REPORT

37 JOHNSON STREET

BARRIE, ON

MICROCLIMATE IMPACT REPORT

PROJECT #2000996

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SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Starlight Investments to conduct a desktop Microclimate Impact assessment for the proposed residential development at 37 Johnson Street in Barrie, Ontario. Drawings and shading plots for the proposed building were received from Starlight Investments on November 11, 2019 and were used as part of the assessment which included a pedestrian outdoor thermal comfort review.

The proposed development is located on Indian Arrow Road just east of Johnson Street (see Image 1). The site is currently occupied by lawn area and trees. The area surrounding the site is primarily low-rise residential buildings in all directions, with taller buildings adjacent and to the southwest, and across the street to the northwest. Lake Simcoe is located approximately 350 m to the south. The proposed project is a 11-storey residential tower. Key pedestrian areas on and around the site includes the proposed building entrances, public sidewalks, the adjacent Shoreview Park, the parking lot area, and 5th floor terraces.

This review will contain:

- A description of the meteorological data pertinent to thermal comfort at the site.
- A description of the thermal comfort metric used.
- An overview of thermal comfort conditions throughout the seasons.
- Conclusions and recommendations.

Image 1: Aerial View of Existing Site and Surrounding
(Courtesy of Google™ Earth)

2. BACKGROUND AND APPROACH

2.1 Factors Affecting Thermal Comfort

To assist in developing a climate-responsive design that delivers a comfortable experience to occupants, one needs to be able to "score" the thermal comfort conditions. This requires a means to evaluate the human physiological response to the thermal environment using a quantifiable index for thermal comfort.
Thermal comfort has been directly correlated to six primary factors (image 2).

Factors Relating to the External Environment (Image 2):

- Dry Bulb Temperature;
- Humidity;
- Air Speed; and
- Mean Radiant Temperature (temperatures of surfaces around the individual)

Factors Relating to the Individual:

- Garment thermal resistance/insulation; and
- Metabolic heat generation (The heat generated by the human body resulting from physical activity).

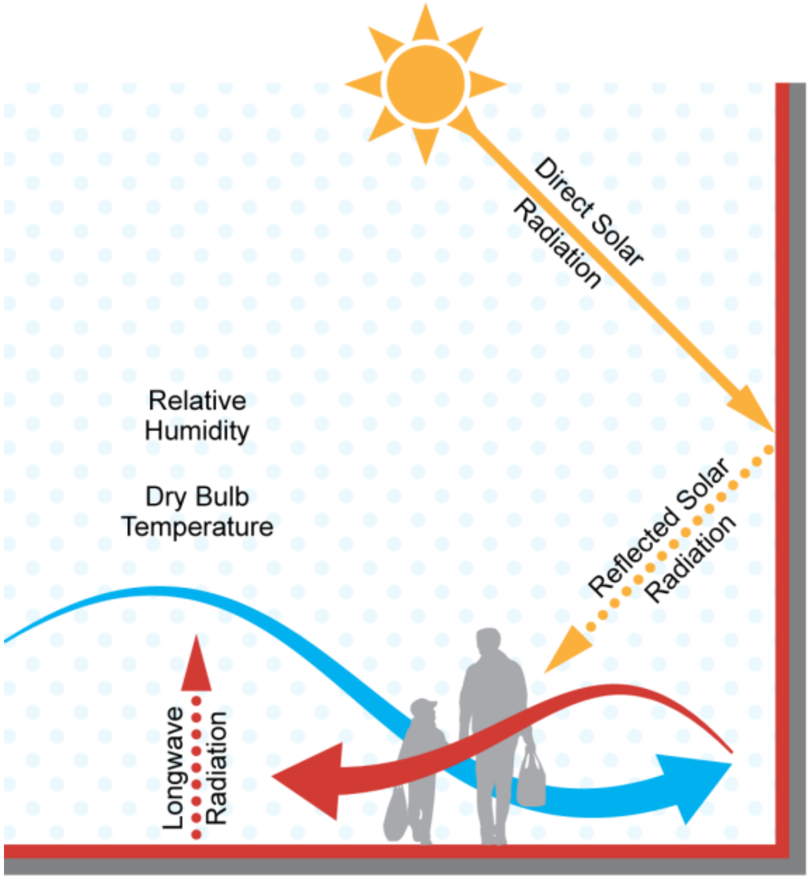


Image 2: Factors Impacting Thermal Comfort

2.2 Methodology

- An industry standard 'Typical Meteorological Year' file was used as the primary input for this analysis. The file contains a single year of hourly climate data which represents the 'typical' conditions at Lake Simcoe Regional Airport. Wind speeds and directions, dry bulb temperatures, solar radiation and relative humidity are all included in this dataset.
- Based on the results of RWDI's pedestrian wind desktop assessment, nine locations around the proposed building were selected for the thermal comfort assessment (see "191126 RWDI Project 2000996 - 37 Johnson Street - Pedestrian Wind Desktop Assessment Report" delivered on November 26, 2019). To accurately represent wind conditions at the site, wind statistics from the climate file were scaled based on the results of the pedestrian wind desktop assessment. Scaling the wind speeds acknowledges the influence that the proposed building will have on the local wind microclimate.
- The solar radiation results were then scaled based on the predicted level of solar shading expected at different areas of interest.
- Hourly thermal comfort conditions were then predicted for each location (Image 3) and statistics generated.

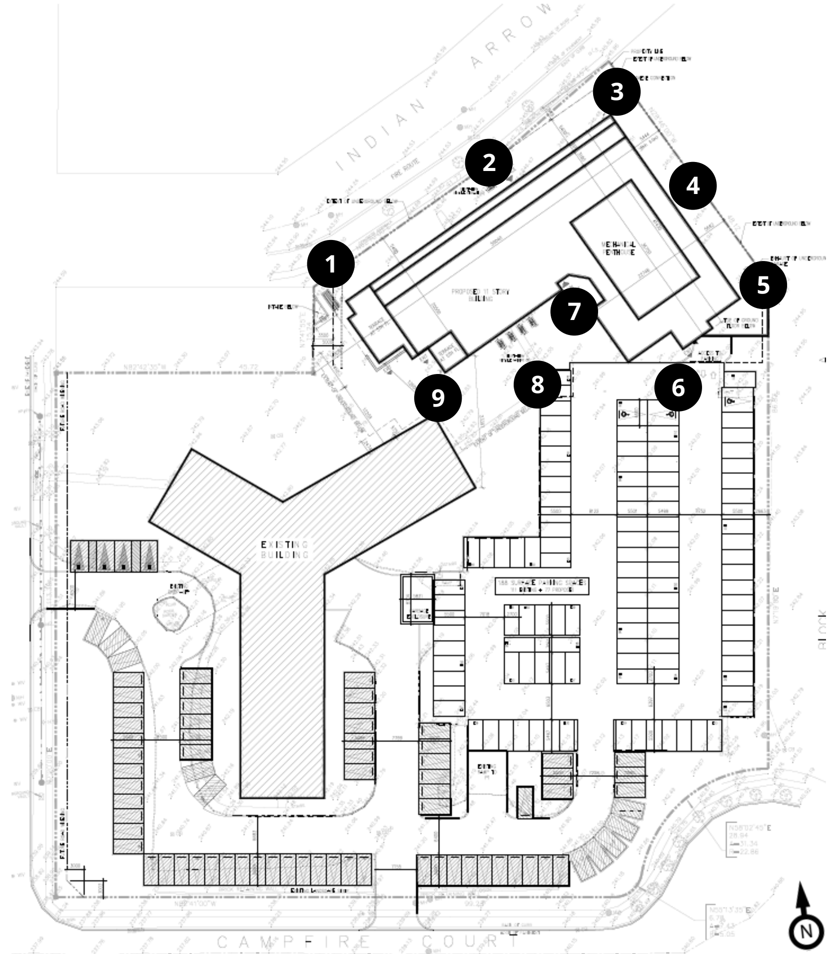
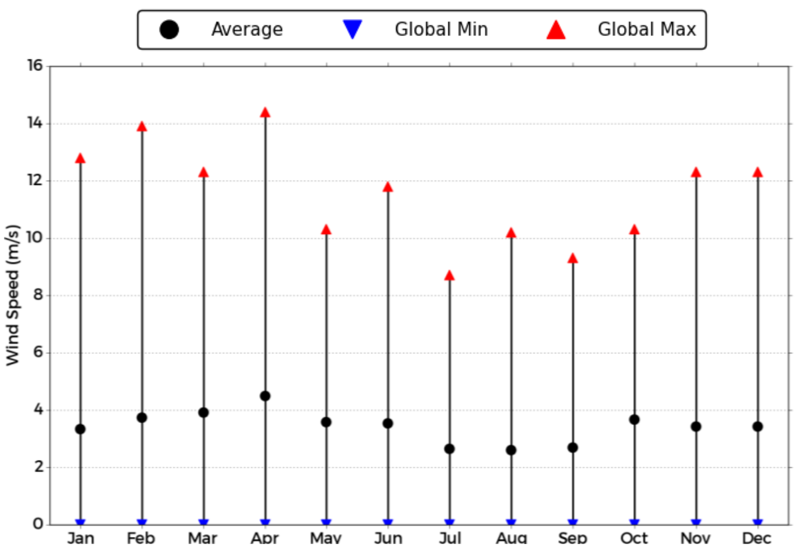


Image 3: Locations Selected for Thermal Comfort Desktop Assessment Based on Preliminary Pedestrian Level Wind Study

3.1 Wind Speeds and Directionality

Image 4 shows the annual distribution of wind frequency and directionality at Lake Simcoe Regional Airport. Winds blow primarily from the west through northwest directions throughout the year. Winds are also expected from the southeast quadrant, although these winds are predicted to be less frequent with lower wind speeds.

Wind speeds average approximately 3.5 m/s on an annual basis (Image 5). Lower wind speeds are expected in the summer months compared to the rest of the year.



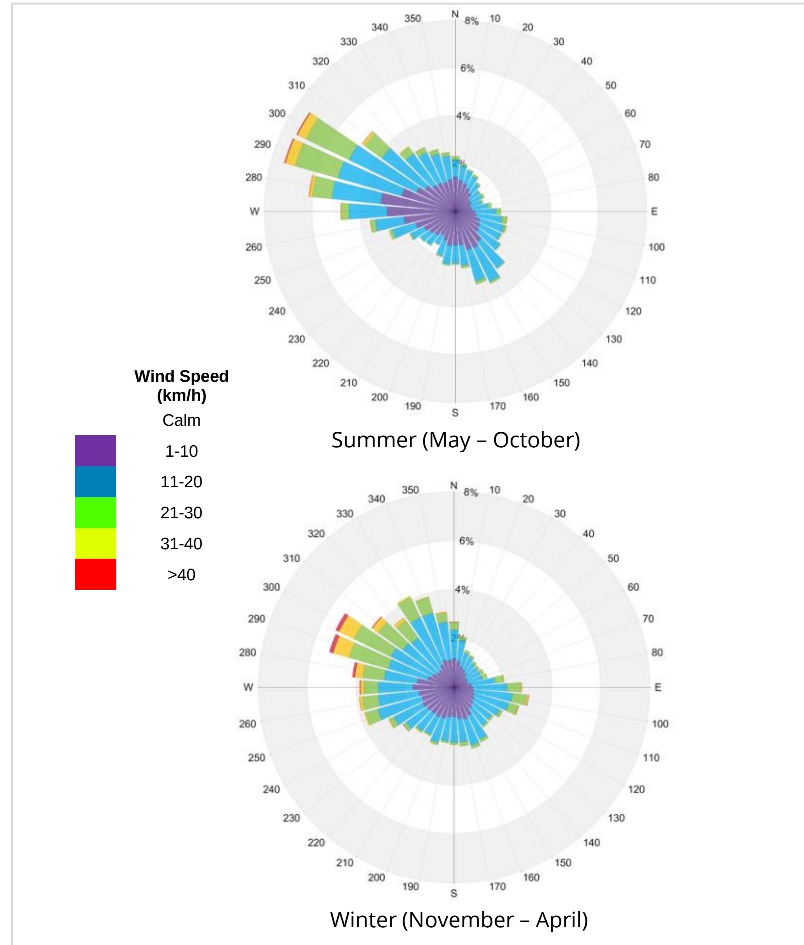


Image 4: Directional Distribution of Winds Recorded at Lake Simcoe Regional Airport 2003 – 2016 (Top) and Monthly Average Wind Speeds based on Typical Meteorological Year at Lake Simcoe Regional Airport (Left)

3.2 Temperature and Relative Humidity

The climate at the site is characterized by cold winters and warm summers. The average dry bulb temperature ranges from -8 °C in January and February to 21 °C in July. The highest recorded temperature for the dataset in the summer was 32 °C while the lowest recorded temperature during the winter was -28 °C (Image 5).

Humidity levels are generally moderately high throughout the year, with an average humidity of approximately 75% (Image 6). During the spring, lower relative humidity levels are expected compared to the rest of the year.

Maintaining thermal comfort through passive means during extreme conditions can be challenging, but the more typical conditions at the site are conducive for passive thermal comfort.

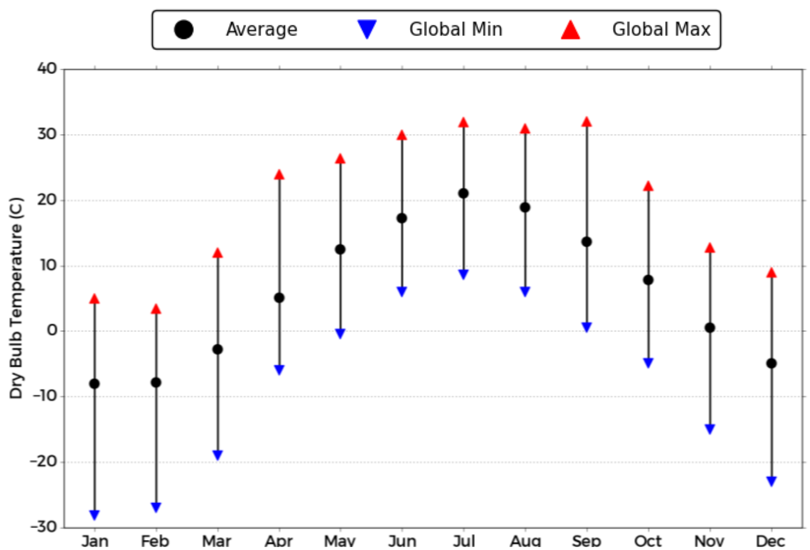


Image 5: Monthly Average Dry Bulb Temperatures based on Typical Meteorological Year at Lake Simcoe Regional Airport

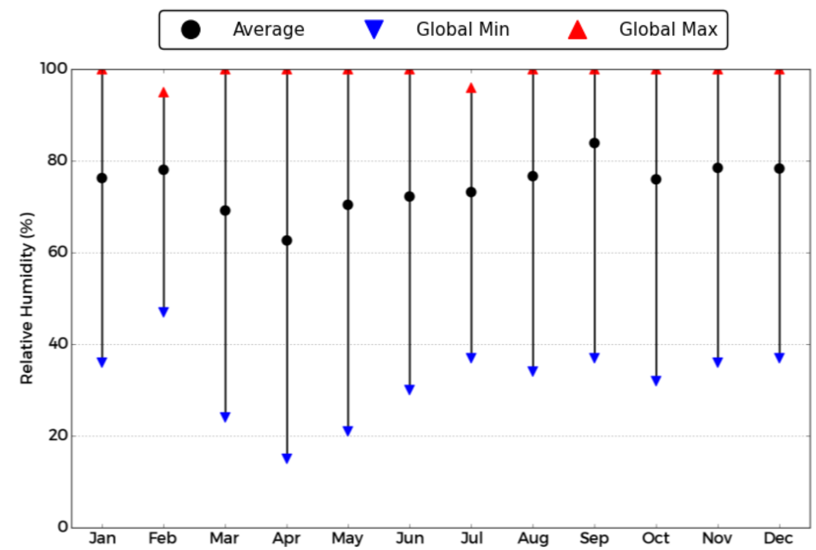


Image 6: Monthly Average Relative Humidity based on Typical Meteorological Year at Lake Simcoe Regional Airport

3.3 Thermal Comfort Criteria

RWDI has elected to use the Standard Predicted Mean Vote (SPMV*) metric for this work. SPMV* is an extended version of the commonly used Predicted Mean Vote (PMV) metric promulgated by ASHRAE for indoor thermal comfort studies.

The modifications to SPMV* permit its use under the wider range of climate conditions found outdoors and provides increased flexibility to define an individual's level of adaptation as well as clothing and activity levels which is important for an environment like a masterplan.

In temperate climates, the SPMV* index is typically broken up into four ranges (Figure 7):

- **Comfortable conditions (SPMV* values of -1 to 1):** People are generally comfortable. The conditions are perceived to be similar to indoor conditions.
- **Acceptable conditions (SPMV* values of 1 to 2 and -1 to -2):** This represents a comfortable outdoor environment (allowing for greater variability).
- **Tolerable conditions (SPMV* values of 2 to 3 and -2 to -3):** People will tolerate these conditions outside but will seek cooler spots when available. In these cases people may seek a more comfortable route if traversing a space depending on their urgency and the convenience of that alternate route.
- **Uncomfortable conditions (SPMV* values greater than 3 or less than -3):** People will not linger and will attempt to move to protected environments.

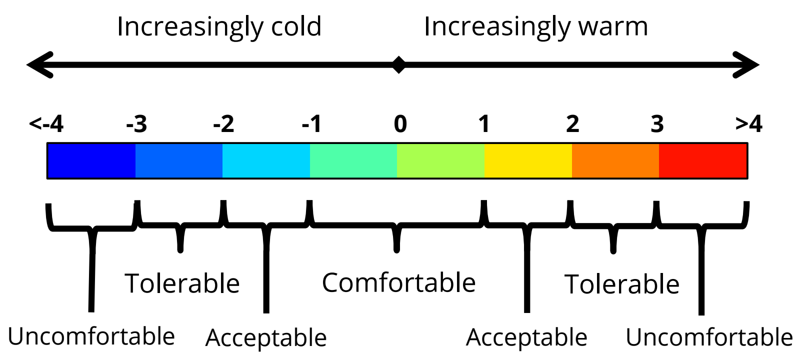


Image 7: SPMV* Thermal Comfort Ranges

4. THERMAL COMFORT DESKTOP ASSESSMENT

4.1 Presentation of Results

The Images on the following pages show thermal comfort over the course of a year, assessed using the SPMV* metric. The horizontal axis of the diagram indicates the date (and includes every day of the year), and the vertical axis indicates the hour of the day.

A baseline condition has been presented in Image 8, representing a situation where an individual is fully exposed to sun and wind.

The thermal comfort results for many of the locations around the building were similar. For brevity, only select locations around the building have been presented to illustrate the effect of the proposed building massing on thermal comfort (Images 9 to 11).

Average hourly SPMV* values for the baseline case are presented in Appendix A.

4.2 Assumptions

The following assumptions were made for the analysis:

- Summer clothing: Trousers and a long sleeved shirt (clothing factor of 0.61).
- Spring and Fall clothing: Trousers, long sleeved shirt, long sleeved sweater and jacket (clothing factor of 1.3).
- Winter clothing: Trousers, long sleeved shirt, long sleeved sweater, heavy jacket (clothing factor 1.74).
- Activity levels: A metabolic rate of 115 W/m^2 was applied (equivalent to a person walking at 3.2 km/hr).

4.3 Comfort Conditions: Baseline

This scenario represents the conditions experienced by an individual fully exposed to sun and wind.

Assuming appropriate clothing, comfortable conditions are expected approximately 57% of the time annually under baseline conditions. The rest of the time, it is either too cold (30%) or too hot (13%).

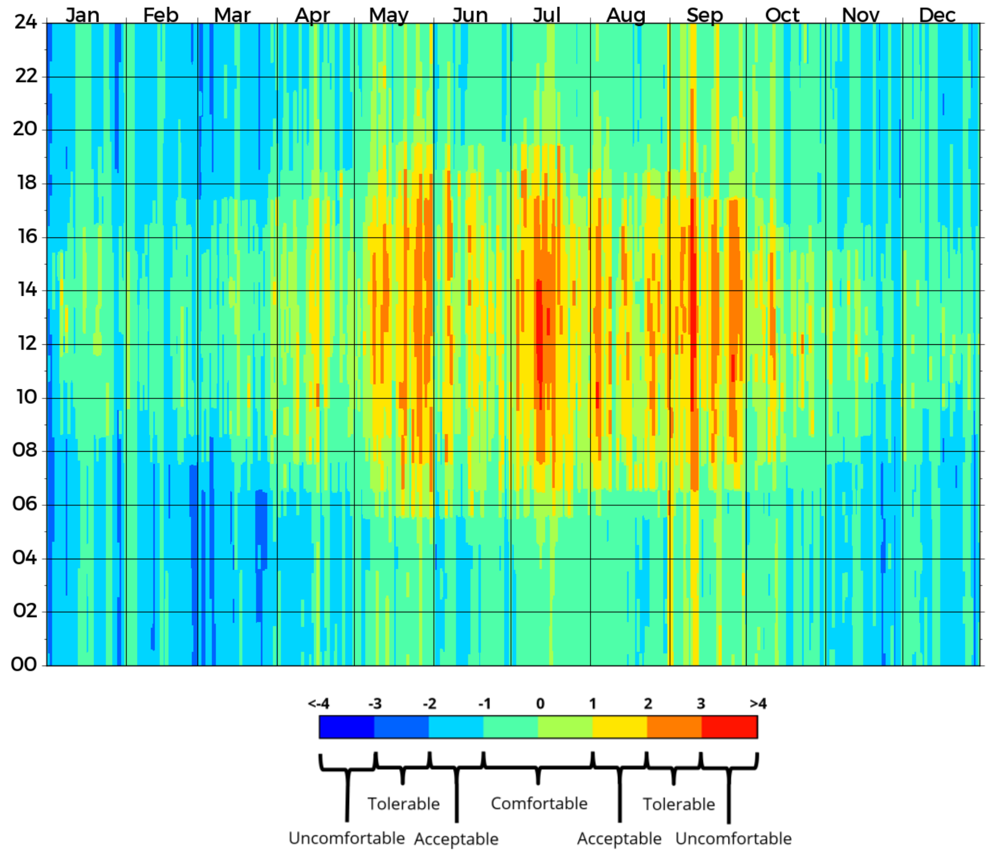
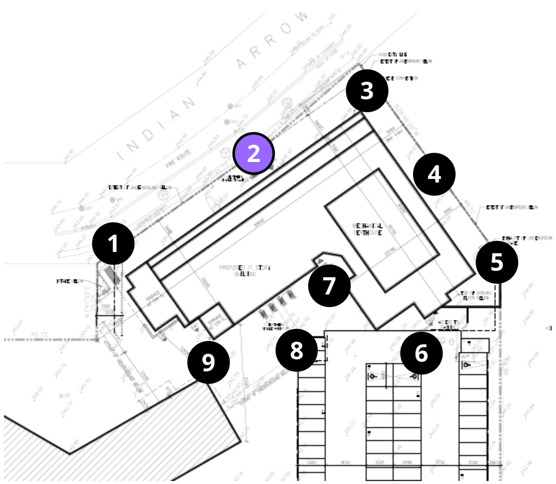


Image 8: Hourly Baseline Thermal Comfort Conditions

4.4 Comfort Conditions: Point 2

This scenario represents the conditions experienced by an individual walking near the second floor entrance of the building from Indian Arrow Rd.

Between May to September, some tolerable to hot conditions are predicted in the afternoon and early evening hours as this location will not be shaded by the proposed building. However, summer mornings tend to be comfortable.



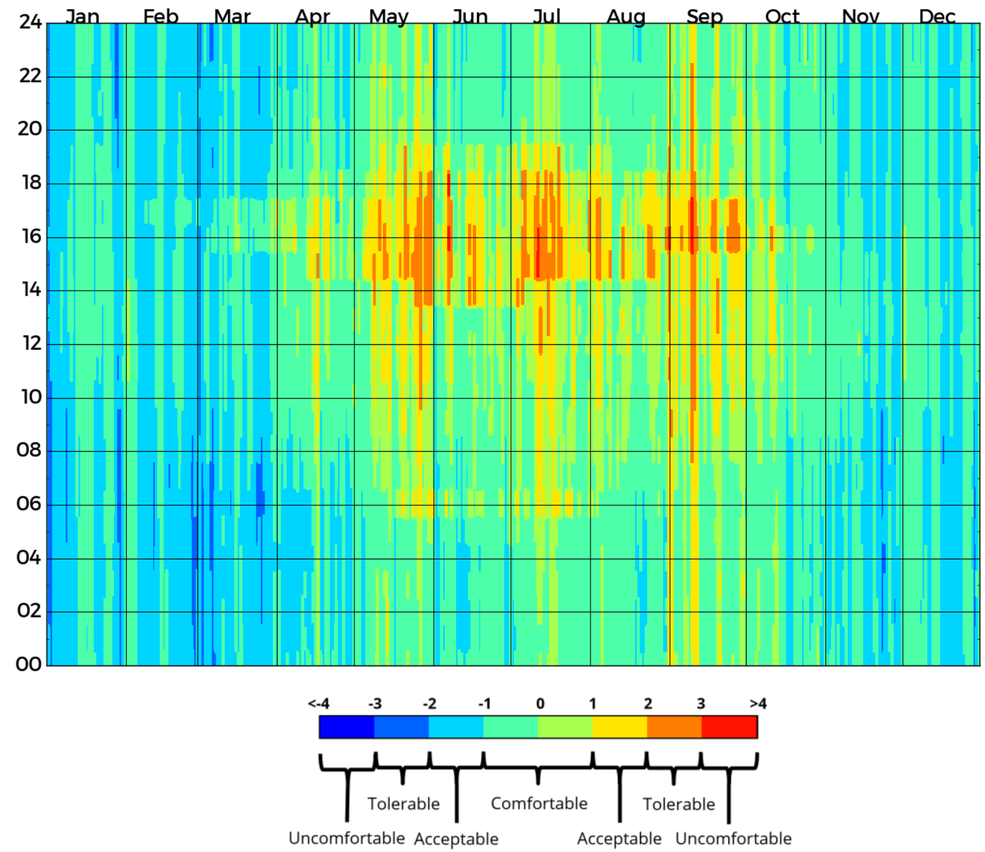
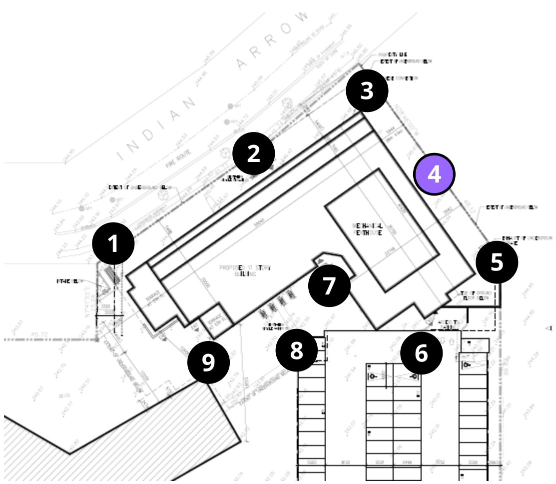


Image 9: Hourly Thermal Comfort Conditions at Point 2

4.5 Comfort Conditions: Point 4

This scenario represents the conditions experienced by an individual walking to the east of the proposed building.

Between May to September, some tolerable to hot conditions are predicted in morning hours as this location will not be shaded by the proposed building massing during this time. Though the afternoon shadow will improve comfort in summer. This shadowing may also make conditions slightly cooler during winter afternoons, though conditions still remain acceptable.



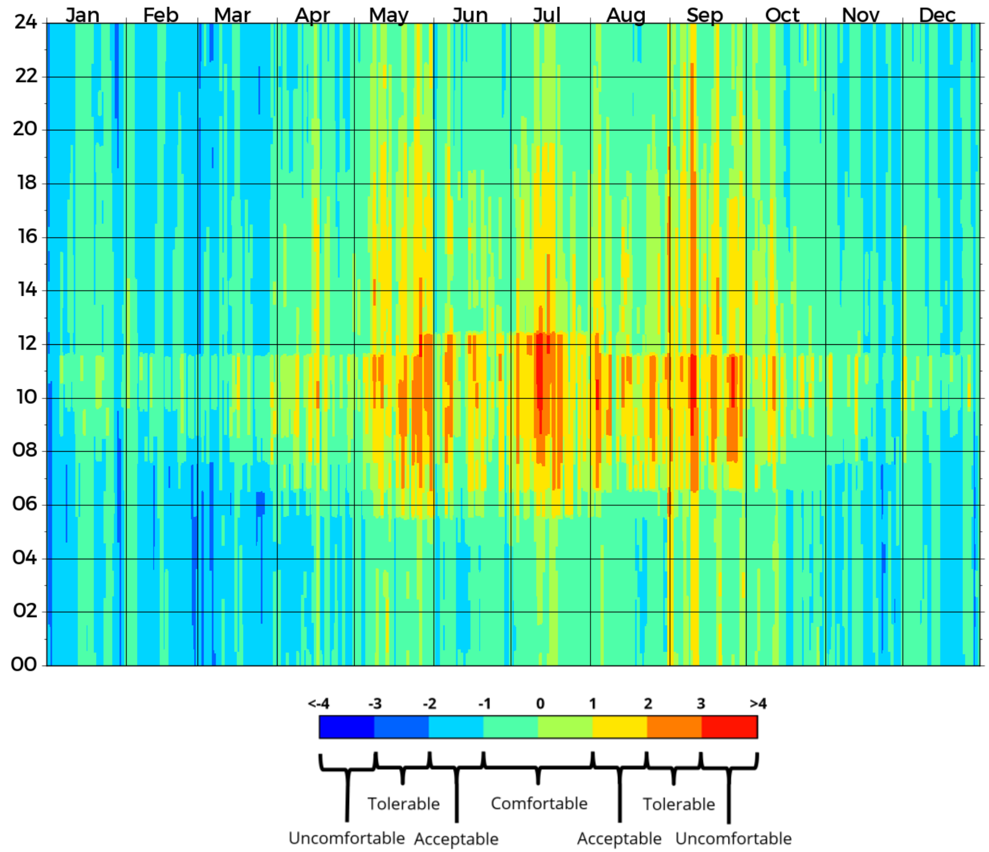
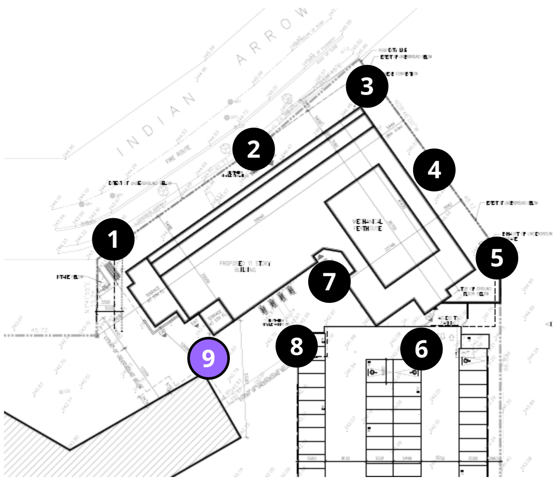


Image 10: Hourly Thermal Comfort Conditions at Point 4

4.6 Comfort Conditions: Point 9

This scenario represents the conditions experienced by an individual walking between the proposed building and the existing building to the south.

Higher wind speeds are expected in this location based on the pedestrian level wind assessment. From a thermal comfort perspective, increased speeds are a positive in summer (particularly in a sunny location like Point 9), but a negative in winter. Overall at this location, the analysis predicted a very slight decrease the number of comfortable hours throughout the year. This indicates that the additional hours of cooler winter conditions are nearly offset by improved conditions in summer.



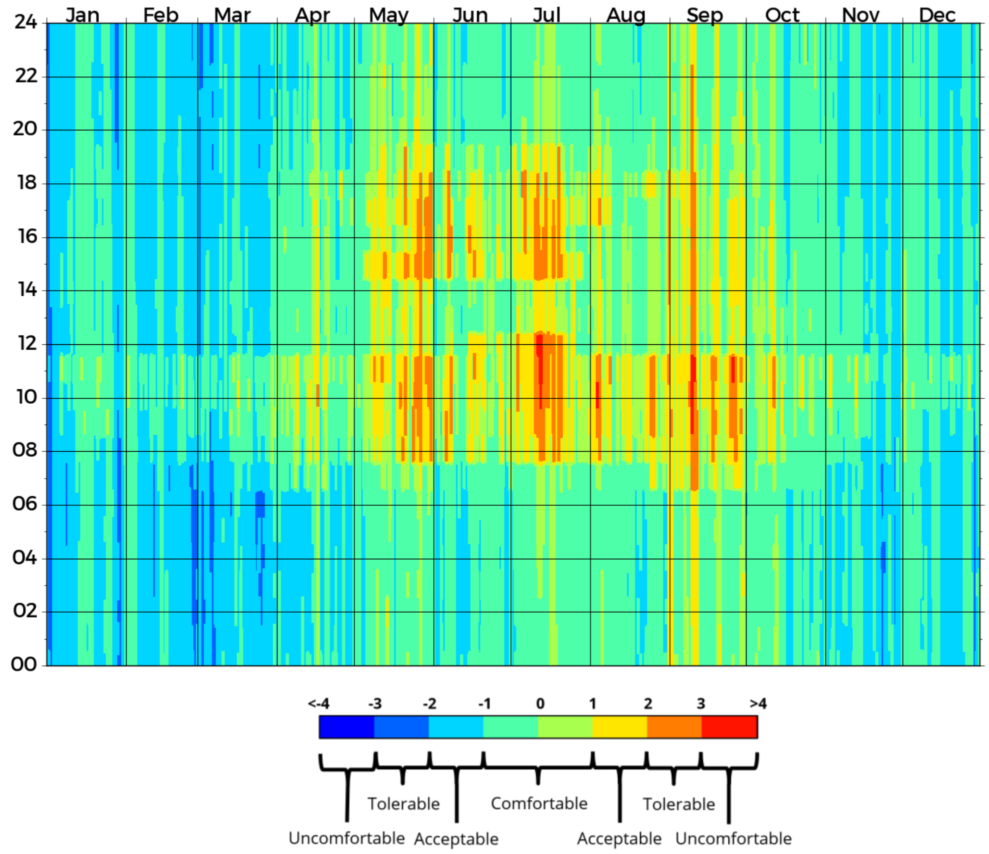


Image 11: Hourly Thermal Comfort Conditions at Point 9

5. SUMMARY OF MICROCLIMATE IMPACT

1. Thermal comfort conditions at the proposed building will vary throughout the year. Winters are expected to be cold, the shoulder seasons are predicted to be cool to cold, and conditions during the summer are generally expected to be warm. High levels of relative humidity are expected throughout the year.
2. Assuming appropriate clothing, comfortable conditions (SPMV* of 1 to -1) are expected approximately 57% of the time annually under baseline conditions (if an individual is fully exposed to wind and sun). The rest of the time, it is either too cold (30%) or too hot (13%).
3. During winter, baseline outdoor conditions are expected to be acceptable to tolerable (SPMV* between -1 to -3) the majority of the time.
4. During summer and the shoulder seasons, some tolerable and uncomfortably hot conditions were predicted to be possible, particularly at midday.
5. The proposed building influences thermal comfort through the acceleration/deceleration of winds and through the creation of shadows. These impacts will have positive and negative impacts on comfort depending on the season.
6. In areas around the proposed building where the massing is expected to accelerate winds such as sidewalks and terraces, higher wind speeds are expected to increase the number of comfortable hours during the summer and decrease the number of comfortable hours during the winter and shoulder seasons.
7. However the design of the building is such that the areas of the highest expected acceleration are on the south side which is more exposed to sun. This means that in summer the additional wind is welcome and in winter the cooling effect is offset somewhat by the warmth from the sun.
8. On the other sides of the building, the project has the potential to create localized shadowing during part of the day. This shadowing significantly improves summer thermal conditions while having only a limited impact during the rest of the year. Winter conditions in the shaded areas generally remain comfortable/acceptable, while many tolerable/uncomfortable summer conditions become comfortable or acceptable.

5. SUMMARY OF MICROCLIMATE IMPACT

9. In areas of low wind and high solar exposure that are expected to be areas where people will congregate, thermal comfort could be enhanced through additional shading devices. Ideally these shading devices would be adjustable (e.g. umbrellas) to allow the occupants to increase or decrease their solar exposure to suit their preference regardless of the weather.

10. Deciduous trees may also be an option as they will provide shading during the summer without impeding solar radiation during the winter.

11. RWDI's Pedestrian Wind Assessment noted that the proposed project is unlikely to have a detrimental impact on winds in Shoreview Park, thus any potential thermal comfort impact would be driven by shadowing.

12. During the summer, the proposed building is not expected to cast long shadows as sun will be high in the sky. During the winter and shoulder seasons, the proposed building is expected to cast longer shadows onto the park during the midday and evening hours. However, much of the park remains in sun during these times and people can easily move to areas not in shade to adjust their levels of thermal comfort. Furthermore, the time of the longest potential shadows (winter) corresponds to a time of year when parks tend to be less populated or less frequently used.

13. The proposed project is replacing an area of existing greenspace, so there will be some change in urban heat island (UHI) effects. The main avenues for this change to occur is due to the addition of paved parking areas and at the roof.

14. Adding additional outdoor parking spaces will increase urban heat island effect, this is often difficult to avoid due to local parking requirements. Spreading them out (as opposed to a single continuous area) will help minimize the impact to an extent.

15. Using high albedo materials (i.e. light concrete instead of asphalt) and providing shading to the parking spots (e.g. trees) will help minimize impacts further.

16. Selecting a roof system which has a high albedo will also reduce any impact there and potentially even reduce UHI compared to what currently exists.

17. The use of a green roof or rooftop solar energy systems would also serve to reduce any potential UHI impact.

18. Overall this analysis indicates that the proposed project has the potential to create only minor changes in expected thermal comfort conditions in the immediate vicinity only.

6. CONCLUSION

Thermal comfort conditions on and around the proposed residential development at 37 Johnson Street in Barrie, ON are discussed in this report and our assessment is based on the local wind climate and sun path, surrounding buildings and our past experience in outdoor thermal comfort analysis around the globe.

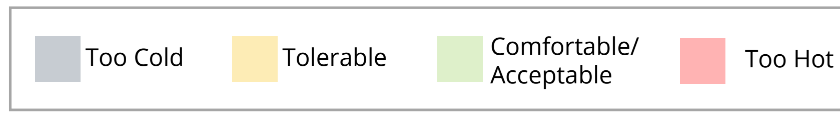
Overall the modest height of the building limits the degree to which winds can accelerate and the extent of its shadows which are two key drivers of thermal comfort impacts. The orientation of the project is such that areas where higher wind speeds are expected occur in spaces with high solar exposure. This will lead to improved thermal comfort conditions in summer and a less noticeable cooling effect in winter.

If further detail on the expected thermal comfort conditions in and around the proposed development is desired, then a more in-depth analysis can be undertaken which would include direct predictions of wind and solar conditions combined with long term historic climate data.

APPENDIX A

HOURLY BASELINE THERMAL COMFORT CONDITIONS BY SEASON

A1. Baseline Case – Spring and Summer Months



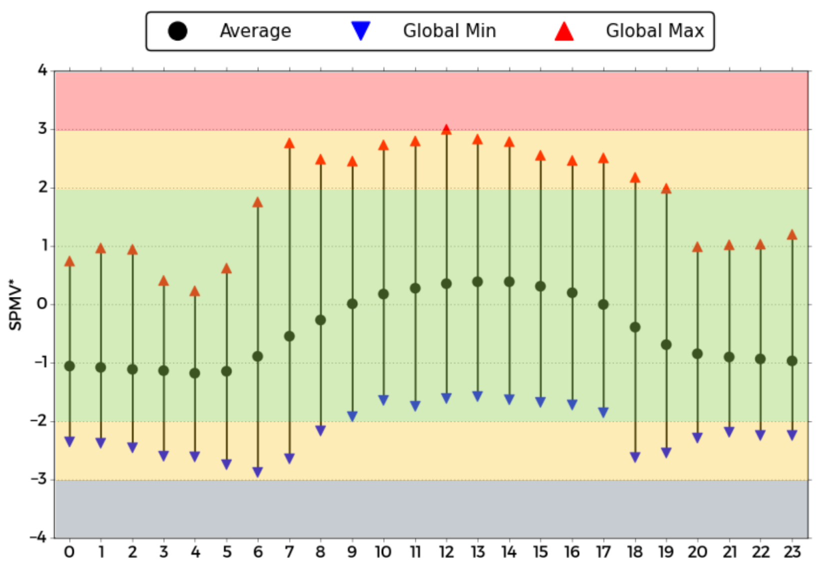


Image A1: Average Hourly Thermal Comfort (Spring).

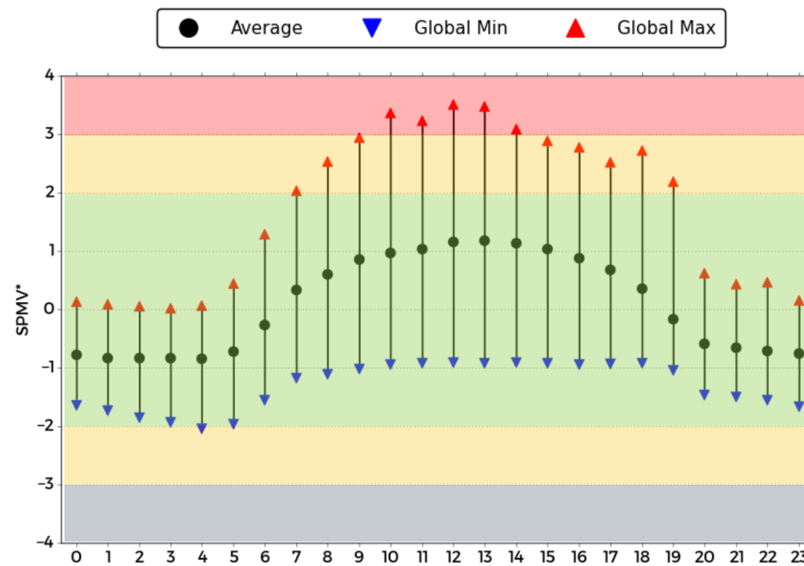
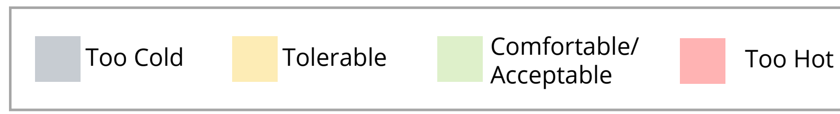


Image A2: Average Hourly Thermal Comfort (Summer).

A2. Baseline Case – Autumn and Winter Months



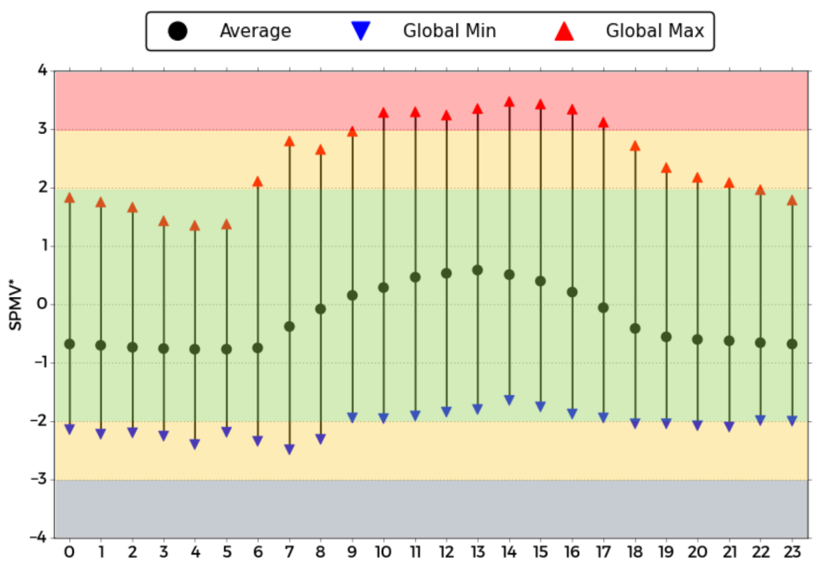


Image A3: Average Hourly Thermal Comfort (Autumn).

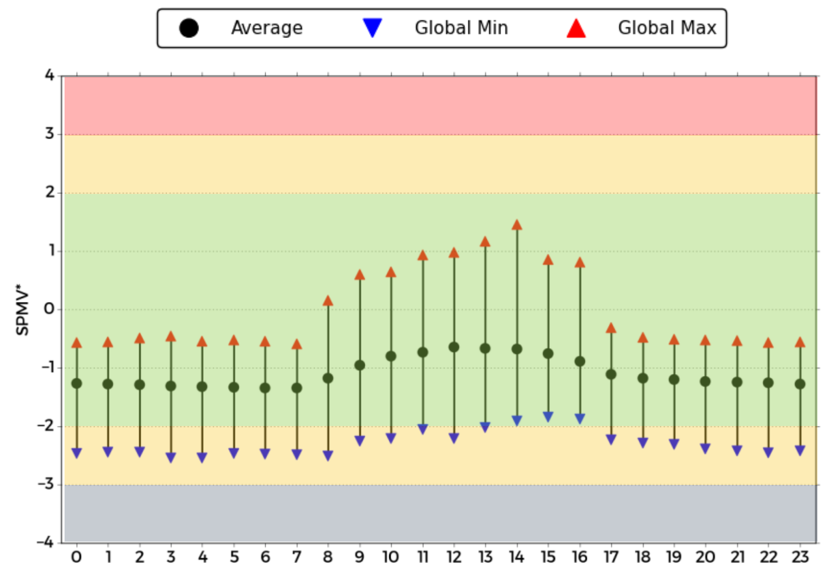


Image A4: Average Hourly Thermal Comfort (Winter).