Vipac Engineers and Scientists Ltd
279 Normanby Rd, Port Melbourne, VIC 3207, Australia
Private Bag 16, Port Melbourne, VIC 3207, Australia
t. +61 3 9647 9700 | **e.** melbourne@vipac.com.au
w. www.vipac.com.au | A.B.N. 33 005 453 627 | A.C.N. 005 453 627

Fusion Project Management Pty Ltd

15 May 2024

Ref: 30N-22-0149-GCO-50694-2

Dear Jordan Hollett,

77 Sutton Street, North Melbourne - S72 Amendment

Vipac Engineers & Scientists Ltd was commissioned by **BEG Projects Pty. Ltd.** to carry out a wind tunnel test of the likely wind conditions for the proposed development at 77 Sutton Street, North Melbourne based on drawings received in July 2022 - refer to test report:

- Pedestrian Level Winds – Wind Tunnel Testing
  Document Reference: 30N-22-0149-TRP-38115-3
  Issue Date: 15th May 2024 (latest version)

Updated architectural and landscaping plans for the development were supplied in April 2024 and May 2024 respectively, and a comparison was made with the findings in the wind tunnel test report - refer to design review letter:

- Design Review
  Document Reference: 30N-22-0149-ADM-50260-3
  Issue Date: 15th May 2024

Vipac concludes that there were no significant changes to the updated design that will alter the findings and conclusions of the wind report. As such, we make no further comments or recommendations for wind amelioration.

Should you have any queries regarding the information enclosed, please do not hesitate to contact us.

Yours sincerely,

Vipac Engineers & Scientists Ltd

Rumman Islam

Consulting Engineer

Vipac Engineers and Scientists Ltd
279 Normanby Rd, Port Melbourne, VIC 3207, Australia
Private Bag 16, Port Melbourne, VIC 3207, Australia
t. +61 3 9647 9700 | **e.** melbourne@vipac.com.au
w. www.vipac.com.au | A.B.N. 33 005 453 627 | A.C.N. 005 453 627

Fusion Project Management Pty Ltd

15 May 2024

Ref: 30N-22-0149-ADM-50260-2-draft

Dear Jordan Hollett,

77 Sutton Street, North Melbourne - S72 Amendment

Vipac Engineers and Scientists completed a wind tunnel test and issued a report (reference: 30N-22-0149-TRP-38115-3) on the proposed development at 77 Sutton Street, North Melbourne based on drawings received in July 2022. Architectural plans of the updated design were supplied in April 2024 from Point Architects; and landscaping plans of the updated design were supplied in May 2024 from Davidson Design Studio. A comparison was made with the findings in the wind tunnel test report. The observations and findings are as follows:

i) A 1.2m high raised planter with a 3m high tree on top north of the pedestrian link on the ground level has been included in the updated landscaping plans, as recommended (Figure 1);

ii) The recommended 1m high raised planters south west of the pedestrian link on the ground level has not been included in the updated landscaping plans, however, the steel arbours are expected to create a similar beneficial effect to the wind environment (Figure 1);

iii) The entrance to the Airlock has been relocated to the west and setback by 1.5m, as recommended (Figure 2). Additional colonnades in this area are expected to be beneficial to the wind environment;

iv) There is a new entrance proposed at the west of the Food & Drink Premise north of site, which can be represented by Location 13 in the wind report – this location measured wind speeds within the standing comfort criterion. As such, no further recommendation is provided (Figure 2);

v) The entrance to the previously proposed Gym (now a residential unit) at the southeast corner has been relocated away from the corner and further east. In combination of this relocation and the proposed steel arbour above, this entrance is expected to have wind levels within the recommended standing comfort criterion (Figure 2);

vi) The southwestern entrance into the building feature steel arbours above. This is expected to be beneficial to the wind environment; such that the standing comfort criterion at the entrances is expected (Figure 2);

vii) The seating area has been relocated immediately north of the Airlock, as recommended (Figure 2);

viii) A "window seat" has been introduced to the 'café' next to the co-working space. In consideration of the steel arbours and landscaping throughout, wind levels are expected to be within the recommended sitting comfort criterion.

ix) There are steel arbours throughout the laneway, which are expected to be beneficial to the wind environment.

x) The recommended 1.8m high solid balustrades at the northern communal terrace on Level 6 have been included in the updated landscaping plans (Figure 3). In consideration of the pergola structures and landscaping, wind speeds are expected to be within the recommended walking comfort criterion;

xi) The southeastern communal terrace on Level 6 is now a private terrace with a reduced extent that has included 1.5-1.8m high solid balustrades in the updated landscaping plans (Figure 3). As such wind speeds are expected to be within the recommended walking comfort criterion; and

xii) The overall height of the development has increased from 38.3m to 39.6m (Figure 4). This is not expected to significantly affect the wind environment.

Vipac has reviewed the updated drawings and determined that the changes listed above are in line with the wind tunnel test results carried out in July 2022.

In conclusion, the architectural and landscaping plans received in April 2024 and May 2024 respectively of the proposed development have incorporated all of the recommended wind control measures and are expected to fulfil:

- The safety wind criterion at all test locations;
- The recommended walking comfort criterion at the pedestrian footpaths and accessways;
- The recommended standing comfort criterion at building entrance areas;
- The recommended sitting comfort criterion at the ground floor alfresco dining areas; and
- The recommended walking comfort criterion at the communal terrace areas.

As there were no other significant massing changes to the updated design, Vipac makes no further recommendations for wind amelioration to the updated plans.

Yours sincerely,

Vipac Engineers & Scientists Ltd

Rumman Islam
Consulting Engineer

Eric Yuen
Wind Team Leader

Attachments

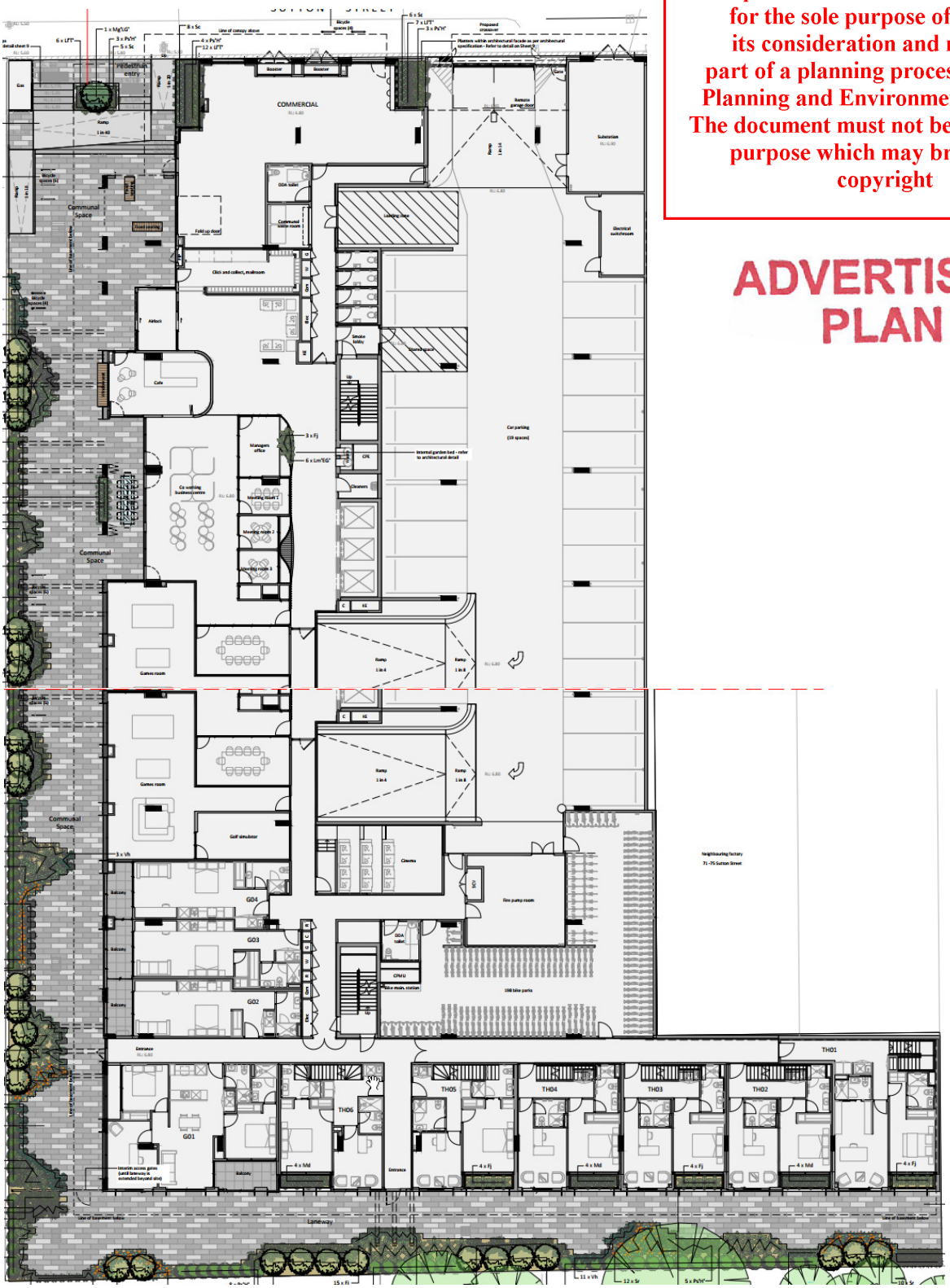

Figure 1: Landscaping plan (May 2024) of the ground level.

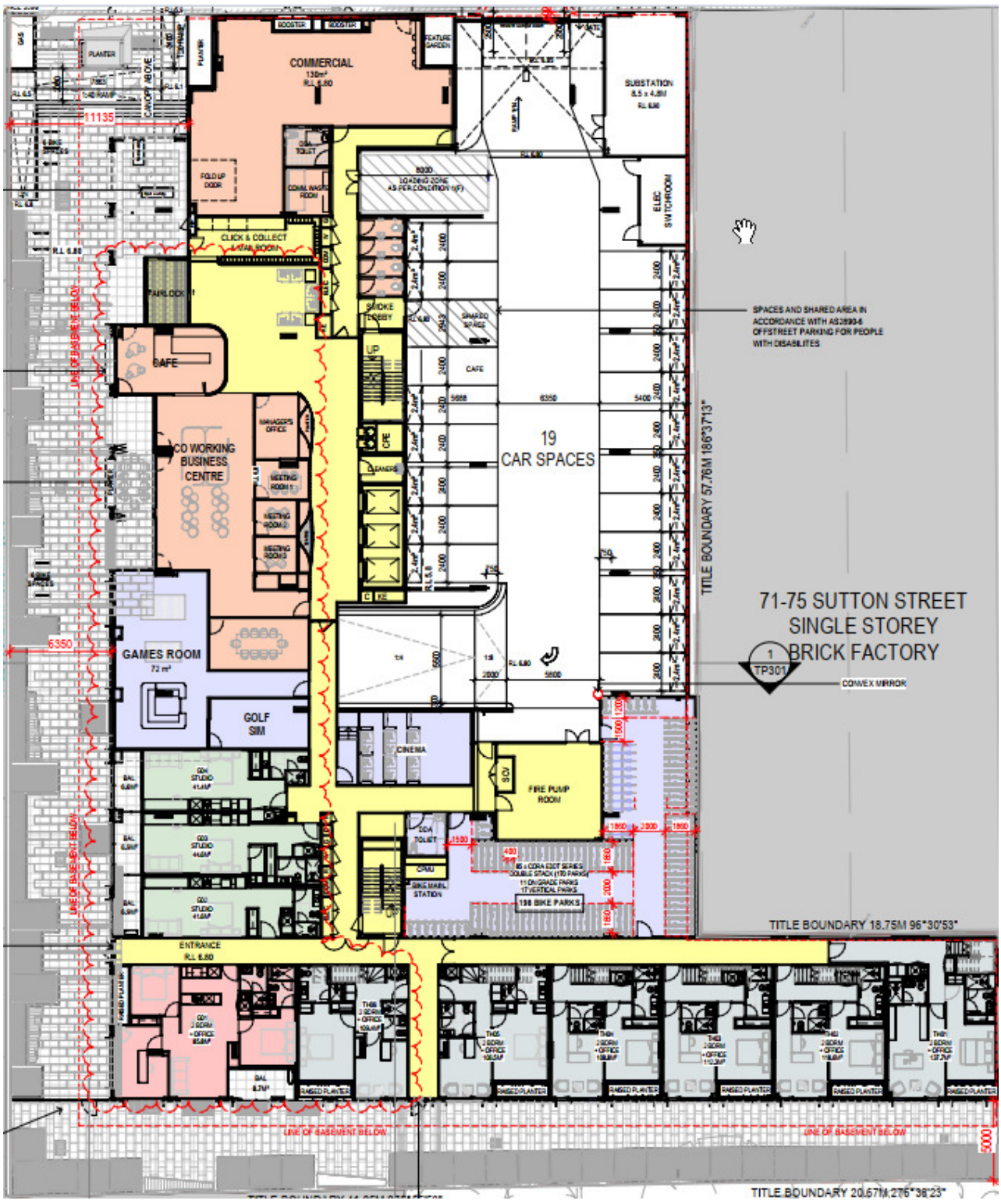

Figure 2: Architectural plan (May 2024) of the ground level.

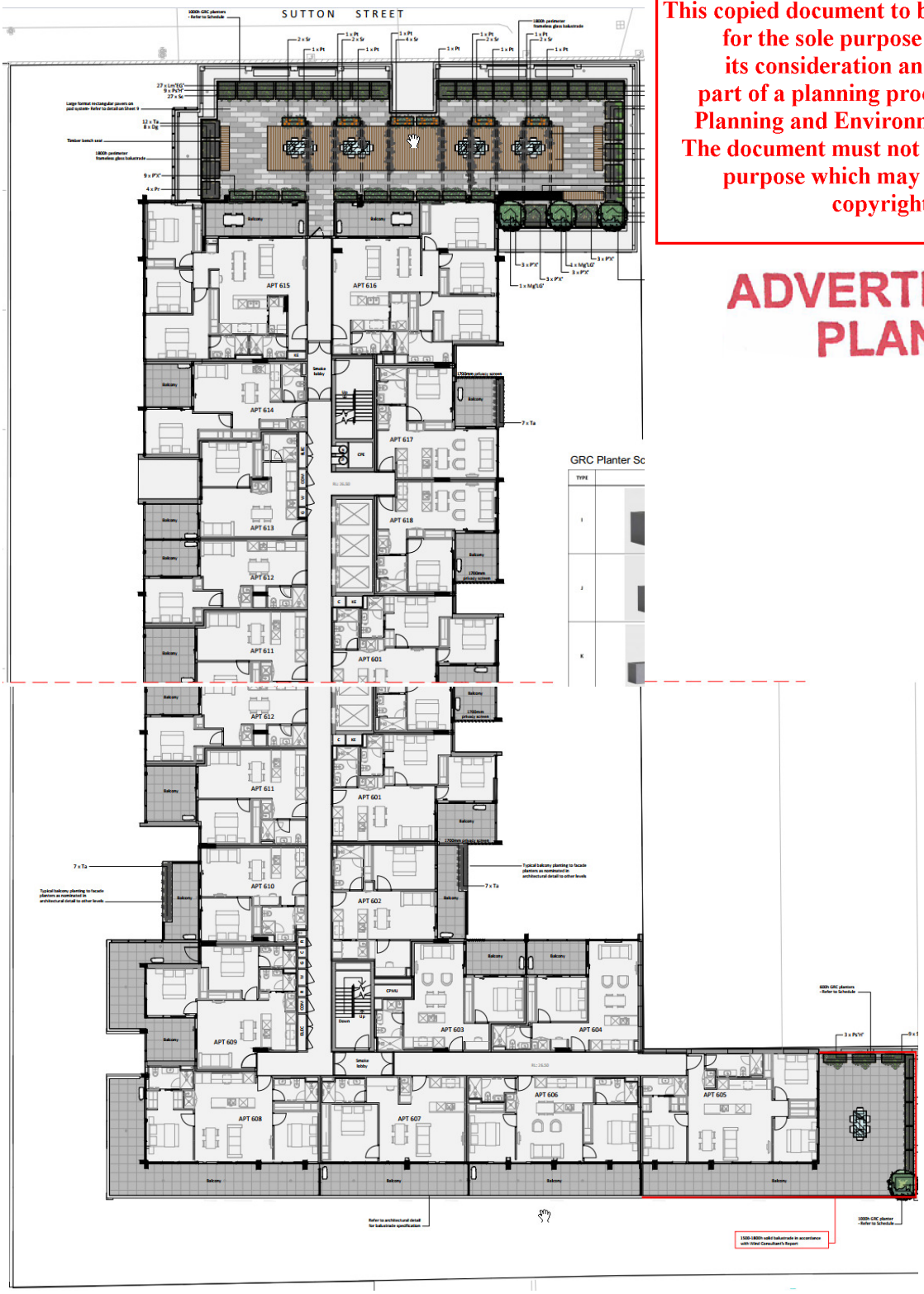

Figure 3: Landscaping plan (May 2024) of the communal terrace on level 6.

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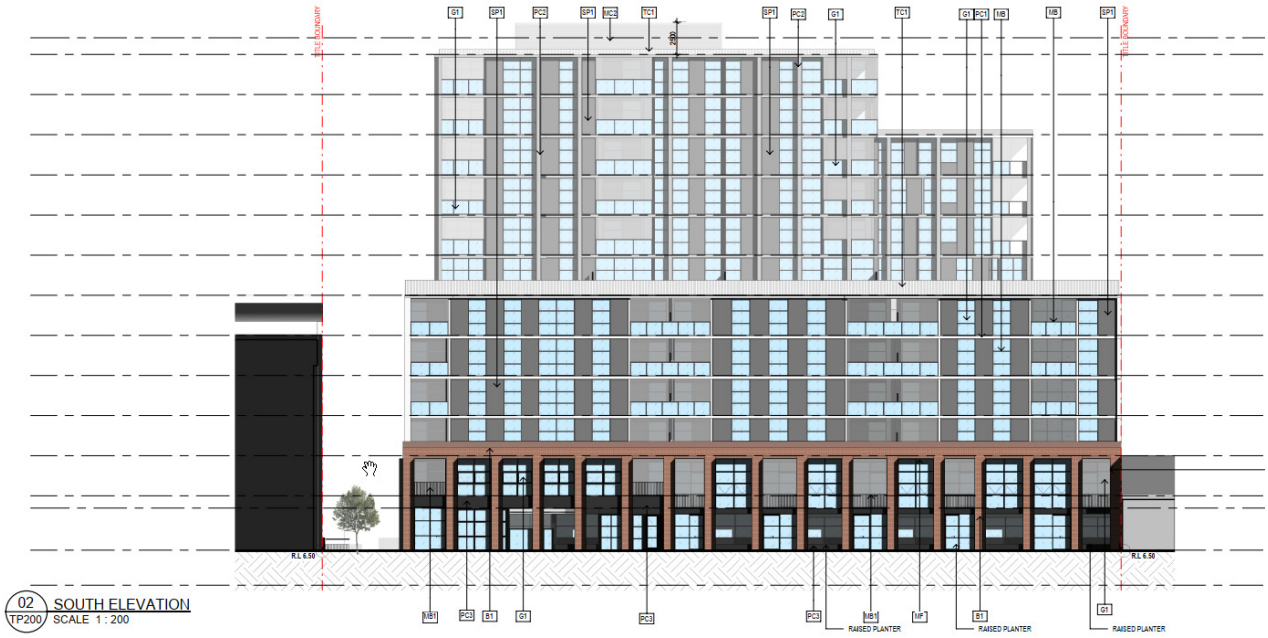


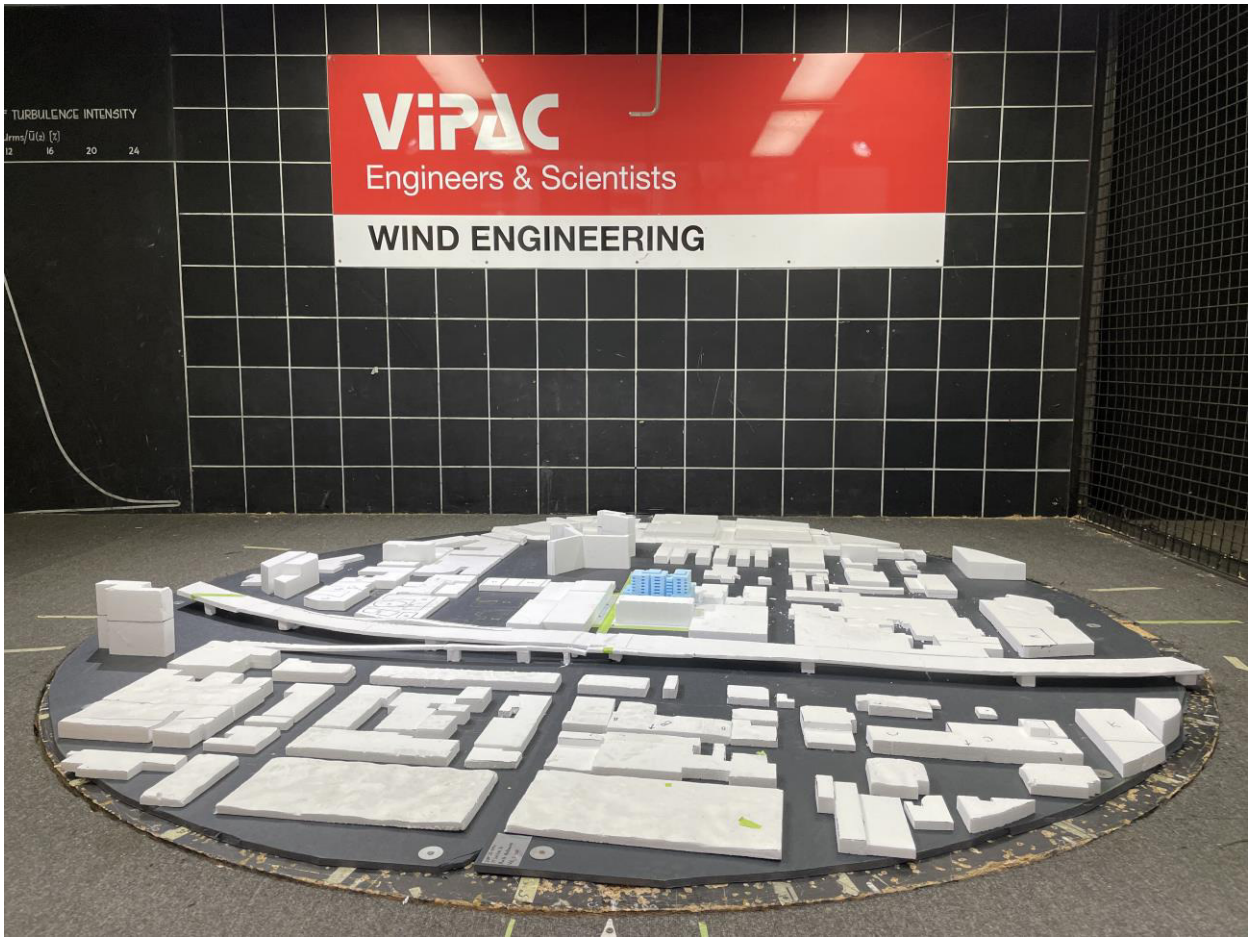
Figure 4: Southern elevation of the updated design (May 2024).

Vipac Engineers and Scientists Limited
279 Normanby Rd, Port Melbourne, VIC 3207, Australia
Private Bag 16, Port Melbourne, VIC 3207, Australia
t. +61 3 9647 9700 | e. melbourne@vipac.com.au
w. www.vipac.com.au | A.B.N. 33 005 453 627 | A.C.N. 005 453 627

Fusion Project Management Pty Ltd

77 Sutton Street, North Melbourne - S72 Amendment

Pedestrian Level Winds - Wind Tunnel Testing



30N-22-0149-TRP-38115-3

15 May 2024

Job Title:	77 Sutton Street, North Melbourne - S72 Amendment
Report Title:	Pedestrian Level Winds - Wind Tunnel Testing
Document Reference:	30N-22-0149-TRP-38115-3

Prepared For:	Prepared By:
Fusion Project Management Pty Ltd	Vipac Engineers and Scientists Limited 279 Normanby Rd, Port Melbourne, VIC 3207, Australia
Contact: James Winstanley Tel:	Tel: +61 3 9647 9700

Author:	 15 May 2024	
Reviewer:	Eric Yuen 15 May 2024	
Issued By:	Rumman Islam  15 May 2024	Wind Consultant

Revision History:

Rev. #	*Comments / Details of change(s) made*	*Date*	*Revised by:*
Rev. 00	Original issue	28 Jul 22	
Rev. 01	Updated wind criteria	6 Sep 22	R. Islam
Rev. 02	Minor amendments	15 May 24	R. Islam
Rev. 03	Updated assessment criteria	14 May 2024	RI

Executive Summary

Fusion Project Management Pty Ltd commissioned Vipac Engineers and Scientists Pty Ltd to carry out a wind tunnel test to determine the likely pedestrian level wind conditions for the proposed development at **77 Sutton Street, North Melbourne** - S72 Amendment**.**

The model was constructed based on drawings supplied by **Point Architects** in **July 2022**. The proposed development and surrounding buildings covering a circular area of approximately 500 m radius were modelled at a 1:400 scale. The approaching mean and turbulent flows of the Terrain Category 2.5 (40 to 120 azimuth degrees) and Terrain Category 3 (all other wind directions) Atmospheric Boundary Layer were modelled based on Australian Standard AS 1170.2-2011.

The findings of the study are summarised as follows:

The proposed design of the development:

- fulfils the recommended criterion for **Safety** at all test locations **with recommendations**;
- fulfils the recommended criterion for **Walking** at all footpath locations;
- fulfils the recommended criterion for **Standing** at all building entrances **with recommendations**;
- fulfils the recommended criterion for **Sitting** at all outdoor seating areas **with recommendations**;
- fulfils the recommended criteria for **Walking** within the plaza **with recommendations**; and
- fulfils the recommended criteria for **Walking** at all communal terraces **with recommendations.**

The proposed development would not cause a significant adverse impact on the adjacent areas.

As a general statement, common to all new developments, educating occupants about wind conditions at high-level terraces/balconies during high-wind events and tying down loose furniture are highly recommended.

Table of Contents

1 Introduction

Vipac Engineers & Scientists Ltd was commissioned by **Fusion Project Management Pty Ltd** to carry out a wind tunnel test of the likely wind conditions for the proposed development at **77 Sutton Street, North Melbourne** - S72 Amendment**.**

The proposed development is a 12-storey residential tower with a building height of approximately 38.3m from street level. The site is bounded by Sutton Street to the north and existing developments in the remaining directions. A satellite image of the proposed development site, the south elevation of the building, and the ground floor plan with approximate dimensions overlaid are shown in Figure 1, Figure 2 and Figure 3, respectively.

The proposed development is predominantly surrounded within a 2.3 km radius by residential dwellings, with parklands and a golf course to the east and the Melbourne CBD to the southeast. Considering the immediate surroundings and terrain, the site of the proposed development is assumed to be within Terrain Category 2.5 for 40-120 azimuth degrees and Terrain Category 3 for all other directions (Figure 4).

This report details the pedestrian level wind assessment results of the tests carried out on a 1:400 scale model of the proposed development in Vipac's Boundary Layer Wind Tunnel in Melbourne, during July 2022. The results show the wind effects in ground level public areas adjacent to the development as proposed.

The pedestrian wind environment study of the development was conducted using Omni-directional pressure sensor techniques to predict wind velocities. The study investigated safety and comfort in ground level pedestrian access-ways adjacent to the project.

The model was constructed to drawings supplied by **Point Architects** in **July 2022**. Figure 5 and Figure 6 show the 1:400 scaled models in the wind tunnel. A complete list of the drawings used to construct the model is provided in Appendix A of this report.

Figure 1: Aerial view of the proposed development site.

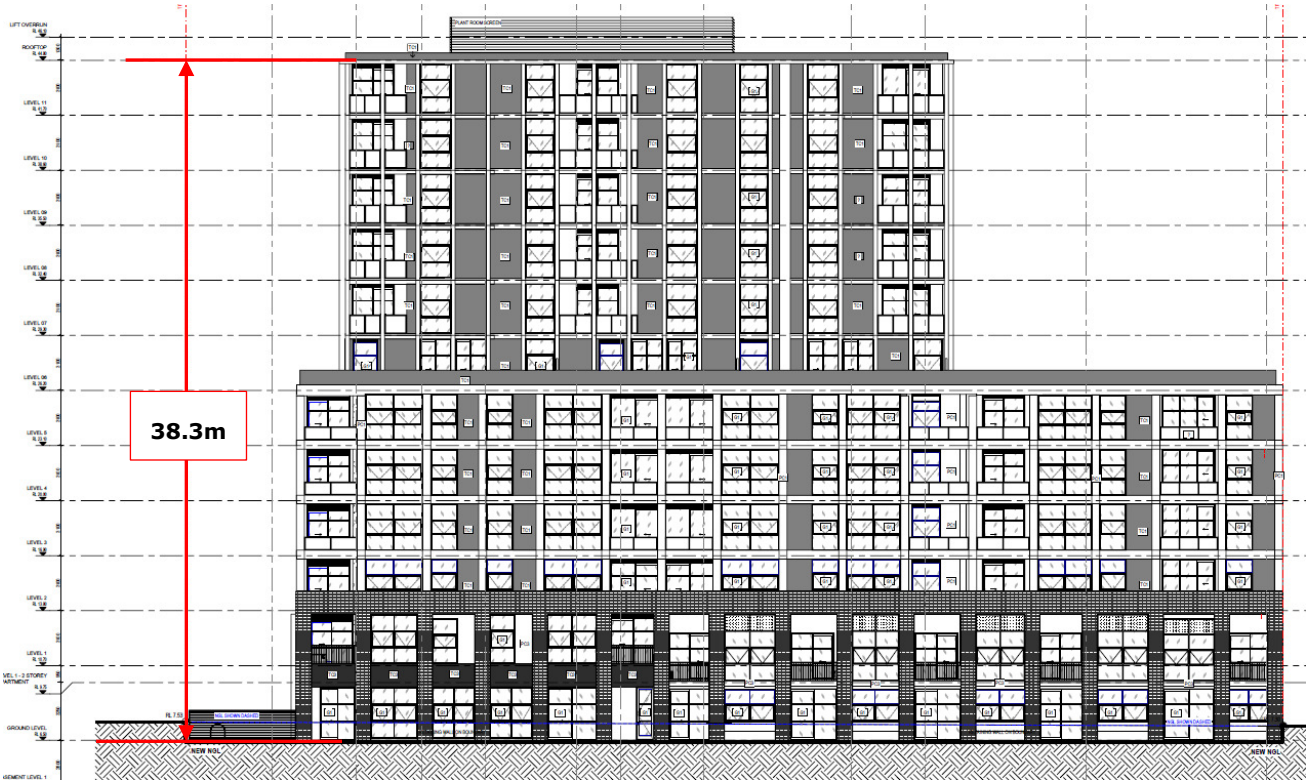


Figure 2: Southern elevation of the proposed development.

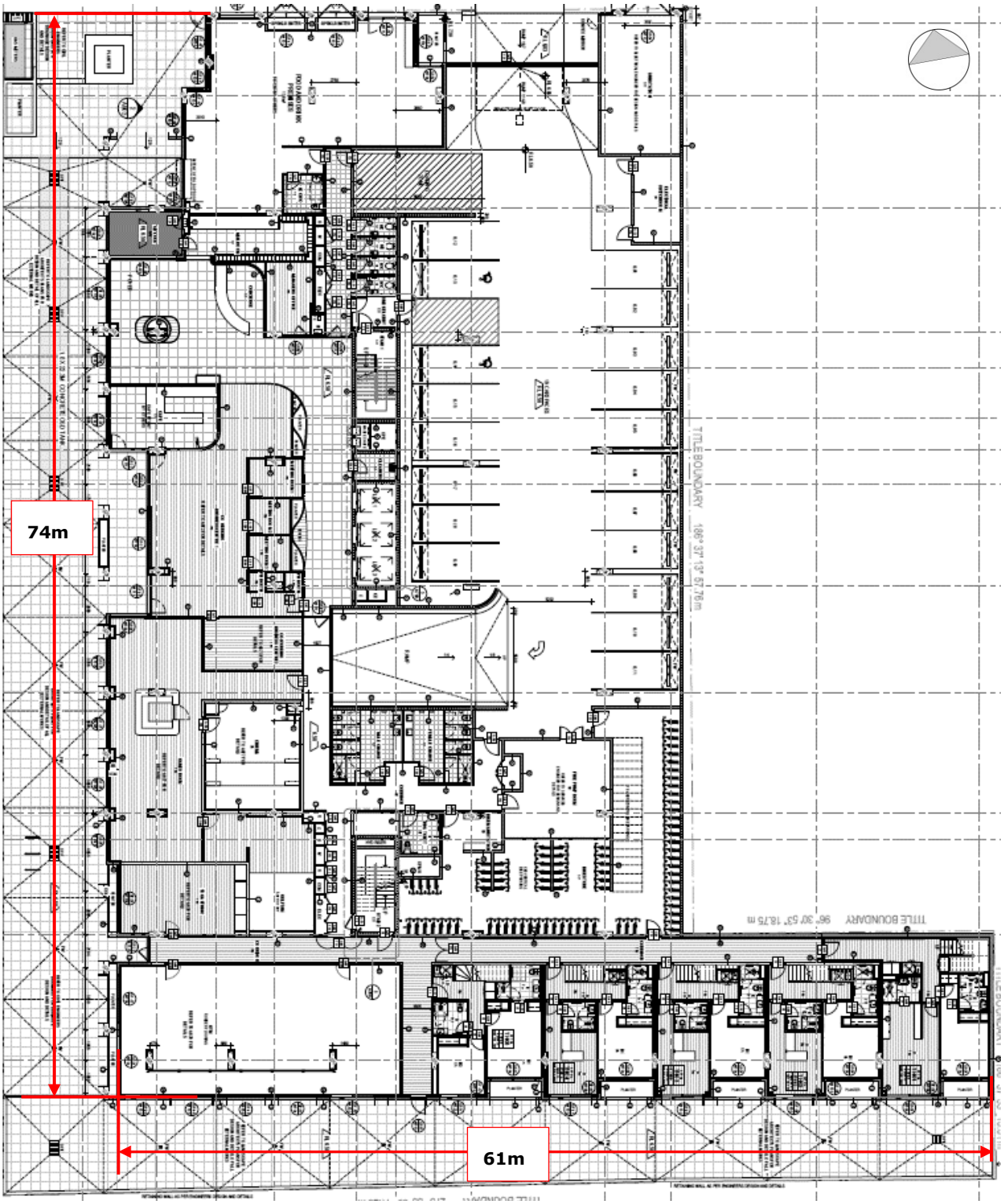


Figure 3: Ground level plan with the overall dimensions overlaid.

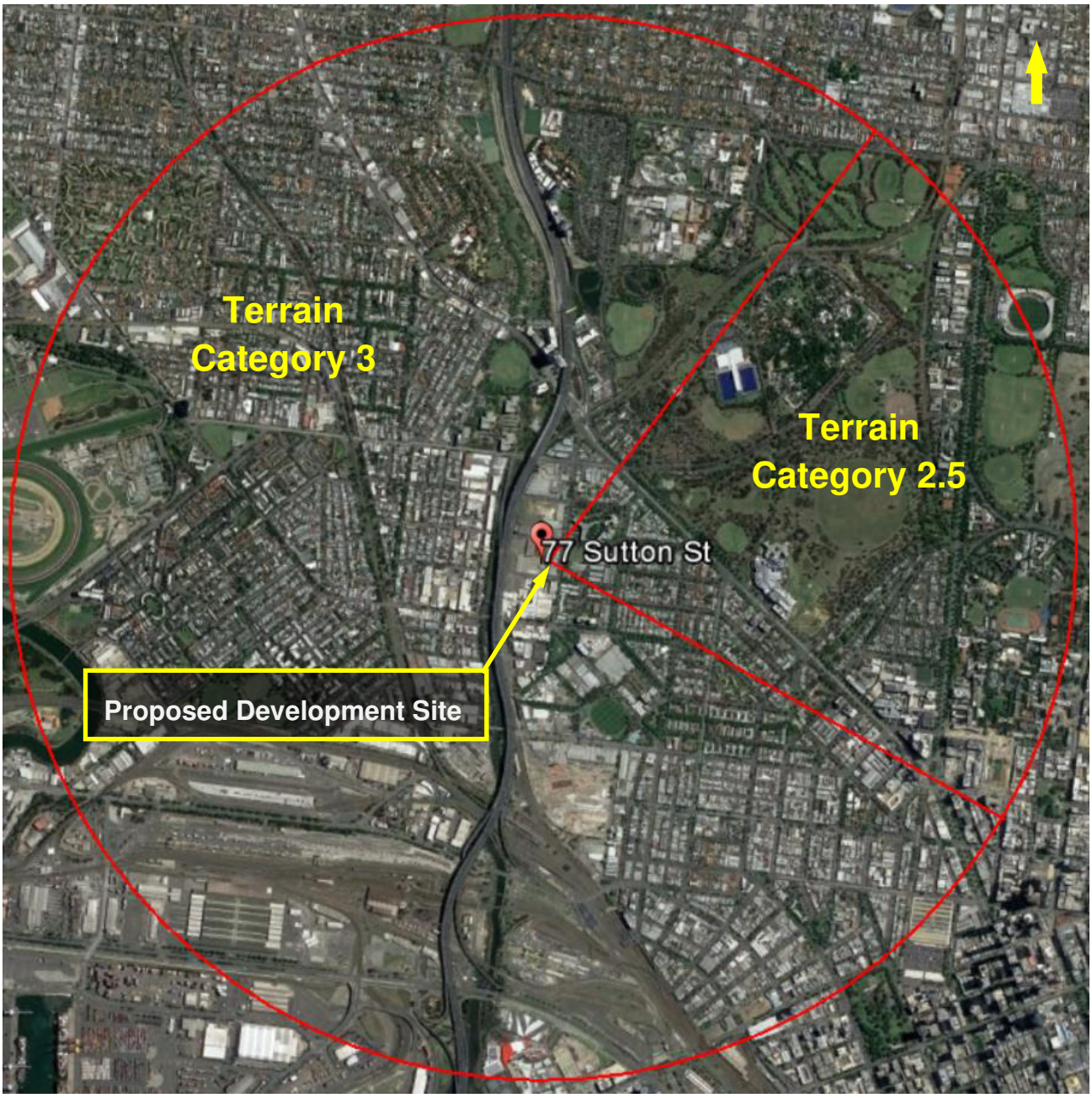


Figure 4: Assumed terrain roughness for wind speed estimation.

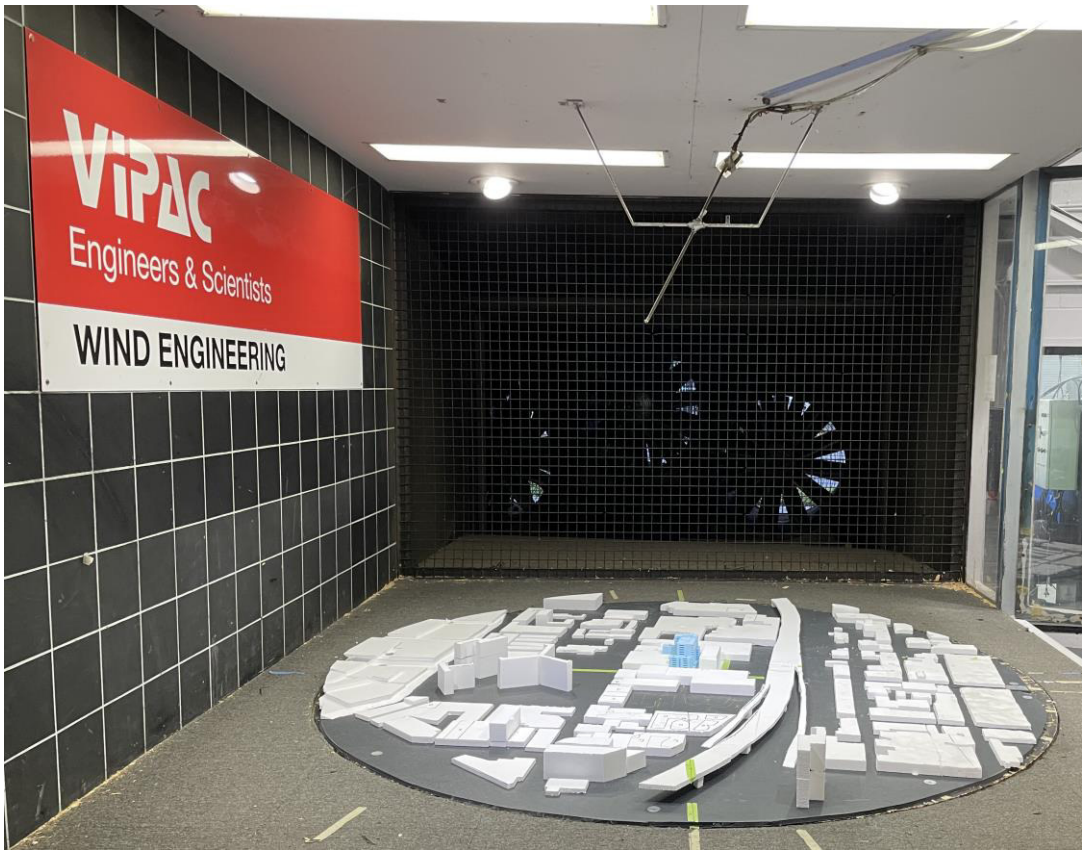


Figure 5: Overall view from north of the 1:400 scale model of the proposed development in the wind tunnel.

Figure 6: Close up view from the north east of the 1:400 scaled model in the wind tunnel.

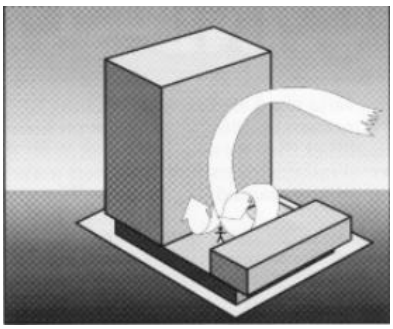
1.1 Environmental Wind Effects

Atmospheric Boundary Layer

As wind flows over the earth it encounters various roughness elements and terrain such as water, forests, houses and buildings. To varying degrees, these elements reduce the mean wind speed at low elevations and increase air turbulence. The wind above these obstructions travels with un-attenuated velocity, driven by atmospheric pressure gradients. The resultant increase in wind speed with height above ground is known as a wind velocity profile. When this wind profile encounters a tall building, some of the fast-moving wind at upper elevations is diverted down to ground level resulting in local adverse wind effects.

The terminology used to describe the wind flow patterns around the proposed Development is based on the aerodynamic mechanism, direction and nature of the wind flow.

Downwash – refers to a flow of air down the exposed face of a tower. A tall tower can deflect a fast-moving wind at higher elevations downwards.

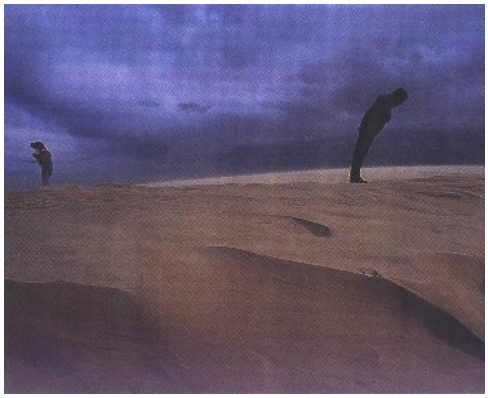


Corner Accelerations – when wind flows around the corner of a building it tends to accelerate in a similar manner to airflow over the top of an aeroplane wing.

Flow separation – when wind flowing along a surface suddenly detaches from that surface and the resultant energy dissipation produces increased turbulence in the flow. Flow separation at a building corner or at a solid screen can result in gusty conditions.

Flow channelling – the well-known "street canyon" effect occurs when a large volume of air is funnelled through a constricted pathway. To maintain flow continuity the wind must speed up as it passes through the constriction. Examples of this might occur between two towers, in a narrowing street or under a bridge.

Direct Exposure – a location with little upstream shielding for a wind direction of interest. The location will be exposed to the unabated mean wind and gust velocity. Piers and open water frontage may have such exposure.



2 Regional Wind Climate

The mean and gust wind speeds have been recorded in the Melbourne area for over 30 years. The data from Melbourne International Airport wind station has been analysed and the directional probability distribution of wind speeds has been determined. The directional distribution of hourly mean wind speed at the gradient height, with a probability of 0.1% of time and 20% of time exceeded are shown in Figure 7. The wind data at this free stream height is common to all Melbourne city sites and may be used as a reference to assess ground level wind conditions at the site.

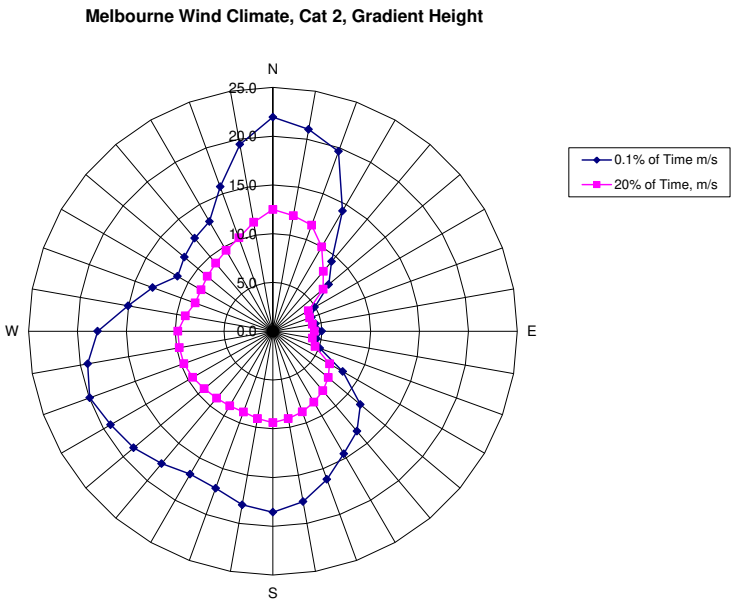


Figure 7: Directional Distribution of Mean Hourly Wind Velocities (m/s) for 0.1% and 20% exceeded at Gradient Height for Melbourne.

3 Assessment Criteria

The Melbourne Planning Scheme (DDO10) criteria for wind impact were applied in the study. The document recommends the following wind comfort criteria (Table 1).

Table 1: Wind Comfort Criteria as per DDO10 of the Melbourne Planning Scheme.

Unsafe	Comfortable
The hourly maximum 3 second gust from any wind direction (consideration at least 16 wind directions) with a corresponding probability of exceedance percentage greater than **20m/sec**	Mean wind speed from any direction with probability of exceedance less than 20% of the time, equal to or less than: **3m/sec** for sitting areas **4m/sec** for standing areas **5m/sec** for walking areas

In Table 1, the mean wind speed is defined as the maximum of hourly mean or gust equivalent mean (Gust/1.85)

This criteria specifies that safe and comfortable wind conditions must be achieved in publicly accessible areas within a distance equal to half the longest width of the building measured from all facades or half the overall height of the building, whichever is greater, as shown in Figure 8.

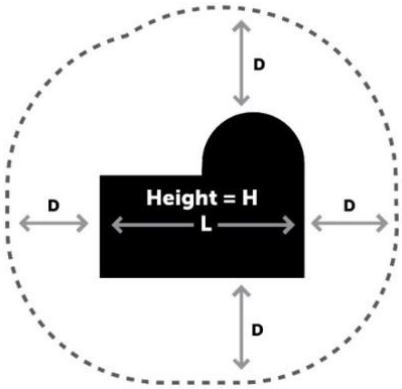


Figure 8: Assessment distance.

3.1.1 Use of Adjacent Pedestrian Occupied Areas & Recommended Comfort Criteria

The following table lists the specific areas adjacent to the proposed development and the corresponding criteria applications recommended.

Table 2 – Recommended applications of criteria.

Area	Specific location	Recommended Criteria
Public Footpaths and Accessways	Along Sutton Street and within site	Walking (Figure 9)
Plaza	West and south of the site	Walking (Figure 9)
Building Entrances	Along Sutton Street and within site	Standing (Figure 9)
Outdoor Seating Areas*[1]	Within the plaza	Sitting (Figure 9)
Communal Terraces	On Levels 1, 6 and 11	Walking (Figure 10 to Figure 12) (see discussion below)

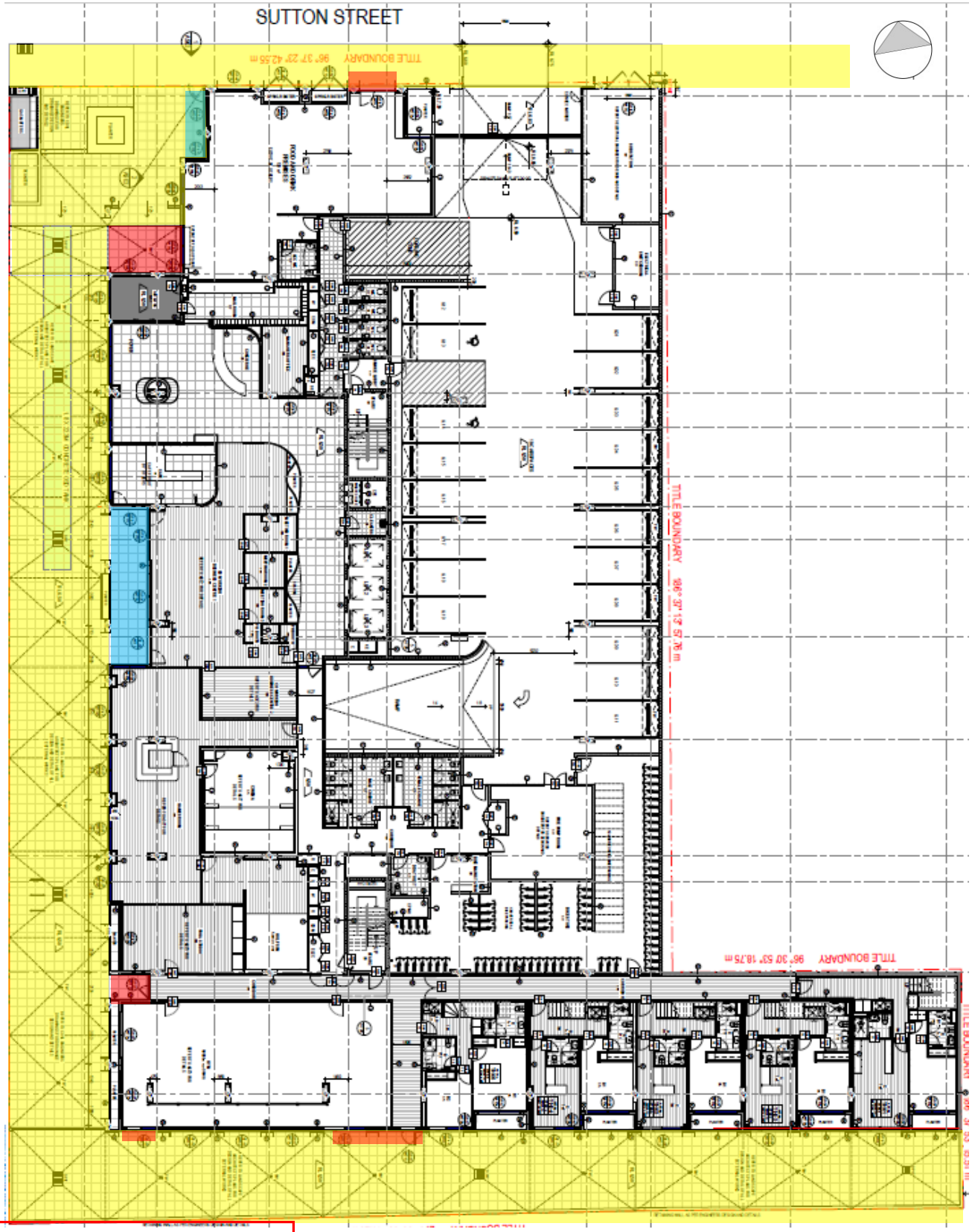
Note 1: *While the architectural plans do not show any outdoor seating areas, discussions with the client have indicated that seating areas will be proposed.*

3.1.2 Terrace / balcony Recommended Criterion Discussion

Vipac recommends as a minimum that communal terrace areas meet the criterion for walking since:

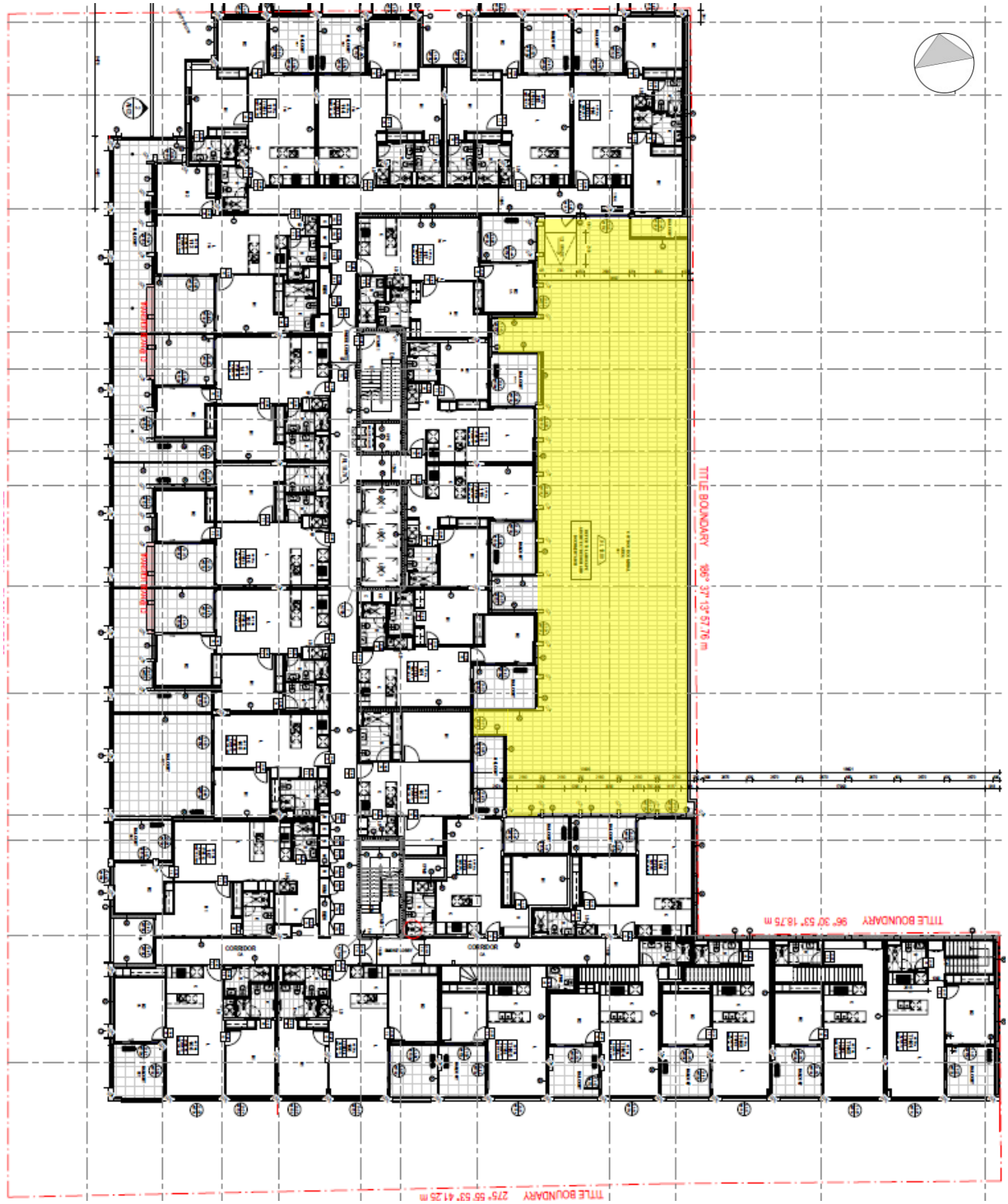
- these areas are not public spaces;
- the use of these areas is optional;
- many similar developments in Melbourne and other Australian capital cities experience wind conditions on balconies and elevated deck areas in the vicinity of the criterion for walking.

However, it should be noted that meeting the walking criterion on elevated recreation areas will be no guarantee that occupants will find wind conditions in these areas acceptable at all times.



Recommended to fulfil Walking *Recommended to fulfil Standing* *Recommended to fulfil Sitting*

Figure 9: Ground level plan of the proposed development with the recommended wind criteria overlaid.



Recommended to fulfil Walking

Figure 10: Level 1 floor plan with the recommended wind criteria overlaid.

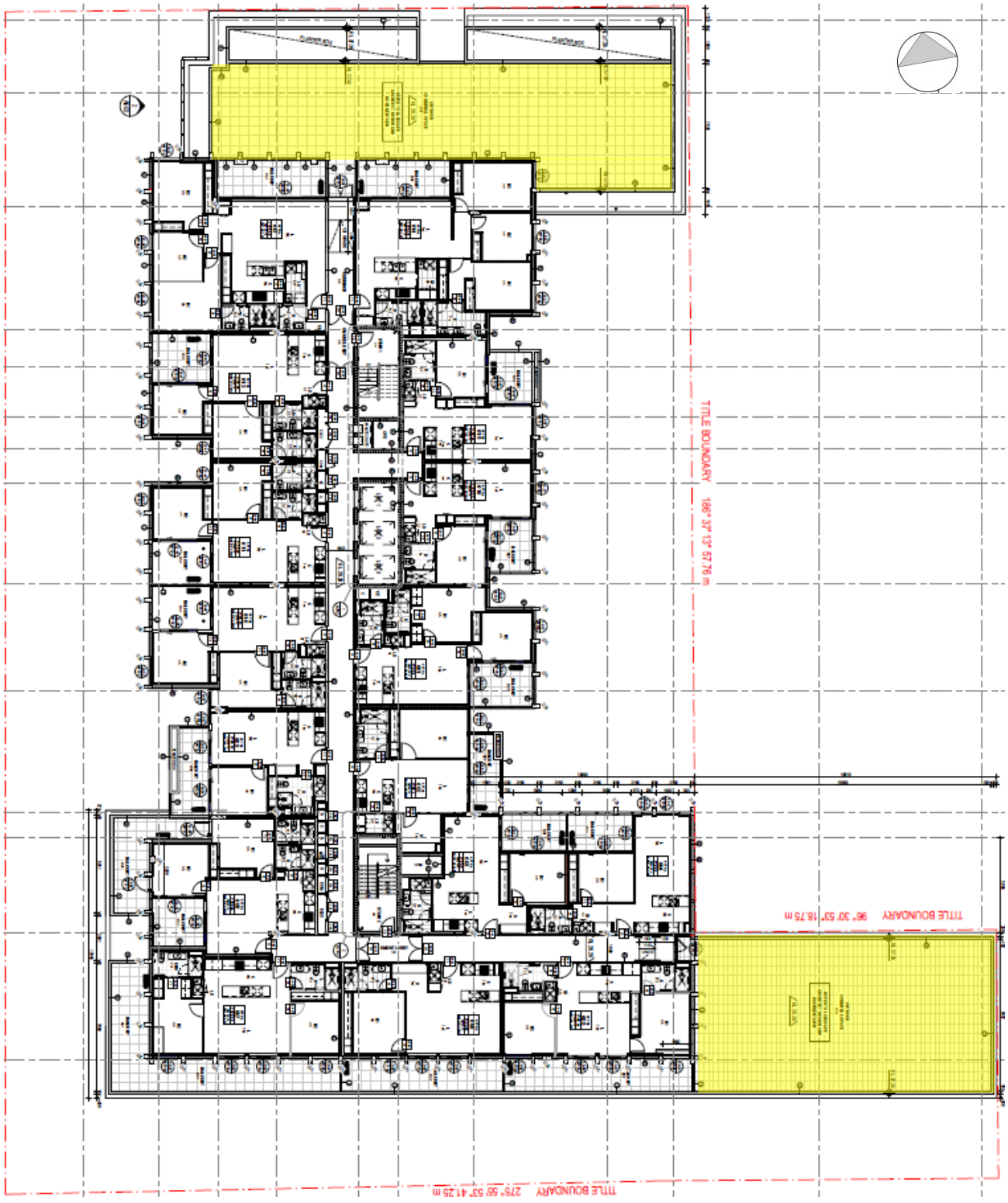
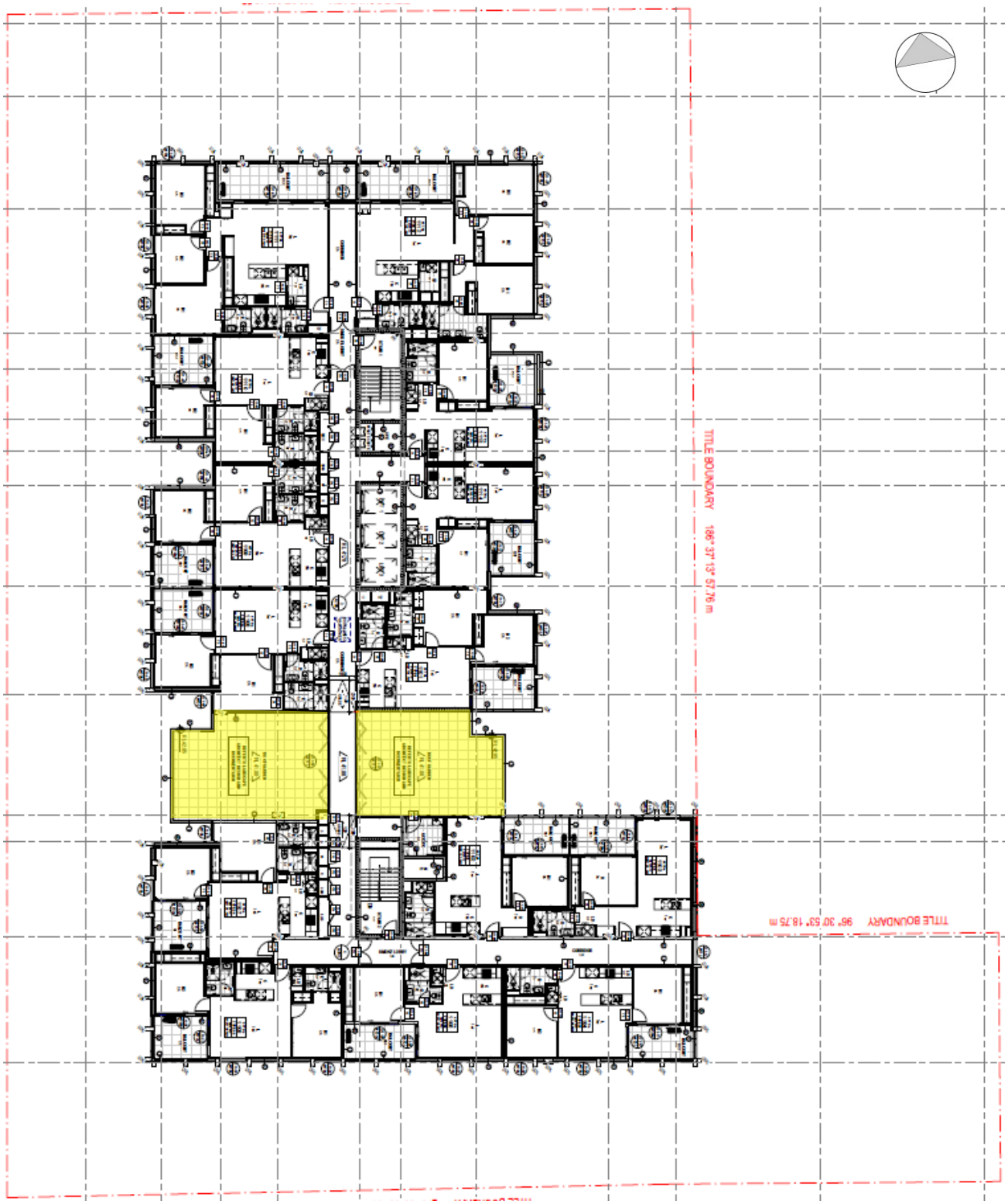


Figure 11: Level 6 floor plan with the recommended wind criteria overlaid.



Recommended to fulfil Walking

Figure 12: Level 11 floor plan with the recommended wind criteria overlaid.

4 Wind Tunnel Simulation

4.1 Similarity Requirements

The validity of wind tunnel testing relies on the similarity between model and full-scale parameters. This requires undistorted length scaling (ie. geometric similarity), similarity of flow parameters (i.e. kinematic similarity) and finally similarity of pressures and forces.

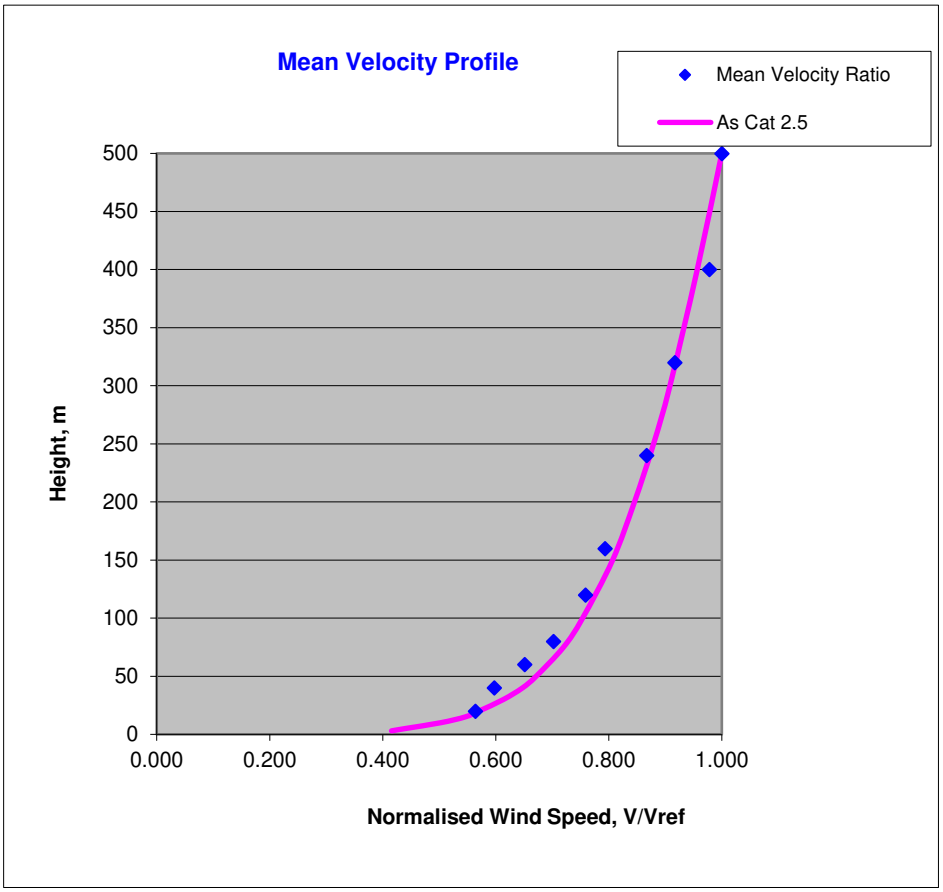
Complete similarity is usually impossible to obtain because of the competing requirements of the various non-dimensional parameters, (e.g. Reynolds Number, Rossby Number and Richardson Number). Some requirements (i.e. Reynolds Number equality) can be waived for sharp edged structures immersed in a neutrally stable atmospheric boundary layer and geometric and kinematic similarity suffice. These are the requirements specified in Section C1.4, AS/NZS 1170.2 Supplement 1: 2011 [4] and are employed in this study.

4.2 Approach Wind Simulation

The wind effects tests were carried out in the 3m wide × 2m tall × 16m long Boundary Layer Wind Tunnel at Vipac Engineers and Scientists Ltd in Melbourne. The Boundary Layer Wind Tunnel is designed to simulate the flow incident on a proposed development by modelling the upstream terrain characteristic roughness. To this end, an estimate of the upstream terrain properties for the Development has been made and reproduced in the wind tunnel.

The approaching mean and turbulent flows of the Terrain Categories 2.5 and 3 Atmospheric Boundary Layers based on different exposures were modelled based on Australia Standard AS 1170.2-2011. The wind tunnel calibration velocity and turbulence intensity profiles for Terrain Categories 2.5 and 3 are shown in Figure 13 and Figure 14. These represent the wind velocity and turbulence intensity profiles approaching the model of the development. Closer to the ground the wind moves more slowly but with increased turbulence. The simulated approach is indicative of full-scale planetary boundary layer velocity and turbulence intensity profiles.

Velocity correction factors are used to adjust the measured wind speed to ensure that the ratio of mean roof-height to reference height wind speed in the wind tunnel matches expected full-scale values.



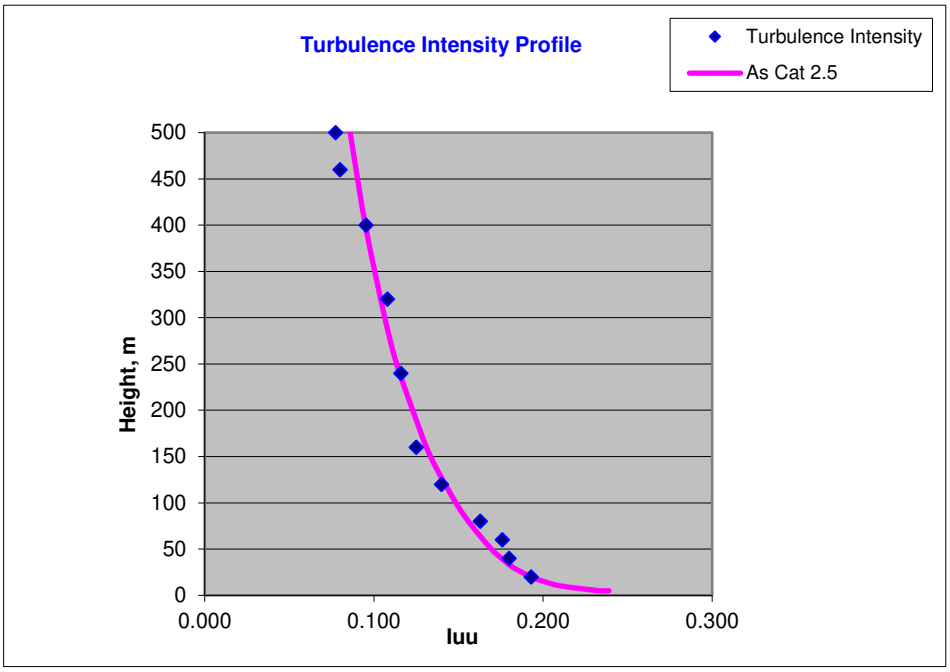
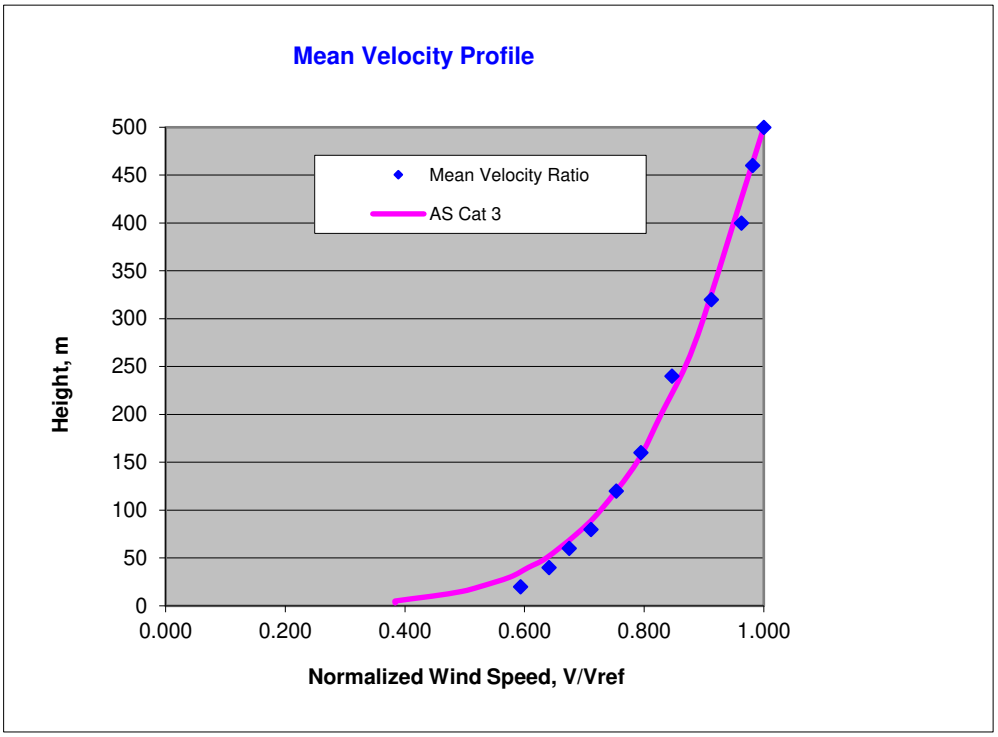


Figure 13: Mean Velocity and Turbulence Intensity Profiles for Terrain Category 2.5 (1:400 scale).



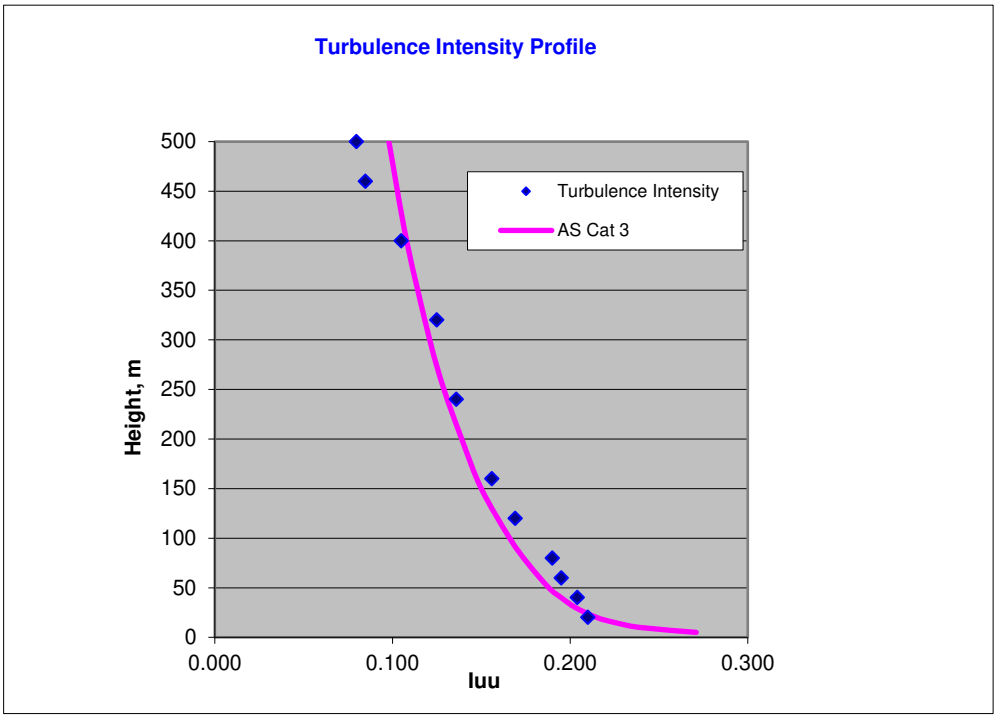


Figure 14: Mean Velocity and Turbulence Intensity Profiles for Terrain Category 3 (1:400 scale).

5 Test Procedure

The pedestrian wind environment in the adjacent footpath areas along Sutton Street, plaza within the site and communal terrace areas were assessed using Omni-directional pressure sensor measurements [4].

Velocity measurements were made using Irwin sensors (Omni-directional pressure sensors) installed at different locations at the adjacent ground level footpath areas and podium level of the proposed development. The test was conducted without any landscaping. The distribution of Irwin sensors has allowed the determination of the variation in velocity sufficient to capture the changes in velocity distribution that can typically occur over such areas. The resolution of measurement locations is in accordance with that prescribed in the Wind Tunnel Testing Quality Assurance Manual of the Australasian Wind Engineering Society.

PVC tubes with 1.3 mm internal diameter linked the Irwin sensors to pressure transducer device using a tuned arrangement to prevent harmonic fluctuations.

Velocity measurements were obtained at 10° wind azimuth increments starting from 0° (north) for a full 360° circle. The sampling time is determined based on the similarity criteria and corresponds to a total time of one hour in full scale. Statistical analysis was carried out on the signals for the mean and standard deviation. All velocity coefficients derived from the wind tunnel were converted to velocities by integrating the data with the regional wind climate and corresponding to design wind speeds with a probability 0.1% of time for safety criterion assessment and 20% of time for comfort criteria assessment.

A total of **32** sensors were used in order to provide a quantitative measure of the ground level wind speeds at various locations around the footpaths and garden. The sensor locations are shown in Figure 15 to Figure 19.

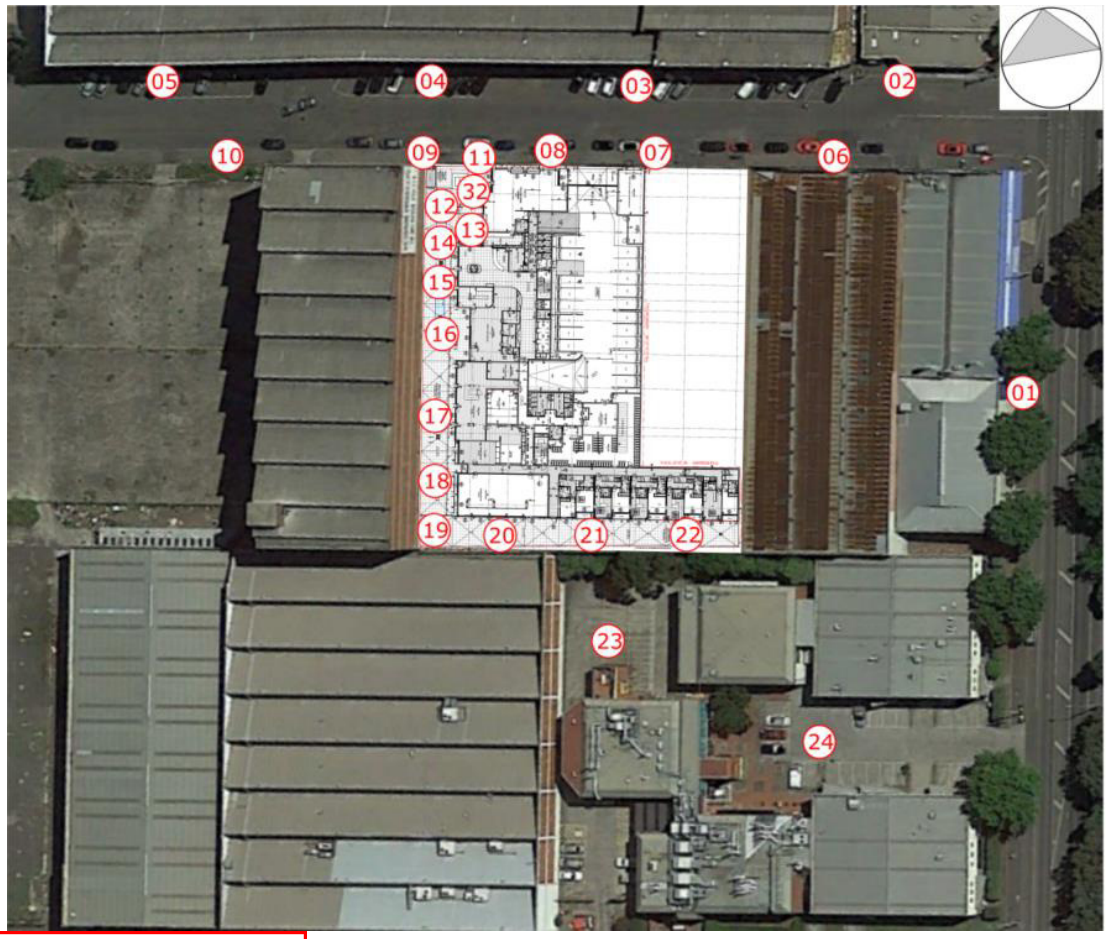


Figure 15: Sensor numbers and locations on the ground level.

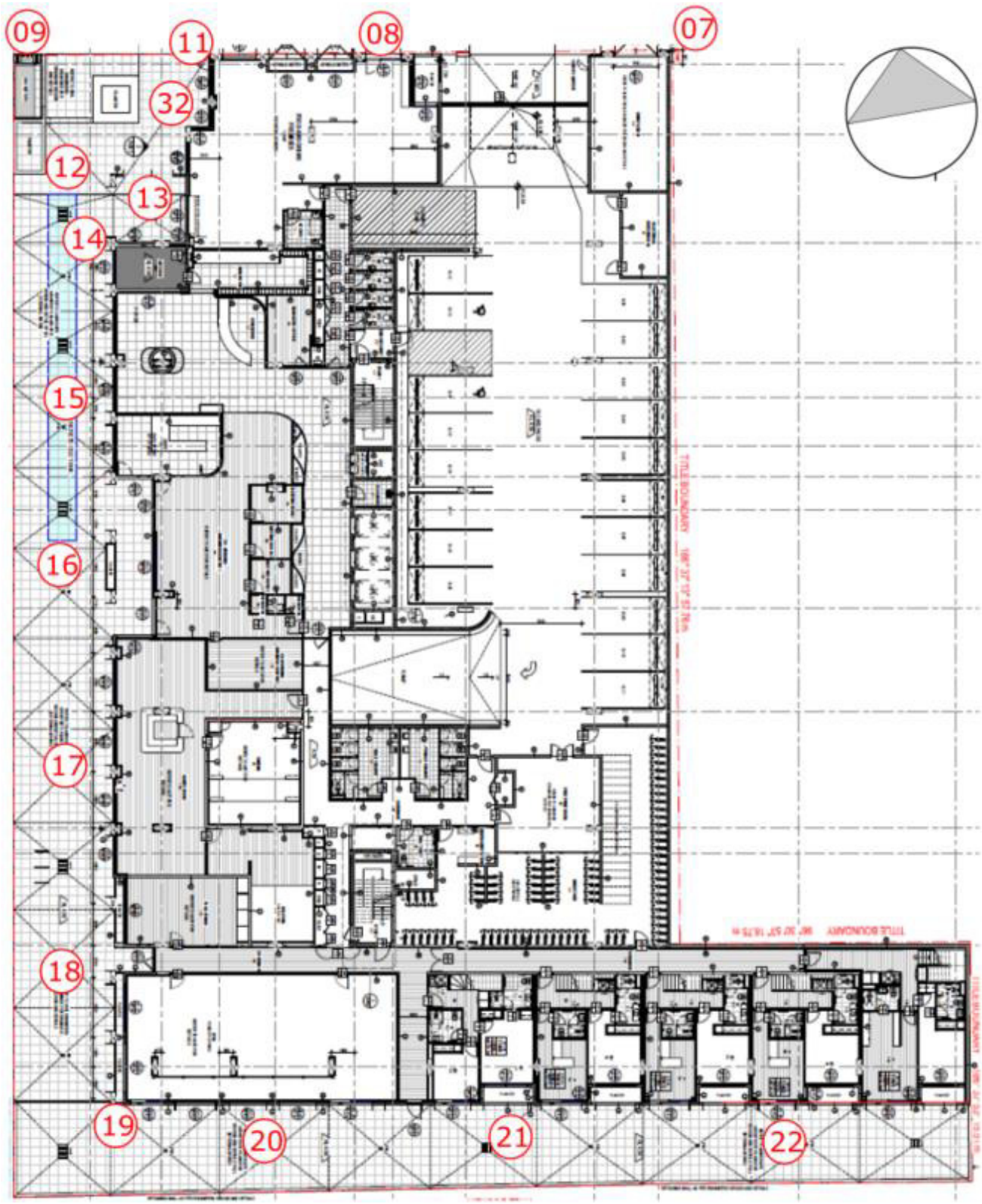


Figure 16: Sensor numbers and locations on the ground level (closeup).

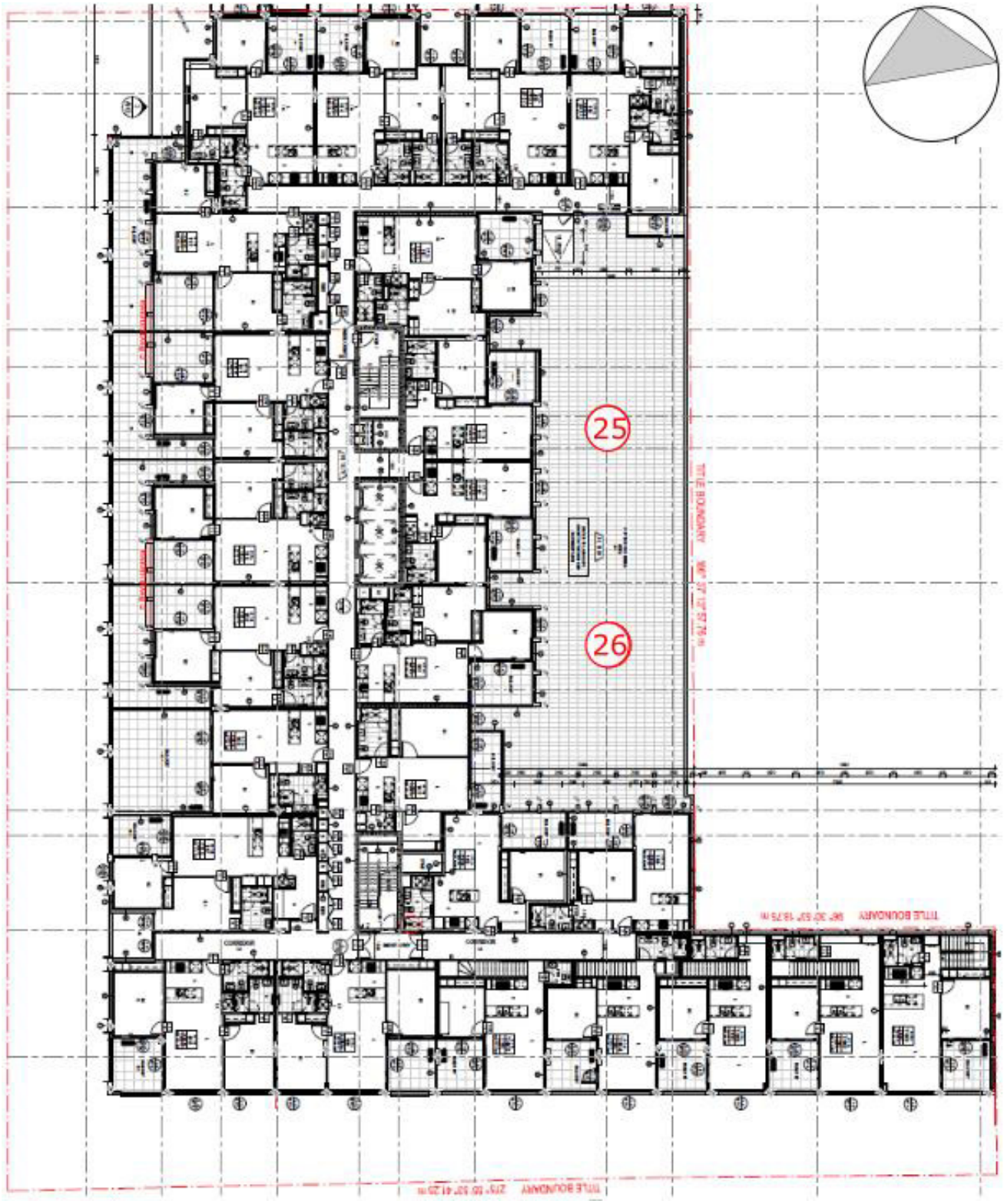


Figure 17: Sensor numbers and locations on Level 1.

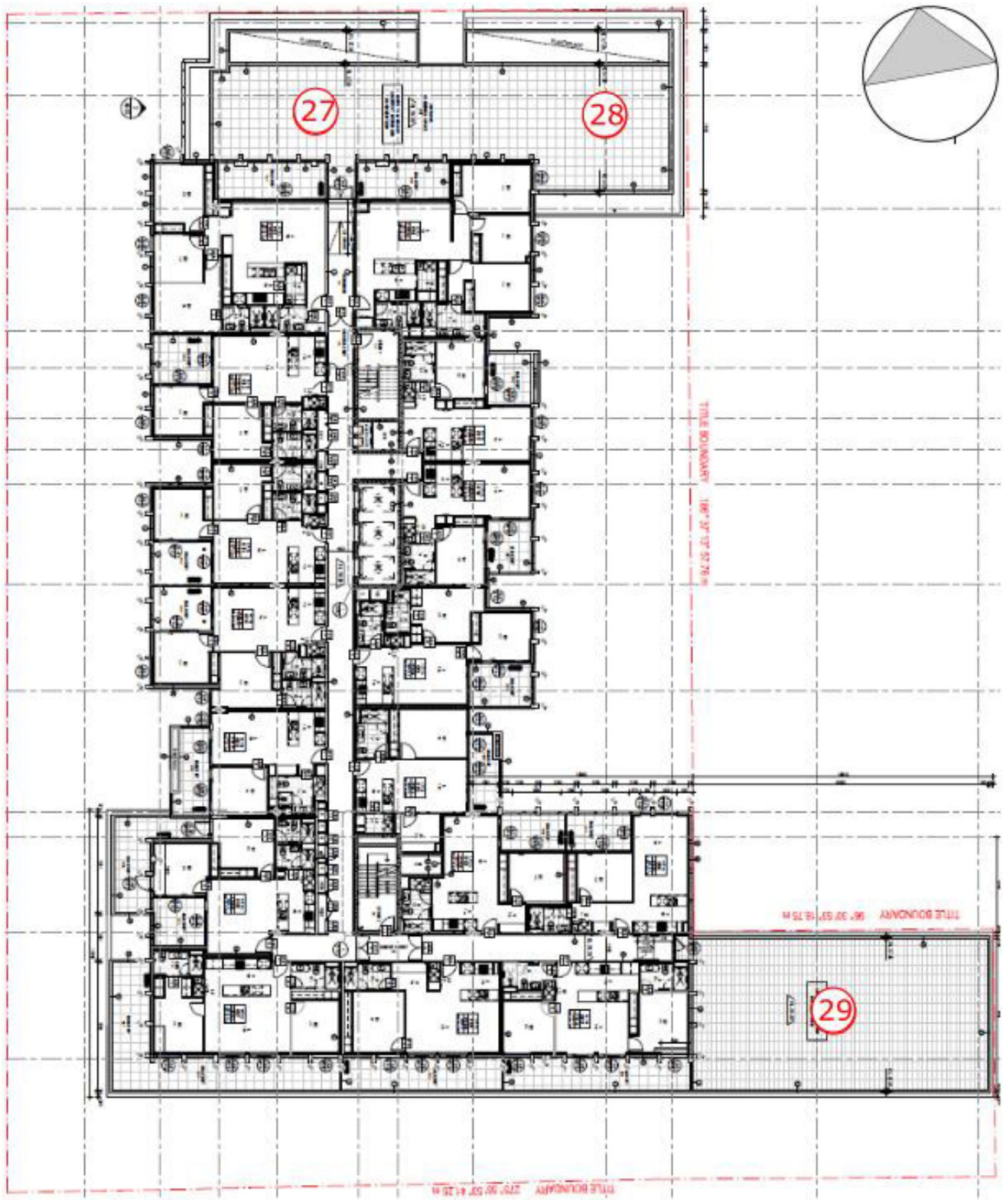


Figure 18: Sensor numbers and locations on Level 6.

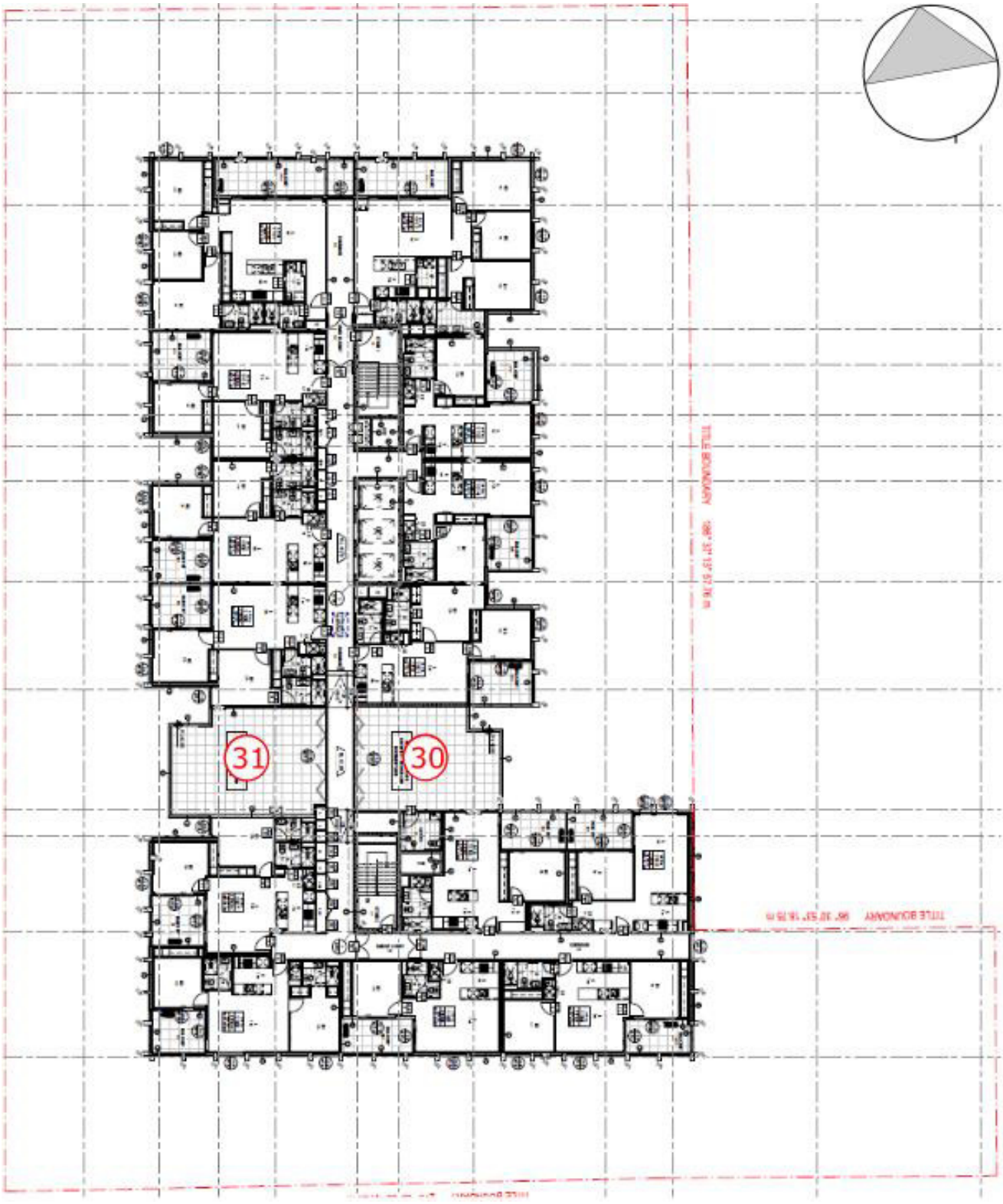


Figure 19: Sensor numbers and locations on Level 11.

6 Results and Discussion

The pedestrian wind environment in the footpath, main entrances and outdoor communal terraces were assessed using omnidirectional pressure sensor tests.

The following configurations were conducted:

Configuration 1: test with the proposed development and existing surrounding developments (Figure 20).

Existing: A reference configuration of existing conditions (Figure 21).

The tests were conducted without any landscaping at the ground level streetscapes.

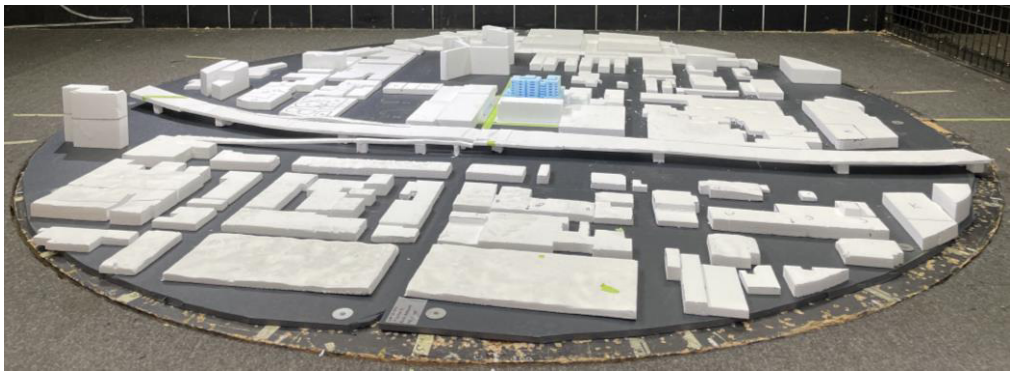


Figure 20: Overall view of the proposed development model in the wind tunnel (Configuration 1).

Figure 21: Overall view of the proposed development model in the wind tunnel (existing).

The test results are presented as polar plots for the gust wind speeds appended in Appendix A of this report. Figure 22 shows an example of these plots. In the figure, the red circle represents the velocities for the safety criterion and the three sets of data points represent the different test configurations and their predicted gust wind speeds for the 36 directions for Location 14.

The plot shows that with the proposed design, Location 14 was within the recommended safety criterion in Configuration 1. The shape of the graphs tells us that wind conditions are most adverse from the west / south west. However, the predicted hourly mean speed marginally exceeded the recommended walking comfort criterion (). Therefore, wind control measures were recommended for this location to achieve wind speeds within the walking comfort criterion.

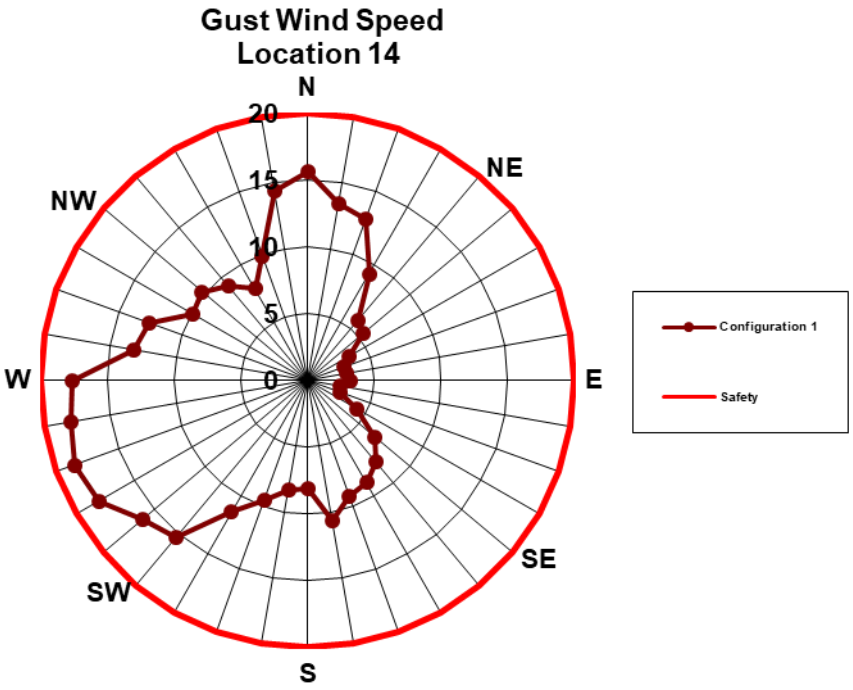


Figure 22: Polar plot showing the wind speed compared with safety criteria (Location 14).

Figure 23 and Figure 24 show the comparison between the comfort criteria and predicted hourly mean wind speeds (maximum of statistic mean and GEM). In these figures, the colour lines represent the threshold velocities for the different criteria and the data series (bars) represent the predicted values of the mean velocities (WCM=Wind Control Measures). For the all wind direction combination, there are no particular methods specified in the BADS guidelines, the up-crossing prediction method described in Appendix D was used in the study. It is noted that all direction combined prediction could result in a slightly lower wind speed value than the maximum of direction-by-direction assessment values.

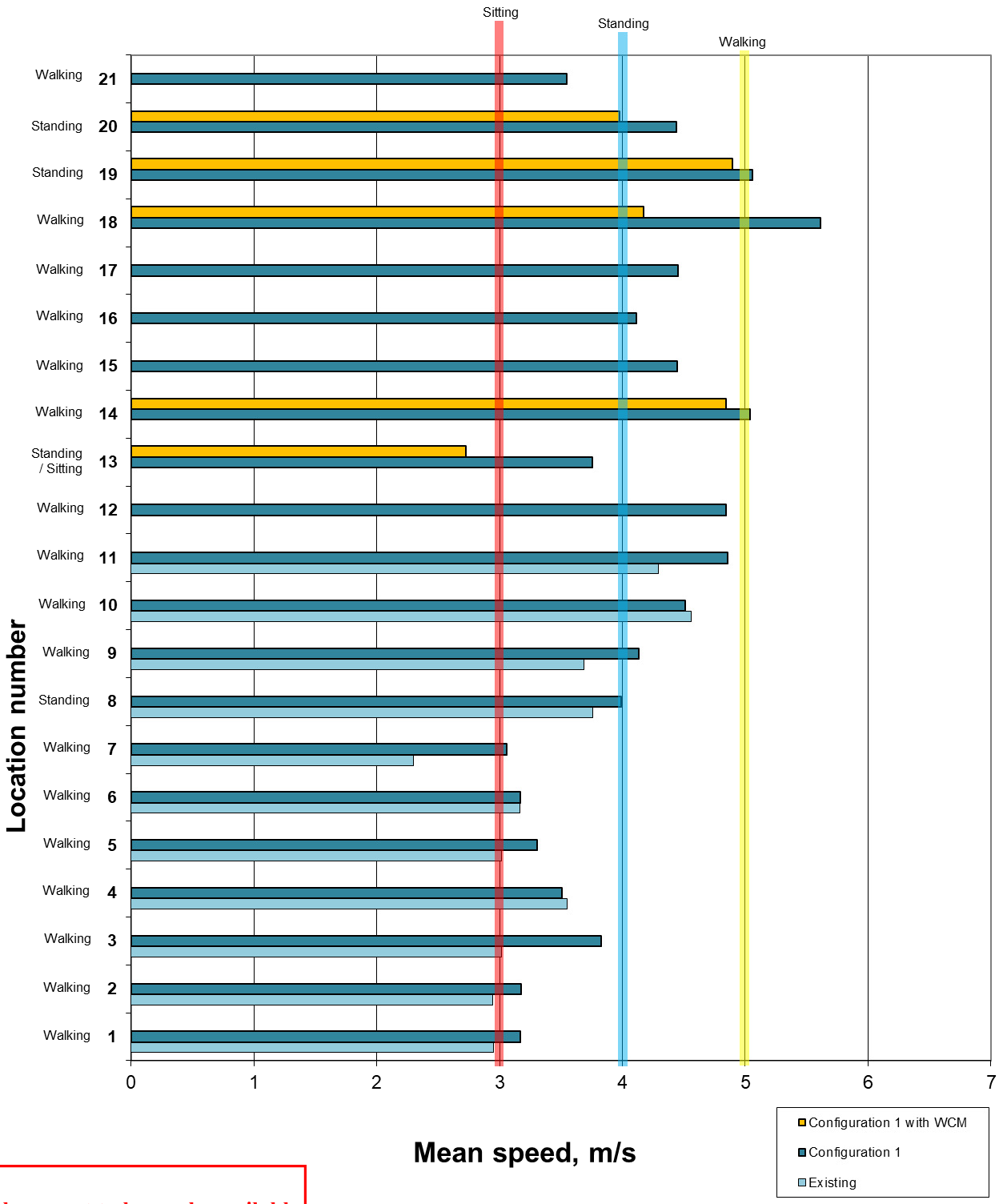


Figure 23: Bar plot showing the wind speed compared with comfort criteria (Locations 1- 21).

Comfort Criteria
Mean wind speed (20% probability)

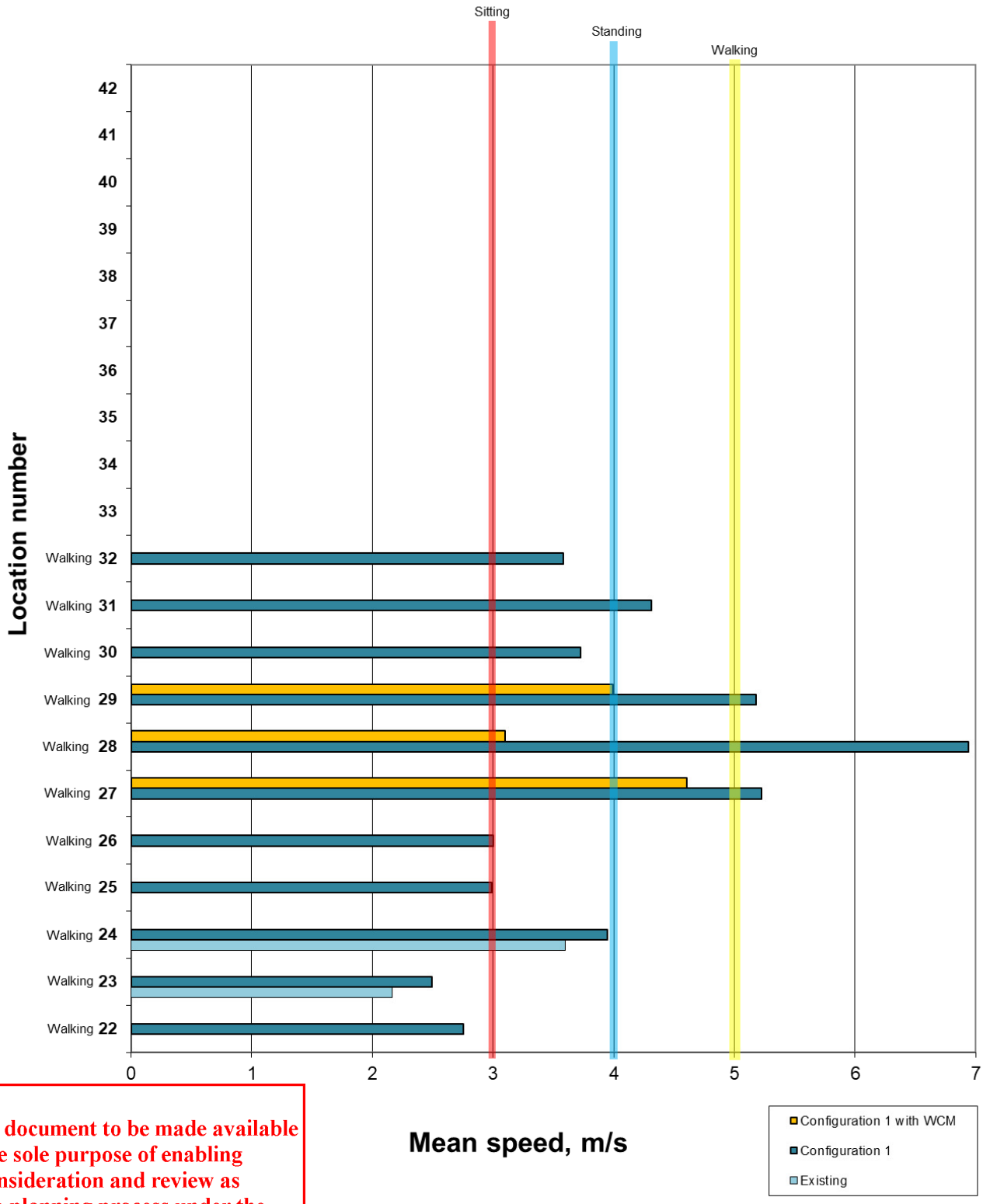


Figure 24: Bar plot showing the wind speed compared with comfort criteria (Locations 22- 32).

Based on the tests conducted, the following points were observed.

6.1 Safety Criterion Test

Most locations within the immediate vicinity of the proposed development measured gust windspeeds within the recommended safety criterion for the proposed development. The northern terraces at Level 6 (Locations 27 and 28) failed to meet this criterion for Configuration 1, and the recommended wind control measures will be discussed in Section 6.2.4.2.

6.2 Comfort Criteria

6.2.1 Pedestrian Footpath and Plaza

Most locations measured windspeeds within the recommended walking comfort criterion for Configuration 1.

Location 14 exceeded this criterion. As such, the planter north of this location is recommended to be raised by a minimum 1m.

Location 18 also exceeded the recommended walking comfort criterion. As such, a raised planter of minimum 1m height north of this location is recommended.

All recommendations discussed in this section are illustrated in Figure 25.

6.2.2 Main Building Entrances

Several building entrances (represented by Locations 8, 13, 16, 18, 19 & 20) measured windspeeds within the recommended standing comfort criterion for Configuration 1.

Location 16 measured wind speeds within the walking comfort criterion. The entrances near this location are setback from the building façade (entrances to the Café and Co-Working Business Centre 1). As such, this entrance is expected to be within the standing comfort criterion due to the set-back design. As such, no further recommendations for wind amelioration were required.

Location 18 measured wind speeds within the walking comfort criterion with the raised planter of 1m height (as recommended Section 6.2.1). As such, the entrance into the residential corridor is expected to be within the standing comfort criterion due to the set-back design. As such, no further recommendations for wind amelioration were required.

Location 19 measured wind speeds exceeding the recommended standing comfort criterion, and even exceeds the walking comfort criterion, for Configuration 1. As such, a raised planter of minimum 1m height east of this location is recommended to bring wind speeds down to within the walking comfort criterion; the entrance is then recommended to be setback from the building façade by minimum 1.5m to ensure wind speeds will be within the standing comfort criterion.

Location 20 measured wind speeds exceeding the recommended standing comfort criterion for Configuration 1. However, the 1m high raised planter recommended above brings wind speeds down to within the standing comfort criterion.

All recommendations discussed in this section are illustrated in Figure 25.

6.2.3 Outdoor Seating Areas

As per discussions with the client, seating areas will be proposed in the future, represented by Locations 16 and 32.

Location 16 measured wind speeds well within the walking comfort criterion for Configuration 1. However, in consideration of the location of the seating area (within the setback and under the building overhang) and the landscaping proposed between the plaza and the setback, this area will be shielding from all directions. As such, no adverse winds are expected and wind speeds will be within the recommended sitting comfort criterion at this location.

Location 32 measured wind speeds within the standing comfort criterion for Configuration 1. As such, the seating area is recommended to be relocated towards Location 13; this would subsequently result in relocation of the entrance at Location 13, and we recommend this Airlock entrance to relocated to the west and setback by 1.5m. A 2-3m high tree is also recommended at the northern planter (Figure 25).

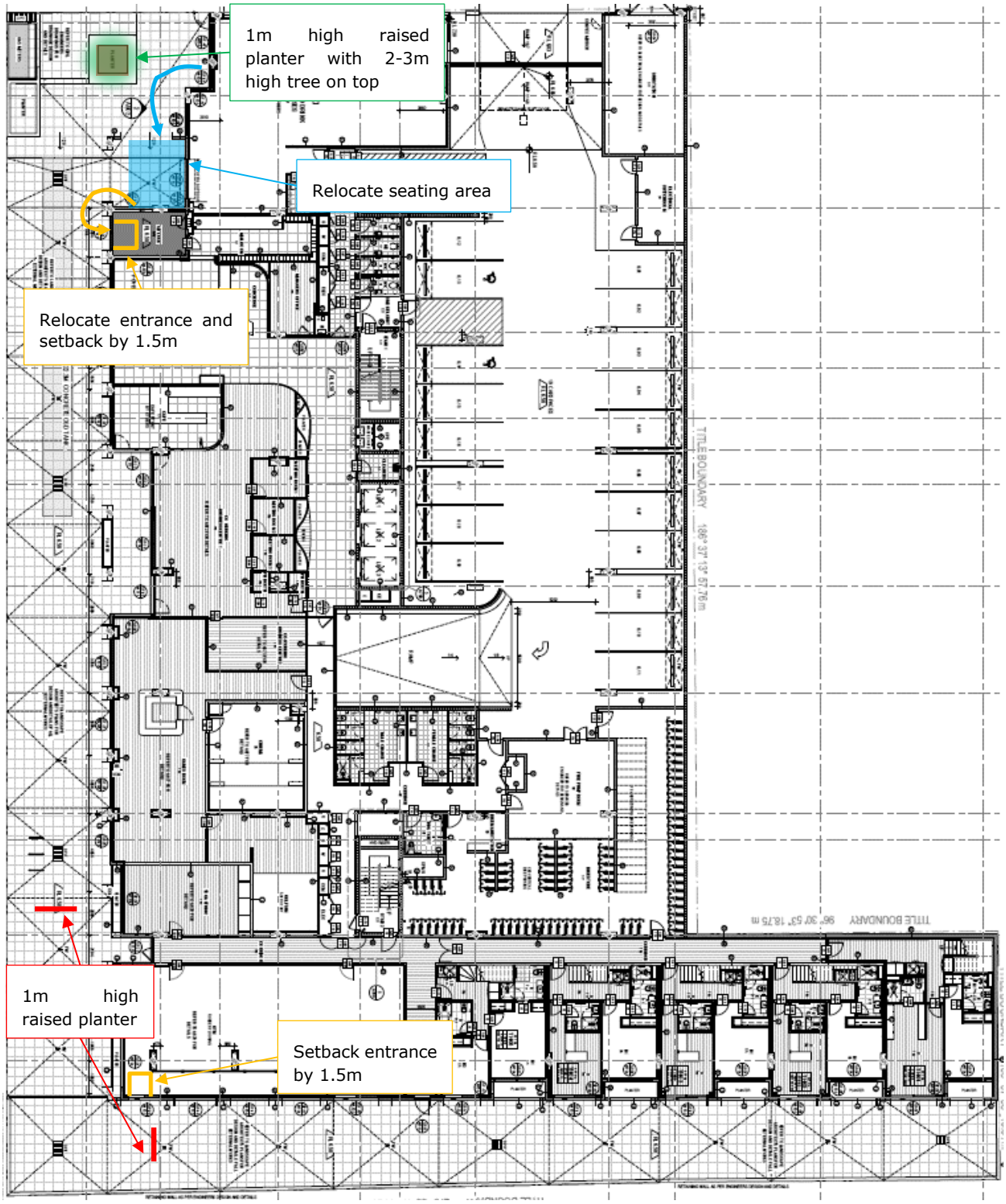


Figure 25: Recommended wind control measures overlaid on the ground floor plan.

6.2.4 Communal Terraces

6.2.4.1 Level 1

The communal terrace on Level 1, represented by Locations 25 & 26, measured wind speeds within the most stringent sitting comfort criterion for Configuration 1. As such, no recommendation for wind amelioration was provided.

6.2.4.2 Level 6

The northern communal terrace on Level 6, represented by Locations 27 & 28, measured wind speeds exceeding the recommended walking comfort criterion for Configuration 1. As such, 1.8m high solid balustrades along the perimeter and 2-3m high trees are recommended at this terrace.

The south eastern communal terrace, represented by Location 29, also measured wind speeds exceeding the recommended walking comfort criterion for Configuration 1. As such, 1.8m high solid balustrades along the perimeter are recommended.

All recommendations discussed in this section are illustrated in Figure 26.

It should be noted that testing was performed as per the architectural drawings. Should the design elements be considered as per the landscaping plans dated 2/06/2022 by Tract Landscape Architects (landscaping at other locations and arbour structures), wind speeds are expected to improve and be within the most stringent sitting comfort criterion.

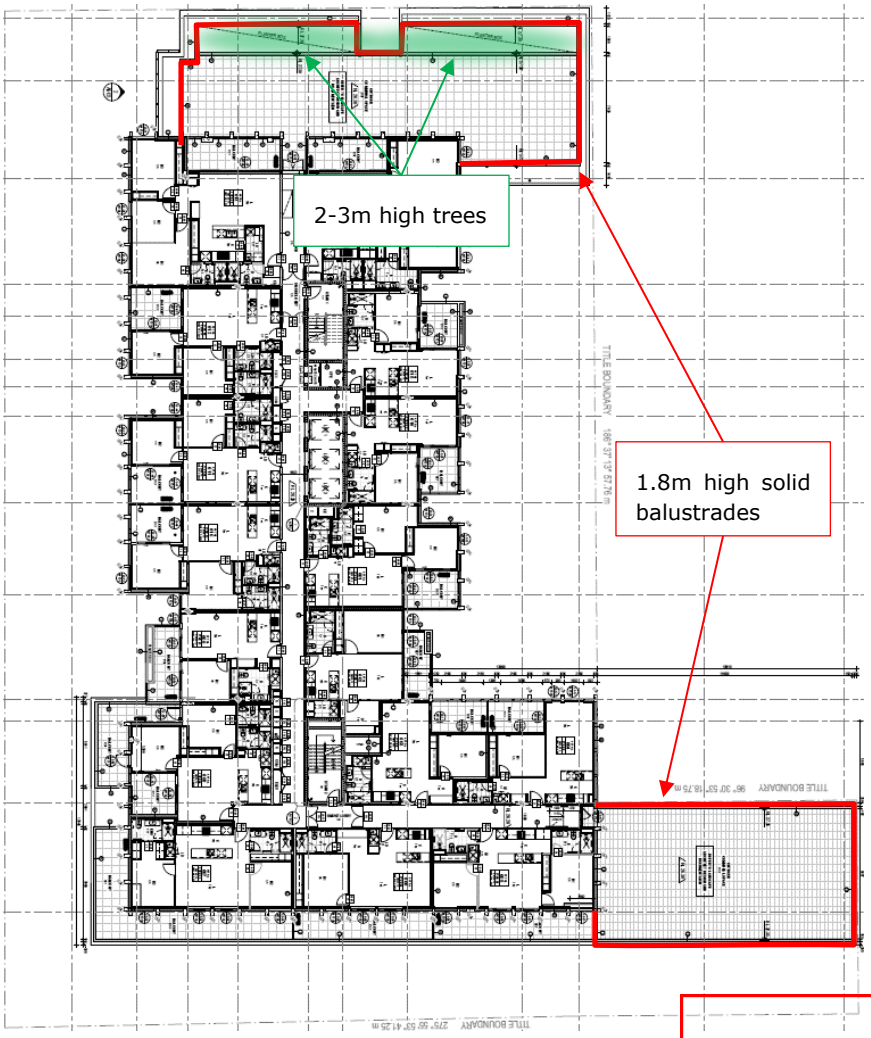


Figure 26: Recommended wind control measures overlaid on the Level 6 floor plan.

6.2.4.3 Level 11

The communal terrace on Level 11 is represented by Locations 30 & 31. While Location 30 measured wind speeds within the more stringent standing comfort criterion and Location 31 measured wind speeds within the recommended walking comfort criterion. As such no recommendations for wind amelioration was provided.

It should be noted that testing was performed as per the architectural drawings. Should the design elements be considered as per the landscaping plans dated 2/06/2022 by Tract Landscape Architects (landscaping and arbour structures), wind speeds are expected to improve and be within the most stringent sitting comfort criterion.

7 Conclusion

Vipac has carried out an assessment of the pedestrian level winds for the proposed development at **77 Sutton Street, North Melbourne** - S72 Amendment based on a scaled wind tunnel test.

The findings of the study are summarised as follows:

The proposed design of the development:

- fulfils the recommended criterion for **Safety** at all test locations **with recommendations**;
- fulfils the recommended criterion for **Walking** at all footpath locations;
- fulfils the recommended criterion for **Standing** at all building entrances **with recommendations**;
- fulfils the recommended criterion for **Sitting** at all outdoor seating areas **with recommendations**;
- fulfils the recommended criteria for **Walking** within the plaza **with recommendations**; and
- fulfils the recommended criteria for **Walking** at all communal terraces **with recommendations.**

The proposed development would not cause significant adversely impact to the adjacent areas.

As a general statement, common to all new developments, educating occupants about wind conditions at high-level terraces/balconies during high-wind events and tying down loose furniture are highly recommended.

Appendix A References

1. Australian/New Zealand Standard 1170.2:2002, Wind actions
2. Melbourne, W. H., "Criteria for Environmental Wind Conditions", Jour. Industrial Aerodynamics, Vol. 3, 241-249, 1978
3. Simiu E, Scanlan R, "*Wind Effects on Structures*". Wiley-Interscience
4. Aynsley R., Melbourne W., Vickery B., *Architectural Aerodynamics* Applied Science Publishers

Appendix B Drawing List

Received July 2022:

Architectural Drawings

Name

1015_A000_DRAWING REGISTER_T2.pdf

1015_A010_SITE PLAN_T2.pdf

1015_A100_BASEMENT LEVEL 2 FLOOR PLAN_T2.pdf

1015_A101_BASEMENT LEVEL 1 FLOOR PLAN_T2.pdf

1015_A102_GROUND LEVEL FLOOR PLAN_T2.pdf

1015_A103_LEVEL 1 FLOOR PLAN_T2.pdf

1015_A104_LEVEL 2 FLOOR PLAN_T2.pdf

1015_A105_LEVEL 3 FLOOR PLAN_T2.pdf

1015_A106_LEVEL 4 FLOOR PLAN_T2.pdf

1015_A107_LEVEL 5 FLOOR PLAN_T2.pdf

1015_A108_LEVEL 6 FLOOR PLAN_T2.pdf

1015_A109_LEVEL 7 FLOOR PLAN_T2.pdf

1015_A110_LEVEL 8 FLOOR PLAN_T2.pdf

1015_A111_LEVEL 9 FLOOR PLAN_T2.pdf

1015_A112_LEVEL 10 FLOOR PLAN_T2.pdf

1015_A113_LEVEL 11 FLOOR PLAN_T2.pdf

1015_A114_ROOF PLAN_T2.pdf

1015_A300_BASEMENT LEVEL 2 REFLECTED CEILING PLAN_T2.pdf

1015_A400_ELEVATIONS SHEET 1_T2.pdf

1015_A401_ELEVATIONS SHEET 2_T2.pdf

1015_A402_ELEVATIONS SHEET 3_T2.pdf

1015_A403_ELEVATIONS SHEET 4_T2.pdf

1015_A500_SECTION A-A_T2.pdf

1015_A501_SECTION B-B_T2.pdf

1015_A502_SECTION C-C_T2.pdf

1015_A503_SECTION D-D_T2.pdf

1015_A504_SECTION E-E_T2.pdf

1015_A505_SECTION F-F_T2.pdf

1015_A506_SECTION G-G_T2.pdf

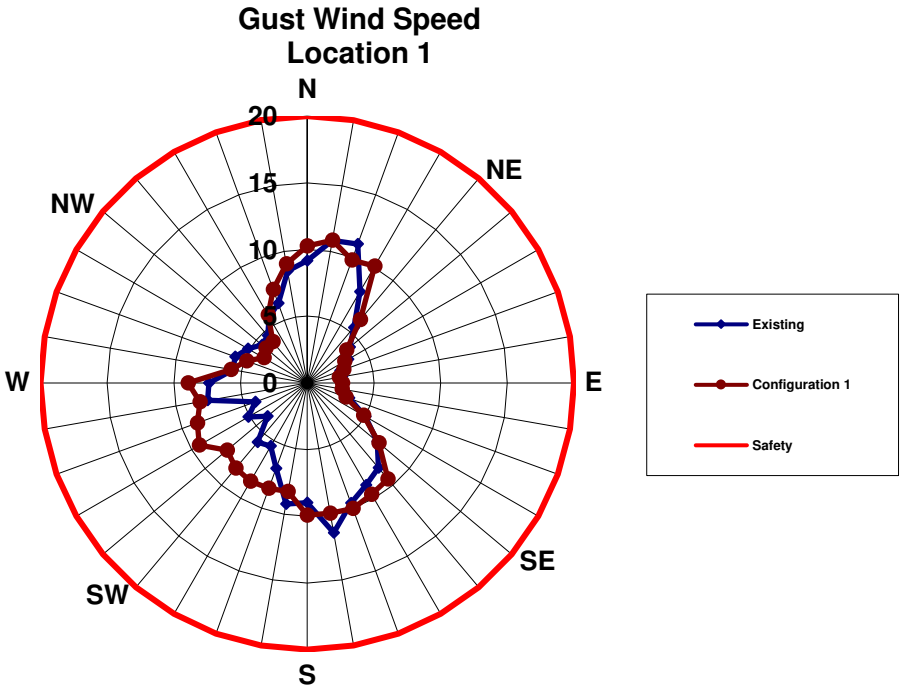
1015_A507_SECTION H-H_T2.pdf

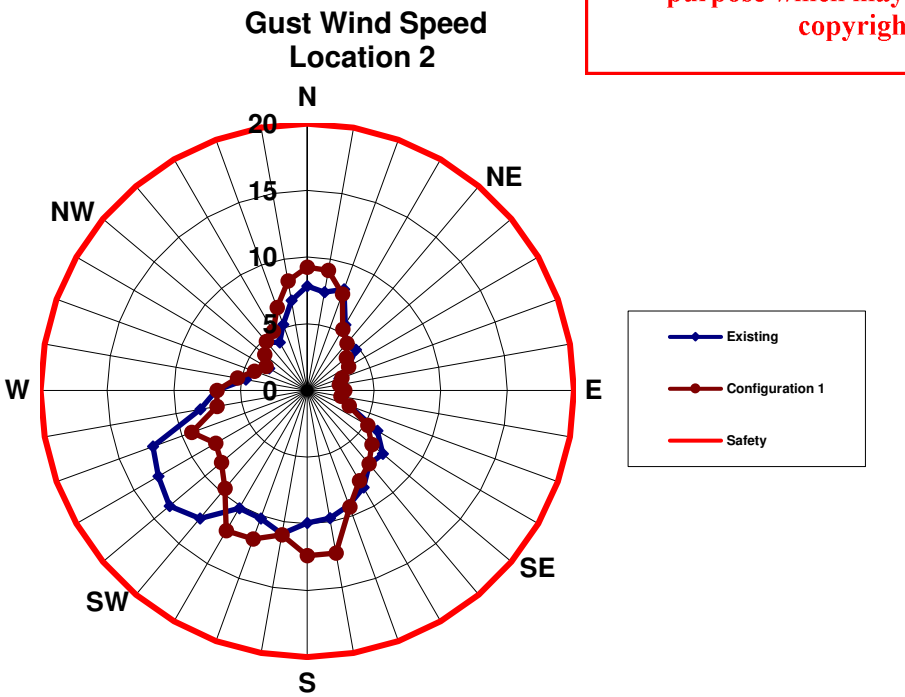
Received July 2022:

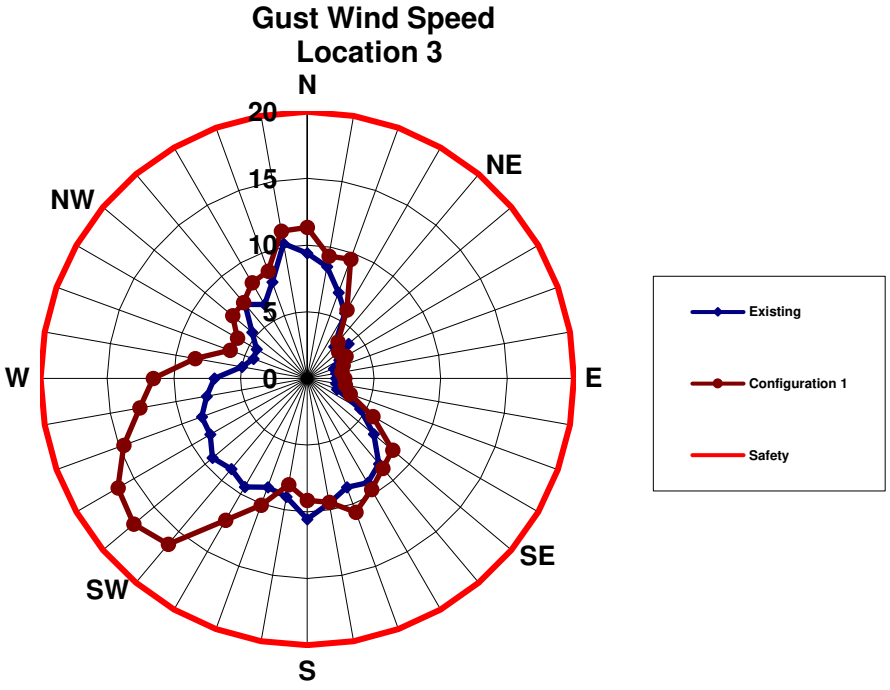
Landscape Drawings

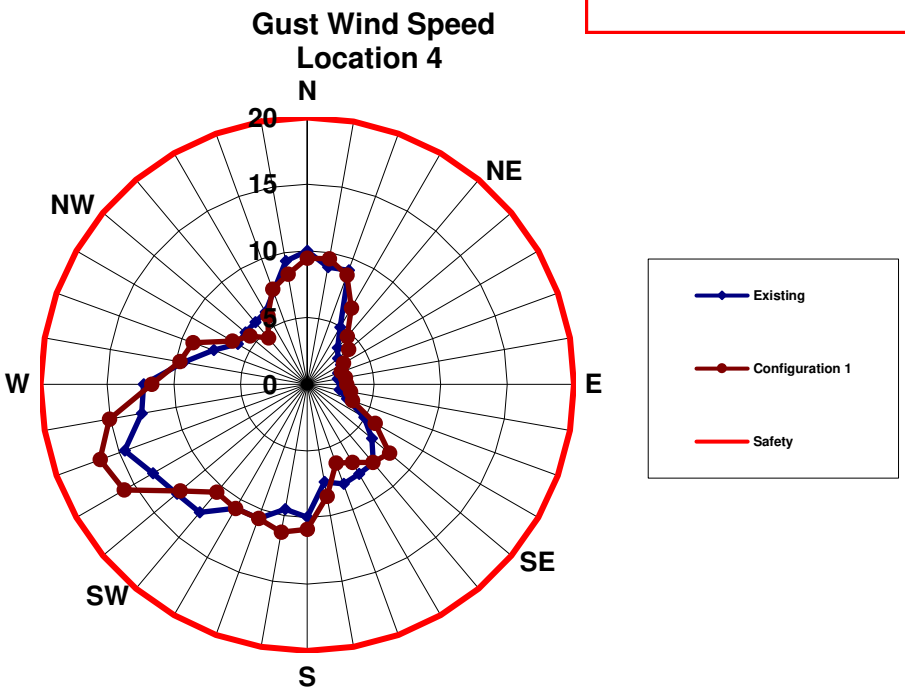
DRAWING NUMBER		DRAWING TITLE
319-0673-00-L-03 DR-101	-	COVER SHEET
319-0673-00-L-03 DR-102	-	LANDSCAPE SPECIFICATION
319-0673-00-L-03 DR-103	-	LANDSCAPE SCHEDULE - MATERIAL & FINISHES
319-0673-00-L-03 DR-104	-	LANDSCAPE SCHEDULE - PLANTING
319-0673-00-L-03 DR-300	-	GENERAL ARRANGEMENT PLAN 01 - GROUND FLOOR
319-0673-00-L-03 DR-301	-	GENERAL ARRANGEMENT PLAN 02 - LEVEL 01
319-0673-00-L-03 DR-302	-	GENERAL ARRANGEMENT PLAN 03 - LEVEL 06
319-0673-00-L-03 DR-303	-	GENERAL ARRANGEMENT PLAN 04 - LEVEL 11
319-0673-00-L-03 DR-304	-	GENERAL ARRANGEMENT PLAN 05 - SOUTHERN LANEWAY (INTERIM)
319-0673-00-L-03 DR-305	-	PLANTERS & SOIL VOLUME PLAN 01 - GROUND FLOOR
319-0673-00-L-03 DR-306	-	PLANTERS & SOIL VOLUME PLAN 02 - LEVEL 01
319-0673-00-L-03 DR-307	-	PLANTERS & SOIL VOLUME PLAN 03 - LEVEL 06
319-0673-00-L-03 DR-308	-	PLANTERS & SOIL VOLUME PLAN 04 - LEVEL 11
319-0673-00-L-03 DR-400	-	PLANTING PLAN 01 - GROUND FLOOR
319-0673-00-L-03 DR-401	-	PLANTING PLAN 02 - LEVEL 01
319-0673-00-L-03 DR-402	-	PLANTING PLAN 03 - LEVEL 06
319-0673-00-L-03 DR-403	-	PLANTING PLAN 04 - LEVEL 11
319-0673-00-L-03 DR-404	-	PLANTING PLAN 05 - SOUTHERN LANEWAY (INTERIM)
319-0673-00-L-03 DR-600	-	LANDSCAPE DETAILS 1 MCC - PAVING
319-0673-00-L-03 DR-601	-	LANDSCAPE DETAILS 2 MCC - FURNITURE
319-0673-00-L-03 DR-602	-	LANDSCAPE DETAILS 3 ON-STRUCTURE - PAVING
319-0673-00-L-03 DR-603	-	LANDSCAPE DETAILS 4 ON-STRUCTURE - PLANTERS
319-0673-00-L-03 DR-604	-	LANDSCAPE DETAILS 5 ARBOUR STRUCTURE
319-0673-00-L-03 DR-605	-	LANDSCAPE DETAILS 6 FENCING
319-0673-00-L-03 DR-606	-	LANDSCAPE DETAILS 7 CUSTOM FURNITURE & JOINERY
319-0673-00-L-03 DR-607	-	LANDSCAPE DETAILS 8 SOFT LANDSCAPE

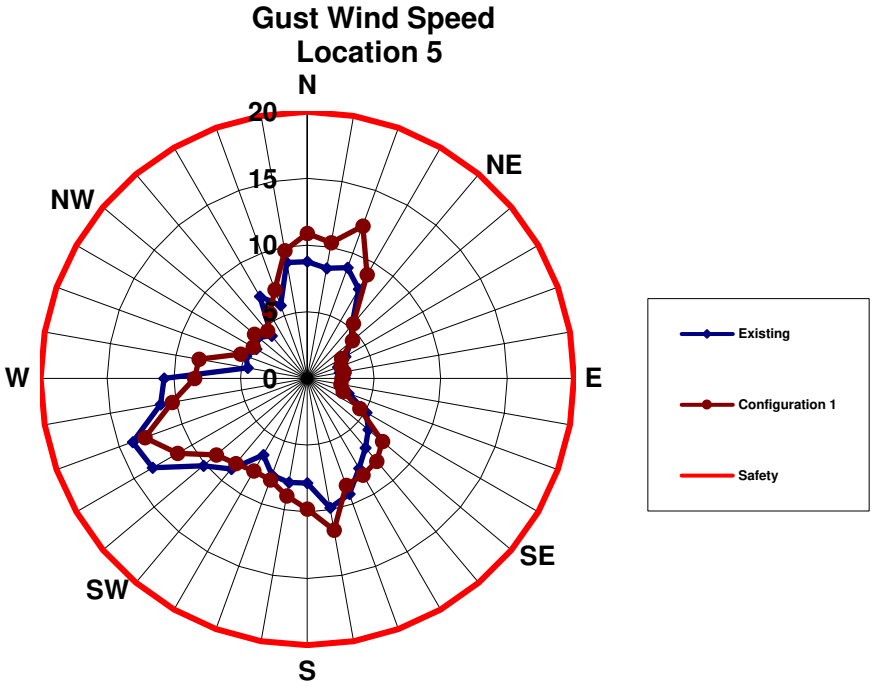
Appendix C Omni Polar Plots - Gust Wind Speed (Safety Criterion)

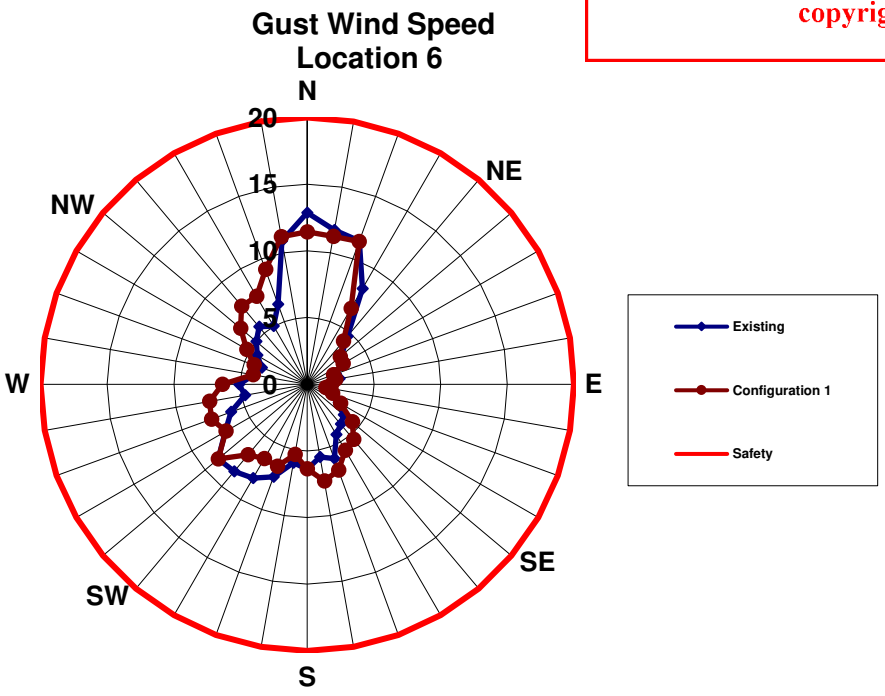


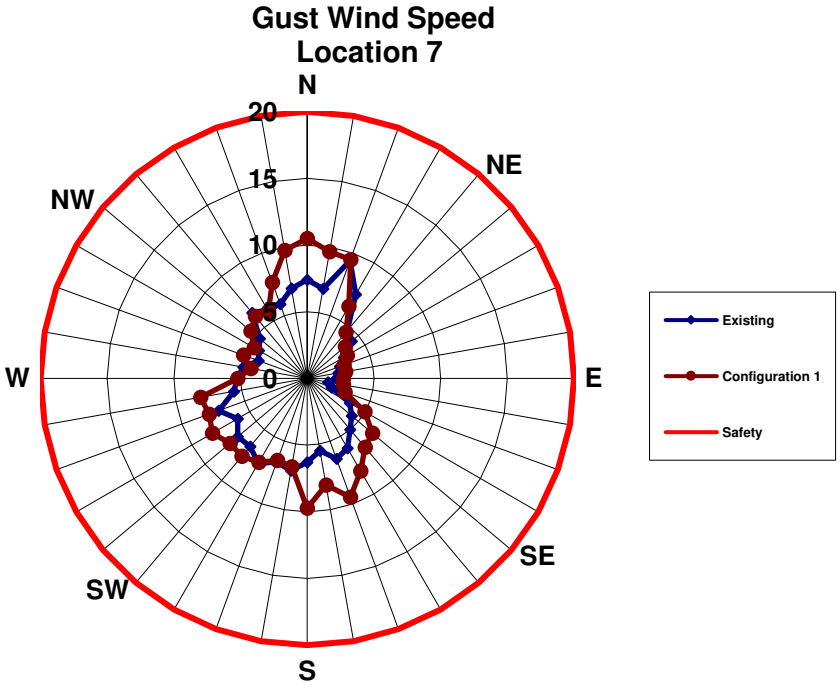


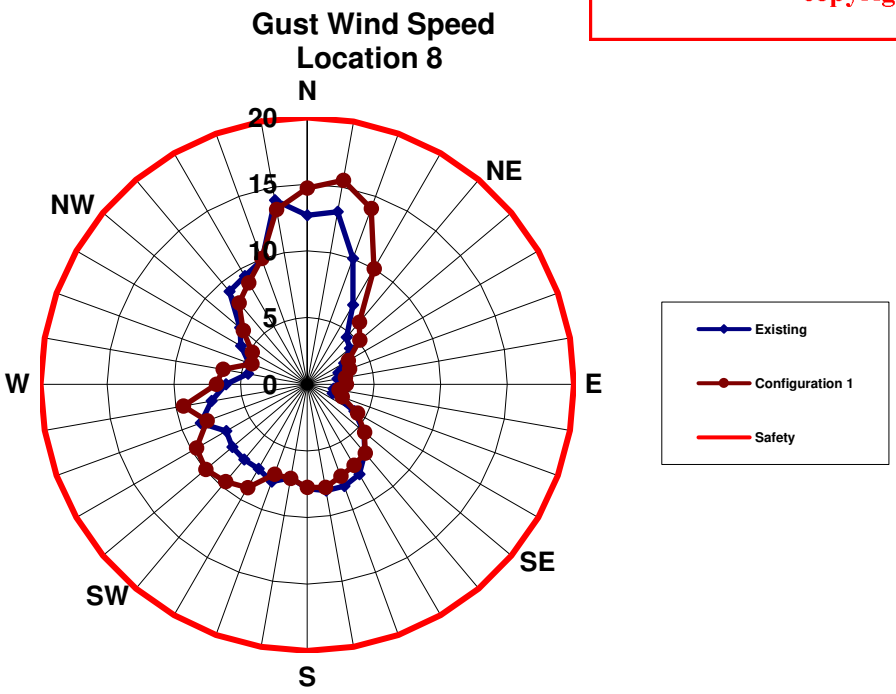


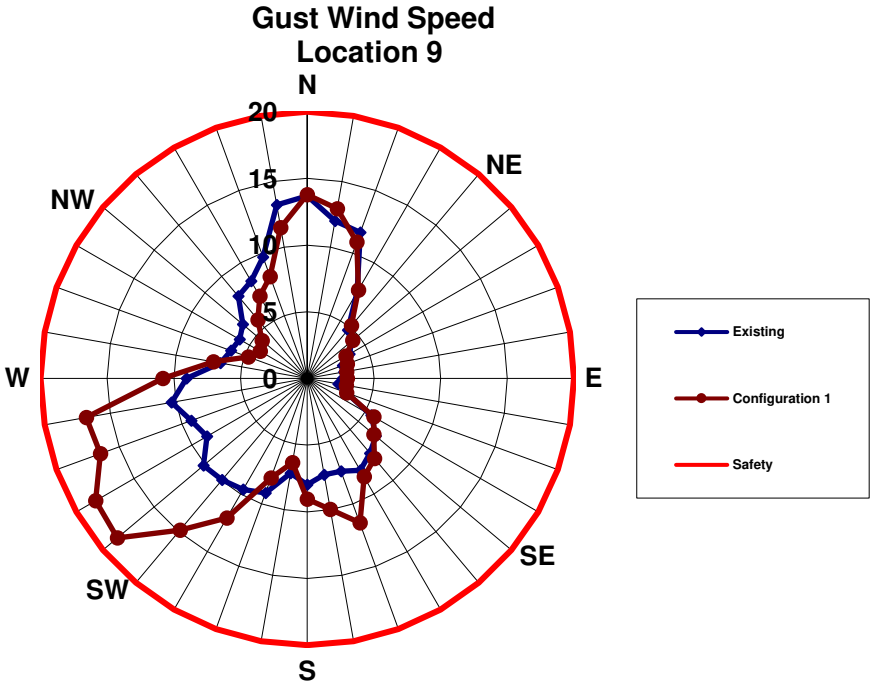


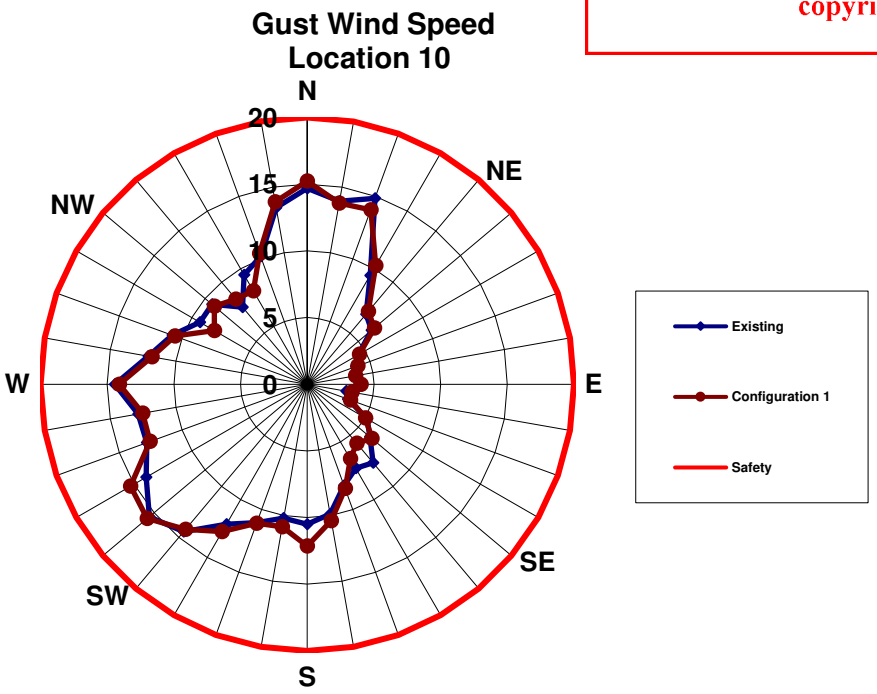


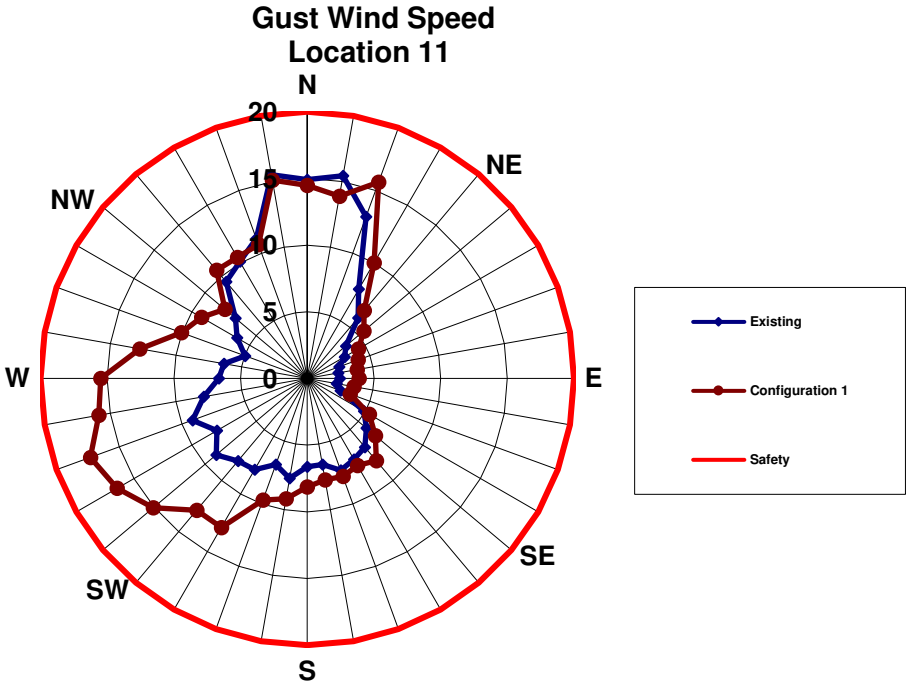


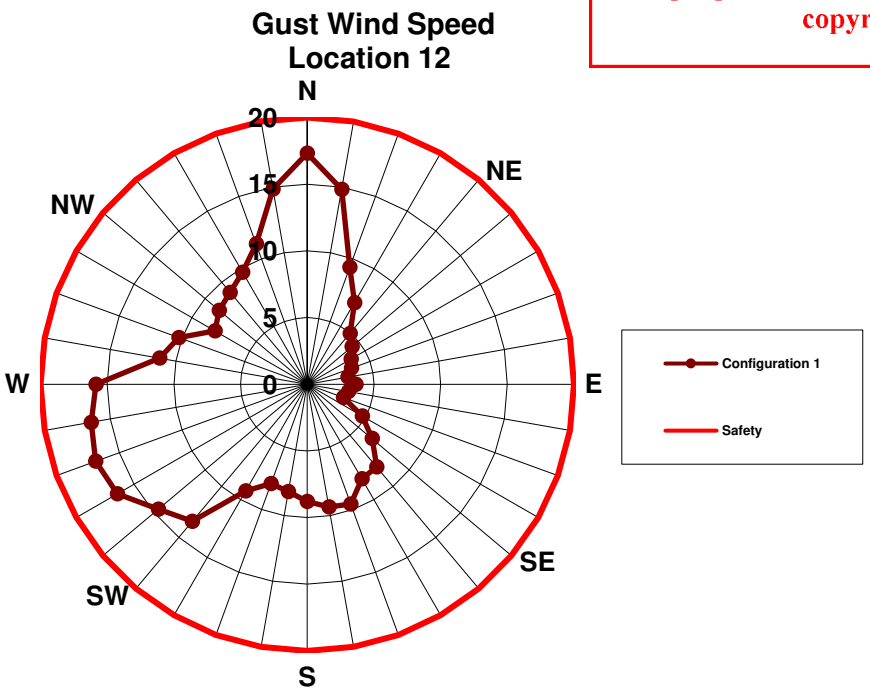


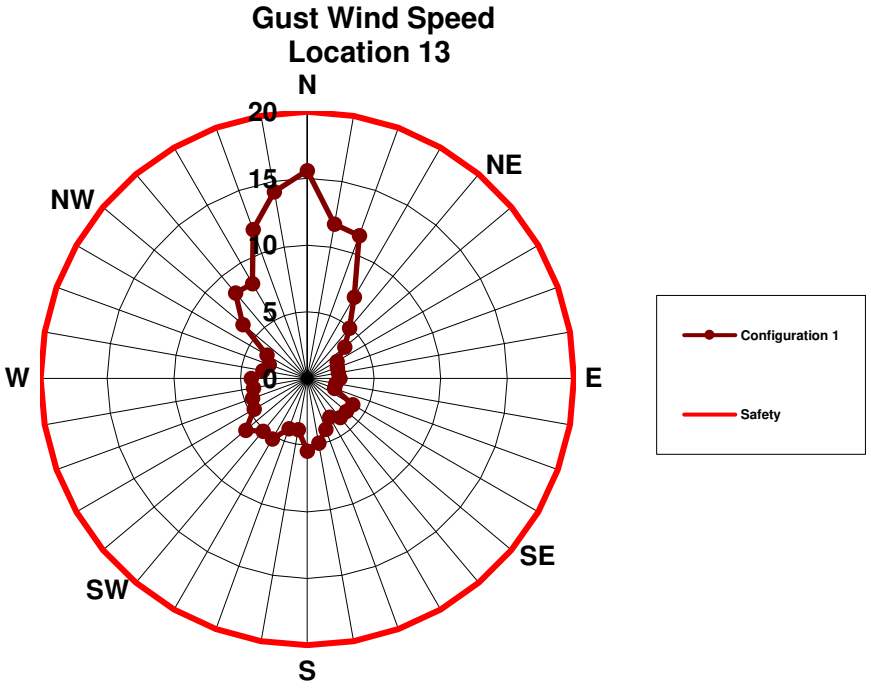


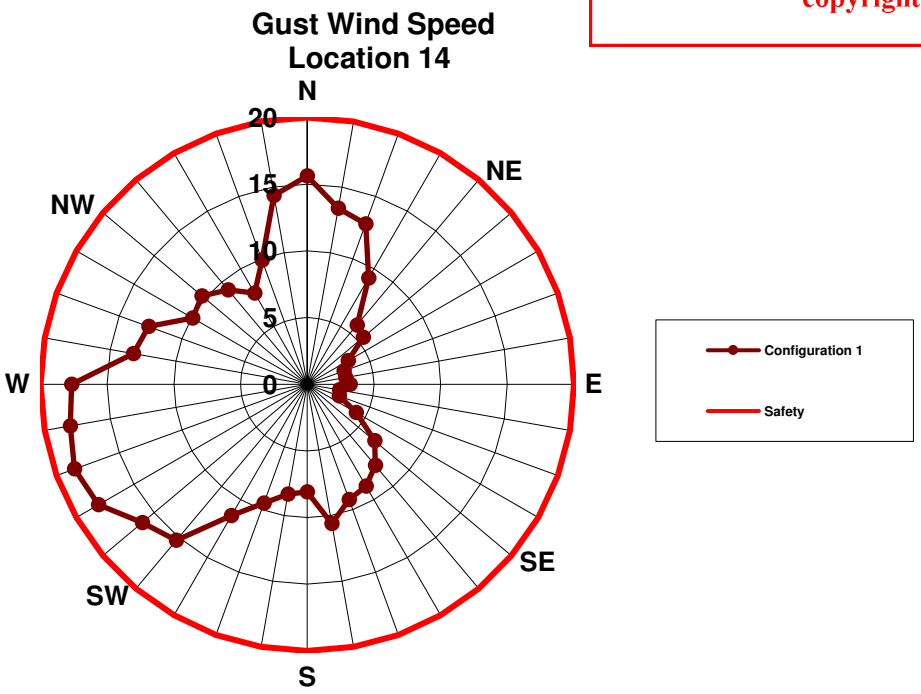


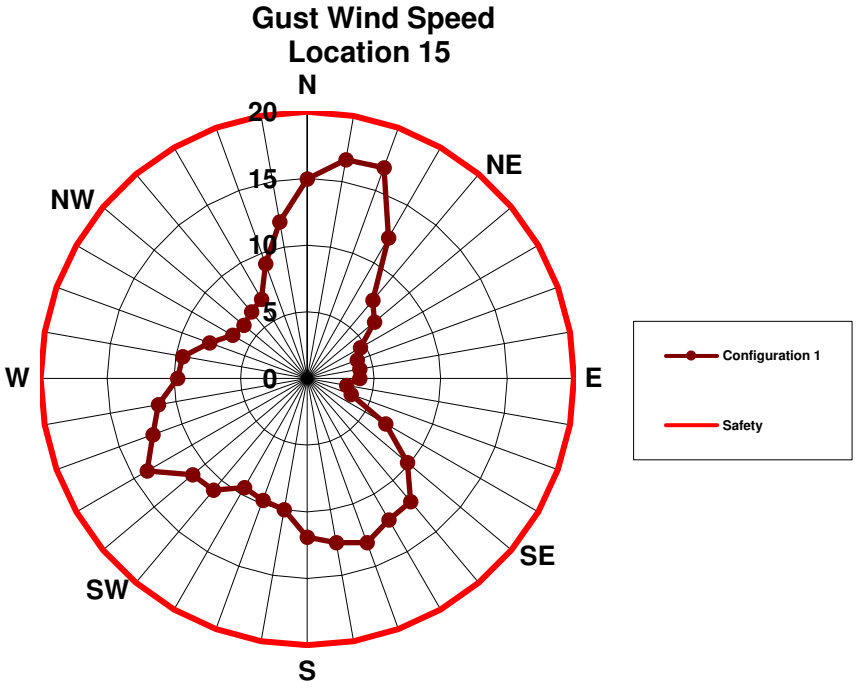


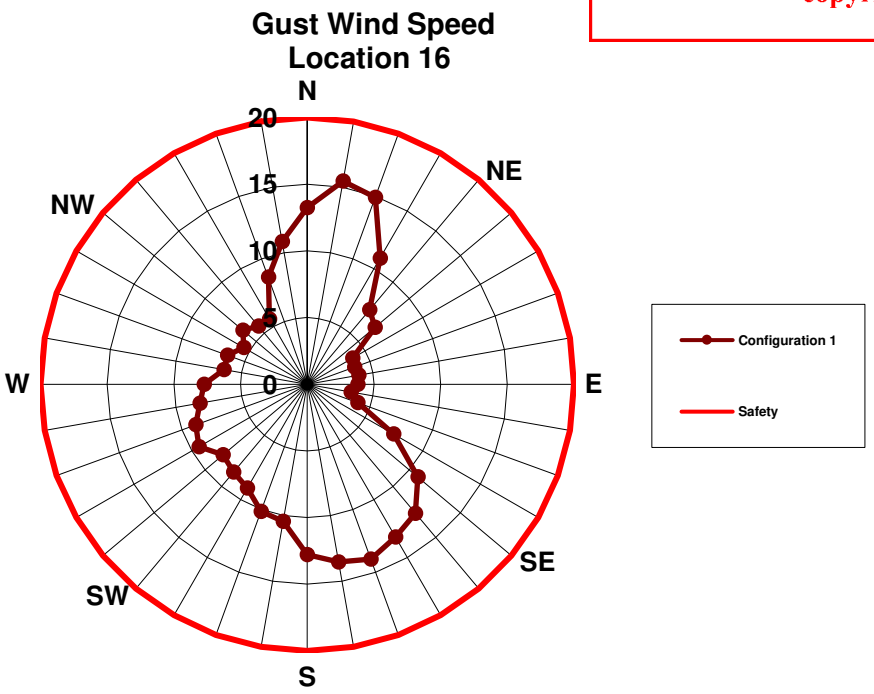


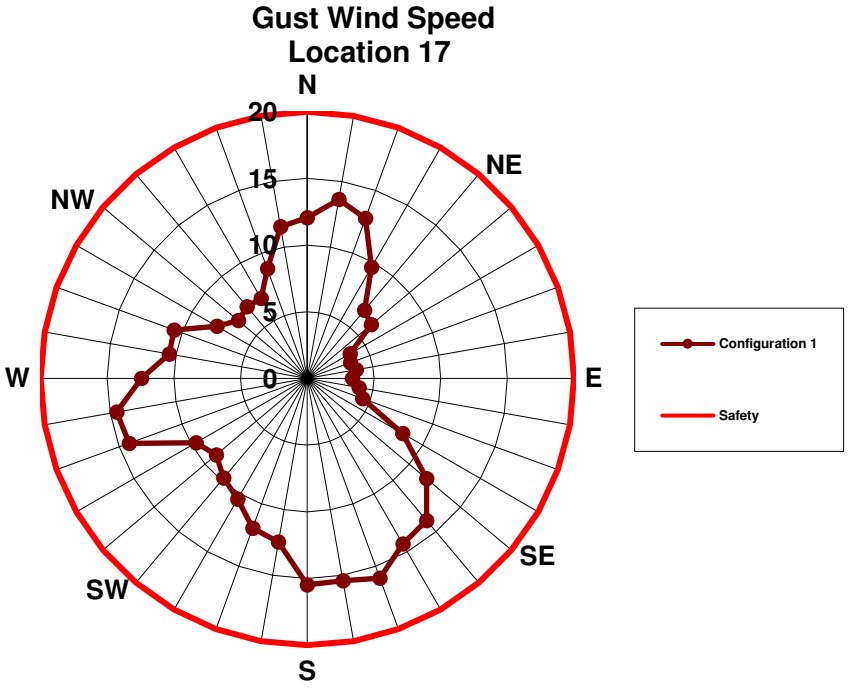


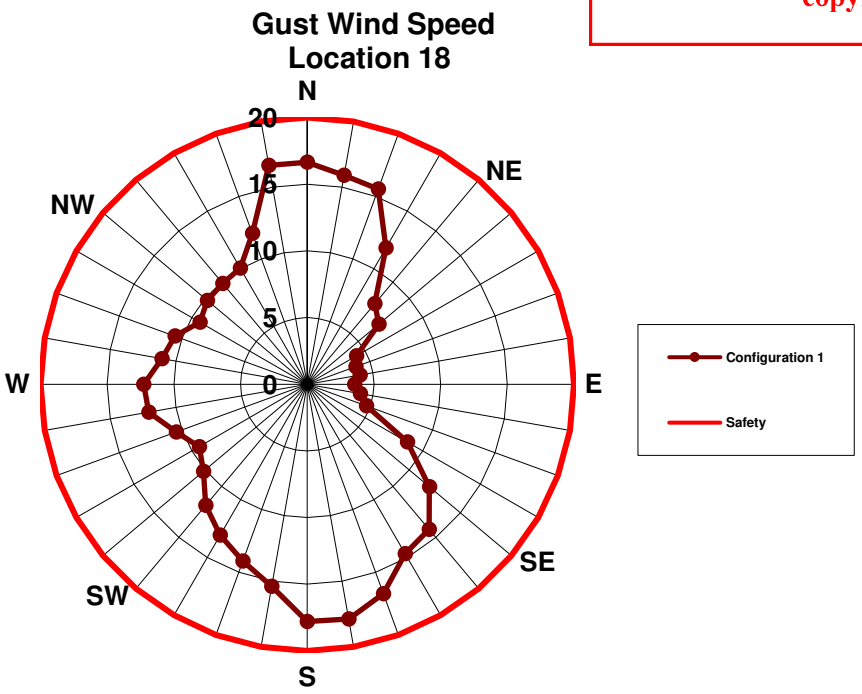


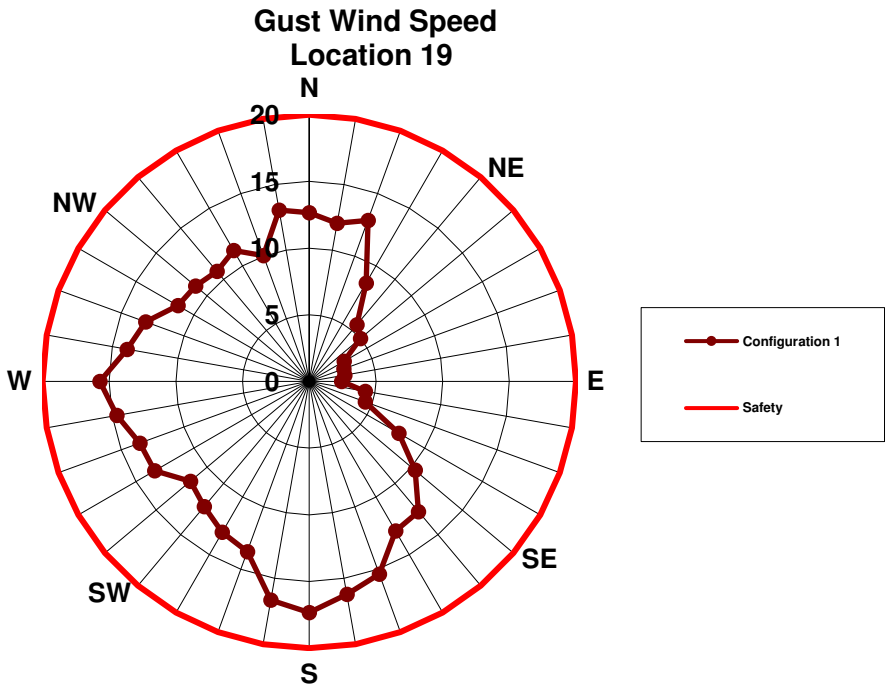


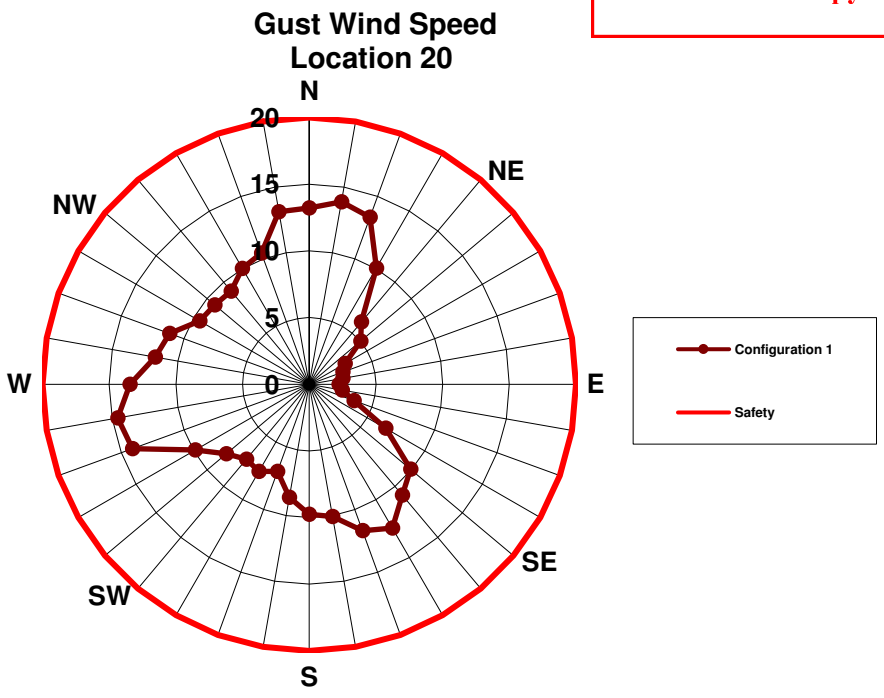


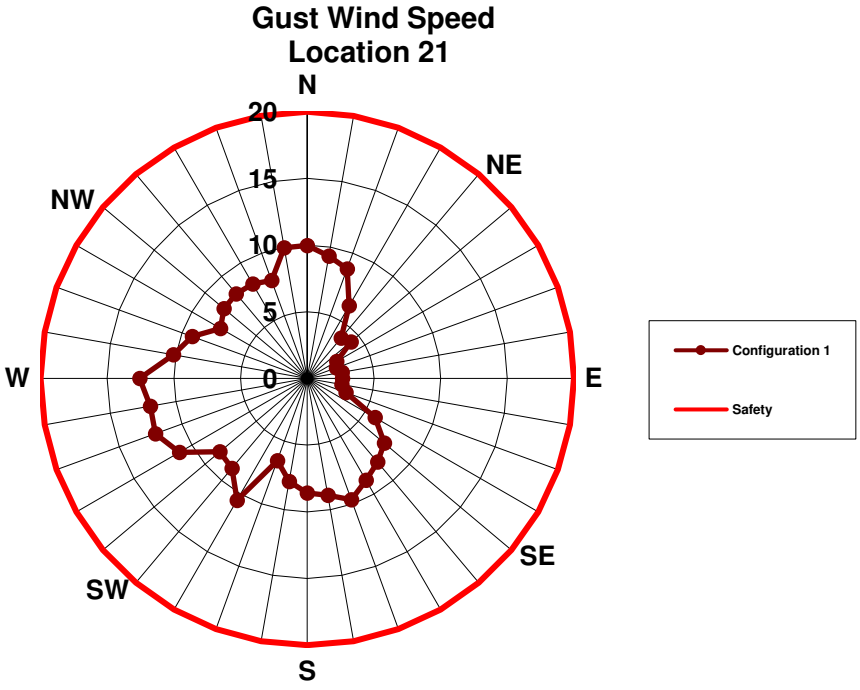


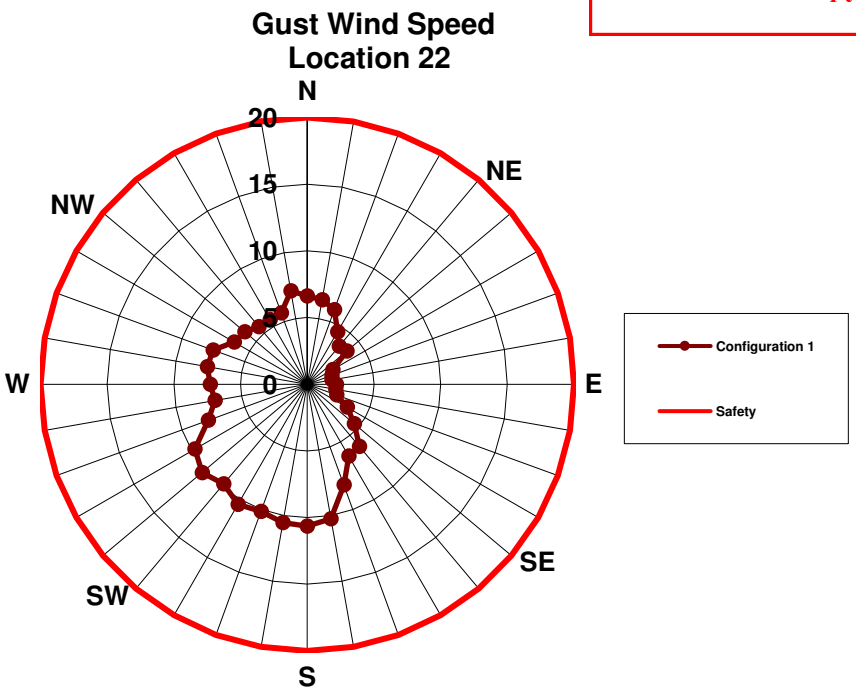


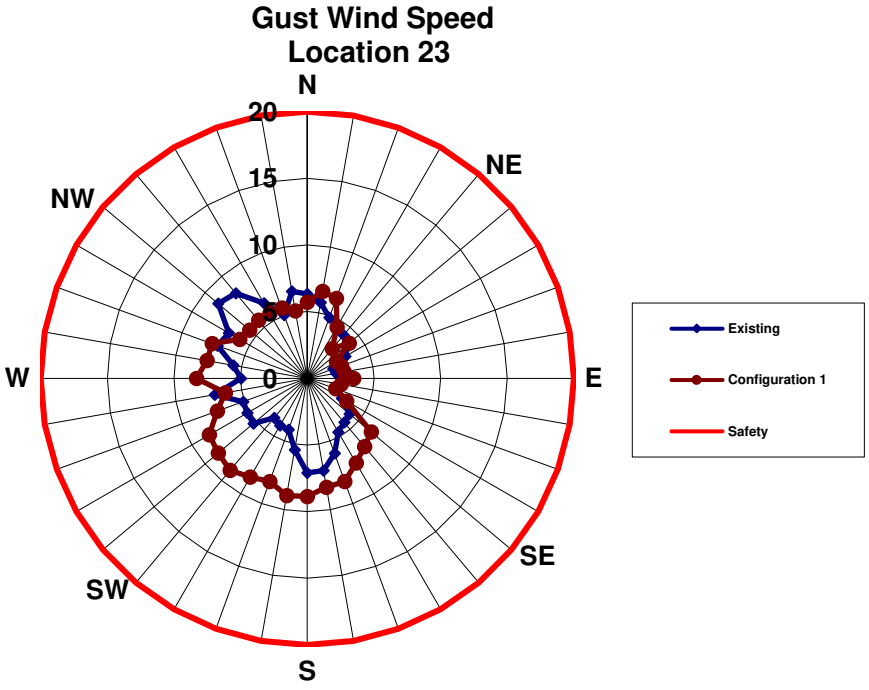


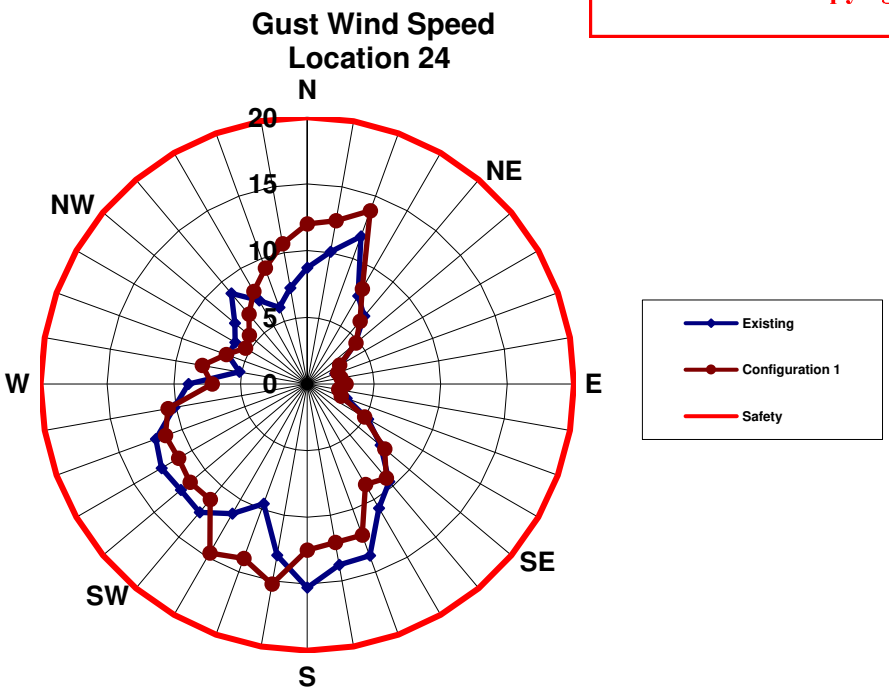


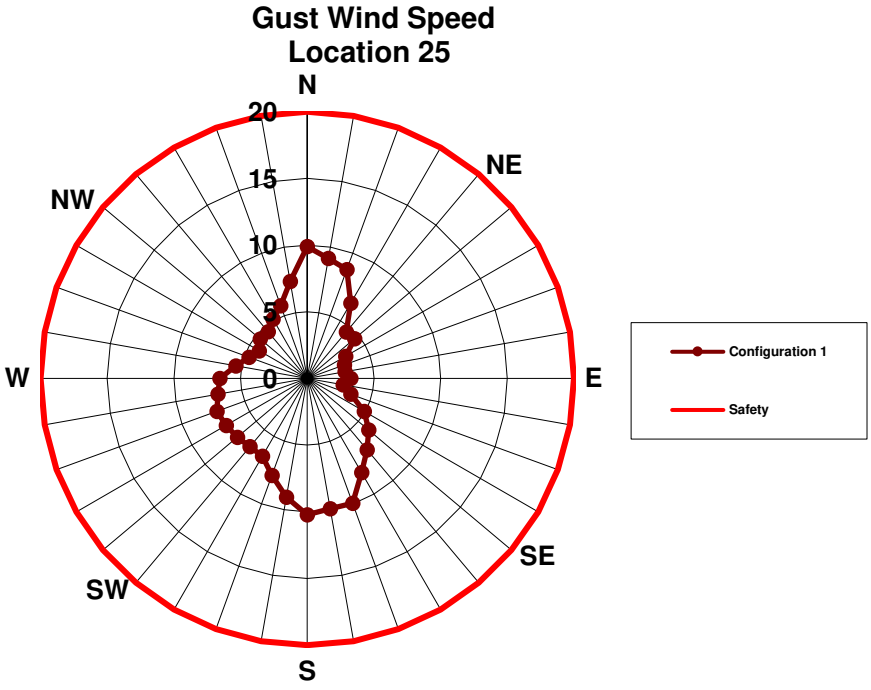


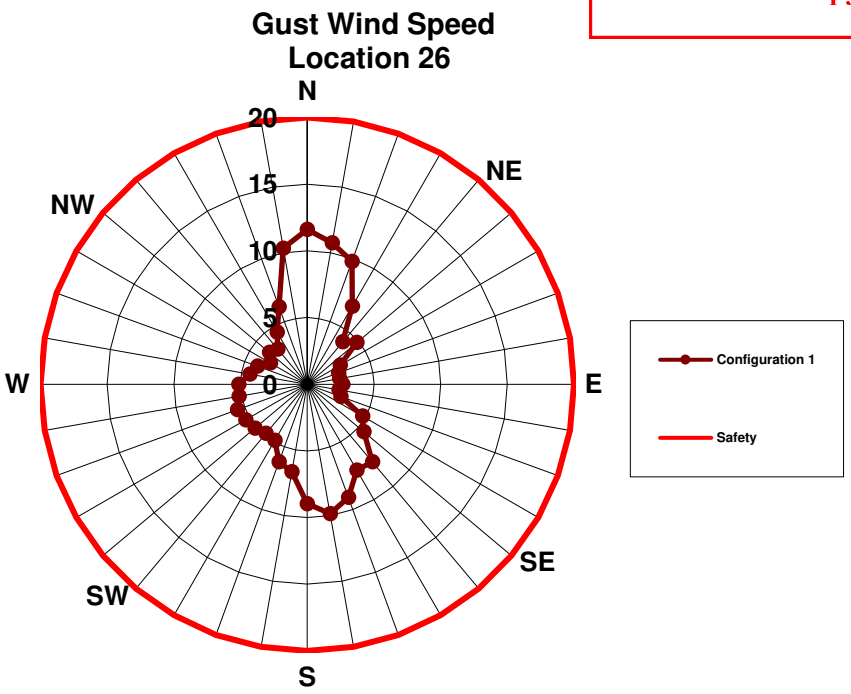


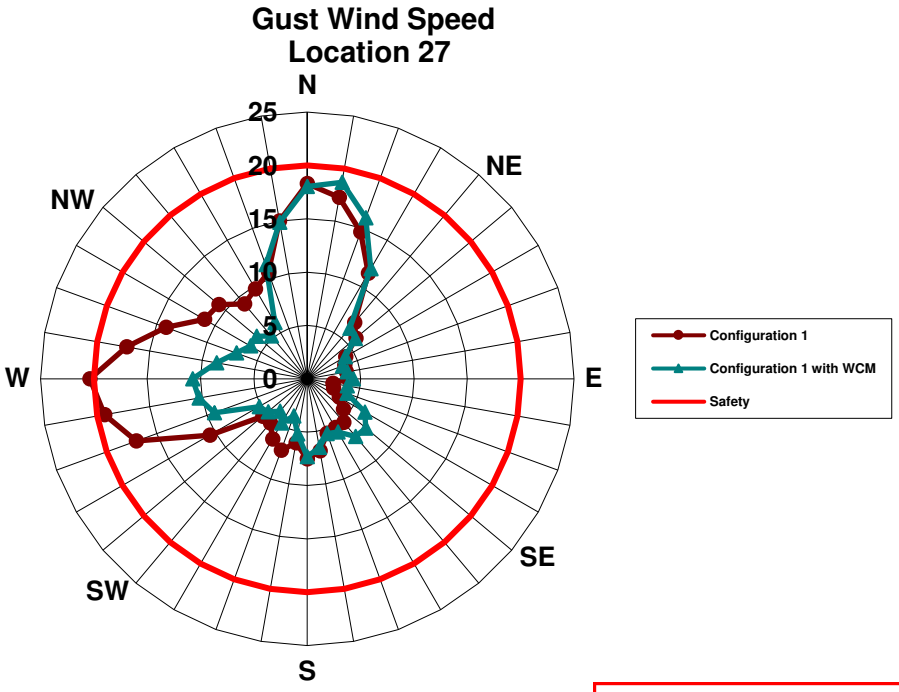


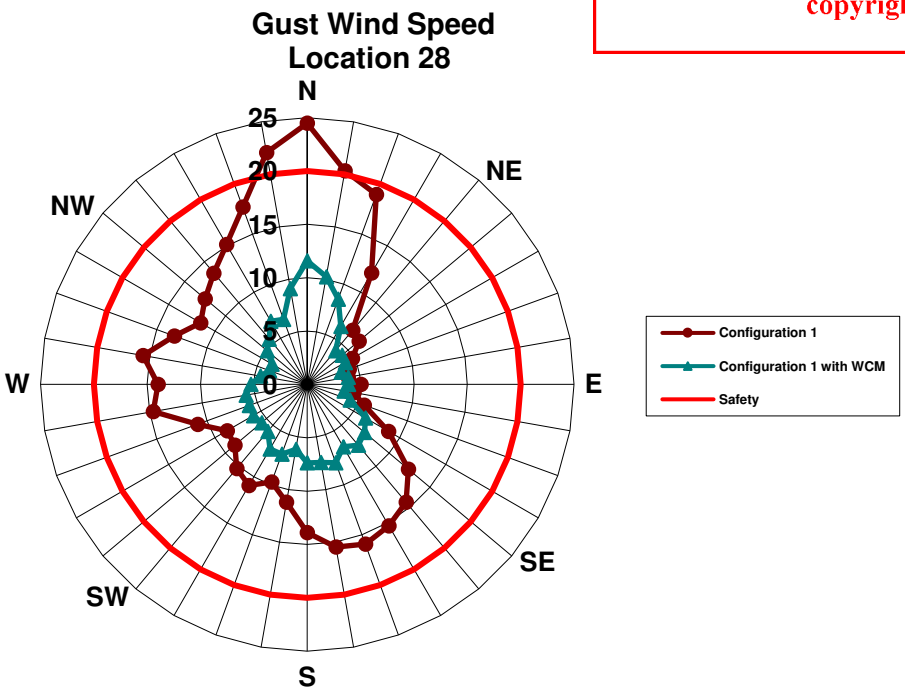


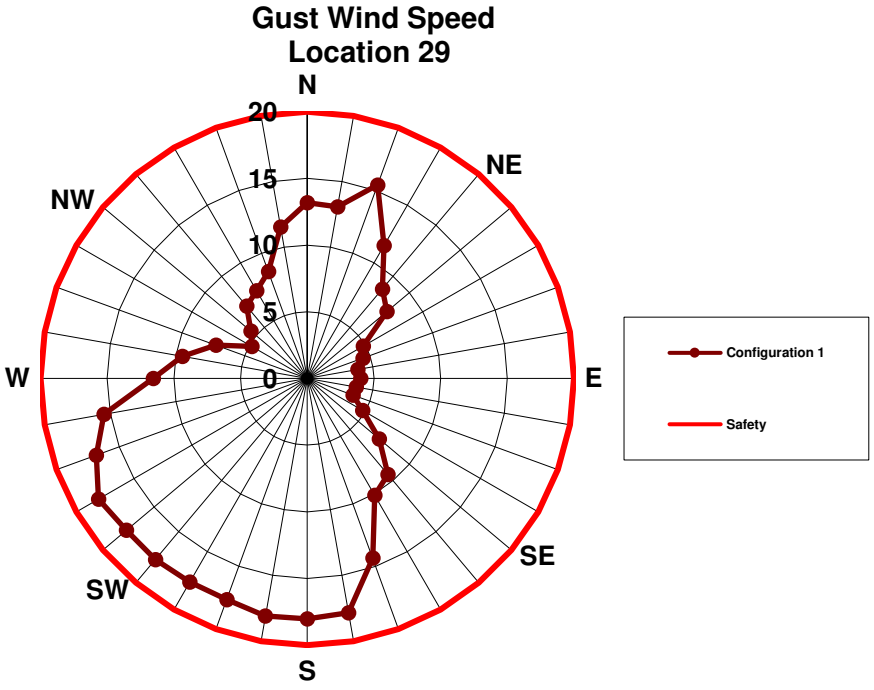


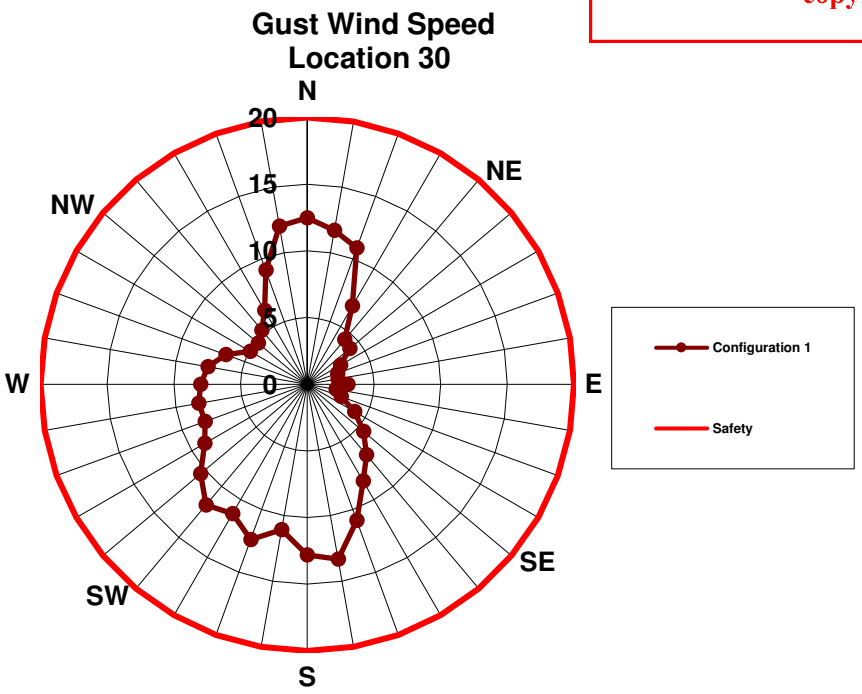


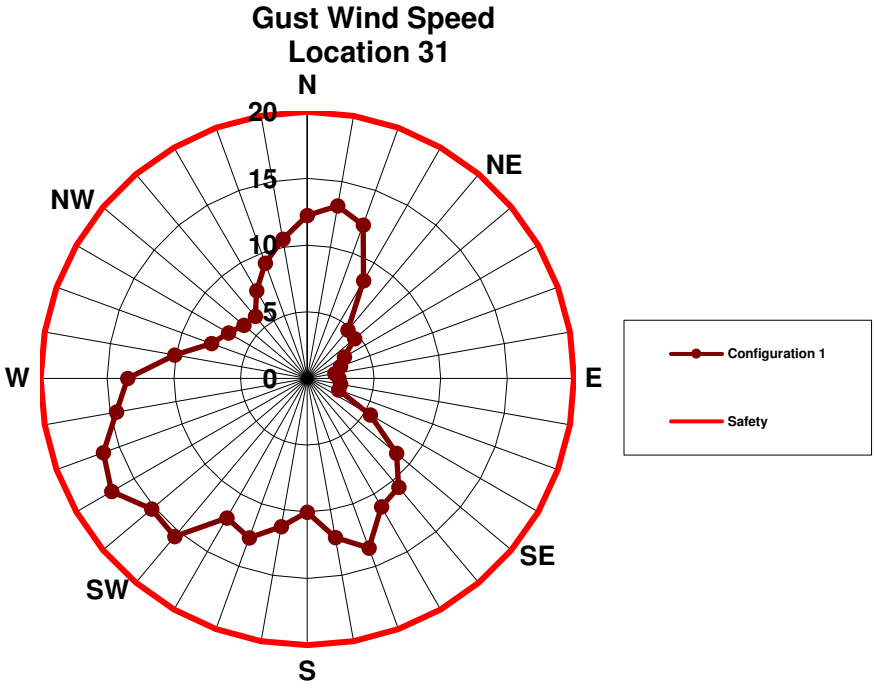


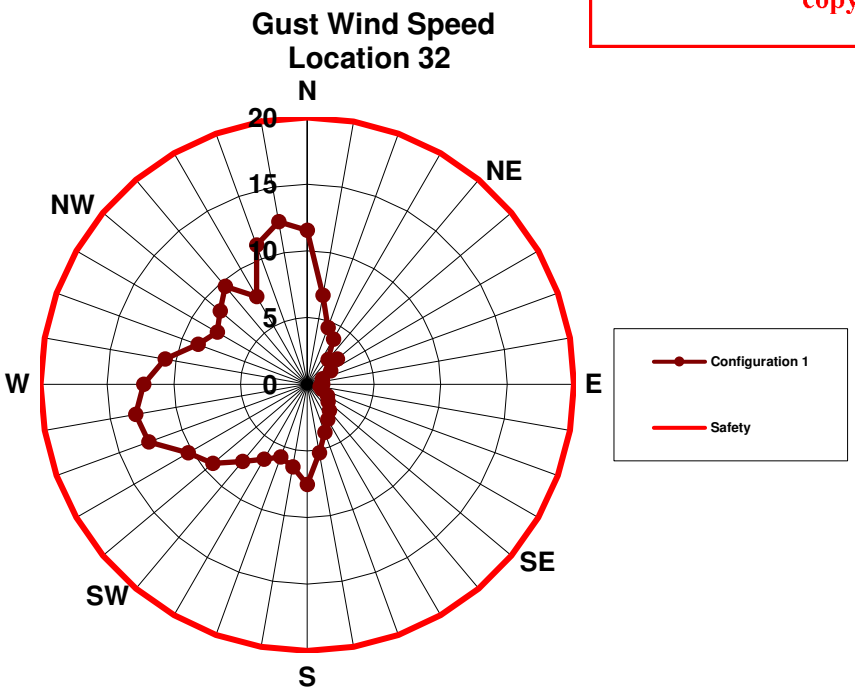












Appendix D Up-crossing Prediction

The up-crossing method was used at Boundary Layer Wind Tunnel Laboratory, University of Western Ontario decades ago and adapted at VIPAC recently. The methodology is based on the following theory.

The expected number of excursions beyond a level x per unit time, or the rate of crossing with positive slope, according to Rice's theory (D.2), is given by:

$$N_x(x) = \int_0^\infty \dot{x}\, p(x, \dot{x})\, dx \tag{1}$$

where $\dot{X}$ is the rate of change of x and $p(x, \dot{x})$ is the joint probability density function of x and $\dot{X}$. For a stationary random process, x and $\dot{X}$ are statistically independent, thus

$$p(x, \dot{x}) = p(x)\, p(\dot{x}) \tag{2}$$

For a Gaussian process,

$$\int_0^\infty \dot{x}\, p(\dot{x})\, d\dot{x} = \frac{\sigma_{\dot{x}}}{\sqrt{2\pi}} \tag{3}$$

where $\sigma_{\dot{x}}$ is the standard deviation of $\dot{x}(t)$. Thus, the crossing rate now becomes

$$N_x(x) = \frac{\sigma_{\dot{x}}}{\sqrt{2\pi}}\, p(x) \tag{4}$$

The statistical frequency or the cycling rate of process $x(t)$ is defined as

$$\nu = \frac{1}{2\pi}\, \frac{\sigma_{\dot{x}}}{\sigma_x} \tag{5}$$

Substituting this in equation (4) yields

$$N_x(x) = \sqrt{2\pi}\, \nu\, \sigma_x\, p(x) \tag{6}$$

Extending Rice's theory, Davenport (D.3) has shown that for a two-dimensional variable, $x = x(V, \alpha)$, the crossing rate of a particular boundary $x = x_1$ becomes:

$$N_x(x) = \sqrt{2\pi}\, \nu\, \sigma \int_0^{2\pi} \sqrt{1 + \left(\frac{d V_1}{V_1\, d\alpha} \right)^2}\; p_V(V_1, \alpha)\, d\alpha \tag{7}$$

where $x_1 = x(V_1, \alpha)$ and $p_V(V, \alpha)$ is the joint probability density function of V and α.

Approximating the probability distribution of the wind speed V and the direction α by a generalized Weibull distribution,

$$p_V(>V, \alpha) = A(\alpha)\, e^{-|V/C(\alpha)|^{K(\alpha)}} \tag{8}$$

the probability density function of V and α becomes

$$p_V(V, \alpha) = A(\alpha)\, \frac{K(\alpha)}{C(\alpha)} \left(\frac{V}{C(\alpha)} \right)^{|K(\alpha)-1|} e^{-|V/C(\alpha)|^{K(\alpha)}}\, d\alpha \tag{9}$$

Hence the crossing rate of a particular boundary $x_1 = x_1(V_1, \alpha)$ from Equation (7) becomes:

$$N_x(x_1) = \sqrt{2\pi}\, \nu\, \alpha \int_0^{2\pi} \left\{ 1 + \frac{d V_1}{V_1\, d\alpha} \right\}^{\frac{1}{2}} A(\alpha)\, \frac{K(\alpha)}{C(\alpha)} \left(\frac{V}{C(\alpha)} \right)^{|K(\alpha)-1|} e^{-|V/C(\alpha)|^{K(\alpha)}}\, d\alpha \tag{10}$$

The cycling rate, ν, and the standard deviation, σ, in Equation (10) are taken as those of the wind speed, V, regardless of direction; namely they are based on the marginal statistical properties of V and $\dot{V}$. With ν expressed in terms of occurrences per annum, $N_x(x_1)$ gives the yearly crossing rate.

The return period, or the average interval of time between events during which the response equals or exceeds the response boundary $x = x_1$, is the inverse of the crossing rate of that boundary. Consequently, from Equation (10) the return period for the response level $x = x_1$ in years is taken as

$$R_x(x_1) = \frac{1}{N_x(x_1)} \tag{11}$$

The risk of exceeding the response level associated with the return period $R_x(x_1)$ in a time period L is:

$$r(x_1) = 1 - \left(1 - \frac{1}{R_x(x_1)}\right)^L \quad (12)$$

From the above equation, the risk of exceeding x_1 within a time interval of $L = R_x(x_1)$ is approximately 63 percent.

Appendix E References

[D.1] Irwin, P, Garber, J and Ho, E., "Integration of Wind Tunnel Data with Full Scale Wind Climate", 10th Americas Conference on Wind Engineering, Baton Rouge, Louisiana, U.S.A., May 2005.

[D.2] Rice, S.O., "Mathematical Analysis of Random Noise", Bell Tech. Journal Vol. 18 and 19, 1945.

[D.3] Davenport, A.G., "The Prediction of Risk Under Wind Loading", 2nd International Conf. on Structural Safety and Reliability (ICOSSAR), Sept. 1977, Munich Germany.