December 27, 2017

Keith Taggart
Taggart Group of Companies (Tamarack)
3187 Albion Road South
Ottawa, ON K1V 8Y3
Canada

Dear Mr. Taggart:

Re: Snow Drift Impact on Existing Building Roofs
275 Carling Avenue, Ottawa
GWE File: 17-194

1. INTRODUCTION

Gradient Wind Engineering Inc. (GWE) was retained by the Taggart Group of Companies (Tamarack) to undertake wind, snow, and noise engineering studies for the proposed 16-storey retirement residence located at 275 Carling Avenue in Ottawa. The complete scope of work within our mandate, as described in GWE proposal #17-271P, dated November 1, 2017, includes the studies of pedestrian level wind comfort and safety, roof snow loads on existing adjacent buildings, as well as a detailed traffic noise study. This report summarizes the results related to the roof snow loads assessment, while the remaining studies will be issued as separate reports.

The snow load assessment is undertaken to determine the impact of the proposed 16-storey retirement residence over the roofs of the existing buildings to the east (265 Carling Avenue) and northeast (350 Clemow Avenue). GWE has extensive experience with wind and precipitation related impacts among structures in urban, suburban, and open settings.

2. TERMS OF REFERENCE

The proposed development is located at 275 Carling Avenue in Ottawa and is situated on the western portion of a parcel of land bounded by Clemow Avenue to the North, Bronson Avenue to the east, Carling Avenue to the south, and Cambridge Street South to the west. Directly to the east of the proposed development are two existing buildings: an 8-storey commercial/office building located at 265 Carling Avenue and a 2½-storey residential building located at 350 Clemow Avenue.

The study site is surrounded in the near-field, within a radius of approximately 200-500 metres (m), by a suburban mix of low- and mid-rise developments in all directions, with the exception of the greenspace of Commissioners Park to the southwest, which gives way to Dow's Lake approximately 470 m from the study site. At greater distances from the study site, the mix of low- and mid-rise developments continues in the northwest, northeast, and southeast quadrants, while the southwest quadrant is characterized by the more open exposures of Dow's Lake beyond which is greenspace and farmland.

The proposed retirement residence is a 16-storey building of nearly rectangular planform with slight rectangular insets and the long axis oriented along Cambridge Street South. The ground level comprises indoor amenity, lobby, and dining/kitchen facilities, in addition to a shipping/receiving room and loading bay adjacent to the east stairwell. The main lobby entrance is situated at the centre of the west elevation, via Cambridge Street South, while the loading bay is accessed from the centre of the east elevation. A ramp accessed from Clemow Avenue provides access to four levels of below-grade parking. At Level 3 the floorplate steps back on all elevations, above which the building rises uniformly to Level 15. At Level 16 the floorplate features cut-outs at the northeast and southwest corners, which are served by outdoor amenity areas.

The overall plan dimensions of the proposed building are approximately 35 m along Cambridge Street South and 24 m along Carling Avenue. The long dimension of the high roof runs approximately parallel to the existing building at 350 Clemow Avenue with a gap width of approximately 7.0 m at its north end and 6.8 m at its south end. The existing building at 265 Carling Avenue is rotated approximately 31° counter-clockwise from its northwest corner, resulting in a gap width of approximately 3.4 m at its north end and 7.3 m at its south end.

The Ontario Building Code (OBC 2012) requires that any existing building within 5 m of a proposed taller building must either be designed for the full snow drift loads specified in the code or for snow loads estimated by rational analysis including testing. However, the existing buildings under consideration are either outside of this offset distance (350 Clemow Avenue), or mostly outside this offset distance (265 Carling Avenue) except for the northwest corner of the building. As a result, a full and detailed analysis is not warranted.

The site plan, inclusive of the noted existing buildings, is illustrated in Figure 1, while isometrics of the computational model are illustrated in Figures 2A and 2B.

3. METHODOLOGY

3.1 CFD Wind Flow Simulation

The foregoing semi-quantitative analysis is based on review of weather records and experience with other projects to quantify the degree of impact on existing adjacent buildings. In addition, since a Pedestrian Level Wind (PLW) study was also performed for study site using the Computational Fluid Dynamic (CFD) technique, the snow loads assessment is also informed by the results of the PLW study, which facilitate the extraction of wind vectors from all three noted roof surfaces.

Detailed wind patterns over the study roofs were determined using commercial CFD software tailored to meet the simulation requirements of the procedure. As illustrated in Figures 2A and 2B, a three-dimensional digital model of the subject site, complete with surrounding buildings within a full-scale radius of approximately 400 m around the site, was created for the PLW study. Sixteen (16) individual trials were simulated representing the full compass azimuth. For each simulated wind direction, the local wind velocity vectors (i.e., wind speed and direction) were estimated over the roof surfaces of the buildings under study, which were normalized by the wind speed captured at the top of the boundary layer, which was represented in the simulation model as 300 m above grade. Further details of the CFD wind flow simulation technique are presented in the PLW study.

Full-scale wind velocities over the roof surfaces, which facilitate the snow drift assessment, can be obtained by combining the velocity ratios from CFD simulations with full-scale wind speeds measured at Ottawa Macdonald-Cartier International Airport and accounting for differences of surface roughness at the project site. Sample plots of velocity contours over the study roof segments are provided in Figures 3A and 3B.

3.2 Meteorological Data Analysis

Meteorological data from Macdonald-Cartier International Airport in Ottawa, Ontario, Canada, was obtained from the Meteorological Service of Environment Canada covering the period between winter 1953 and spring 2013, representing sixty (60) years of climate data. The assessment considered hourly data, such as snowfall amount, rainfall amount, wind speed, wind direction, and dry bulb temperature.

Figure 4 illustrates the statistical model of the Ottawa wind climate, which indicates the directional character of local winds during the winter and spring seasons in metres per second (m/s). Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen (16) azimuth divisions. The radial direction represents the percentage of occurrence of each wind speed and corresponding direction during the noted measurement period. The preferred wind speeds and directions can be identified as the length of the bar where the given bar has the largest length. For Ottawa, the most common winds occur for west and west-northwest wind directions, followed by those from the east and northeast, while the most common wind speeds are below 10 m/s. However, it is noted that the most prominent wind directions for higher wind speeds originate from the west clockwise through northwest during the winter months.

However, during periods of snowfall, the prominent winds occur for easterly and northeasterly wind directions, as illustrated in Figure 5. Additionally, a sample of the raw climate statistics for the 1970-1971 winter season is provided in Figure 6.

The ten (10) years of largest snowfall data, selected from among the total recorded data, representing the arithmetic sum of all snowfalls during a given winter, are summarized below in Table 1, which also form the basis of the OBC 2012 snow load calculation procedure. The OBC 2012 Part 4 50-year return period specified basic snow load for Ottawa is 2.32 kilopascals (kPa), inclusive of the rain load. The corresponding Part 9 basic snow load is 1.72 kPa.

TABLE 1: SUMMARY OF LARGEST CUMULATIVE SEASONAL SNOWFALL AMOUNTS AND TOTAL SNOWFALL DAYS MEASURED AT OTTAWA INTERNATIONAL AIRPORT AND INTERPRETED FOR THE SUBJECT SITE (10 YEARS SELECTED FROM 60 YEARS OF AVAILABLE DATA)

Year	Snowfall Amount (cm)	Total Snowfall Days
1970 - 1971	445	161
2007 - 2008	433	149
1992 - 1993	347	187
1971 - 1972	313	151
1996 - 1997	302	170
1993 - 1994	284	170
1954 - 1955	282	170
2000 - 2001	278	181
2002 - 2003	252	181
2008 - 2009	226	162

4. RESULTS AND RECOMMENDATIONS

GWE has reviewed the massing of the proposed 16-storey building and its relation to the existing neighbouring buildings at 265 Carling Avenue and 350 Clemow Avenue, as well as the climate statistics for Ottawa, including snowfall data and prominent wind directions. Based on this information and experience with similar projects, as well as detailed computer-generated wind patterns over the study roofs from the Pedestrian Level Wind (PLW) study, we conclude that the presence of the proposed building will have no meaningful impact on the existing building at 350 Clemow Avenue.

The recommended 50-year snow loads over the roof surfaces of the existing building at 265 Carling Avenue, within a 3-m zone of influence from the adjacent proposed building, are illustrated in Figure 7 and are less than the specified snow loads required by Part 4 of the OBC 2012. Although the impacts are considered small, we suggest the capacity of the existing building roof corner be confirmed by a structural engineer to withstand the recommended snow loads in Figure 7. Historical snow loads beyond the 3-m offset distance will not be modified by the introduction of the proposed building.

All snow loads in this report represent specified loads corresponding to a 50-year return period, which shall be multiplied by the live load safety factor as per the Ontario Building Code (OBC 2012) and industry standards to obtain corresponding structural design loads.

This concludes our semi-quantitative roof snow loads assessment and report. Please contact the undersigned with questions or comments.

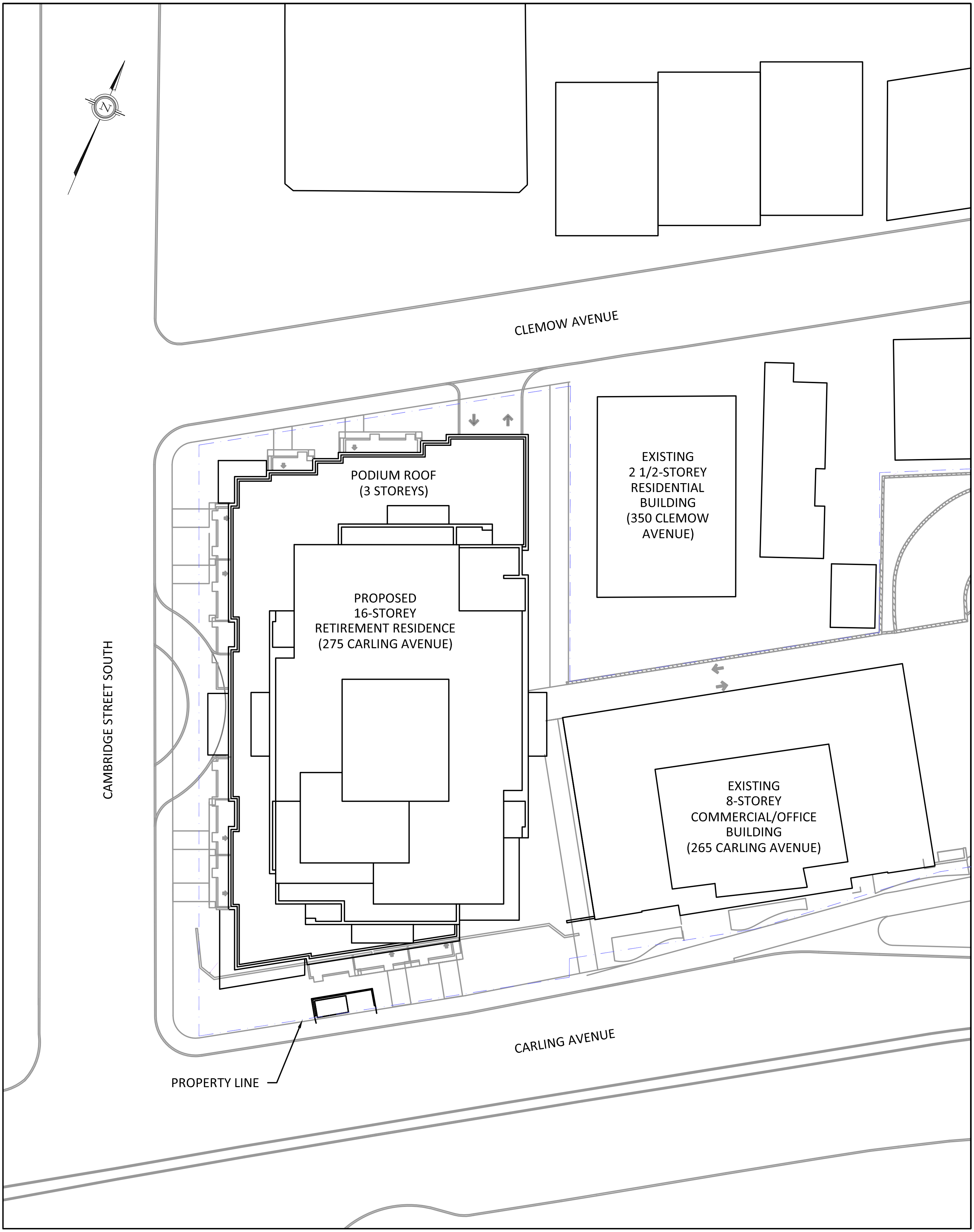
Sincerely,

Gradient Wind Engineering Inc.

Justin Ferraro
Principal

LICENSED PROFESSIONAL ENGINEER
V. M. FERRARO
PROVINCE OF ONTARIO
July 31, 2018

Vincent Ferraro, M.Eng., P.Eng.
Managing Principal



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GRADIENT WIND ENGINEERING INC

PROJECT	275 CARLING AVENUE, OTTAWA SEMI-QUANTITATIVE SNOW LOADS STUDY ON EXISTING ROOFS		
SCALE	1:500 (APPROX.)	DRAWING NO.	GWE17-194-DTSNOW-1
DATE	DECEMBER 27, 2017	DRAWN BY	B.J.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING EXISTING BUILDINGS

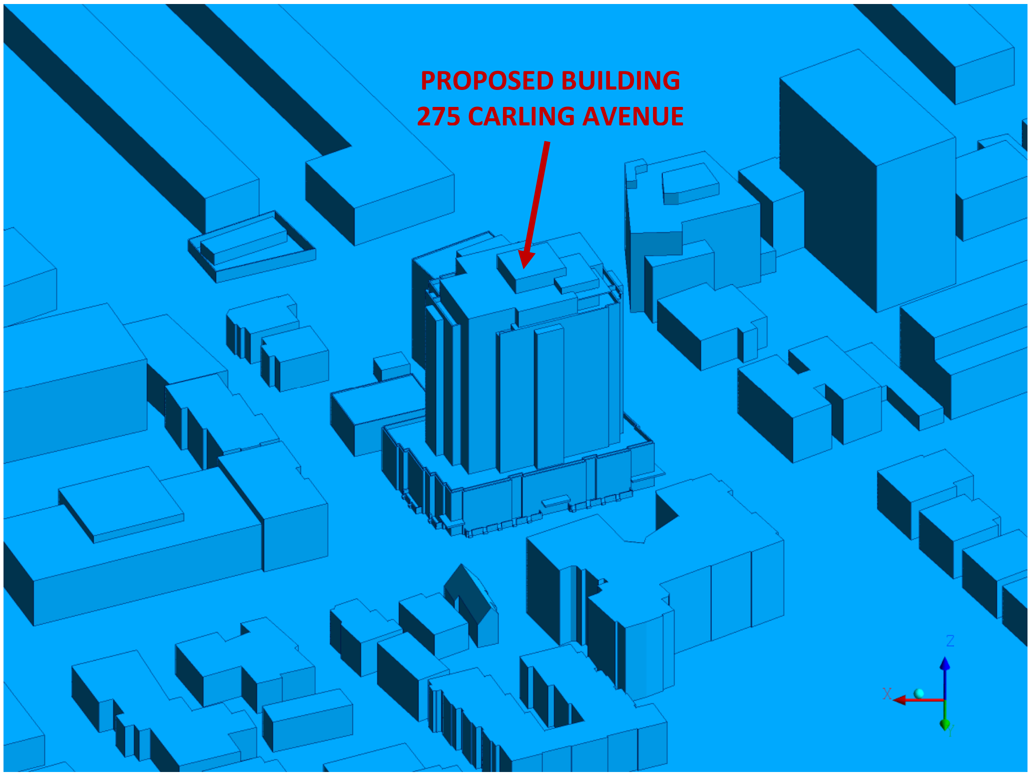


FIGURE 2A: COMPUTATIONAL STUDY MODEL, WEST PERSPECTIVE (270° TRUE)

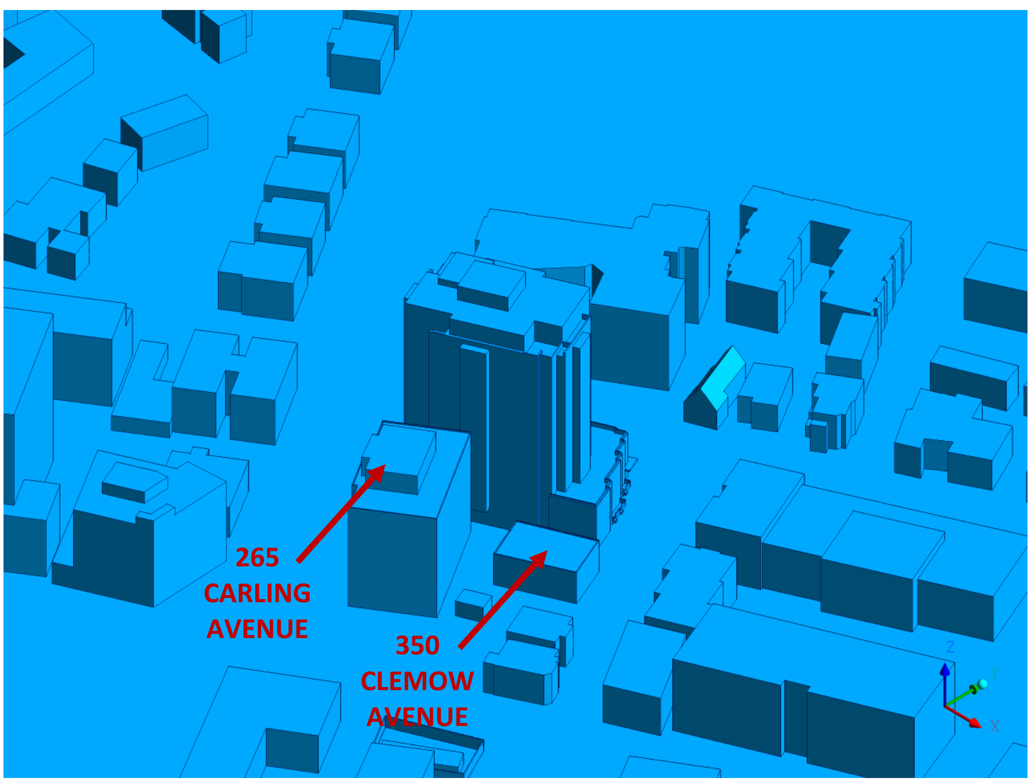


FIGURE 2B: COMPUTATIONAL STUDY MODEL, NORTHEAST PERSPECTIVE (45° TRUE)

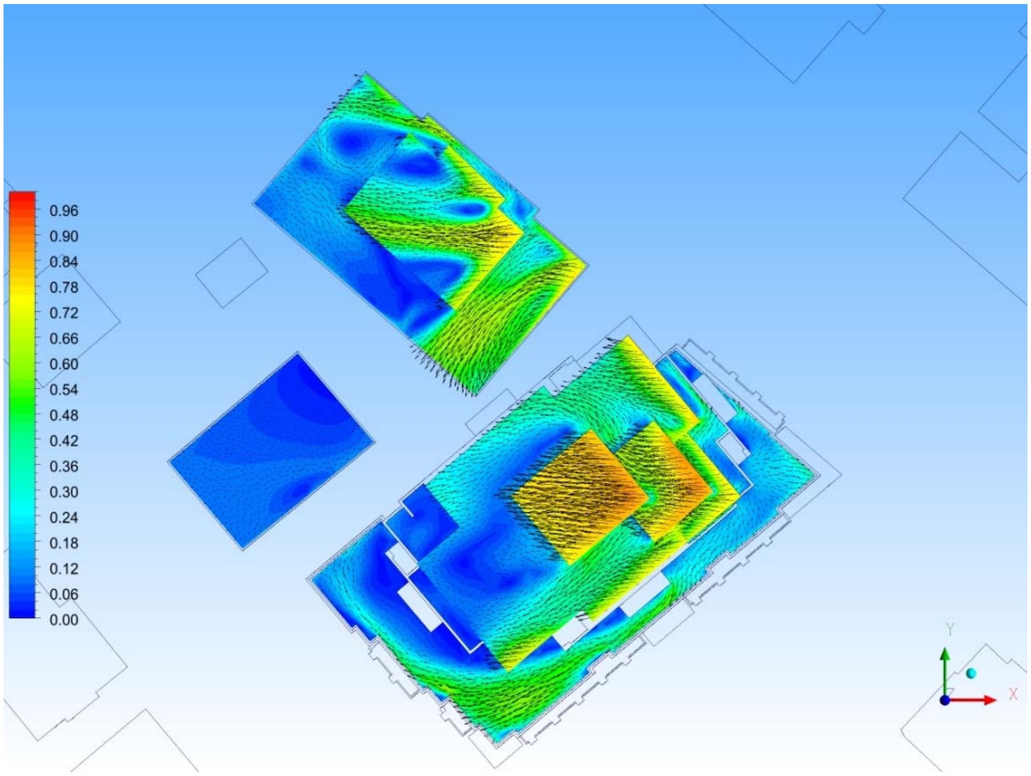


FIGURE 3A: SAMPLE CFD WIND VECTORS, SOUTH-SOUTHWEST WIND (197° TRUE)

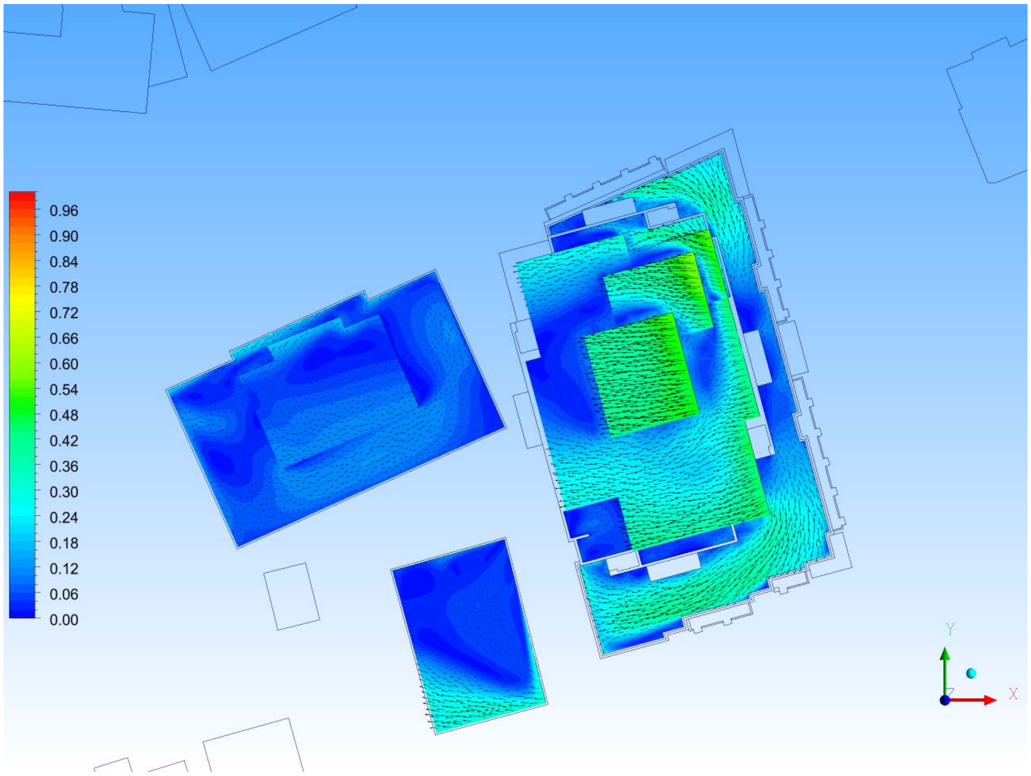
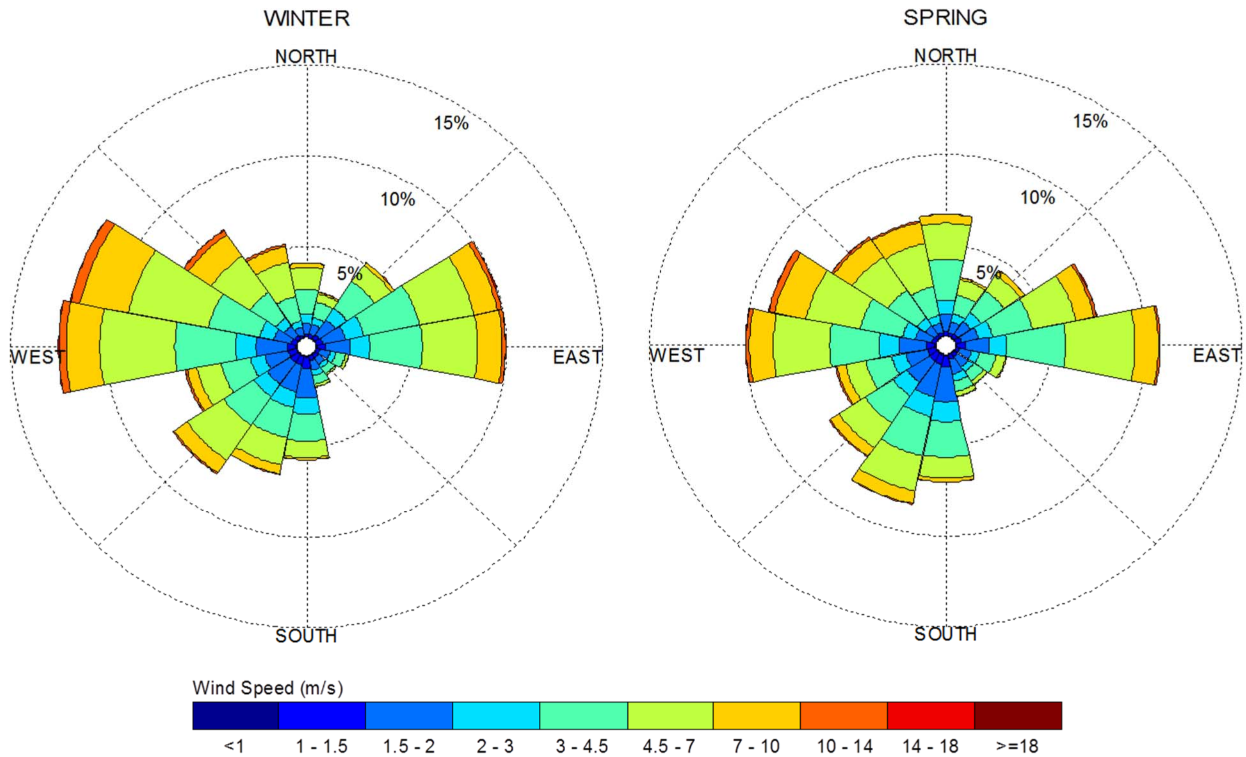


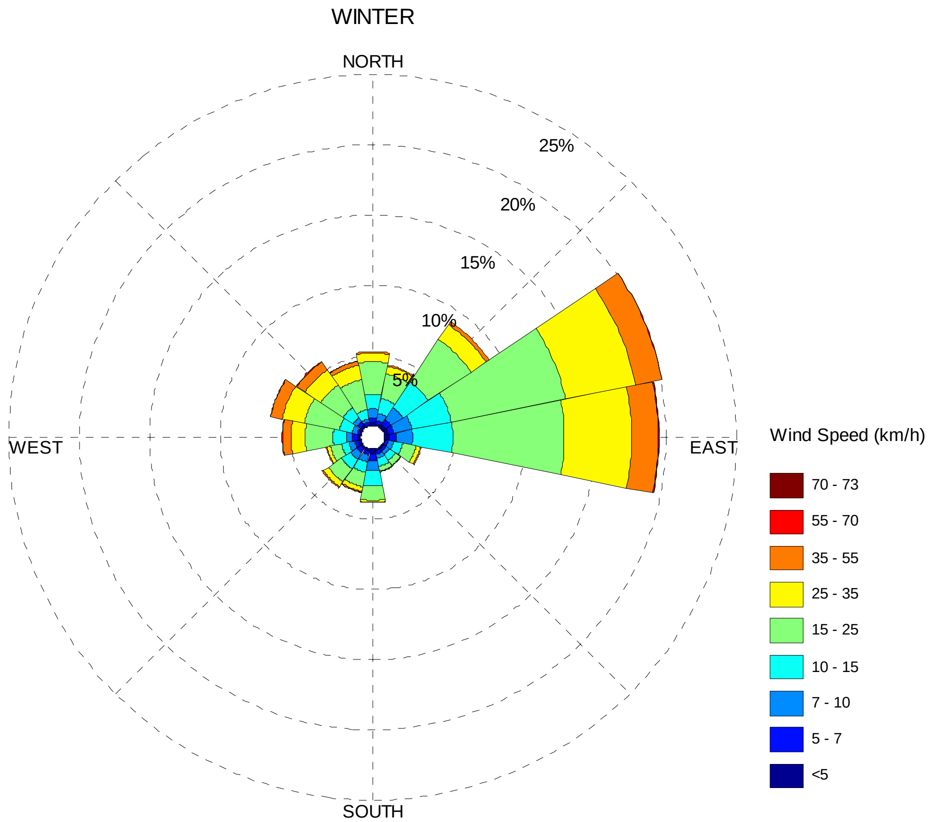
FIGURE 3B: SAMPLE CFD WIND VECTORS, WEST-SOUTHWEST WIND (262° TRUE)



Notes:

1. Radial distances indicate percentage of time of wind events.
2. Wind speeds are mean hourly in m/s measured at 10 m above the ground.
3. Apply a factor of 3.6 to convert m/s to km/h.

FIGURE 4: SEASONAL DISTRIBUTION OF WINDS FOR VARIOUS PROBABILITIES MACDONALD-CARTIER INTERNATIONAL AIRPORT, OTTAWA, ONTARIO, CANADA



Notes:

1. Radial distances indicate percentage of time of wind events.
2. Wind speeds are mean hourly in km/h measured at 10 m above the ground.

FIGURE 5: DISTRIBUTION OF WINDS DURING SNOWFALL EVENTS OF AT LEAST FIVE (5) CENTIMETERS MACDONALD-CARTIER INTERNATIONAL AIRPORT, OTTAWA, ONTARIO, CANADA

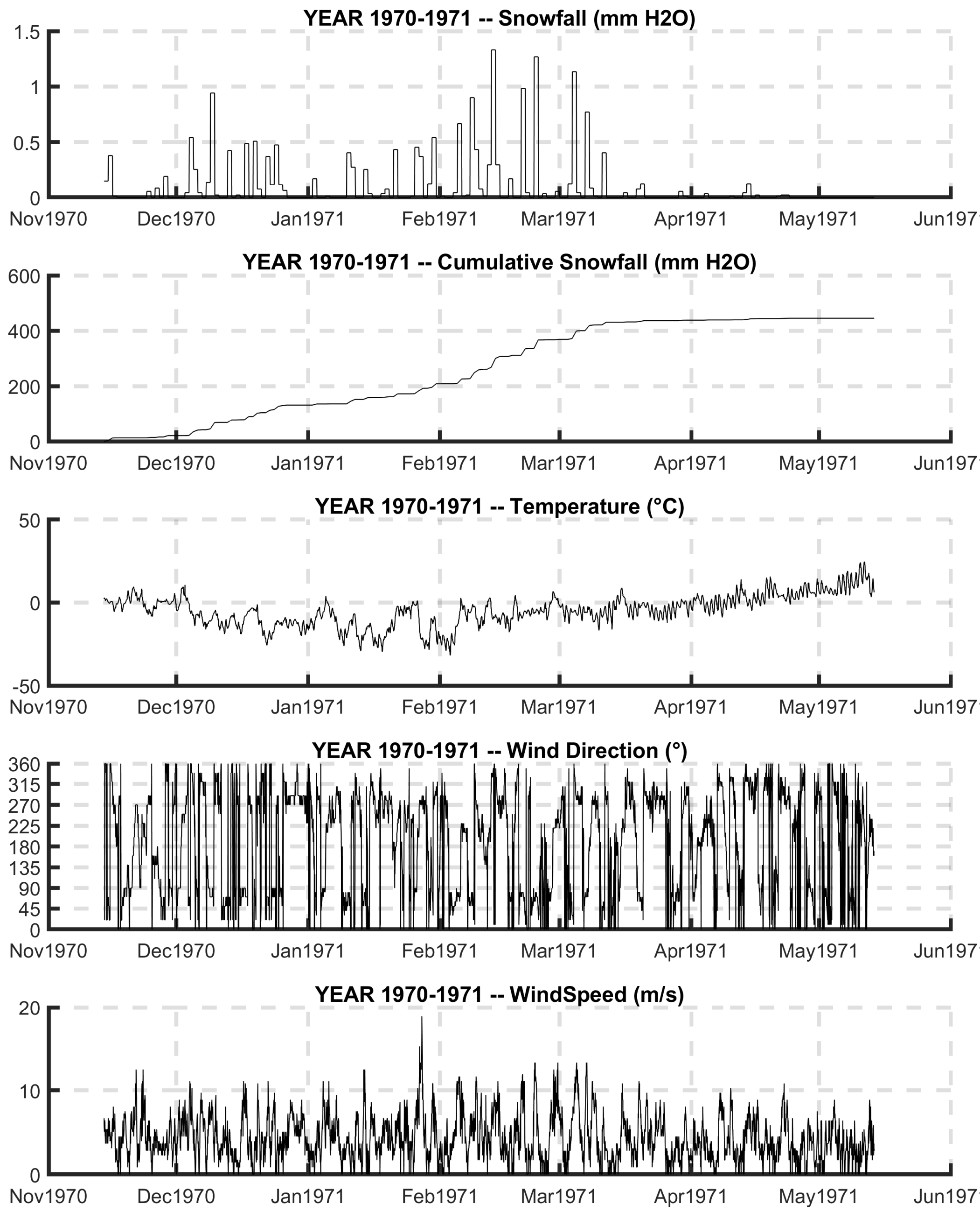
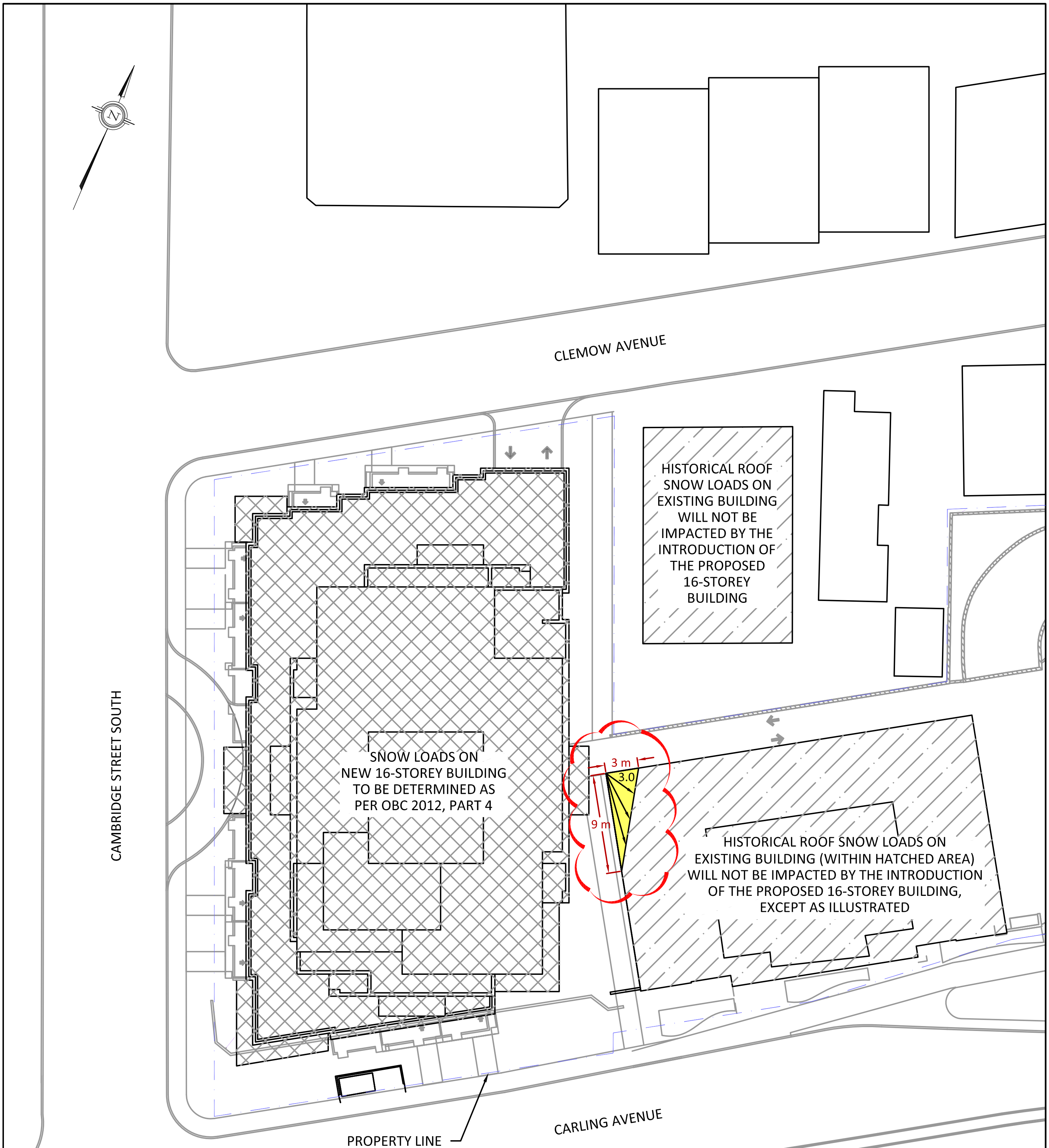


FIGURE 6: RAW CLIMATE STATISTICS (WINTER SEASON, 1970-1971)
MACDONALD-CARTIER INTERNATIONAL AIRPORT, OTTAWA, ONTARIO



NOTES:

1. DIMENSIONS ARE IN METRES (m).
2. SOLID HATCH REPRESENTS LINEARLY REDUCING SNOW LOAD IN KILOPASCALS (kPa) WITH MAXIMUM AT NODE (3.0 kPa) AND MINIMUM AT ARROW HEAD (2.3 kPa).

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PROJECT	275 CARLING AVENUE, OTTAWA SEMI-QUANTITATIVE SNOW LOADS STUDY ON EXISTING ROOFS
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE17-194-DTSNOW-7
DATE	DECEMBER 27, 2017
DRAWN BY	B.J. / JDF
DESCRIPTION	FIGURE 7: RECOMMENDED SPECIFIED PEAK 50-YEAR RETURN PERIOD ROOF SNOW LOADS AS DEFINED BY RATIONAL ANALYSIS IN THIS STUDY