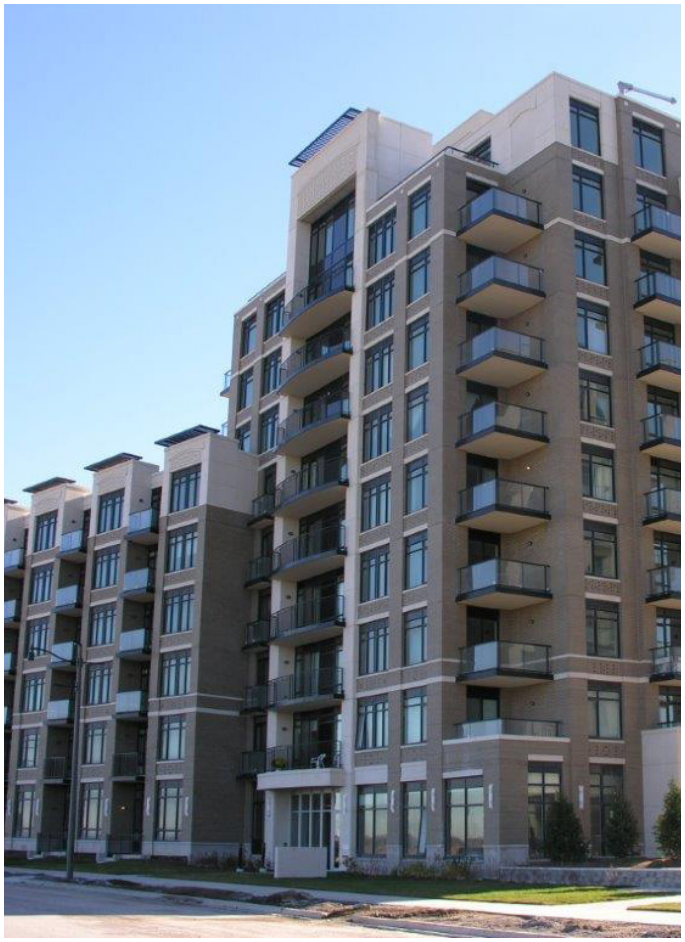
Type of Study Required

- **Wind Tunnel Testing** for developments that are:
  - greater than 20-storeys;
  - comprise of multiple buildings or towers ;
  - feature complex or atypical massing; and/or
  - are located immediately adjacent to a sensitive use area (e.g., park, plaza, school, community centre, or other large public amenity area).

- **Computational Fluid Dynamics (CFD)** for developments that are:
  - single tower developments of less than or equal to 20-storeys.

1.5 Who Prepares This?

A Pedestrian Level Wind Study must be prepared, signed, and stamped by a Professional Engineer who specializes in microclimate studies and wind engineering. Typically, this work is completed by engineers who specialize in atmospheric sciences, building aerodynamics, and computational or wind tunnel analysis. These professionals often work within consulting firms that focus on microclimate assessment, boundary layer wind tunnel testing, and urban environmental conditions. Their specialized training ensures they can accurately model how proposed buildings, site configurations, and surrounding structures influence wind behaviour at the pedestrian level and can recommend appropriate design or mitigation measures.



2.0 Requirements

2.1 Submission Criteria

The Pedestrian Level Wind Study shall include:

- Descriptions of the types of wind studies available (Computational Fluid Dynamics or Wind Tunnel Testing);
- Criteria to determine which type of study is appropriate for a development application, based on application type and characteristics of the proposed development; and,
- Guidelines for conducting each study, including appropriate testing and analysis parameters, wind comfort criteria, and mitigation measures, as well as guidelines for content and reporting.

The structure of the Pedestrian Level Wind Study shall include the following sections:

- Assumptions
- Meteorological Analysis
- Evaluation Criteria
- Mitigation
- Summary of Findings & Figures

2.2 Assumptions

A pedestrian level wind analysis requires the following:

- The model must include all existing buildings within 350m radius of the subject site; and,
- The model must include all planned developments, including applications that are active or have been approved.

2.3 Meteorological Analysis

Meteorological analysis must be performed using a minimum of 30 years of hourly wind data, obtained from Toronto Pearson International Airport and include a visualization of the directional character of local winds on a seasonal basis (as shown in Figure 1 below).

Data representing each of the four seasons must be grouped as follows:

- Winter (December to March)
- Spring (April and May)
- Summer (June to September)
- Fall (October and November)

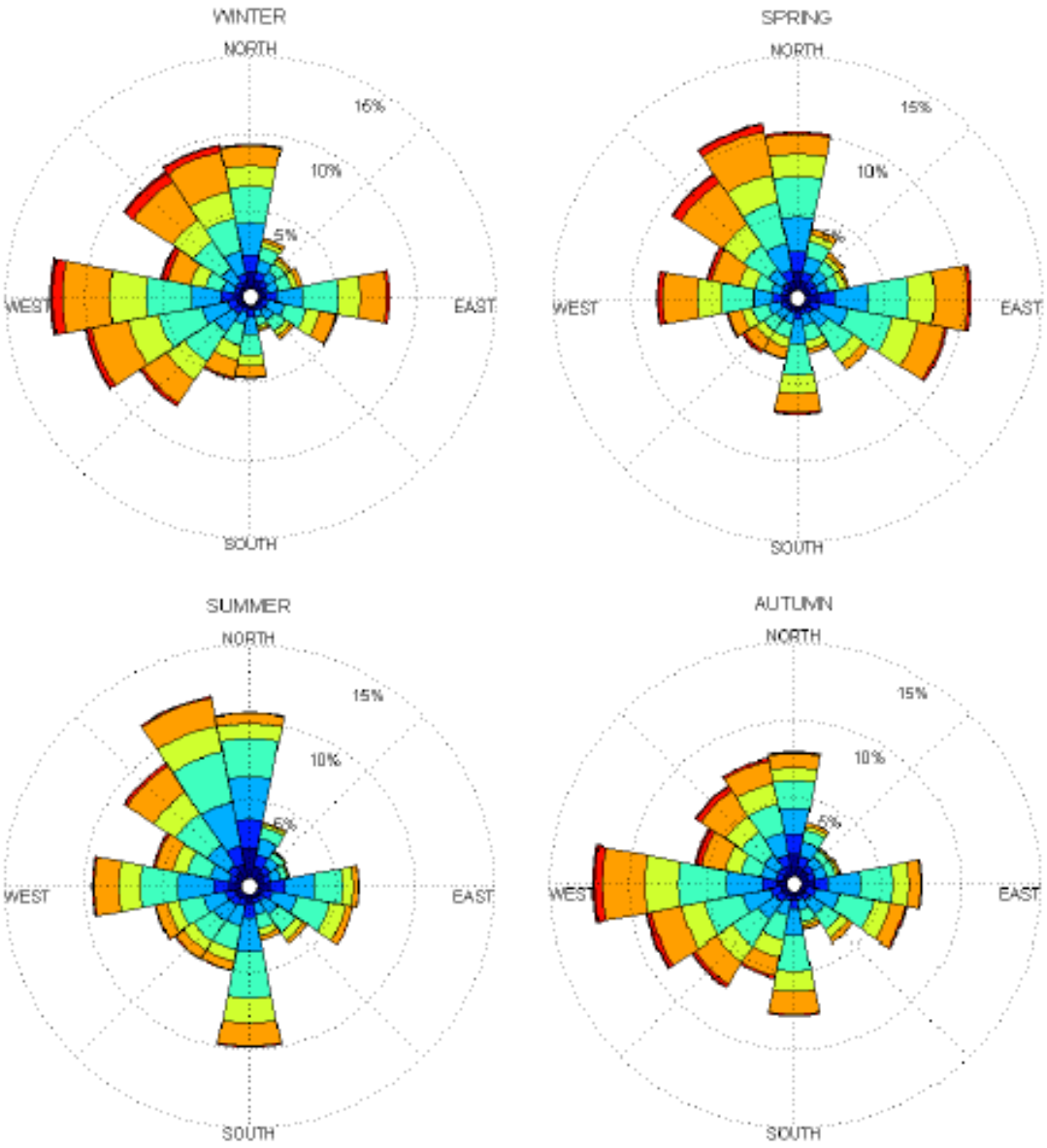


Figure 1: Seasonal Distribution of Winds for Various Probabilities: Buttonville Municipal Airport, Markham, Ontario (commonly referred to as a "Wind Rose")

Notes:

1. Radial distance indicates percentage of time of wind events.
2. Wind speeds represent mean hourly wind speeds measured at 10m above the ground.

2.4 Evaluation Criteria

The categories of pedestrian comfort as outlined in Table 1 below shall be used to evaluate wind speeds in and around the study site on a seasonal basis. Gust wind speeds will be used to assess pedestrian safety. Wind speeds exceeding 90 km/h occurring more than 0.1% on annual basis are considered dangerous and will require mitigation.

The Gust Equivalent Mean (GEM) wind speed should be used, which is the greater of the mean wind speed or the gust wind speed divided by 1.85. GEM wind speeds are categorized based on an 80% non-exceedance factor gust (i.e., wind speeds ≤ 10 km/hr occurring more than 80% of time are suitable for sitting).

The wind analysis should evaluate pedestrian comfort at all grade-level and elevated pedestrian-sensitive areas in and around the study site.

Examples of pedestrian-sensitive areas/sensor locations:

- Building access points sidewalks, transit stops and parking lots;
- Elevated outdoor amenity areas or amenity terraces; and,
- Grade-level outdoor amenity areas (including parks, plazas, courtyards, restaurant patios, privately owned public spaces, etc.).

Table 1: Comfort Categories and Correlating Wind Speeds

Category	Speed (km/hr)	Where Applicable
Sitting	≤10	Sensitive use and outdoor amenity areas (e.g., parks, elevated amenity terraces, restaurant patios, grade-level seating areas)
Standing	≤15	Primary building entrances and transit stops
Walking	≤20	Sidewalks, parking lots, bicycle paths, secondary building access points
Uncomfortable	≥20	Moderate excesses falling within this category would be acceptable for brisk walking and exercise such as jogging

All sensor locations must be reviewed and approved by the City prior to conducting wind analysis.

2.5 Mitigation

Where a proposed development does not achieve the desired pedestrian comfort criteria, the evaluation will consider the desired comfort category, building massing, orientation, and design features to recommend suitable options for mitigation.

Potential mitigation measures may include, but are not limited to, the following:

- Modifications to the building massing (such as the introduction of building setbacks, podiums, overhangs, and/or smoothed or transitioning building corners);
- Wind barriers (such as wind screens, dense coniferous plantings, raised parapets, or earth berms);
- Canopies; and/or,
- Entrance modifications (such as recessed entrances, relocation of entrances away from building corners, or replacing swing doors with vestibules or sliding doors).

Recommended mitigation measures may require additional confirmation testing following the study submission as the landscape plan or site plan progresses.

2.6 Summary of Findings & Figures

A written summary must identify the predicted comfort class for each pedestrian-sensitive location. Additionally, all studies require a figure(s) showing grade-level and elevated pedestrian-sensitive locations within and immediately adjacent to the proposed development.

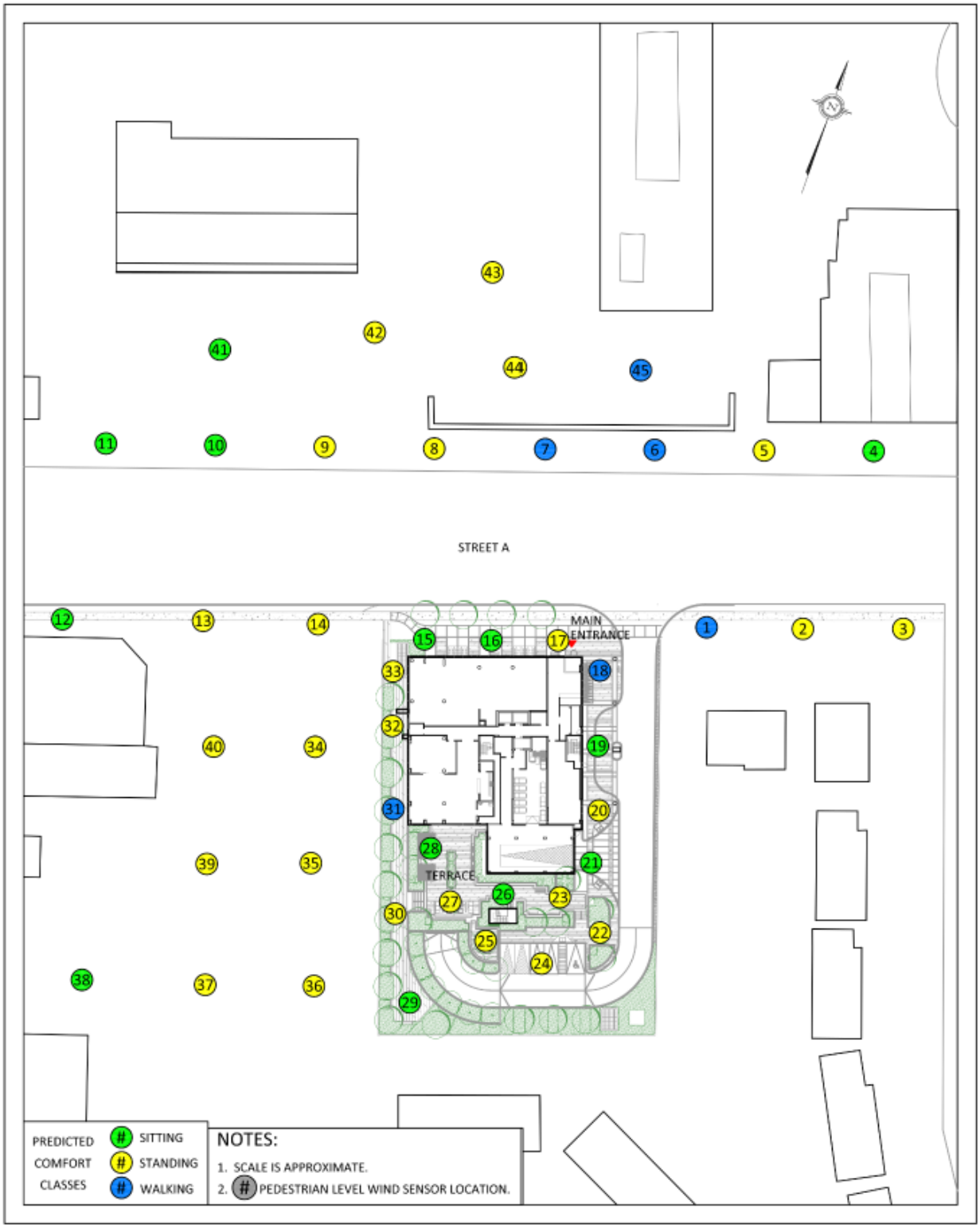
Quantitative studies have the following additional requirements:

- **Wind Tunnel Testing Study:** a figure showing sensor locations, and tables containing numerical pedestrian comfort results for each sensor location, by season.

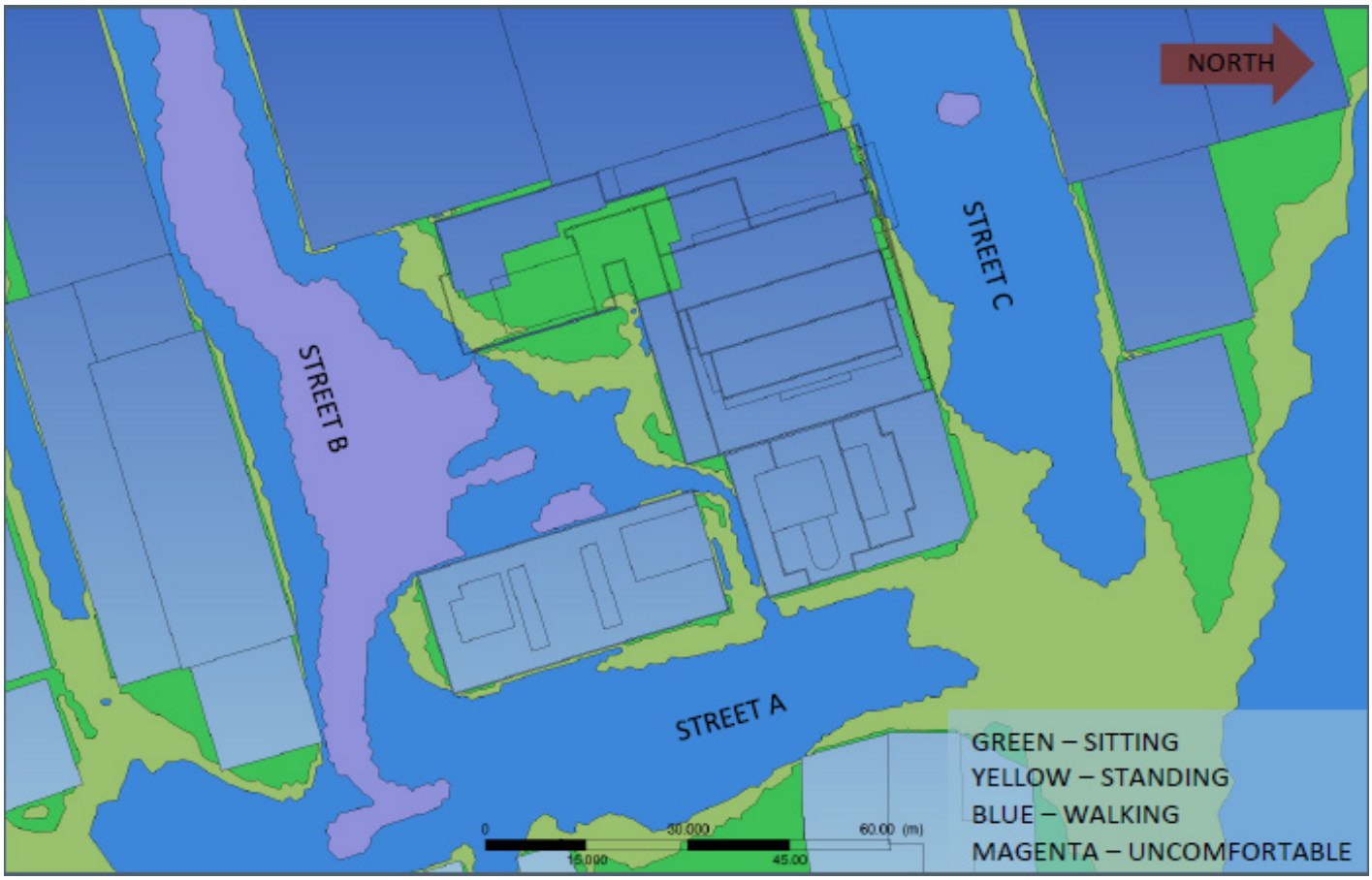
- **Computational Fluid Dynamics (CFD) Testing Study:** pedestrian comfort contours generated for the study.

Appendices

Appendix A: Wind Tunnel Testing Study Example



Appendix B: CFD Pedestrian Comfort Contours Example



Markham Civic Centre

101 Town Centre Blvd., Markham, ON, L3R 9W3