

**ENVIRONMENTAL WIND SPEED MEASUREMENTS
ON A WIND TUNNEL MODEL OF THE LINKS DEVELOPMENT, 1041
CENTRE ROAD, OAKLEIGH SOUTH**

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SUMMARY

Wind tunnel tests have been conducted on a 1/400 scale model of The Links Development, 1041 Centre Road, Oakleigh South. The model of the Development within surrounding buildings and with no existing or future street trees, was tested in a simulated upstream boundary layer of the natural wind to determine likely environmental wind conditions. These wind conditions have been related to the freestream mean wind speed at a reference height of 300m and compared with wind comfort criteria region as a function of wind direction.

For the Proposed Configuration, wind conditions for all Test Locations in the streetscapes surrounding the development have been shown to pass the walking comfort criterion; with many Test Locations on the east side of the development and along the under-croft passage at ground level also passing the sitting comfort criterion. It has been shown that the use of a 1.5m screen at the northeast corner at ground level would further improve the wind conditions in that area.

The wind conditions for the Proposed Configuration in the streetscapes that surround The Links Development pass the safety criterion. The wind conditions for the Existing Configuration at many Test Locations have been included for comparison.

The wind conditions at certain Test Locations on the Podium Garden at Level 1 have been shown to approach the safety limit as a result of flow deflecting off the north face of the development. However, with the inclusion of higher balustrades along the northern edge

of the podium and the inclusion of a planter box placed near these locations as wind mitigation strategies, the wind conditions have been shown to improve significantly.



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**ENVIRONMENTAL WIND SPEED MEASUREMENTS
THE LINKS DEVELOPMENT
1041 CENTRE ROAD, OAKLEIGH SOUTH**

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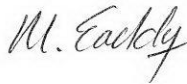

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INTRODUCTION

The Links development at 1041 Centre Road, Oakleigh South, will be a 9-storey multipurpose building with height of approximately 33.5m and will be bounded by Centre Road to the south, Ventura Oakleigh Depot to the west and Link Avenue to the north and east, as highlighted in Figure 1.



Figure 1: Location of The Links development at the 1041 Centre Road, Oakleigh South site.

A wind tunnel model study was commissioned by Pellicano Group to investigate the environmental wind effects of the proposed development and, if necessary, to develop wind amelioration features to achieve conditions satisfying the recommended environmental wind criteria. This study was undertaken in the MEL Consultants 400kW Boundary Layer Wind Tunnel during July 2021.

1. ENVIRONMENTAL WIND CRITERIA

The advancement of wind tunnel testing techniques, using large boundary layer flows to simulate the natural wind, has facilitated the prediction of wind speeds likely to be induced around a development. To assess whether the predicted wind conditions are likely to be acceptable or not, some form of criteria are required. The Department of Environment, Land, Water and Planning (DELWP) has developed wind comfort criteria for the assessment of the wind conditions for apartment developments in Victoria. These are known as the Better Apartment Design (BAD) Guidelines. The definition of the criteria is as follows:

Unsafe wind conditions means the hourly maximum 3 second gust which exceeds 20 metres/second from any wind direction considering at least 16 wind directions with the corresponding probability of exceedance percentage.

Comfortable wind conditions means a mean wind speed from all wind directions combined with probability of exceedance less than 20% of the time, equal to or less than:

- 3 metres/second for **sitting areas**
 - Sitting criterion: generally acceptable for stationary, long exposure activities such as dining at outdoor restaurants or theatres.
- 4 metres/second for **standing areas**
 - Standing criterion: generally acceptable for stationary short exposure activities such as window shopping, standing or sitting in plazas.
- 5 metres/second for **walking areas**
 - Walking criterion: generally acceptable for walking in urban and suburban areas.

Mean wind speed means the maximum of:

- Hourly mean wind speed, or
- Gust equivalent mean wind speed (3 second gust wind speed divided by 1.85)

The above comfort criteria are pass/fail criteria which assess the integrated probability of all wind directions to determine whether a location passes or fails the threshold criterion.

The safety criterion is a pass/fail criterion based upon exceedance of the wind speed for any one wind direction. For completeness, this report will provide data for each Test Location as a function of wind direction in Appendix A.

The BAD Guidelines do not provide any methodology or worked example as how to obtain the 'from all wind directions combined'. Therefore, to obtain the probability for all wind directions combined we will apply the methodology described in Melbourne (1978) to determine the probability for all wind directions. The Guidelines use the definition of mean wind speed as based on the hourly wind speed so the probabilities will be determined from the hourly wind data for an applicable automatic weather station for the Melbourne City. The probability data used have been corrected for the approach terrain at the location of the automatic weather station and referenced to 10m in Terrain Category 2. This is the standard reference height of AS/NZS1170.2:2011.

2.1 Suggested Pedestrian Comfort Criteria.

The Links development at 1041 Centre Road, Oakleigh South will have hospitality and retail tenancies on the Ground Floors, podium garden at Level 1 and Roof space amenities. The main foyer for the apartment can be accessed via swinging doors from the under-croft passage created between the Ground Floor tenancies.

The following wind criteria are suggested for the surrounding streetscapes:

- | | |
|------------------------------|--------------------|
| - Pedestrian transit areas | Walking Criterion |
| - Building/Tenancy entrances | Standing Criterion |
| - Terraces/Balconies | Walking Criterion |

The activation of the public realm external to the site would depend on the existing wind conditions in the streetscapes that are often beyond the control of the proposed development. For cases where the existing wind conditions in the public realm external to the site are on or above the walking criterion, then the proposed development should not have any adverse wind effects in these areas.

The wind conditions on private outdoor areas have been recommended to satisfy the walking criterion as these spaces could be considered elective when external conditions would be perceived as acceptable for the desired activity. Users of these terraces will need to be educated on the wind effects and loose objects should not be left unattended in outdoor areas. However, if outdoor terraces are intended to be used as breakout spaces for commercial offices then standing and sitting criteria may be appropriate due to an expectation of higher utilisation.

2. MODEL AND EXPERIMENTAL TECHNIQUES

A 1/400 scale model of The Links Development was constructed from digital information provided by i2C Architecture and received 23rd June 2021.

The scale model of the Development was inserted into a proximity model with significant surrounding buildings, including any under construction out to a minimum radius of 300m. The building model was tested in a model of the natural wind generated by flow over roughness elements augmented by vorticity generators at the beginning of the wind tunnel working section. The basic natural wind model was for flow over suburban terrain roughness, terrain category 3, as shown in Figure 2. The surrounding wind tunnel model modified the approach wind model for the presence of the surrounding buildings.

The techniques used to investigate the environmental wind conditions and the method of determining the local criteria are given in detail in Reference 2. In these tests measurements in the Development areas are inside separated regions and peak velocity squared ratios were required to make conclusions about likely wind conditions. In summary, measurements were made of the peak gust wind velocity with a hot wire anemometer at various stations and expressed as a squared ratio with the mean wind velocity at a scaled reference height of 300m. This gives the peak velocity squared ratio

$$\left| \frac{\hat{V}_{local}}{\bar{V}_{300m}} \right|^2$$

Wind tunnel velocity measurements were made for an equivalent 1 hour period in full scale and filtered to provide an equivalent full scale 3 second gust wind speed. Photographs of the model as tested in the wind tunnel are shown in Figures 3 and 4.

3. DISCUSSION OF RESULTS

Velocity measurements were made at various locations around The Links development for different wind directions at 22.5° intervals. As discussed in Section 2, the BAD Guidelines wind comfort criteria are pass/fail criteria based on an assessment of the probability for all wind directions combined. The wind comfort criteria for sitting, standing and walking are given in percentage for which a given mean wind speed is exceeded. A test location will pass the sitting, standing and walking criteria if the percentage for which a given mean wind speed is exceeded is below 20%. Therefore, to assess the wind conditions the exceedances will be presented in tabular form in Tables 1 – 11 and colour coded; **green** for below 20% exceedance, **orange** for above 20% exceedance and **green** or **red** for passing/failing the safety criterion respectively. For completeness these data are also provided in Appendix A as a function of wind direction and compared with the pedestrian criteria for gust wind speeds.

The Proposed Configuration, is as outlined in the digital information provided by Pellicano Group and received up to 23rd June 2021. The Existing Configuration is defined as the present warehouse on the site. This study did not include or rely on existing or proposed street trees for wind mitigation. The Test Locations for The Links development are shown in Figures 5a to 5e. The following Sections detail the results for the various areas tested.

4.1 Summary of Discussion (Figures 5, 6 and 7)

To assist with the assessment of the wind conditions, summaries of the highest wind criteria achieved based on the BAD Guidelines at the Test Locations have been presented using a colour code system in the following figures:

- Figures 6a to 6b Existing Configuration (Ground Level)
- Figures 7a to 7e Proposed Configuration
- Figures 8a & 8b Proposed Configuration with wind mitigation strategies

Different colours have been used to represent the wind criteria achieved at the respective Test Locations.

4.2. Centre Road

The wind conditions for the Proposed Configuration along Centre Road (Test Locations 1-10 and 60) have been shown to achieve the walking comfort criterion; with all but Test Location 9 also passing the standing comfort criterion. There was an increase in wind conditions at locations close to the development (Test Locations 7, 8 and 9) as a result of flow deflecting off from the southeast and southwest corners of the tower and being induced onto ground level. The criteria achieved at these Test Locations have been presented in Table 1 as well as the data for the Existing Configuration.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A2 to A4). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 1: Pedestrian Wind Comfort and Safety – Centre Road

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
1	Existing Configuration	21%	11%	5%	Pass
	Proposed Configuration	21%	11%	5%	Pass
2	Existing Configuration	30%	16%	8%	Pass
	Proposed Configuration	33%	18%	10%	Pass
3	Existing Configuration	30%	15%	7%	Pass
	Proposed Configuration	30%	15%	7%	Pass
4	Existing Configuration	21%	10%	4%	Pass
	Proposed Configuration	23%	11%	5%	Pass
5	Existing Configuration	24%	12%	5%	Pass
	Proposed Configuration	29%	16%	9%	Pass
6	Existing Configuration	27%	15%	7%	Pass
	Proposed Configuration	29%	16%	8%	Pass
7	Existing Configuration	15%	6%	2%	Pass
	Proposed Configuration	21%	10%	4%	Pass
8	Existing Configuration	15%	7%	2%	Pass
	Proposed Configuration	23%	11%	5%	Pass
9	Existing Configuration	34%	19%	10%	Pass
	Proposed Configuration	37%	21%	12%	Pass
10	Existing Configuration	28%	15%	8%	Pass
	Proposed Configuration	33%	19%	11%	Pass
60	Existing Configuration	22%	12%	6%	Pass
	Proposed Configuration	21%	11%	5%	Pass

4.3. Oakleigh BMX Track

The wind conditions for the Proposed Configuration along the Oakleigh BMX Track (Test Locations 11-14) have been shown to pass the walking comfort criterion. Test Location 12 has been shown to experience slightly elevated wind conditions due to flow being deflected off the northern and southern faces of the development. The criteria achieved at these Test Locations have been presented in Table 2 as well as the data for the Existing Configuration.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figure A5). It is noted that at the Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 2: Pedestrian Wind Comfort and Safety – Oakleigh BMX Track

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
11	Existing Configuration	21%	12%	7%	Pass
	Proposed Configuration	23%	14%	9%	Pass
12	Existing Configuration	30%	17%	10%	Pass
	Proposed Configuration	35%	21%	13%	Pass
13	Existing Configuration	28%	16%	9%	Pass
	Proposed Configuration	31%	19%	11%	Pass
14	Existing Configuration	44%	28%	17%	Pass
	Proposed Configuration	43%	27%	16%	Pass

4.4. The Links Shopping Mall Car Park

The wind conditions for the Proposed Configuration in The Links Shopping Mall Car Park (Test Locations 15-18 and 20-25) have been shown to pass the walking comfort criterion. Test Locations 15, 16 and 18, on the east side of The Links Shopping Mall Car Park, would experience additional wind flow from the large sail area of the west face of the development being induced towards these locales resulting in an increase of wind conditions. A comparison with the existing conditions indicates that The Links Development would not significantly adversely impact the wind conditions on the west side of The Links Shopping Mall Car Park (Test Locations 20 -25). These criteria achieved at these Test Locations have been presented in Table 3 as well as the data for the Existing Configuration.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A6 to A8). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 3: Pedestrian Wind Comfort and Safety – The Links Shopping Mall Car Park

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
15	Existing Configuration	32%	17%	9%	Pass
	Proposed Configuration	36%	21%	11%	Pass
16	Existing Configuration	33%	18%	9%	Pass
	Proposed Configuration	34%	21%	10%	Pass
17	Existing Configuration	29%	13%	6%	Pass
	Proposed Configuration	26%	12%	5%	Pass
18	Existing Configuration	32%	18%	9%	Pass
	Proposed Configuration	35%	21%	11%	Pass
20	Existing Configuration	36%	21%	12%	Pass
	Proposed Configuration	34%	21%	11%	Pass
21	Existing Configuration	40%	24%	13%	Pass
	Proposed Configuration	40%	24%	13%	Pass
22	Existing Configuration	21%	10%	5%	Pass
	Proposed Configuration	21%	10%	5%	Pass
23	Existing Configuration	38%	22%	11%	Pass
	Proposed Configuration	37%	22%	12%	Pass
24	Existing Configuration	41%	24%	14%	Pass
	Proposed Configuration	40%	24%	13%	Pass
25	Existing Configuration	27%	14%	7%	Pass
	Proposed Configuration	27%	13%	7%	Pass

4.5. Link Avenue

The wind conditions for the Proposed Configuration along Link Avenue (Test Locations 19, 26 and 54) have been shown to pass the walking comfort criterion; with Test Location 54 also passing the standing comfort criterion. Additional wind flow induced to ground level by the broad west face of the development then flows around to the north side of the site which then elevates the wind conditions at Test Location 19. These criteria achieved at these Test Locations have been presented in Table 4 as well as the data for the Existing Configuration.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figure A9). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 4: Pedestrian Wind Comfort and Safety – Link Avenue

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
19	Existing Configuration	34%	19%	11%	Pass
	Proposed Configuration	32%	21%	14%	Pass
26	Existing Configuration	33%	21%	12%	Pass
	Proposed Configuration	37%	24%	16%	Pass
54	Existing Configuration	30%	18%	11%	Pass
	Proposed Configuration	29%	15%	7%	Pass

4.6. Ventura Oakleigh Depot & Caltex Petrol Station

The wind conditions for the Proposed Configuration at the Ventura Oakleigh Depot and Caltex Petrol Station (Test Locations 27-32) have been shown to pass the walking comfort criterion; with many Test Locations also passing the standing comfort criterion. The wind conditions have been shown to be comparable to the Existing Configuration at Test Locations 27-31, indicating that The Links Development would have no significant influence at these locales. These criteria achieved at these Test Locations have been presented in Table 5 as well as the data for the Existing Configuration.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A10 and A11). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 5: Pedestrian Wind Comfort and Safety – Ventura Oakleigh Depot & Caltex Petrol Station

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
27	Existing Configuration	30%	16%	9%	Pass
	Proposed Configuration	34%	18%	10%	Pass
28	Existing Configuration	28%	14%	6%	Pass
	Proposed Configuration	28%	14%	6%	Pass
29	Existing Configuration	35%	19%	10%	Pass
	Proposed Configuration	34%	19%	10%	Pass
30	Existing Configuration	35%	19%	10%	Pass
	Proposed Configuration	35%	19%	10%	Pass
31	Existing Configuration	35%	21%	10%	Pass
	Proposed Configuration	36%	22%	11%	Pass
32	Existing Configuration	19%	7%	3%	Pass
	Proposed Configuration	23%	10%	4%	Pass

4.7. South side of The Links development

The wind conditions along the South side of The Links development (Test Locations 33-35) have been shown to pass the walking comfort criterion; with Test Locations 33 and 34 also passing the sitting comfort criterion. Test Location 35 has been shown to experience an increase of wind conditions as a result of downwash effects from the east and west building faces and flow acceleration around the southeast corner at ground level. These criteria achieved at these Test Locations have been presented in Table 6 as well as the data for the Existing Configuration.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figure A12). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 6: Pedestrian Wind Comfort and Safety – South side of The Links development

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
33	Existing Configuration	10%	3%	1%	Pass
	Proposed Configuration	16%	6%	2%	Pass
34	Existing Configuration	16%	7%	3%	Pass
	Proposed Configuration	13%	5%	1%	Pass
35	Existing Configuration	31%	17%	8%	Pass
	Proposed Configuration	36%	21%	11%	Pass

4.8. East side of The Links development

The wind conditions along the East side of The Links development (Test Locations 36-38, 40-44, 42a and 53) have been shown to pass the walking comfort criterion; with the wind conditions at the retail entrances (Test Locations 38 and 41) also passing the sitting comfort criterion. Setting the entry to the northeast corner tenancy (Test Location 42) further away from the corner (to Test Location 42a) would ensure improved wind comfort. There is also significant improvement in wind conditions at Test Locations 40, 41, 43 and 53 as a result of immediate shielding to northwest wind directions effect provided by the proposed development.

The wind conditions at Test Locations 42 and 44 can be further improved by using a screen of 1.5m height at the northeast corner at the ground level of the development (Refer to Figure 8a) which would allow for improved utilisation for the intended activation of the area. The wind conditions at the outside northeast corner of the screen (Test Location 42b) were shown to achieve the walking comfort criterion. These criteria achieved at these Test Locations have been presented in Table 7 as well as the data for the Existing Configuration for most Test Locations.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A13 to A15). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 7: Pedestrian Wind Comfort and Safety – East side of The Links development

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
36	Existing Configuration	19%	9%	4%	Pass
	Proposed Configuration	17%	6%	2%	Pass
37	Existing Configuration	12%	5%	2%	Pass
	Proposed Configuration	18%	6%	2%	Pass
38	Existing Configuration	19%	9%	3%	Pass
	Proposed Configuration	18%	7%	3%	Pass
40	Existing Configuration	30%	16%	9%	Pass
	Proposed Configuration	9%	2%	1%	Pass
41	Existing Configuration	26%	14%	7%	Pass
	Proposed Configuration	9%	2%	1%	Pass
42	Existing Configuration	35%	19%	10%	Pass
	Proposed Configuration	38%	24%	15%	Pass
42a	with 1.5m screen	31%	19%	12%	Pass
	Proposed Configuration	22%	11%	4%	Pass
42b	with 1.5m screen	44%	29%	19%	Pass
43	Existing Configuration	27%	13%	6%	Pass
	Proposed Configuration	19%	7%	2%	Pass
43a	with 1.5m screen	15%	5%	1%	Pass
44	Existing Configuration	33%	18%	10%	Pass
	Proposed Configuration	30%	16%	9%	Pass
	with 1.5m screen	19%	10%	5%	Pass
53	Existing Configuration	21%	11%	6%	Pass
	Proposed Configuration	16%	6%	1%	Pass

4.9. North side of The Links development

The wind conditions along the North side of The Links development (Test Locations 45, 46, 46a and 55-59) have been shown to pass the standing comfort criterion; with Test Location 58 also passing the sitting comfort criterion. As noted in Section 4.8, the screen of 1.5m height at the northeast corner at ground level (Refer to Figure 8a) was shown to improve the wind conditions at Test Location 45. The criteria achieved at these Test Locations have been presented in Table 8 as well as the data for the Existing Configuration for most Test Locations.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A16 and A17). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 8: Pedestrian Wind Comfort and Safety – North side of the development

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
45	Existing Configuration	34%	18%	10%	Pass
	Proposed Configuration	33%	19%	12%	Pass
	with 1.5m screen	29%	17%	10%	Pass
46	Existing Configuration	30%	16%	8%	Pass
	Proposed Configuration	25%	15%	9%	Pass
46a	with 1.5m screen	30%	17%	10%	Pass
55	Existing Configuration	21%	10%	4%	Pass
	Proposed Configuration	21%	11%	6%	Pass
56	Existing Configuration	23%	12%	6%	Pass
	Proposed Configuration	22%	11%	5%	Pass
57	Existing Configuration	17%	8%	3%	Pass
	Proposed Configuration	21%	10%	5%	Pass
58	Existing Configuration	14%	7%	3%	Pass
	Proposed Configuration	8%	3%	1%	Pass
59	Existing Configuration	19%	11%	5%	Pass
	Proposed Configuration	21%	10%	4%	Pass

4.10. Under-croft Passage

The wind conditions for the Proposed Configuration along the under-croft passage (Test Locations 39, 47a and 47-52) have been shown to pass the sitting comfort criterion and largely benefit by the immediate shielding provided by The Links development. The criteria achieved at these Test Locations have been presented in Table 9 as well as the data for the Existing Configuration for Test Locations 47 and 49.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A18 and A19). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 9: Pedestrian Wind Comfort and Safety – Under-croft Passage

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
39	Proposed Configuration	17%	7%	3%	Pass
47	Existing Configuration	23%	13%	7%	Pass
	Proposed Configuration	11%	4%	1%	Pass
47a	Proposed Configuration	8%	3%	1%	Pass
48	Existing Configuration	19%	9%	4%	Pass
	Proposed Configuration	15%	8%	3%	Pass
49	Existing Configuration	16%	8%	4%	Pass
	Proposed Configuration	14%	7%	3%	Pass
50	Proposed Configuration	16%	6%	2%	Pass
51	Proposed Configuration	10%	4%	1%	Pass
52	Proposed Configuration	3%	2%	1%	Pass

4.11. Terraces & Podium Garden at Level 1

The wind conditions for the Proposed Configuration on the Terraces and Podium Garden at Level 1 (Test Locations T1-T16) have been shown to pass the walking comfort criterion; with many Test Locations also passing the sitting comfort criterion.

However, for the dominant north direction, the wind conditions at Test Locations T13 and T16 (Refer to Figures A23 and A24) have been shown to approach the safety limit. It has been demonstrated that increasing the balustrade height to 2.1m and introducing a plater box (or similar) of 1.5m height (refer to Figure 8b) that wind conditions near Test Locations T13 and T16 would improve. Furthermore, increasing the balustrade height would have the added benefit of also improving the wind conditions at Test Location T5 significantly thereby passing the standing comfort criterion. These criteria achieved at these Test Locations have been presented in Table 10.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A20 to A24). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 10: Pedestrian Wind Comfort and Safety – Terraces & Garden Podium at Level 1

Test Location	Configuration	Wind Comfort Criteria			Safety
		Sitting	Standing	Walking	
T1	Proposed Configuration	15%	5%	1%	Pass
T2	Proposed Configuration	11%	5%	2%	Pass
T3	Proposed Configuration	40%	24%	14%	Pass
T4	Proposed Configuration	13%	5%	2%	Pass
T5	Proposed Configuration	32%	22%	14%	Pass
	with 2.1m Balustrade	26%	18%	12%	Pass
T6	Proposed Configuration	28%	19%	13%	Pass
	with 2.1m Balustrade	27%	19%	13%	Pass
T7	Proposed Configuration	17%	8%	4%	Pass
T8	Proposed Configuration	8%	3%	1%	Pass
T9	Proposed Configuration	22%	12%	6%	Pass
T10	Proposed Configuration	18%	9%	4%	Pass
T11	Proposed Configuration	21%	10%	5%	Pass
T12	Proposed Configuration	21%	11%	7%	Pass
T13	Proposed Configuration	29%	19%	13%	Pass
T13a	with 1.5m planter box	25%	16%	11%	Pass
T13b	with 1.5m planter box	21%	10%	5%	Pass
T14	Proposed Configuration	27%	17%	11%	Pass
	with 2.1m Balustrade	23%	16%	11%	Pass
T15	Proposed Configuration	18%	7%	2%	Pass
T16	Proposed Configuration	28%	19%	13%	Pass
	with 2.1m Balustrade	26%	16%	10%	Pass

4.12. Balconies at Level 5 & Rooftop Amenity Spaces

The wind conditions for the Proposed Configuration on the Balconies at Level 5 and the Rooftop Amenity Spaces (Test Locations B1-B4 and R1-R4) have been shown to pass the sitting comfort criterion; with the exception of Test Location R1 which has been shown to pass the standing comfort criterion. These criteria achieved at these Test Locations have been presented in Table 11 and 12.

The wind conditions as a function of wind direction based on the gust criteria developed for Melbourne are presented in Appendix A (Figures A25 and A26). It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results for certain incident wind directions.

Table 11: Pedestrian Wind Comfort and Safety – Balconies at Level 5

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
B1	Proposed Configuration	8%	3%	1%	Pass
B2	Proposed Configuration	6%	2%	1%	Pass
B3	Proposed Configuration	7%	3%	1%	Pass
B4	Proposed Configuration	9%	3%	1%	Pass

Table 12: Pedestrian Wind Comfort and Safety – Rooftop Amenity Space

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
R1	Proposed Configuration	23%	12%	5%	Pass
R2	Proposed Configuration	10%	2%	1%	Pass
R3	Proposed Configuration	11%	4%	1%	Pass
R4	Proposed Configuration	13%	7%	3%	Pass

4. CONCLUSIONS

Wind tunnel tests have been conducted on a 1/400 scale model of The Links Development, 1041 Centre Road, Oakleigh South. The model of the Development within surrounding buildings and with no existing or future street trees, was tested in a simulated upstream boundary layer of the natural wind to determine likely environmental wind conditions. These wind conditions have been related to the freestream mean wind speed at a reference height of 300m and compared with wind comfort criteria region as a function of wind direction.

The wind conditions for the Proposed Configuration in the streetscapes that surround The Links Development pass the safety criterion. The wind conditions for the Existing Configuration at many Test Locations have been included for comparison.

The wind conditions at certain Test Locations on the Podium Garden at Level 1 have been shown to approach the safety limit as a result of flow deflecting off the north face of the development. However, with the inclusion of higher balustrades along the northern edge of the podium and the inclusion of a planter box placed near these locations as wind mitigation strategies, the wind conditions have been shown to improve significantly.



G.Oree



August 2021

5. REFERENCES

1. W. H. Melbourne, Criteria for environmental wind conditions, Journal of Industrial Aerodynamics, Volume 3, 1978, pp. 241-249
2. W. H. Melbourne, Wind environment studies in Australia, Journal of Industrial Aerodynamics, Volume 3, 1978, pp. 201-214

FIGURES

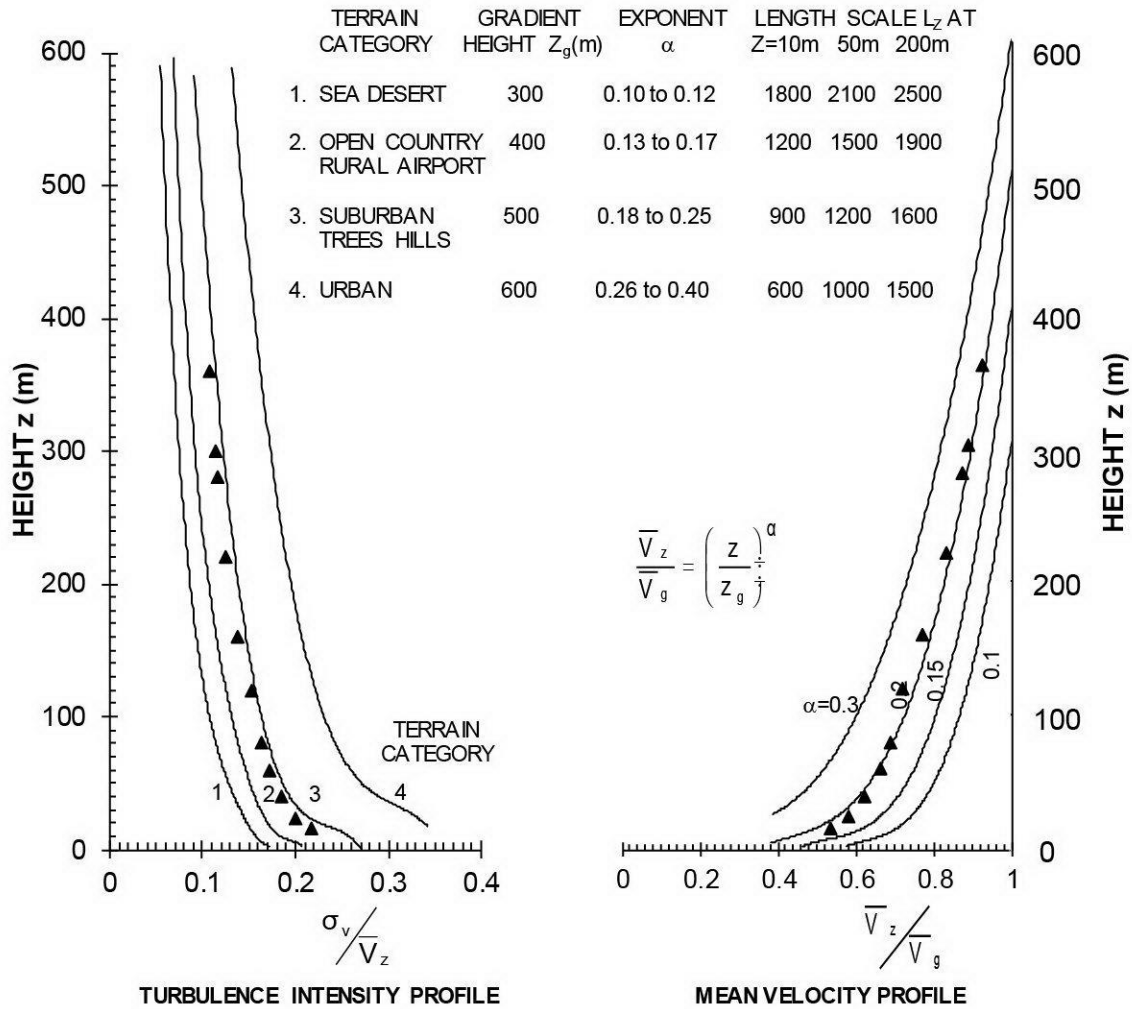


Figure 2 - 1/400 scale TC3 boundary layer turbulence intensity and mean velocity profiles and spectra in the MEL Consultants Boundary Layer Wind Tunnel 5m x 2.4m working section, scaled to full scale dimensions



Figure 3 – View from the northwest of the 1/400 scale proposed The Links Development in the wind tunnel



Figure 4 – Close-up view from the east of the 1/400 scale proposed The Links development in the wind tunnel.



Figure 5a - Ground Level Test Locations in the surrounding streetscapes for The Links development

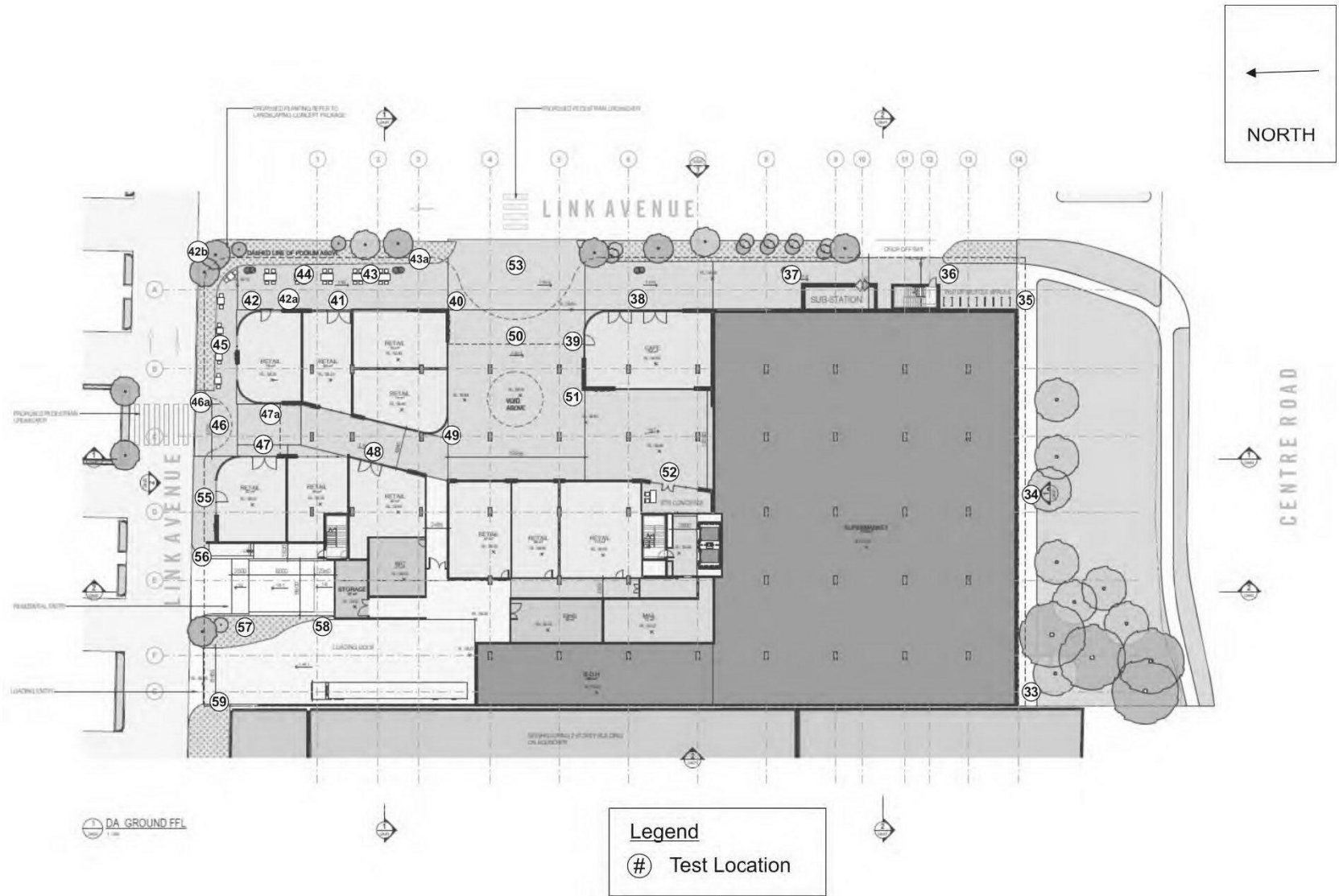


Figure 5b - Ground Level Test Locations adjacent to The Links development

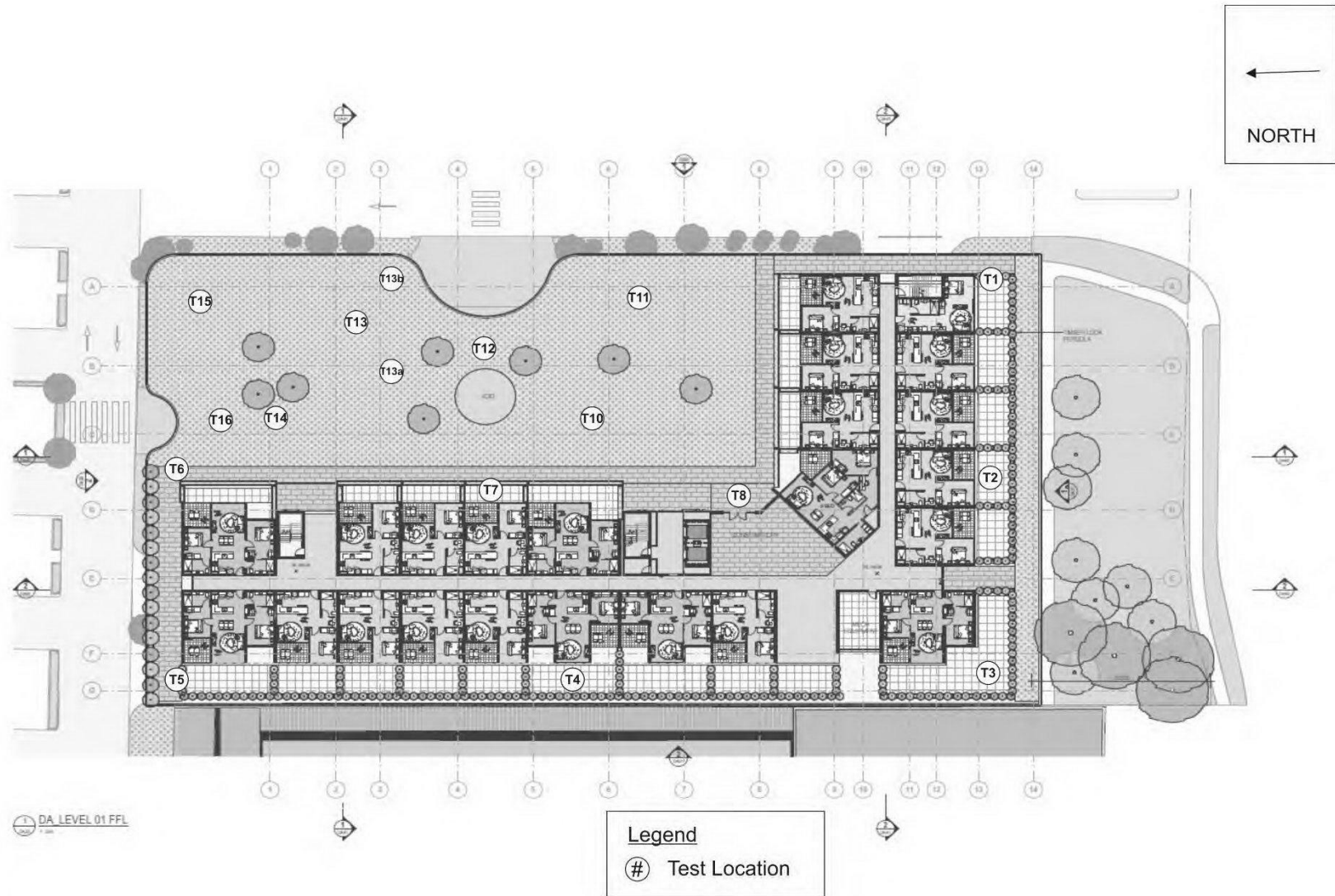


Figure 5c - Test Locations on Terraces and Podium Garden at Level 1 of The Links development

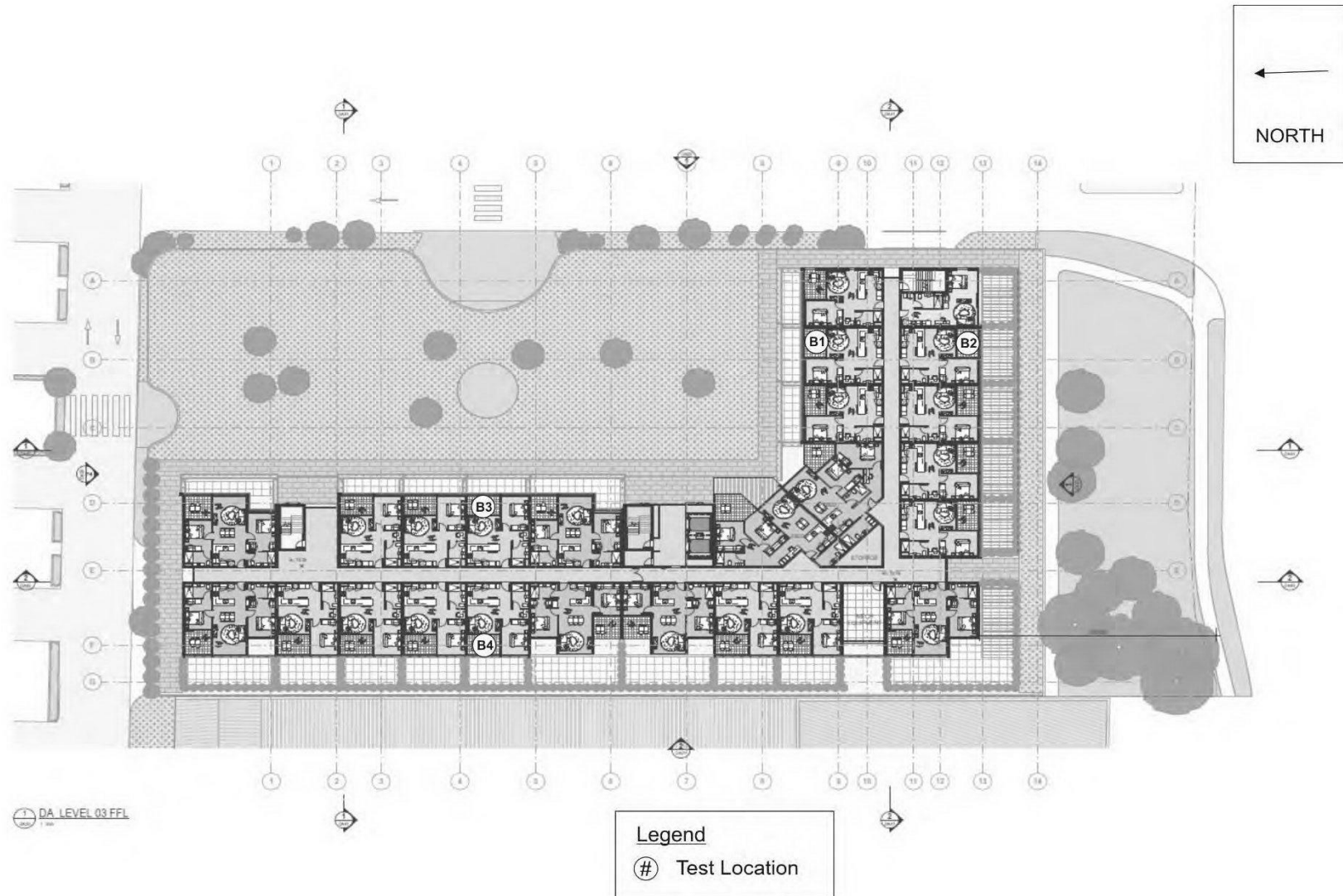


Figure 5d - Test Locations on Balconies at Level 5 of The Links development

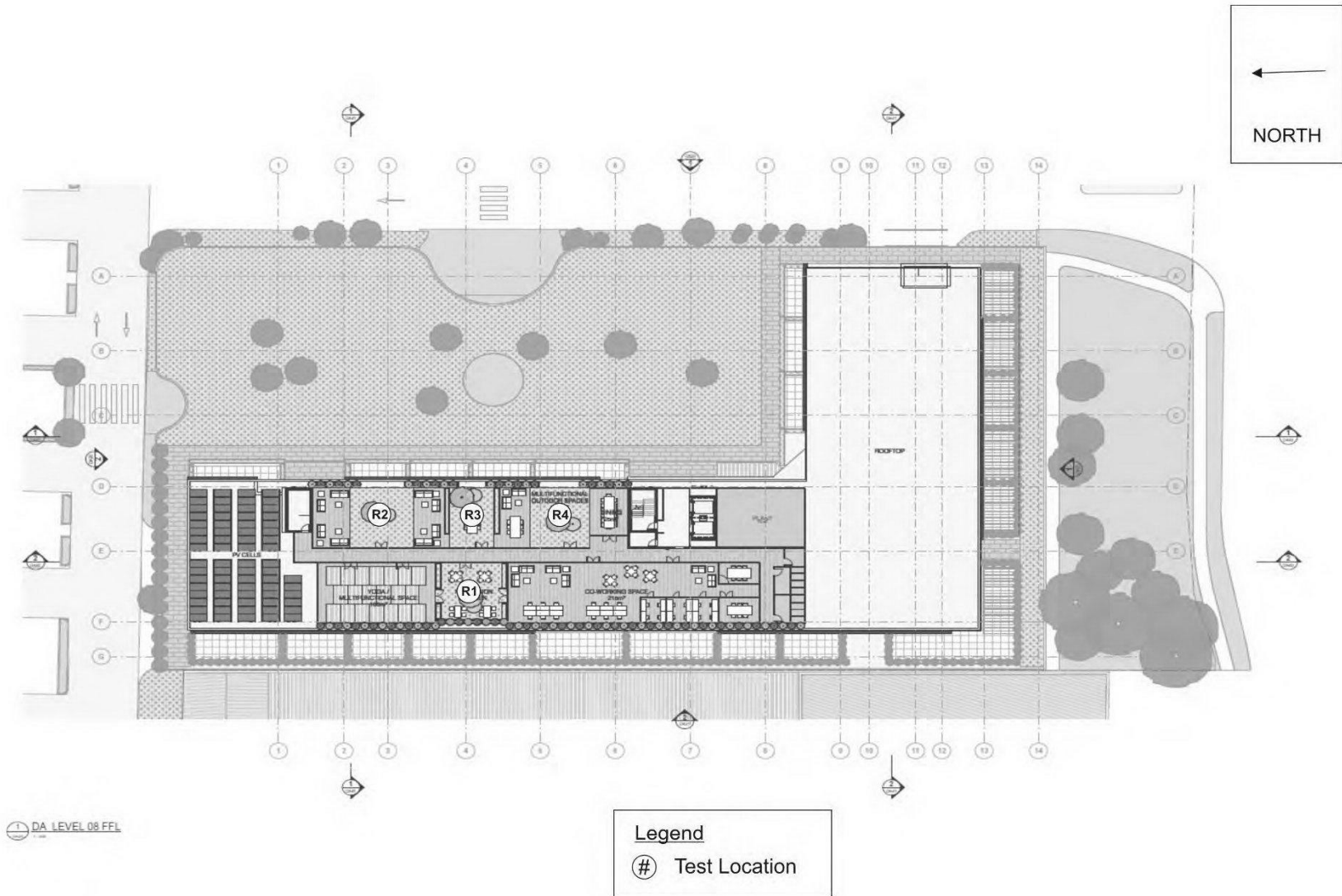


Figure 5e - Test Locations on Roof Amenity Spaces of The Links development

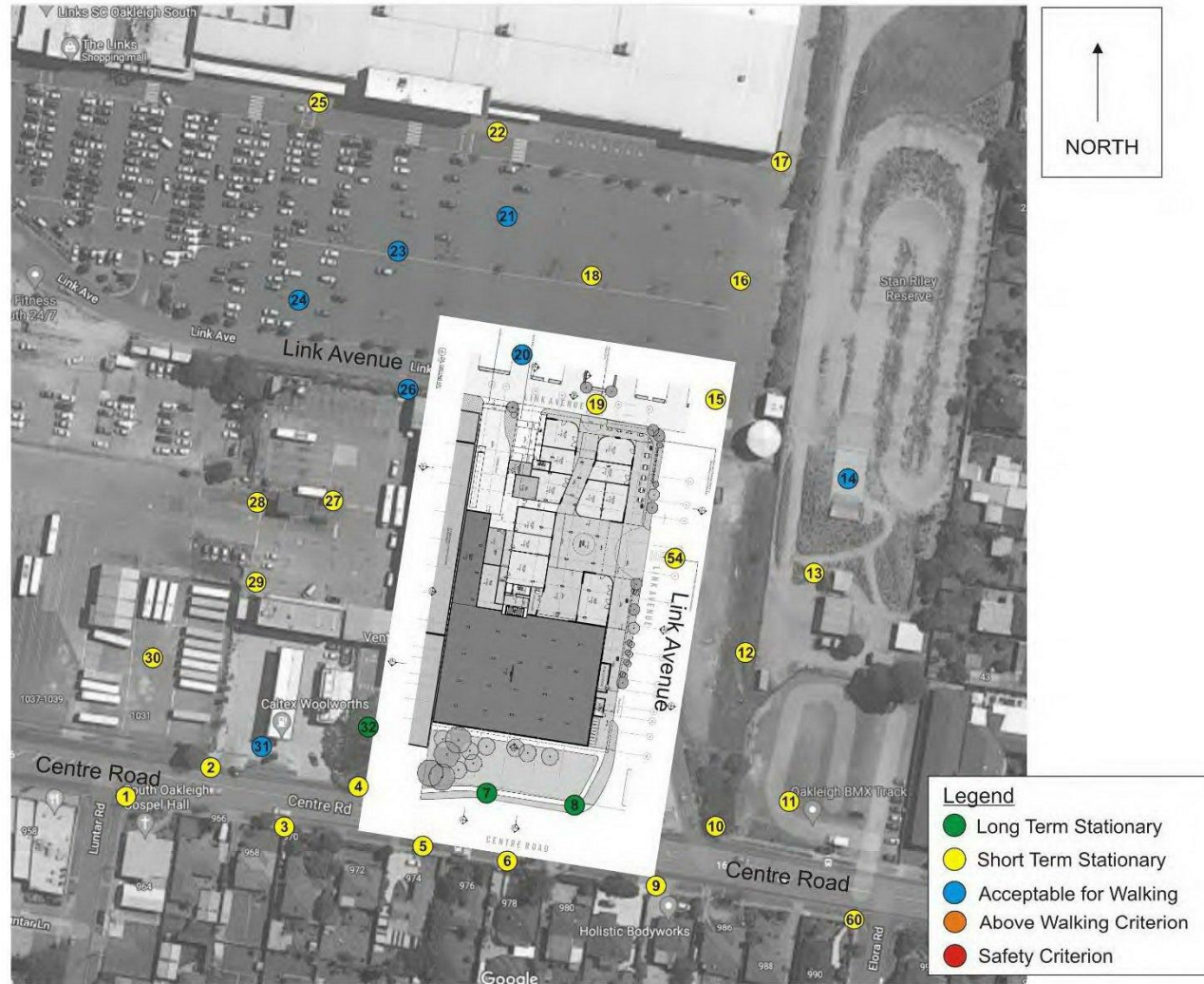


Figure 6a - Summary of wind conditions at Ground Level Test Locations in the surrounding streetscapes for The Links development for the Existing Configuration for 360° of wind direction

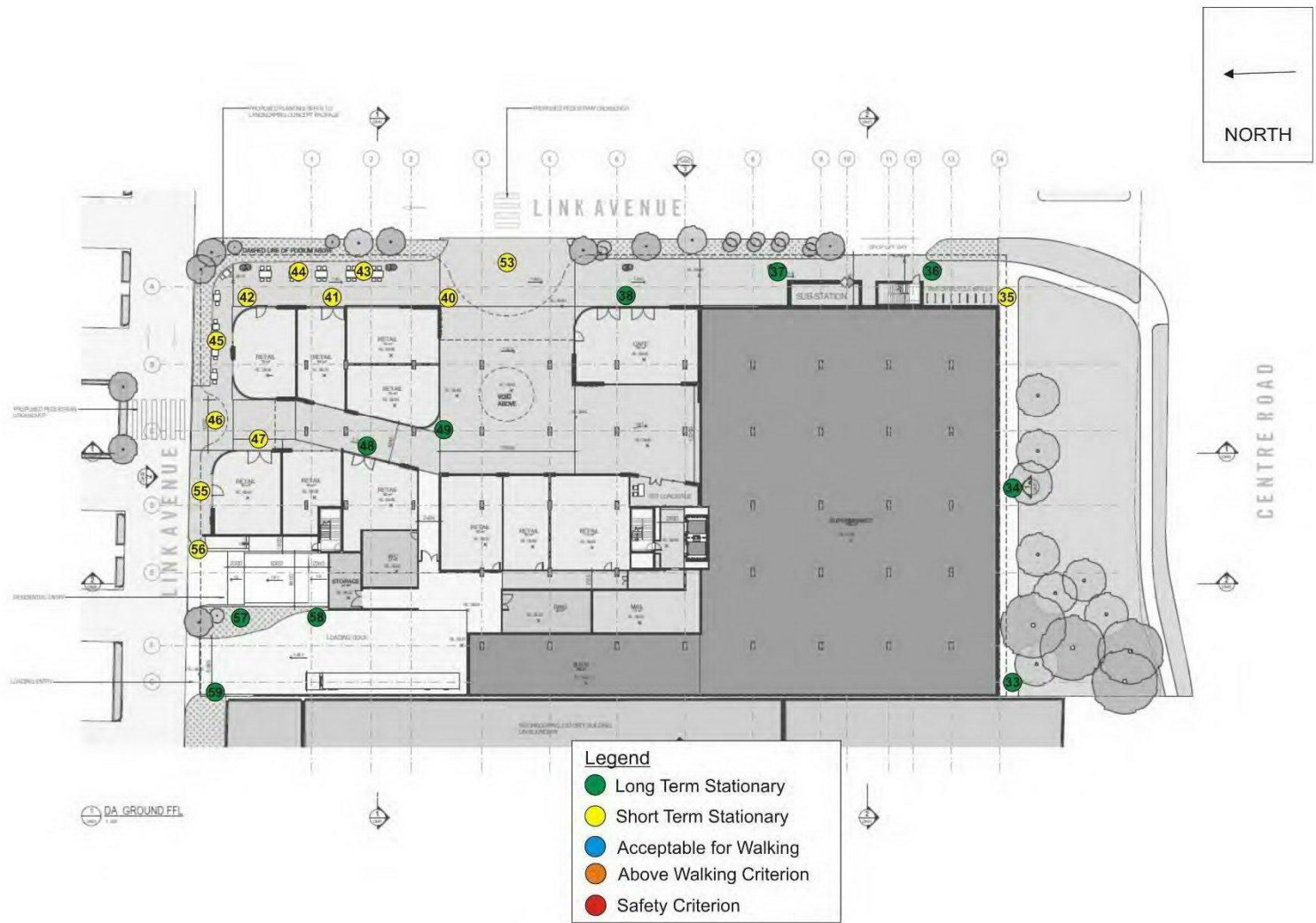


Figure 6b - Summary of wind conditions at Ground Level Test Locations adjacent to The Links development for the Existing Configuration for 360° of wind direction

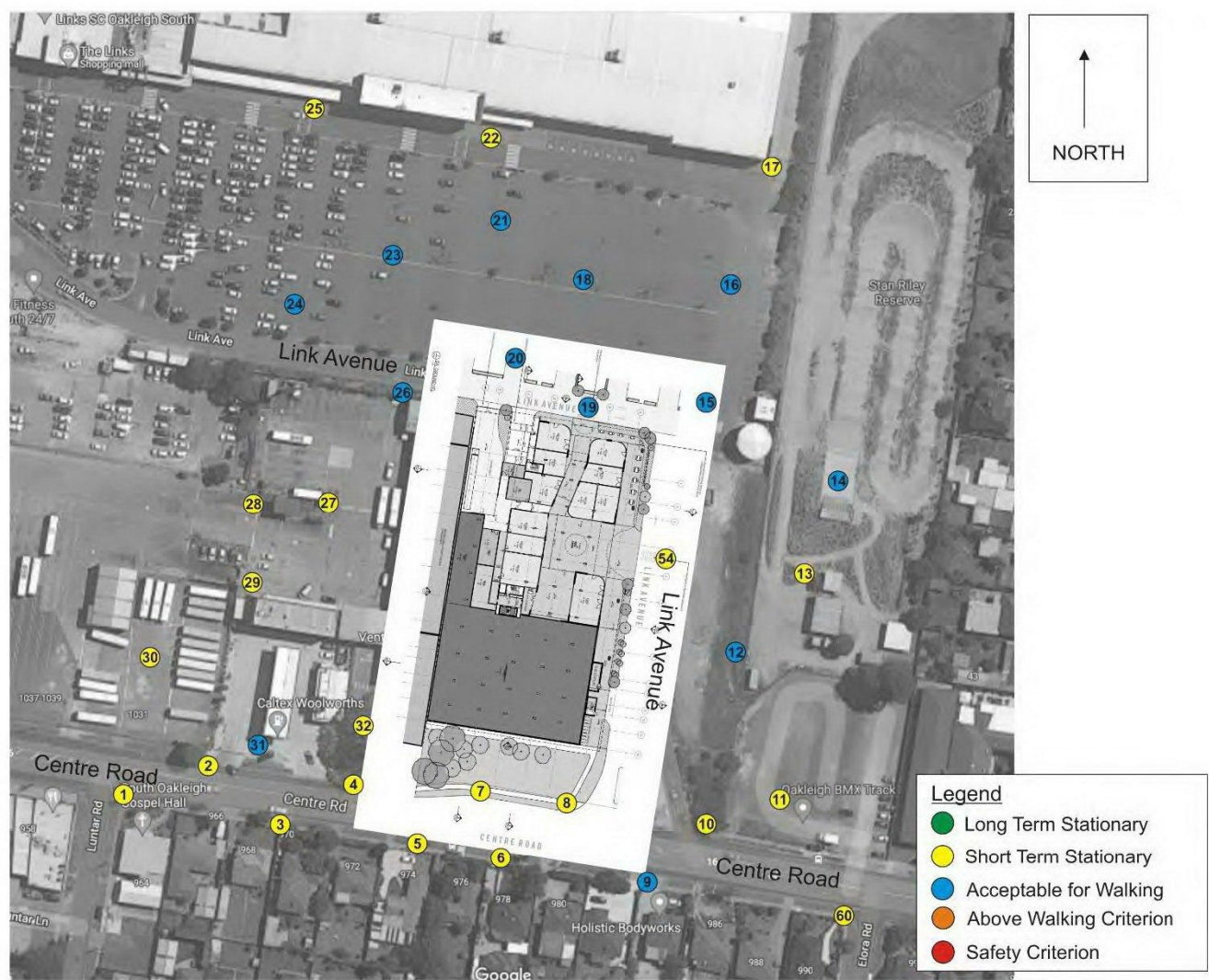


Figure 7a - Summary of wind conditions at Ground Level Test Locations in the surrounding streetscapes for The Links development for the Proposed Configuration for 360° of wind direction

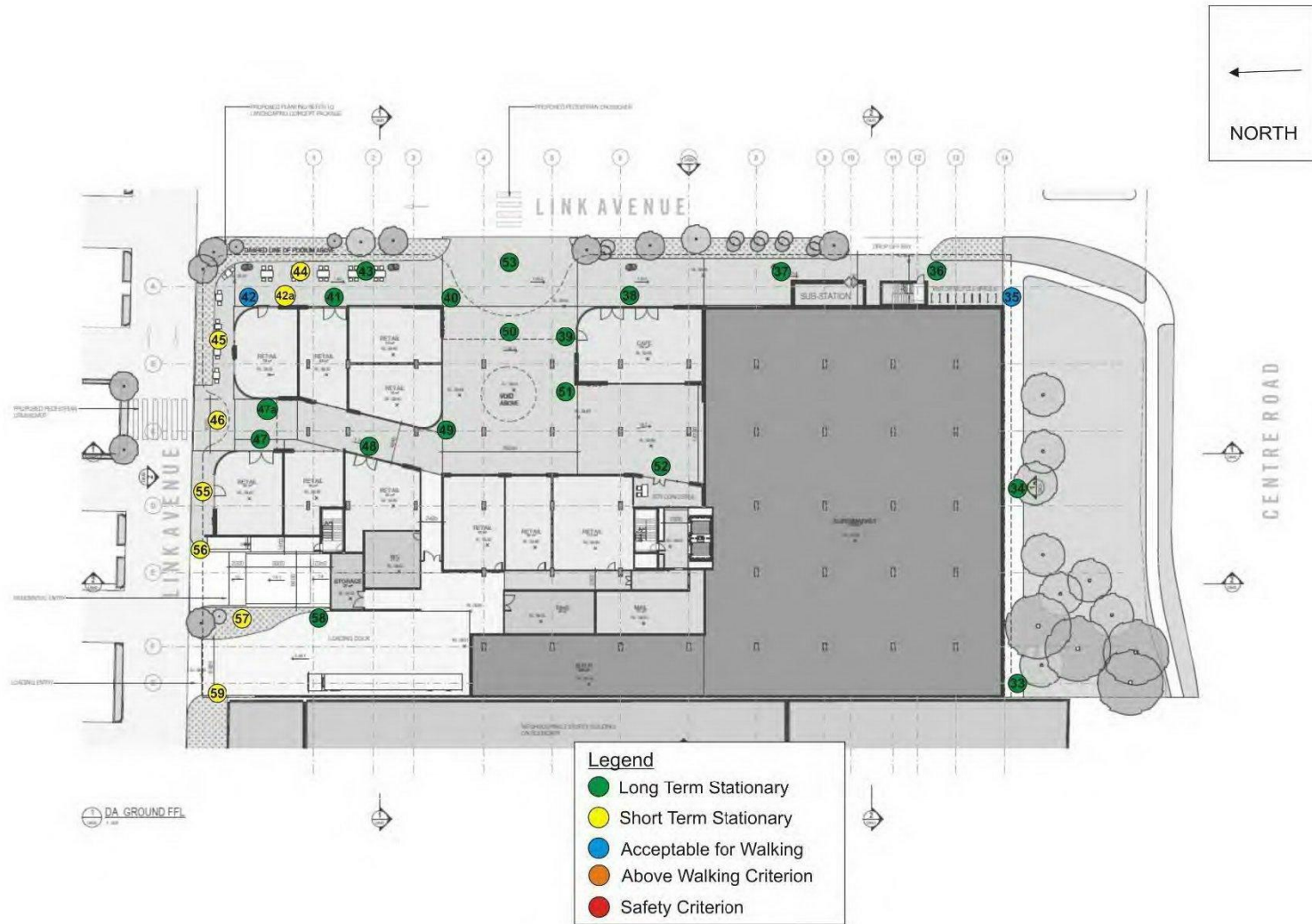


Figure 7b - Summary of wind conditions at Ground Level Test Locations adjacent to The Links development for the Proposed Configuration for 360° of wind direction

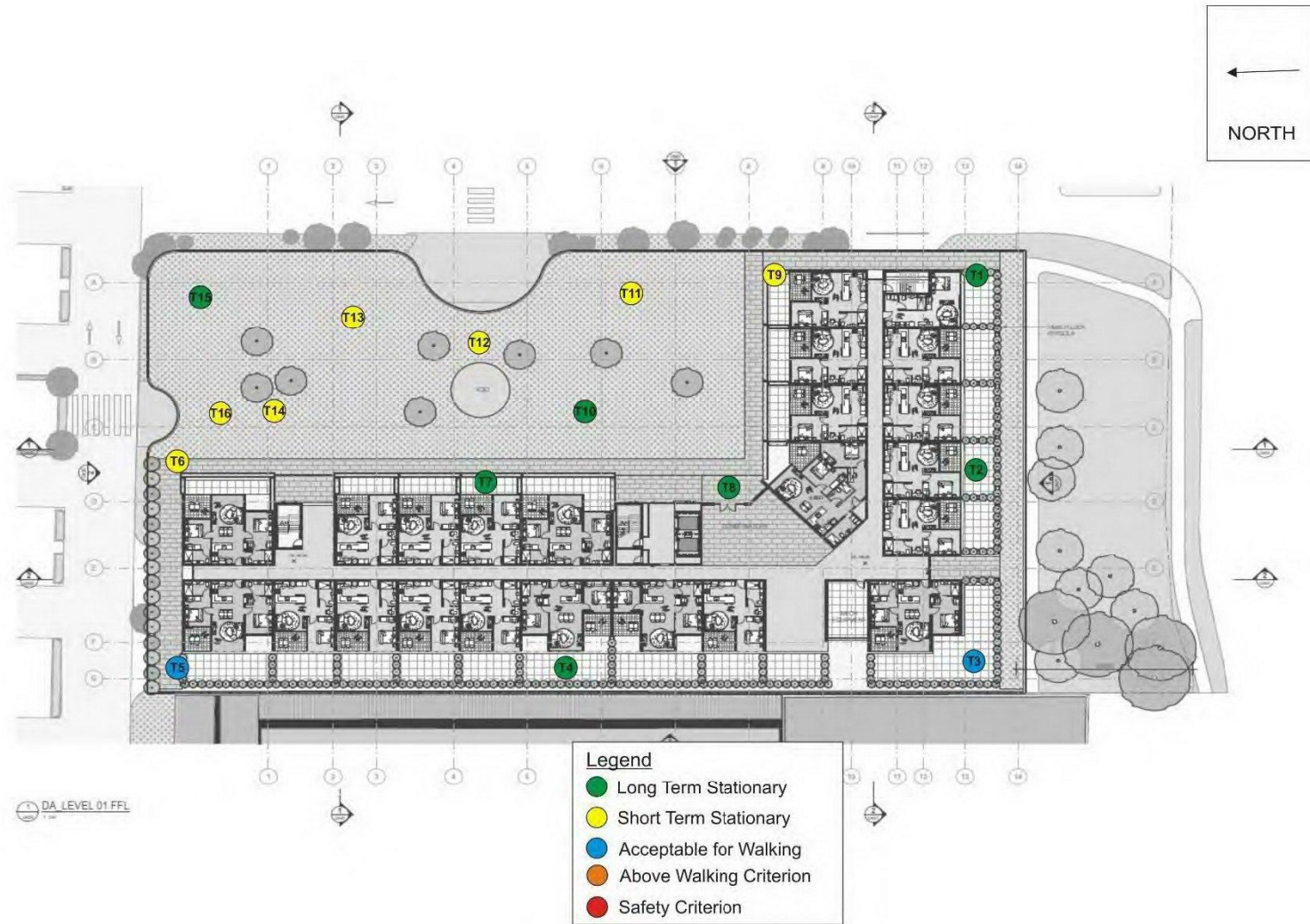


Figure 7c - Summary of wind conditions on Terraces and Podium Garden at Level 1 of The Links development for the Proposed Configuration for 360° of wind direction



Figure 7d - Summary of wind conditions on Balconies at Level 5 of The Links development for the Proposed Configuration for 360° of wind direction

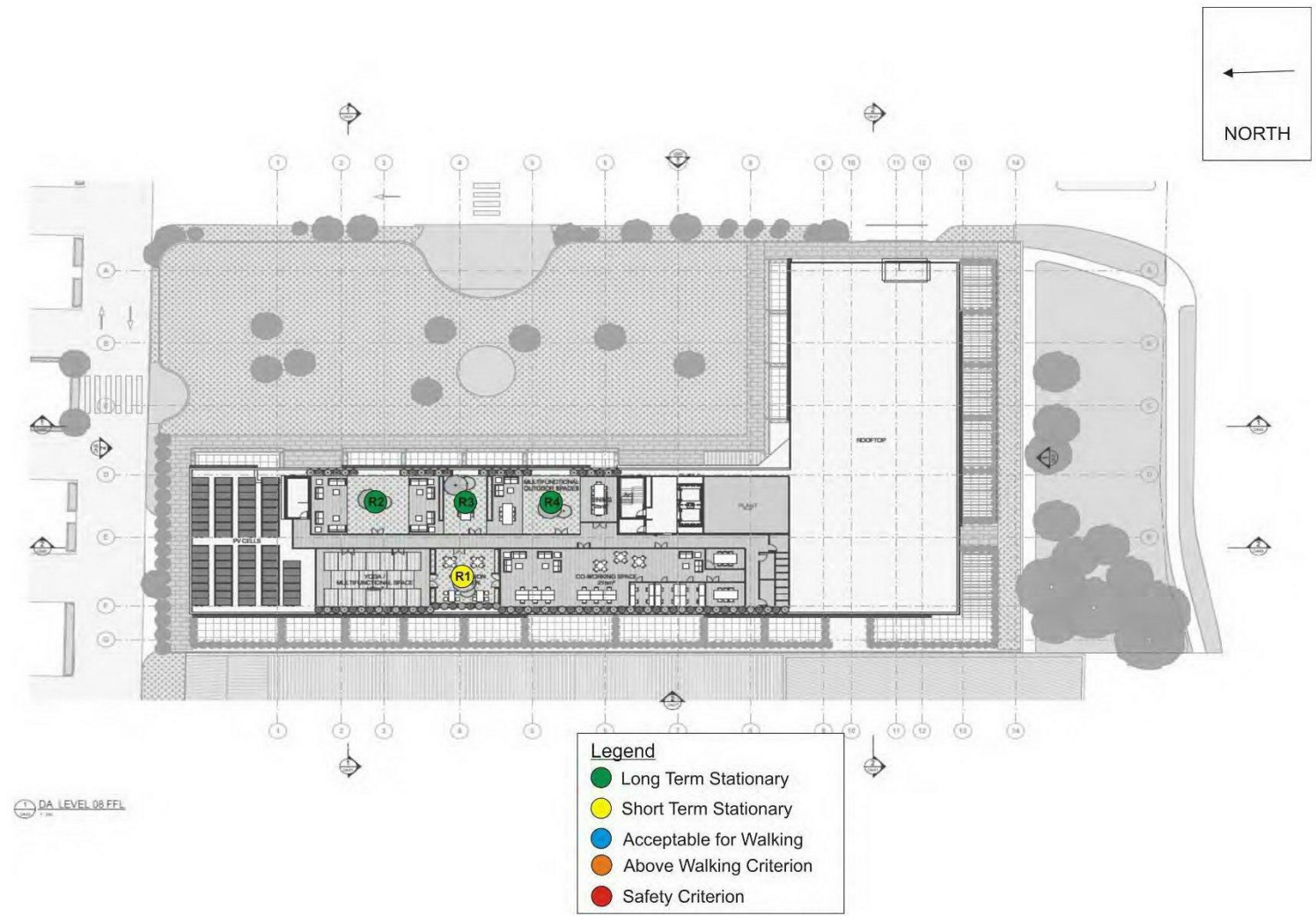


Figure 7e - Summary of wind conditions on Roof Amenity Spaces of The Links development for the Proposed Configuration for 360° of wind direction

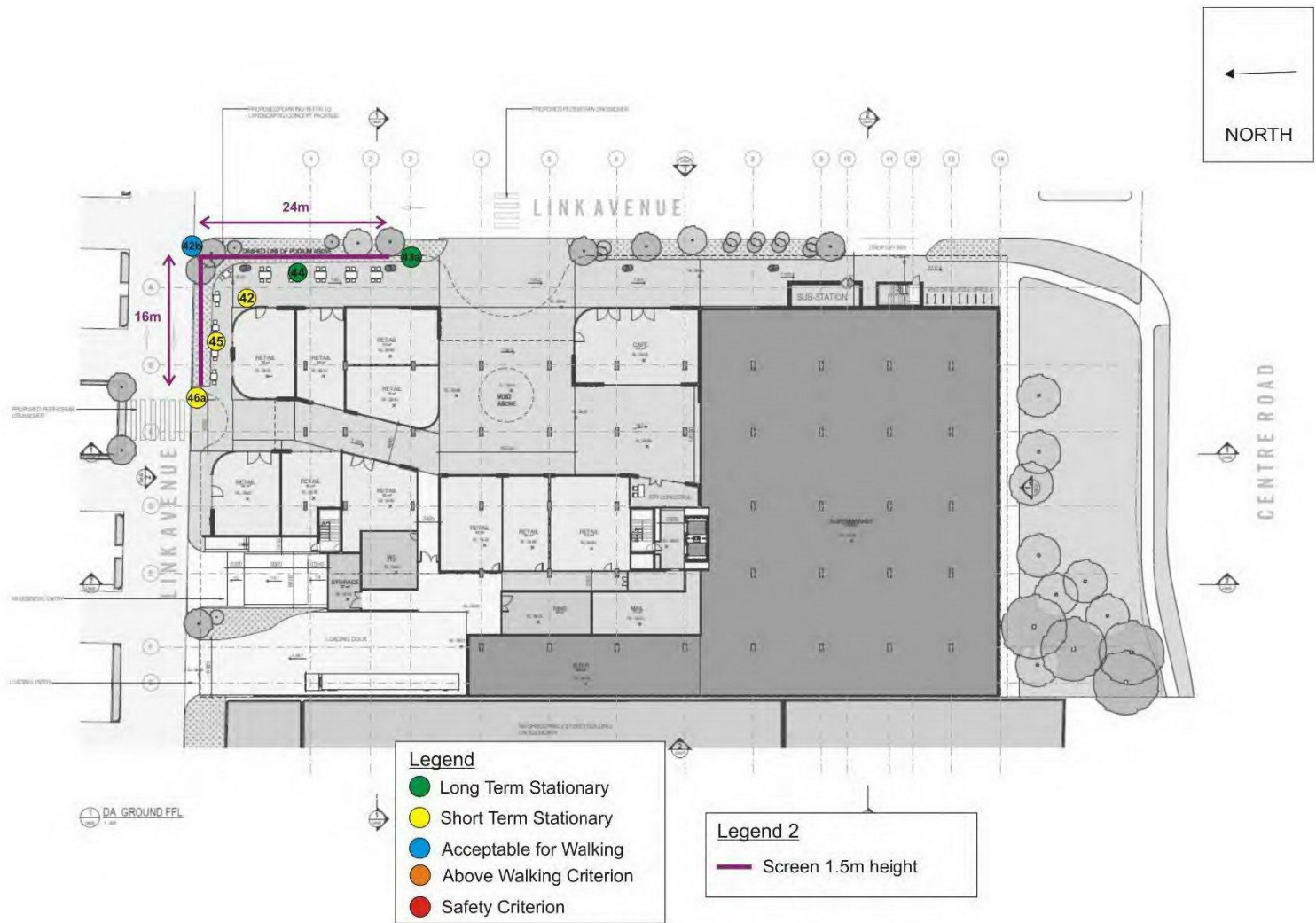


Figure 8a - Summary of wind conditions with wind mitigation strategy at Ground Level Test Locations adjacent to The Links development for the Proposed Configuration for 360° of wind direction

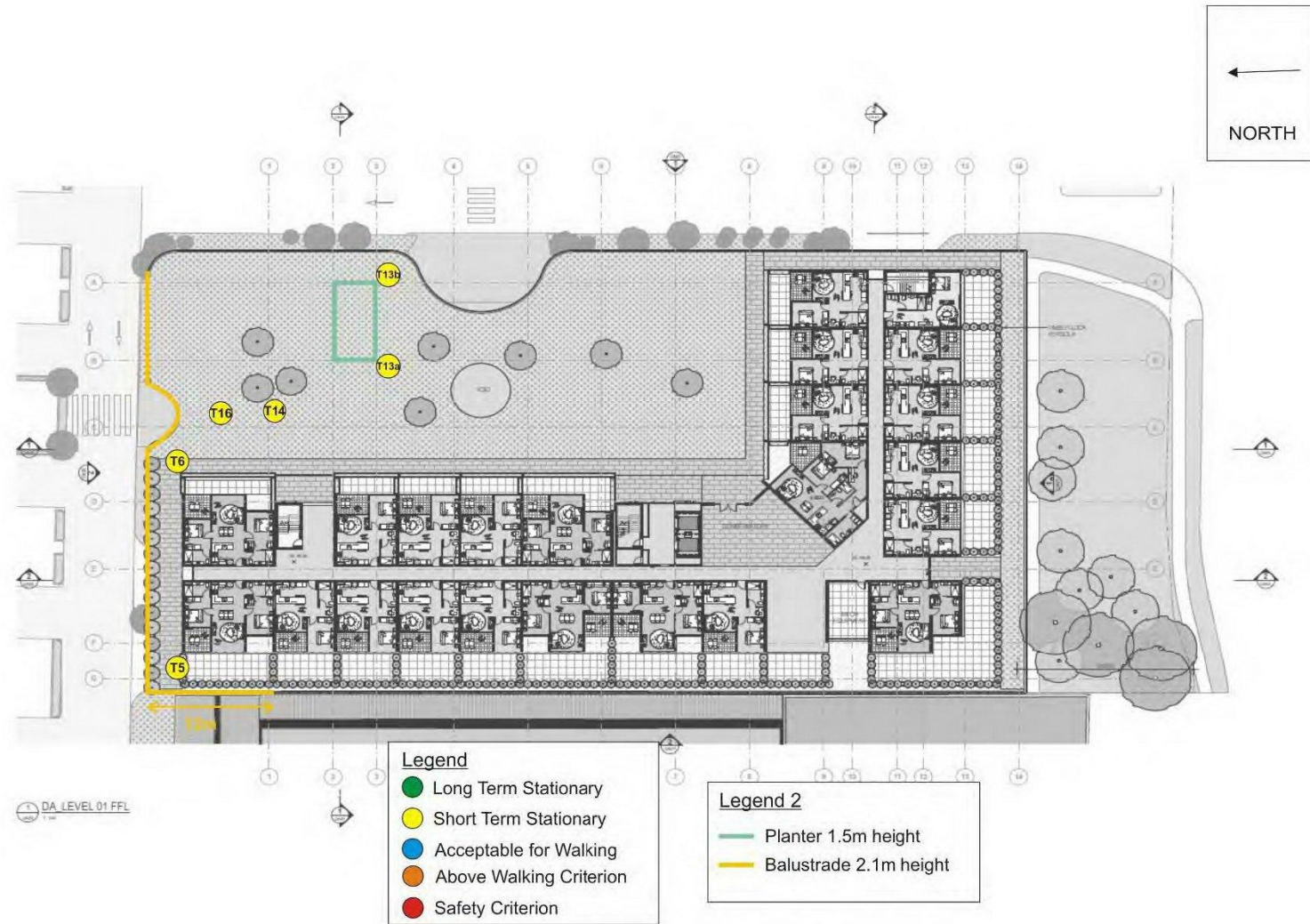


Figure 7b - Summary of wind conditions with wind mitigation strategy on Terraces and Podium Garden at Level 1 of The Links development for the Proposed Configuration for 360° of wind direction

APPENDIX A – TEST LOCATION 3 SECOND GUST WIND CRITERIA PLOTS AS A FUNCTION OF WIND DIRECTION

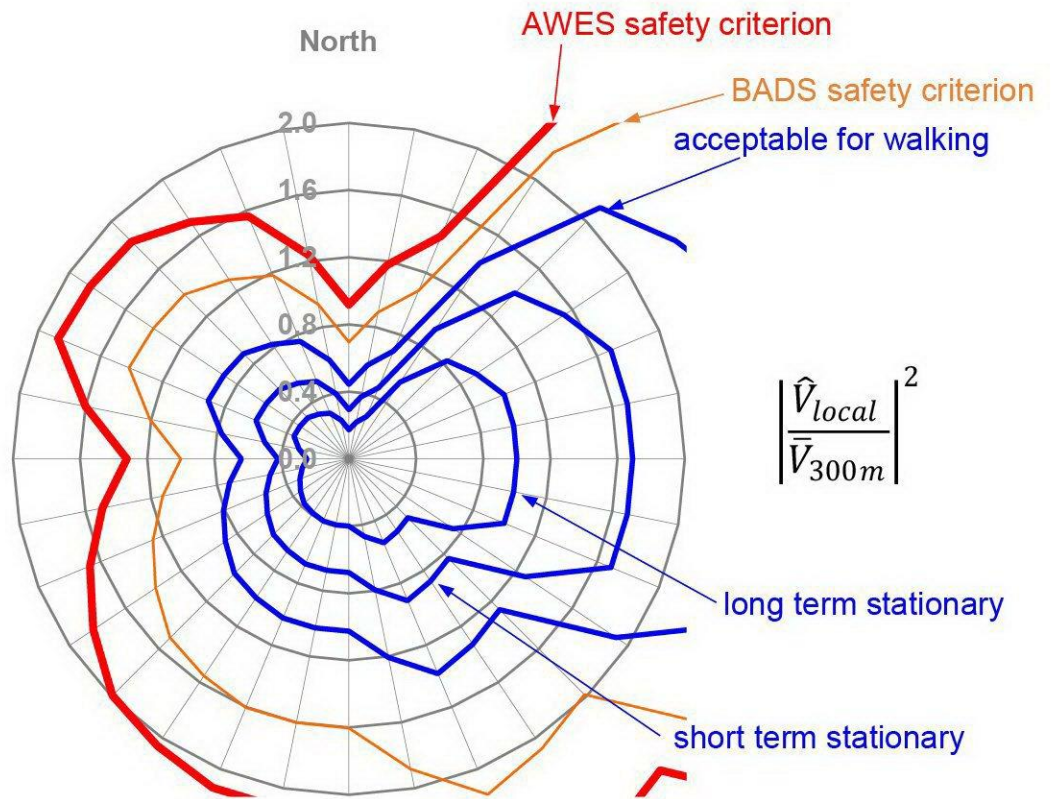
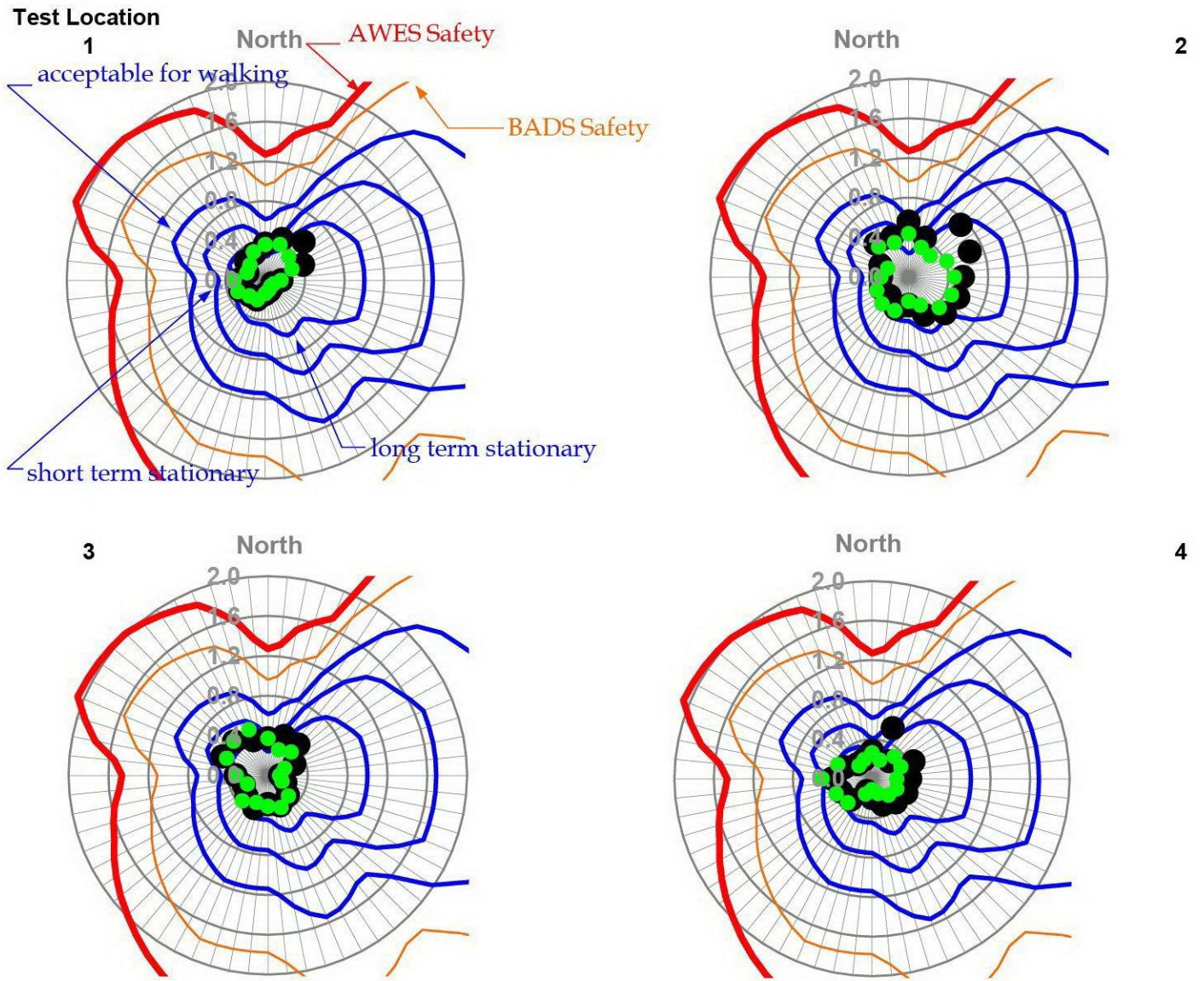


Figure A1 - Environmental wind criteria for Melbourne as a function of wind direction based on a 3 second gust



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



Figure A2 - Centre Road

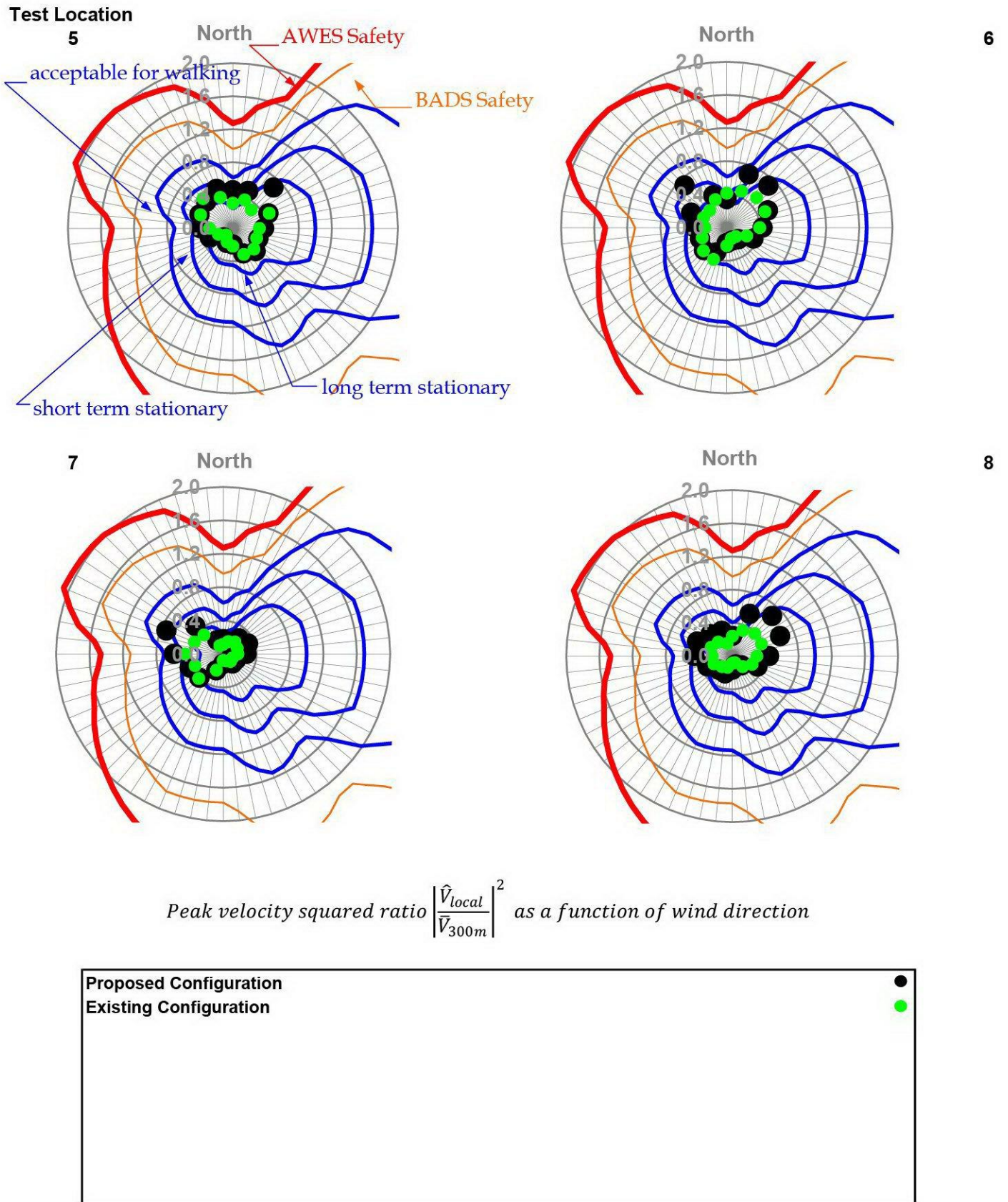
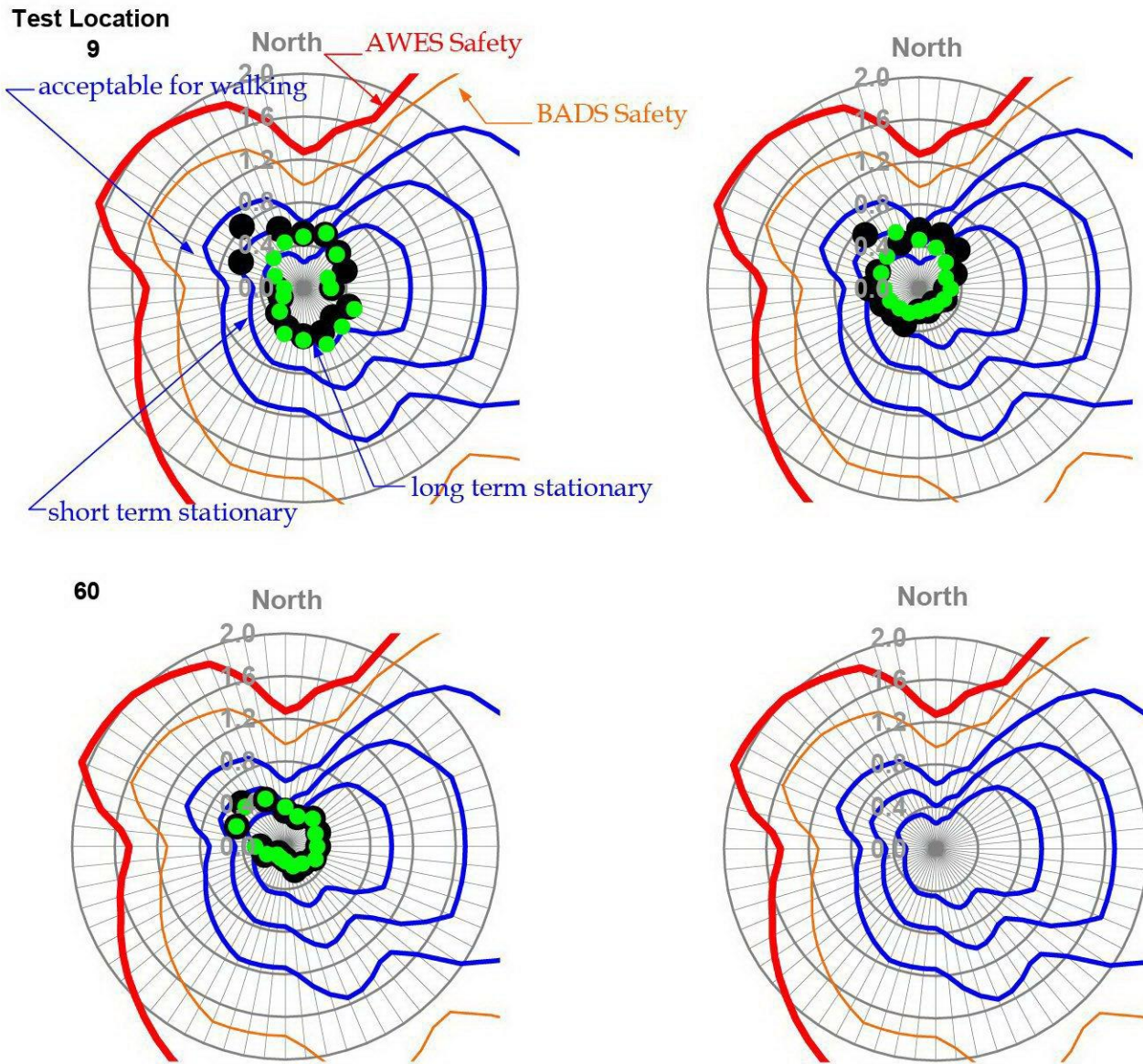


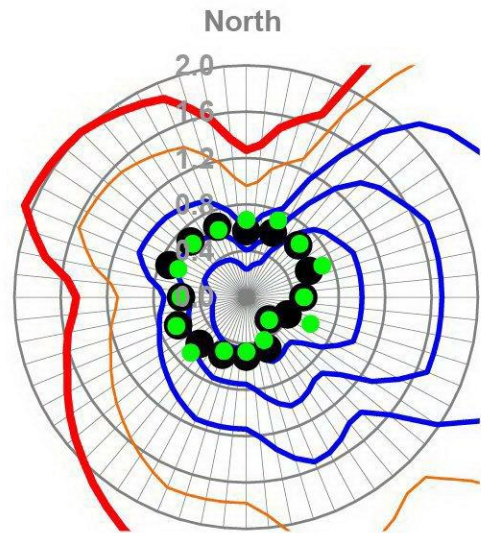
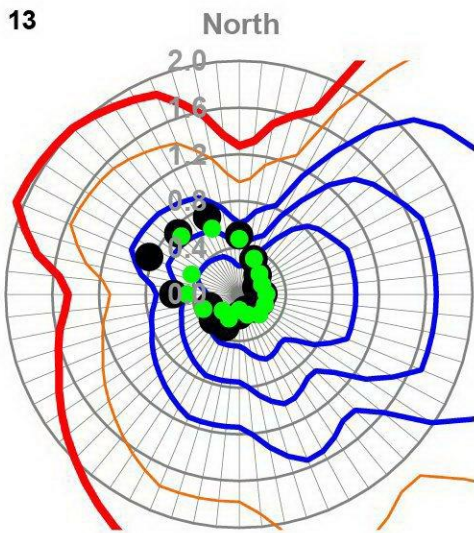
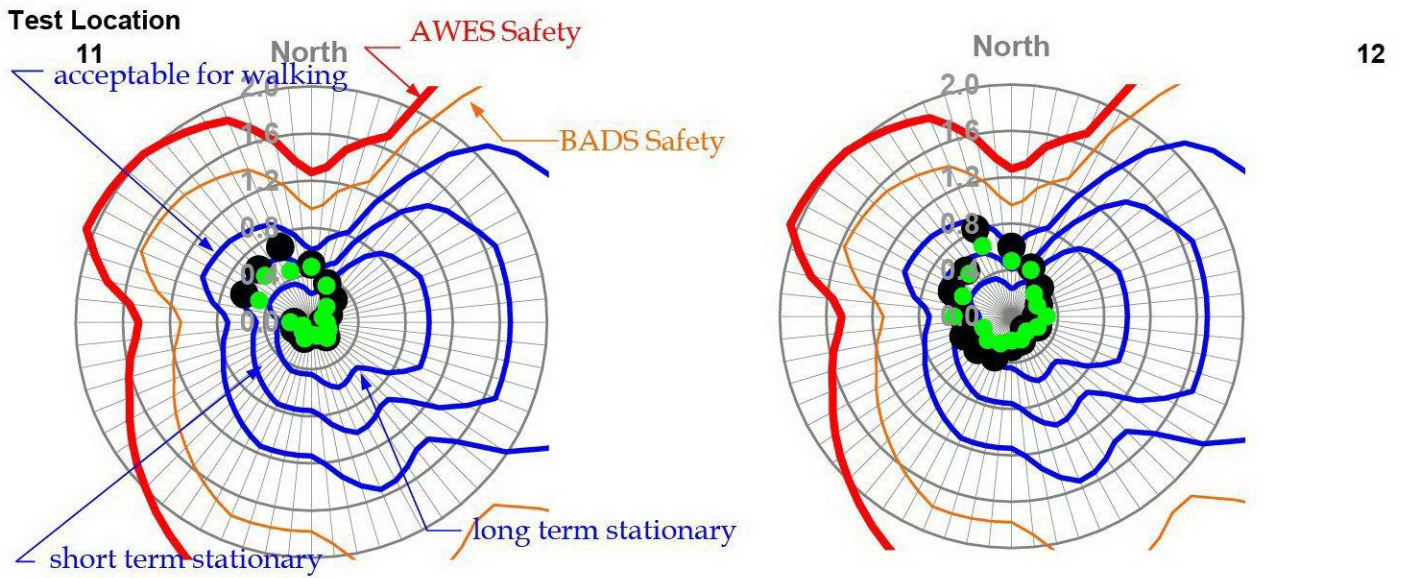
Figure A3 - Centre Road (Continued)



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



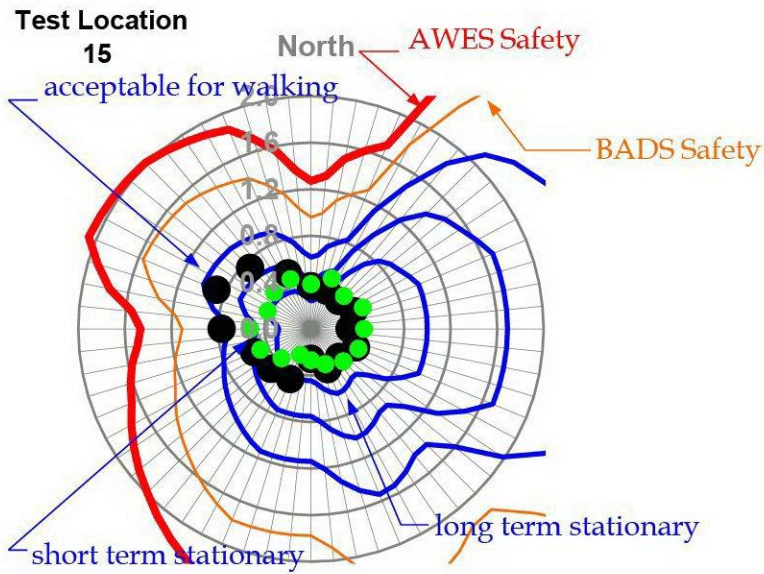
Figure A4 - Centre Road (Continued)



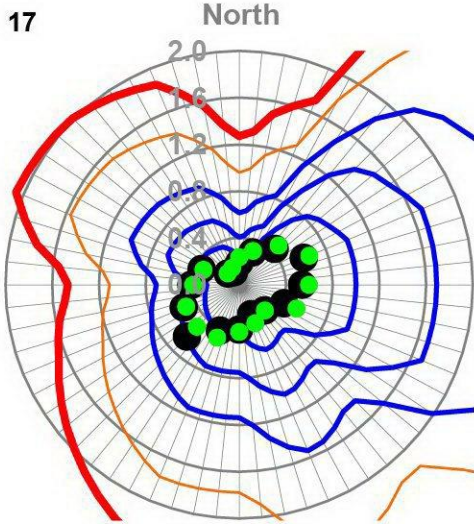
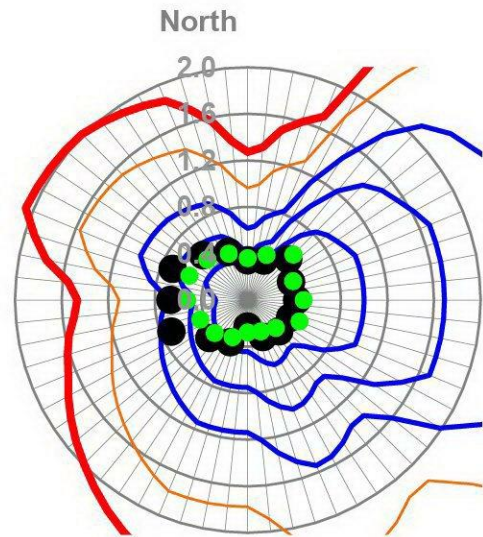
Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



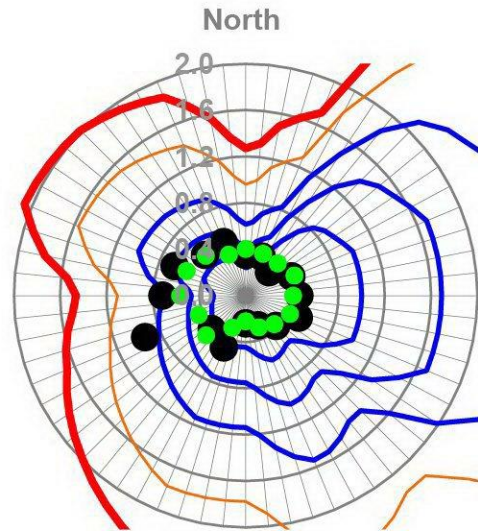
Figure A5 - Oakleigh BMX Track



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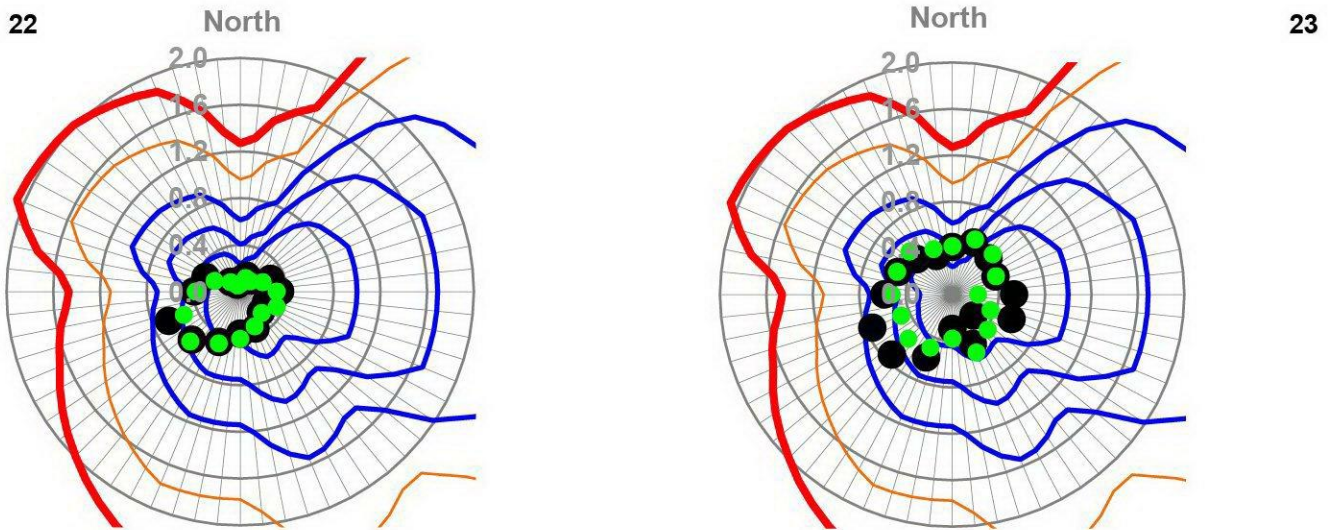
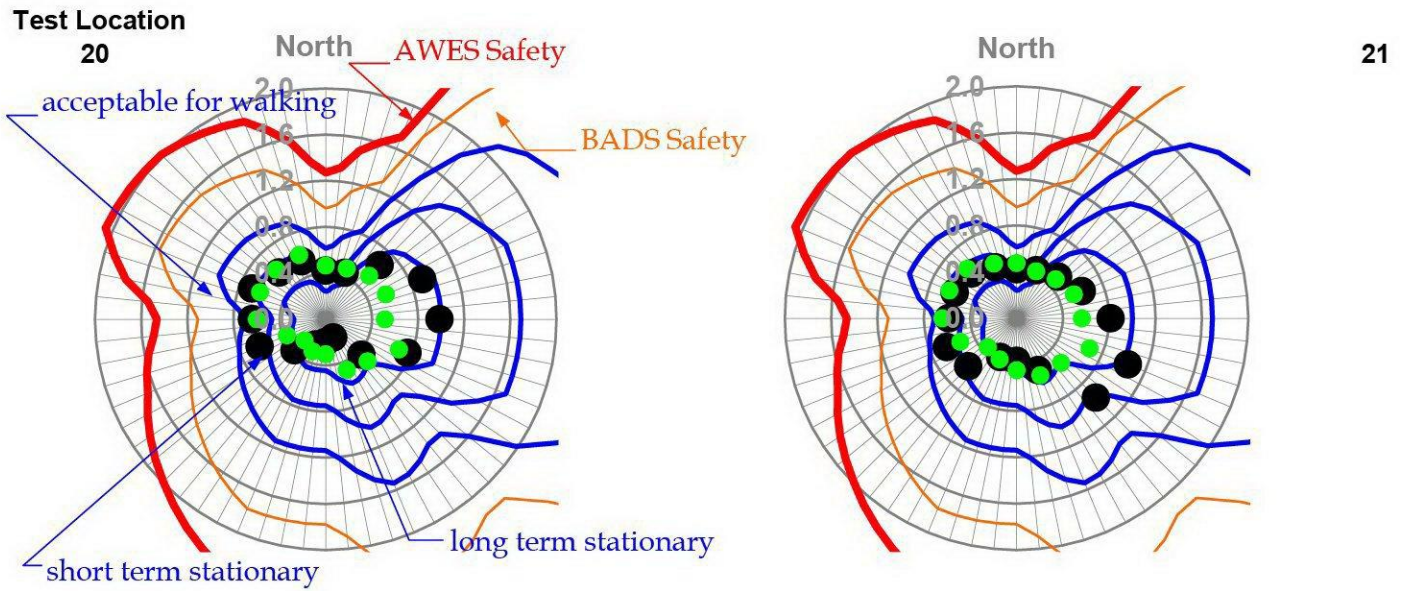


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Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



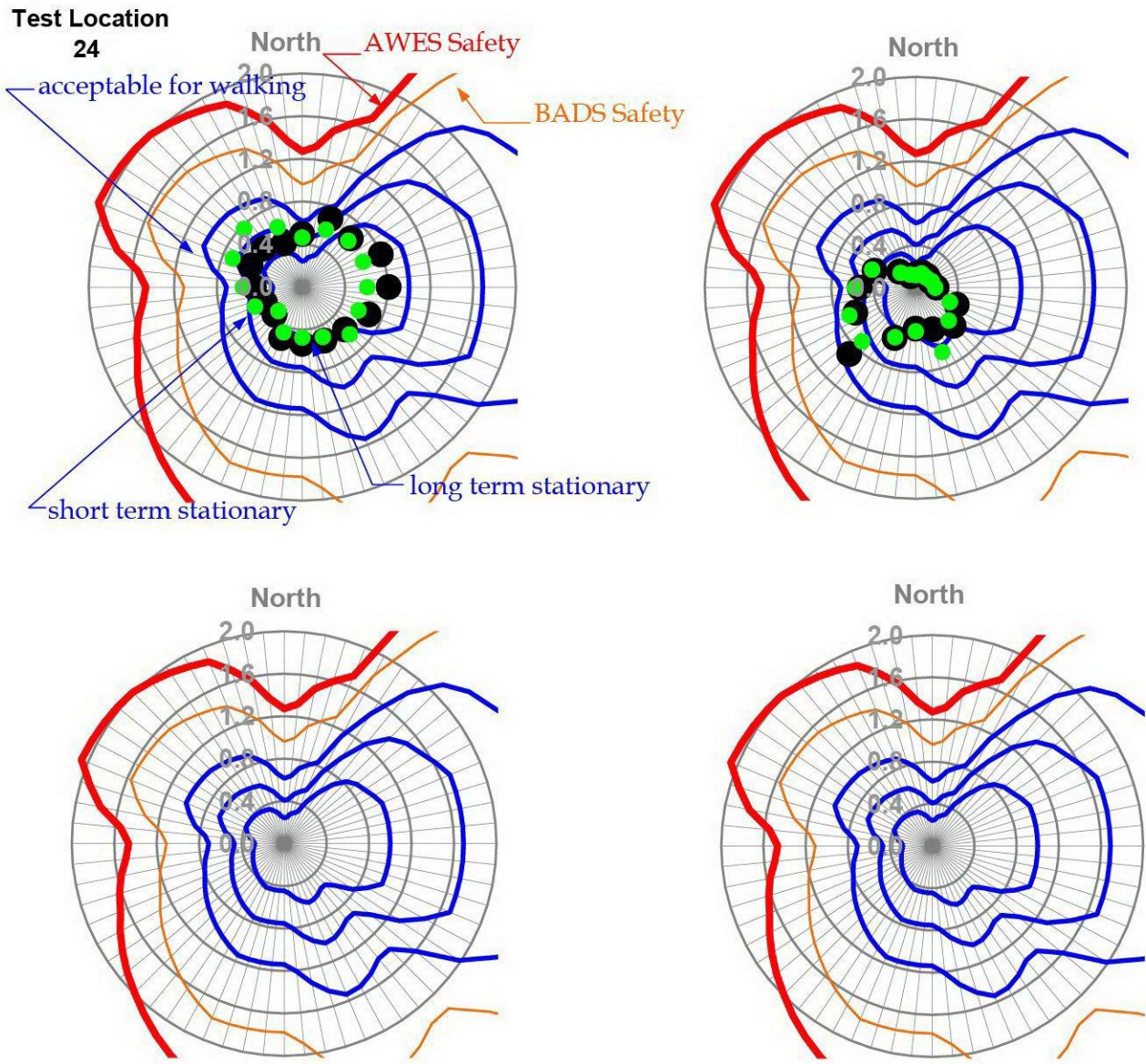
Figure A6 - The Links Shopping Mall Car Park



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\bar{V}_{300m}} \right|^2$ as a function of wind direction



Figure A7 - The Links Shopping Mall Car Park (Continued)



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction

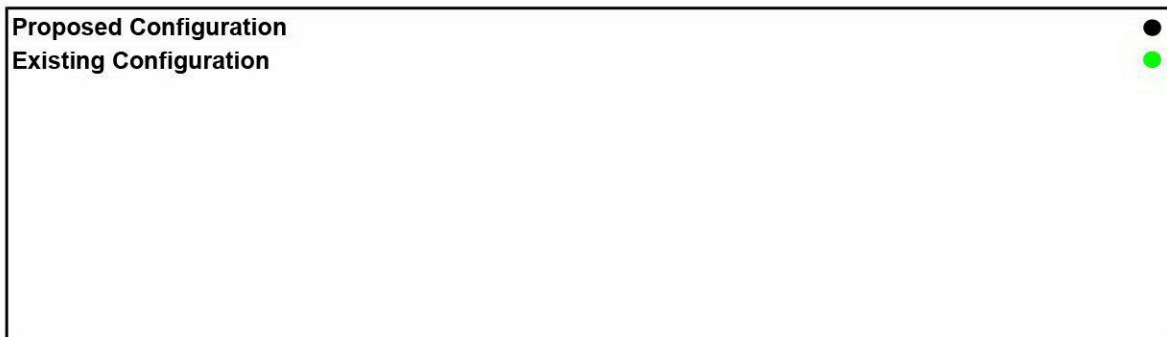
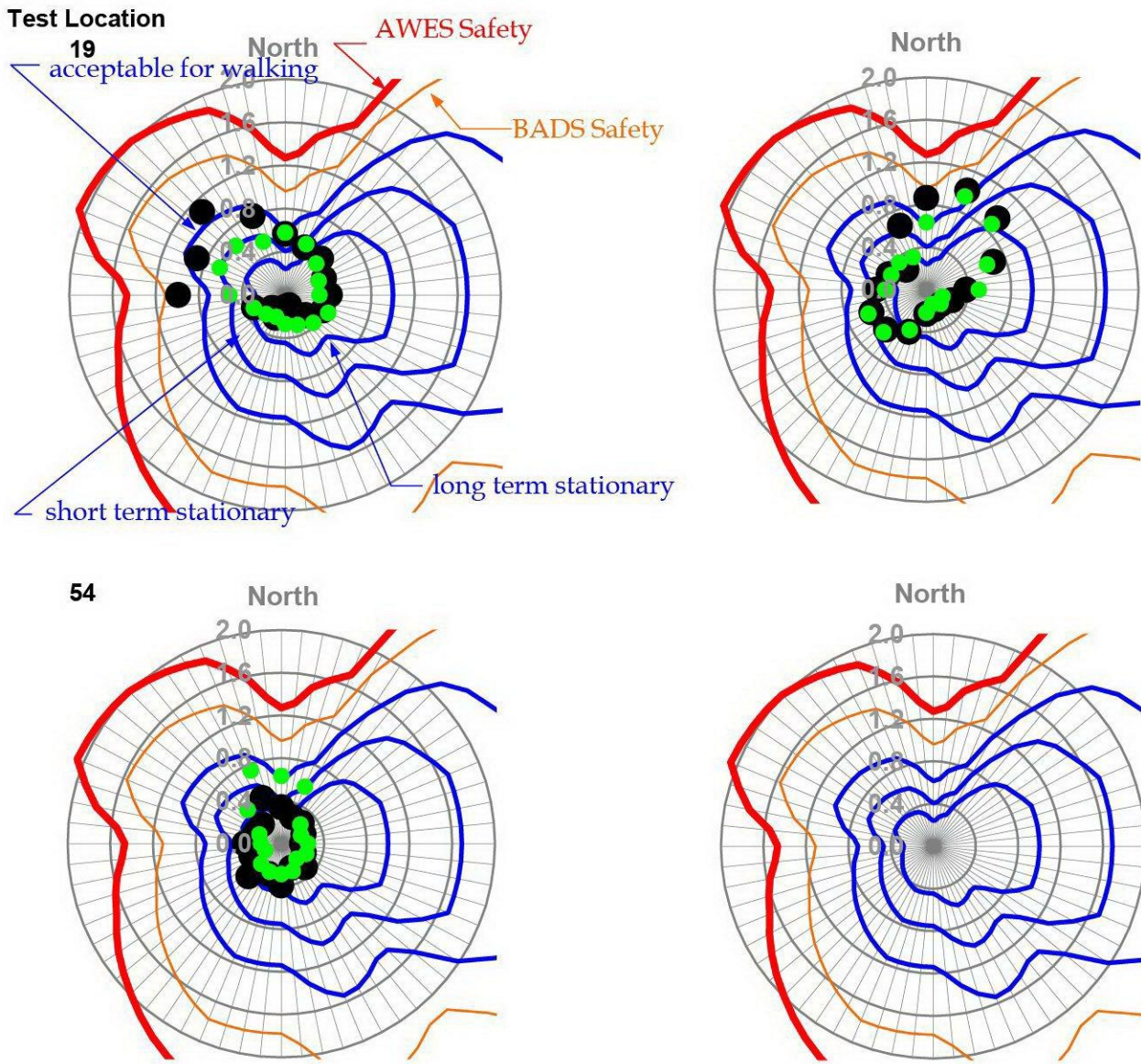


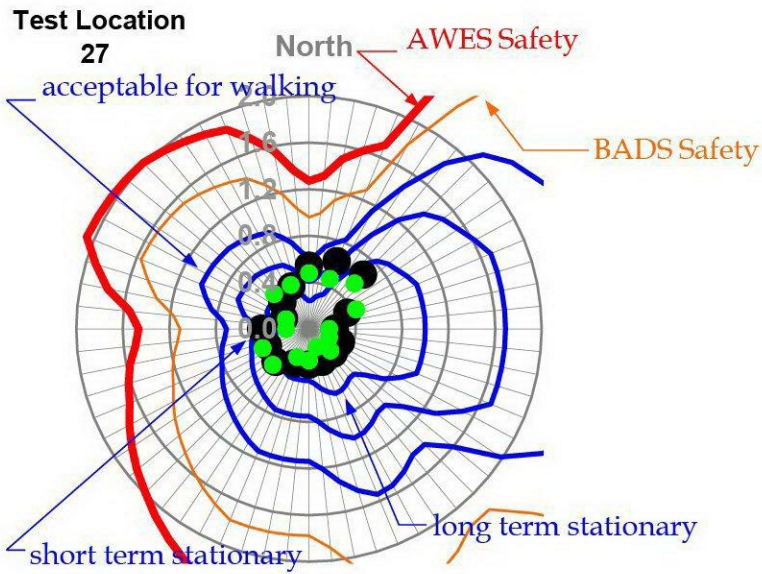
Figure A8 - The Links Shopping Mall Car Park (Continued)



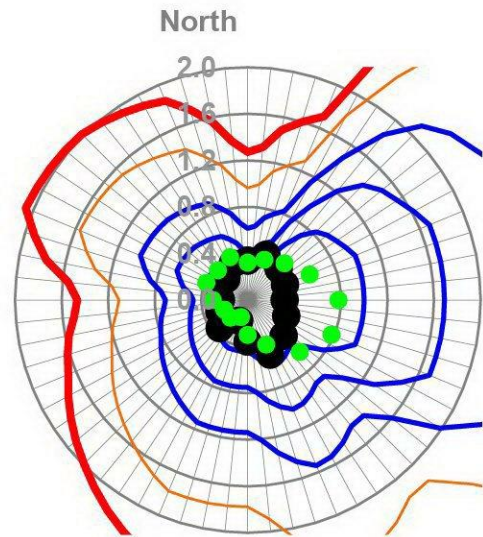
Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



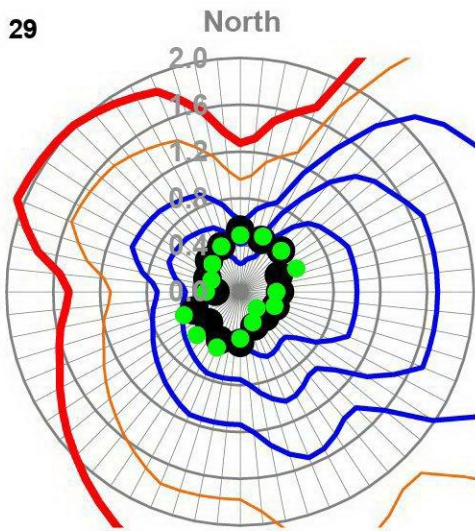
Figure A9 - Link Avenue



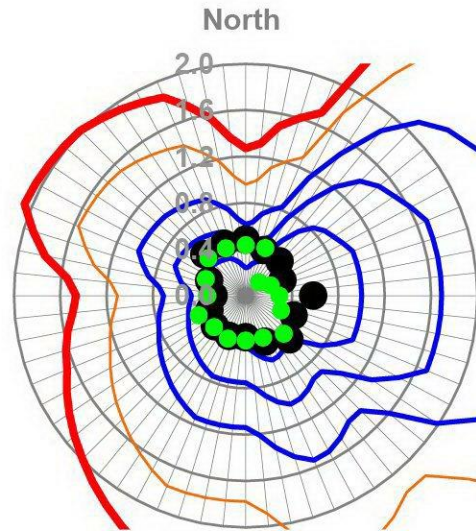
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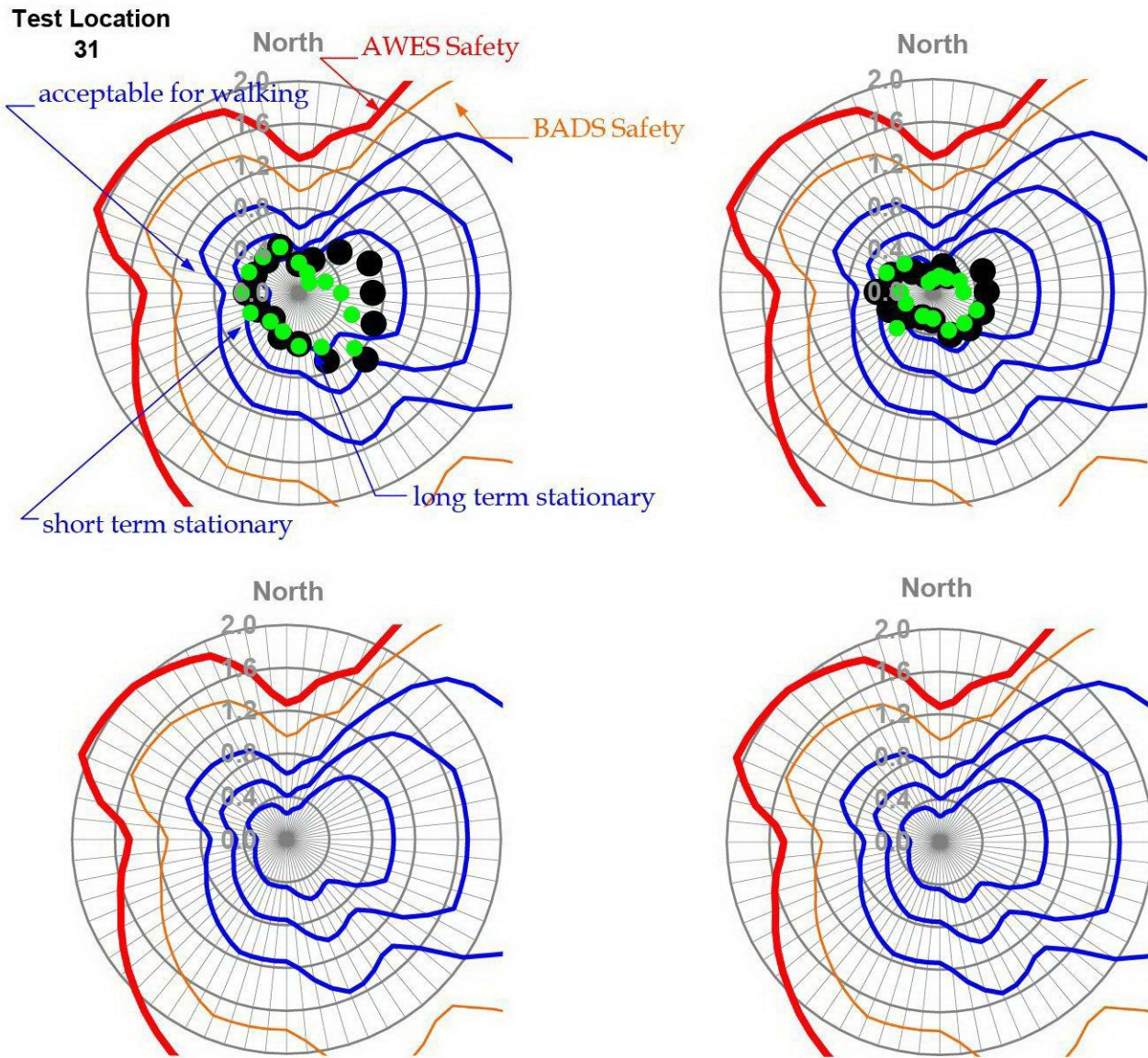
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Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



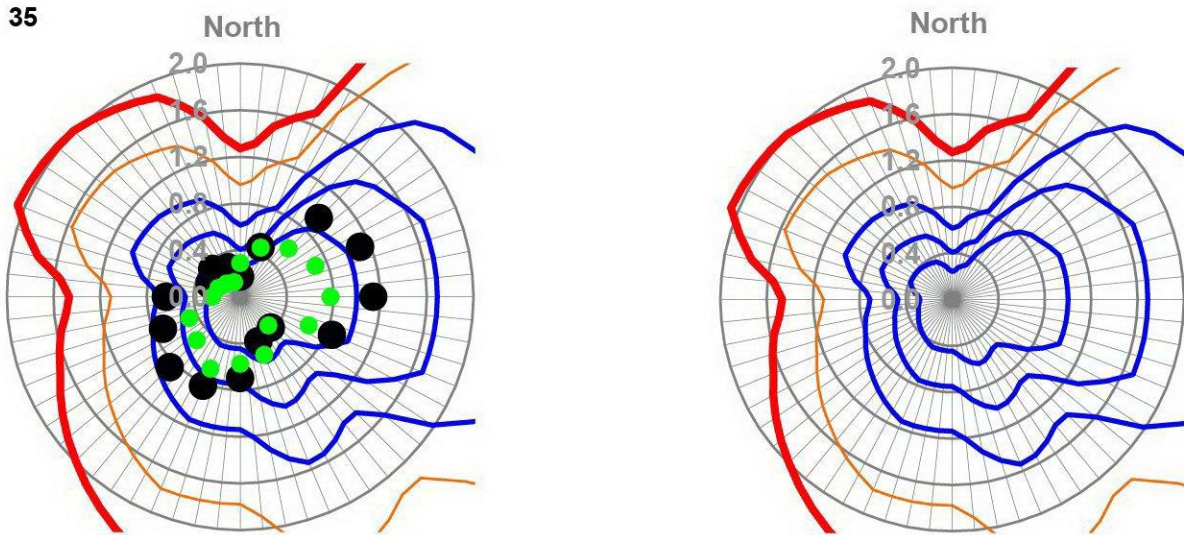
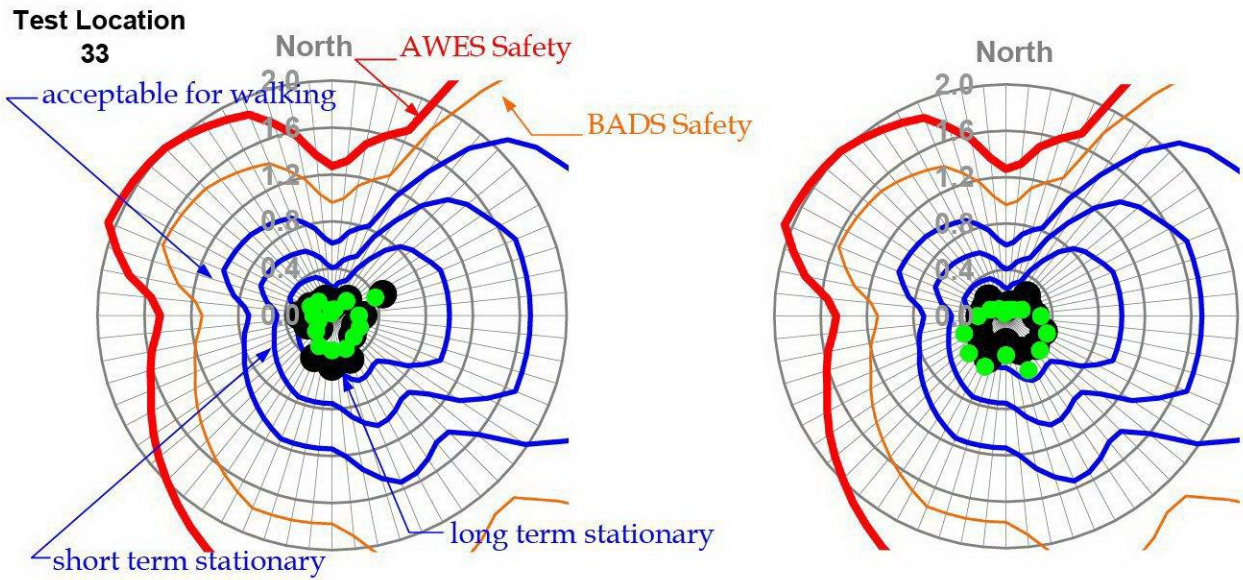
Figure A10 - Ventura Oakleigh Depot



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\bar{V}_{300m}} \right|^2$ as a function of wind direction



Figure A11 - Ventura Oakleigh Depot (Continued) & Caltex Petrol Station



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction

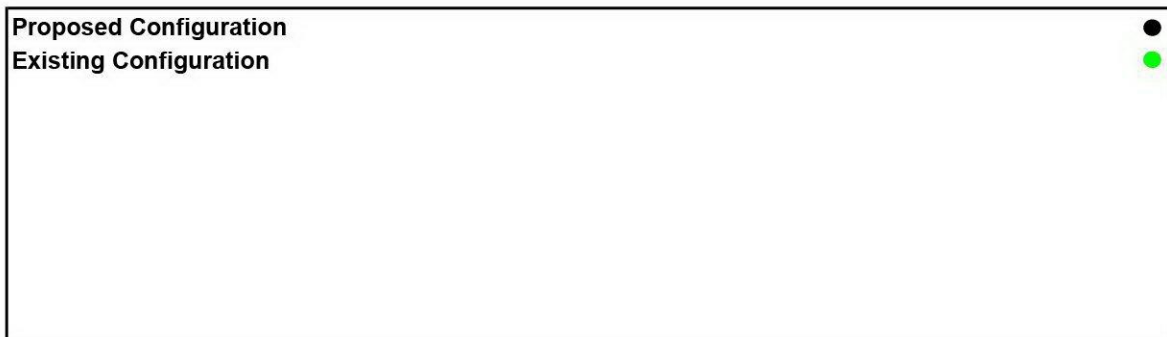
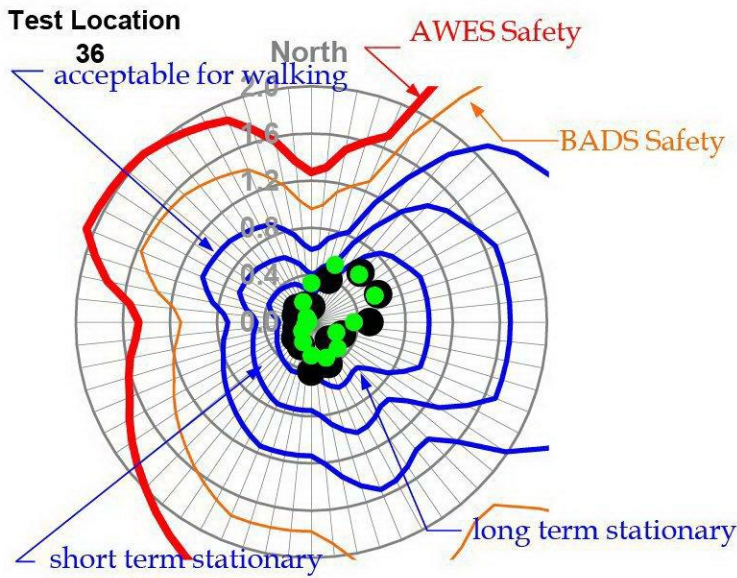
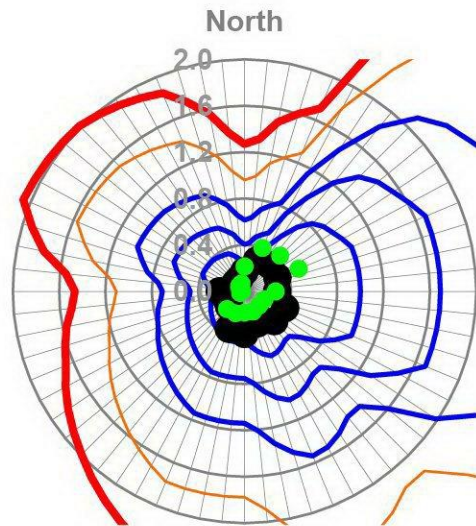


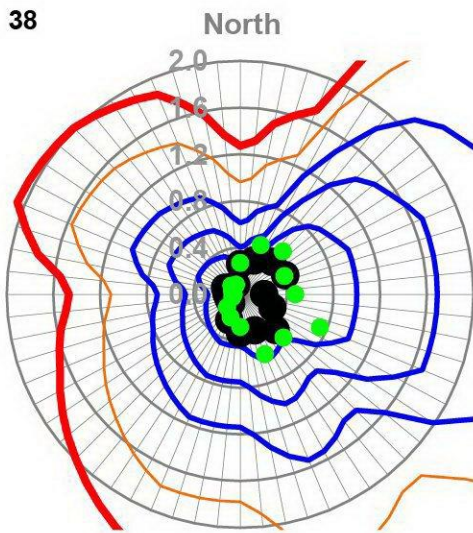
Figure A12 - Adjacent to South side of The Links development



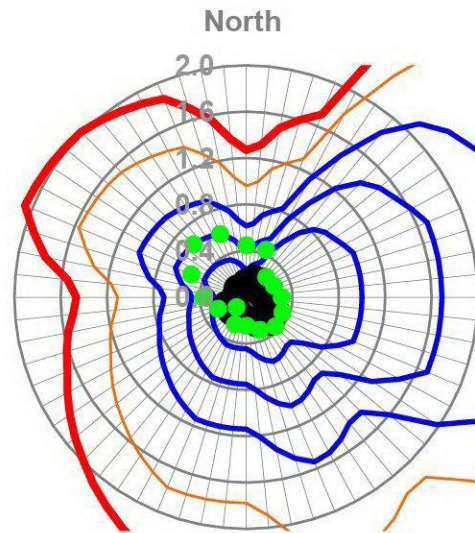
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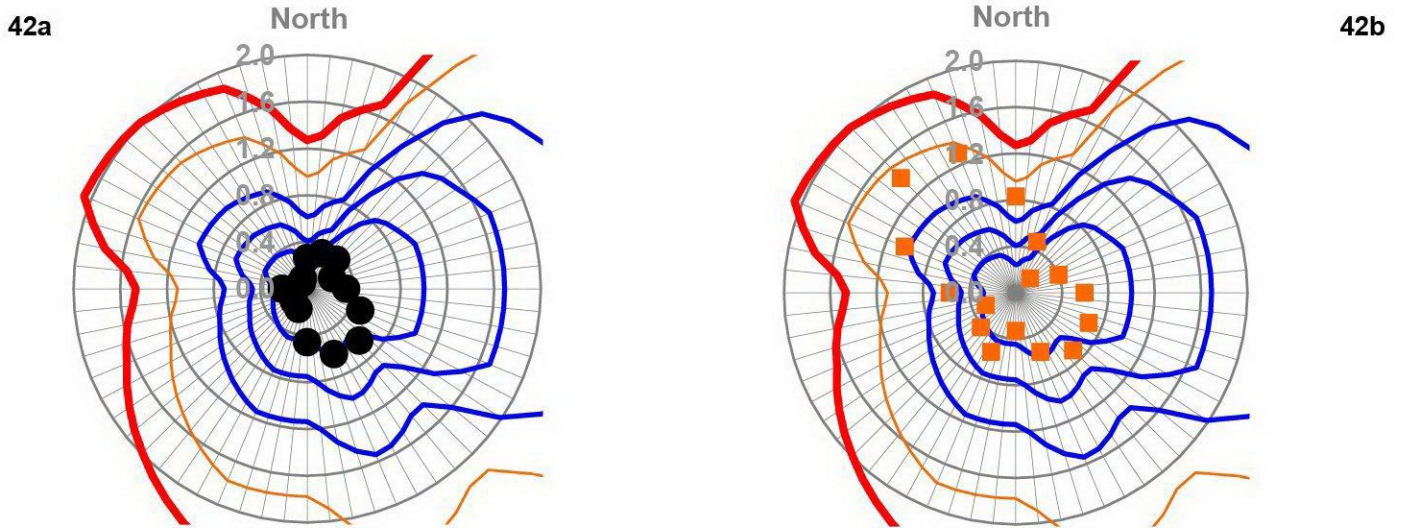
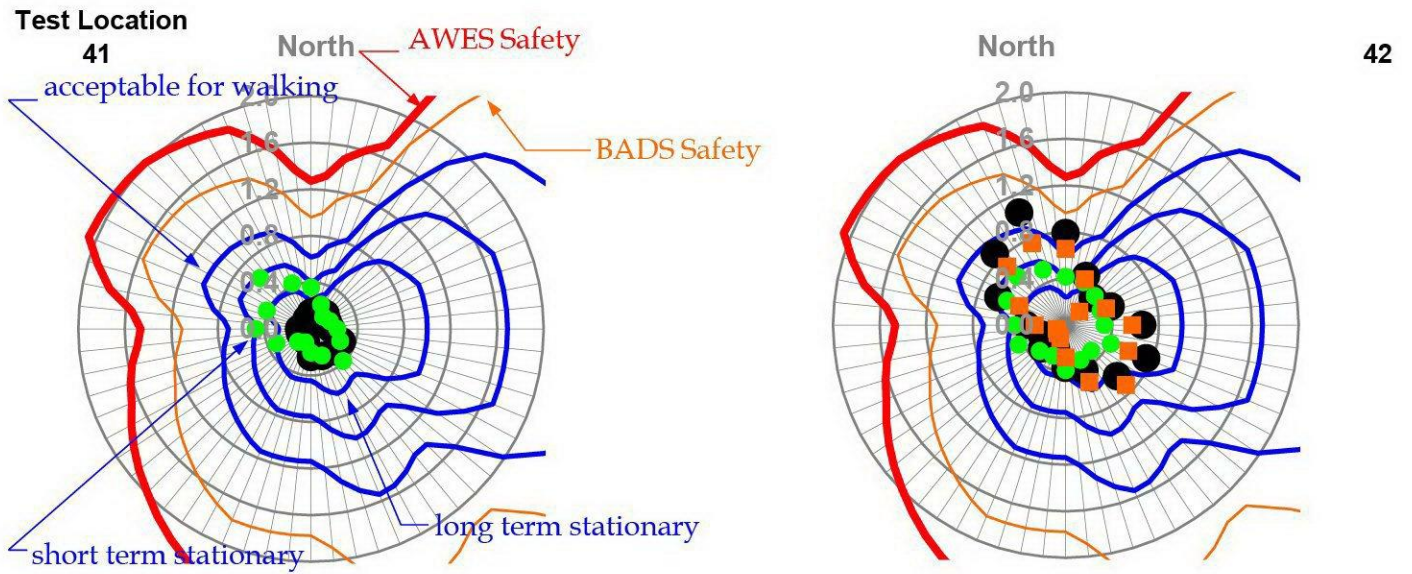
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Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\bar{V}_{300m}} \right|^2$ as a function of wind direction



Figure A13 - Adjacent to East side of The Links development



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction

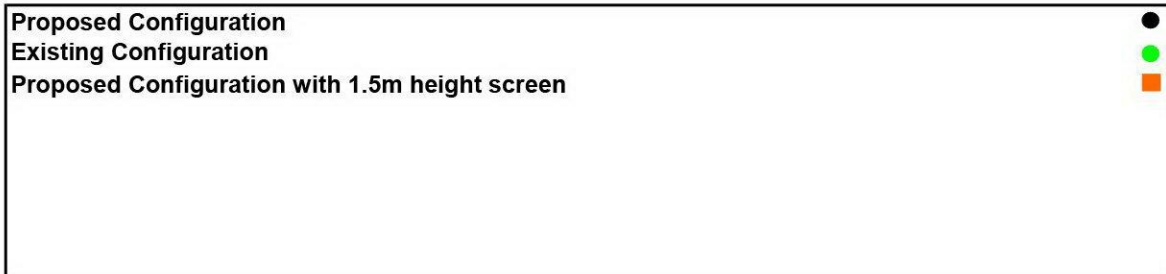


Figure A14 - Adjacent to East side of development (Continued)

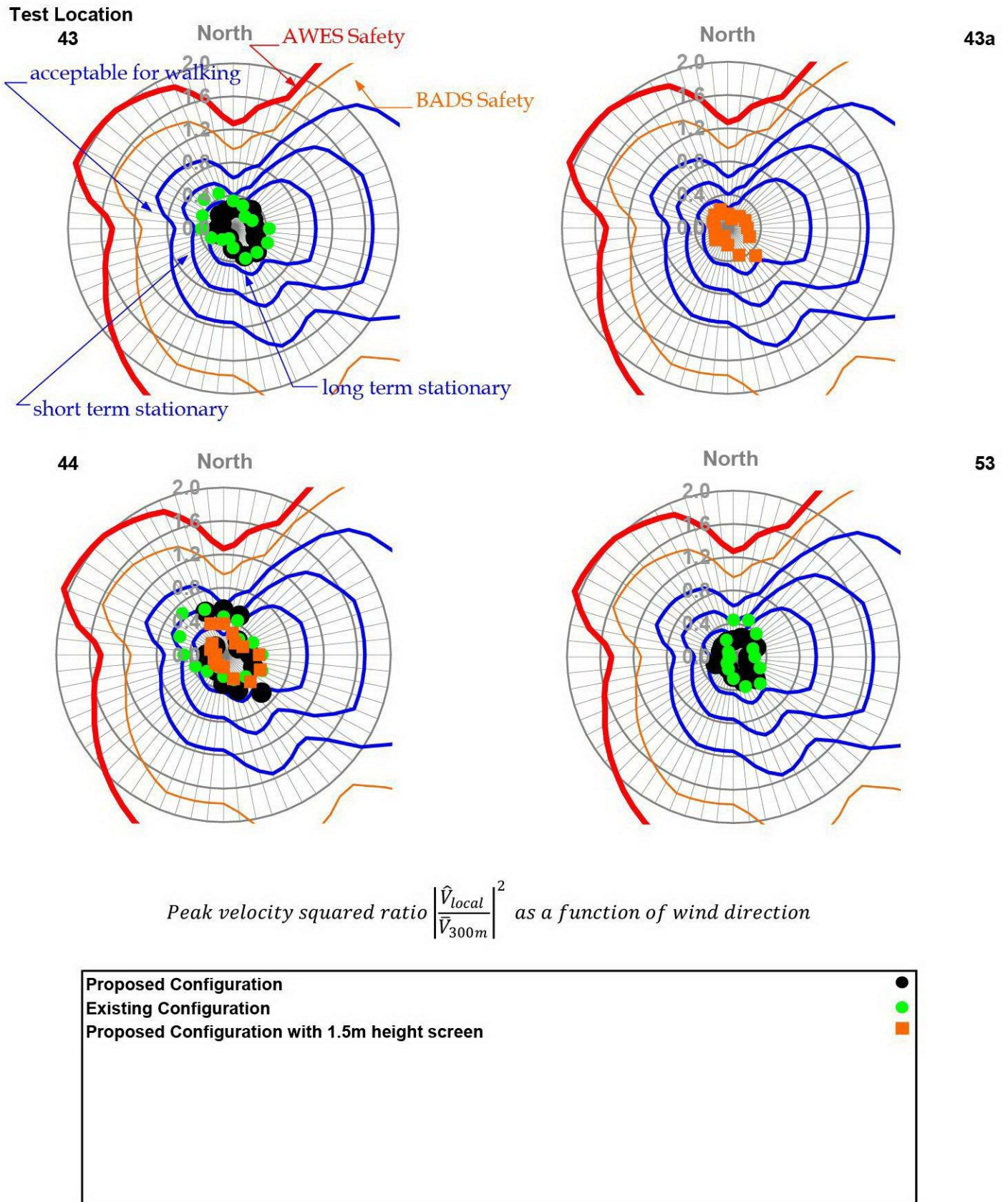
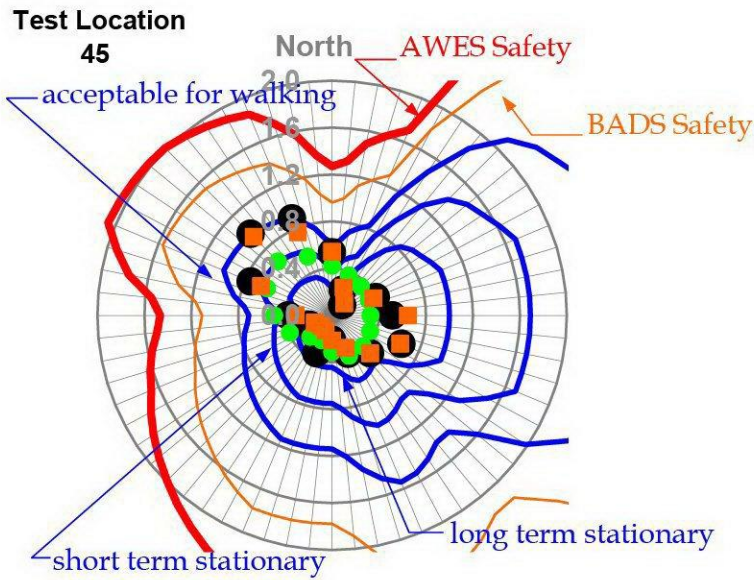
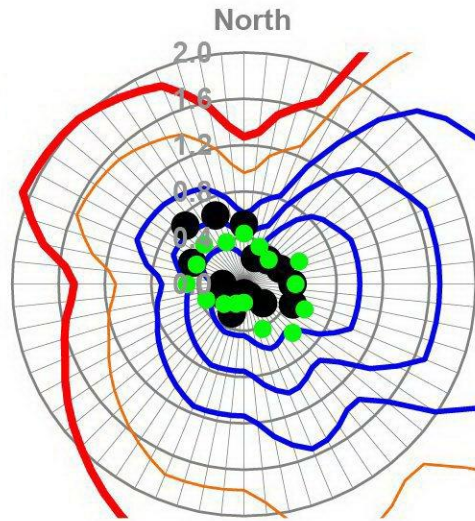


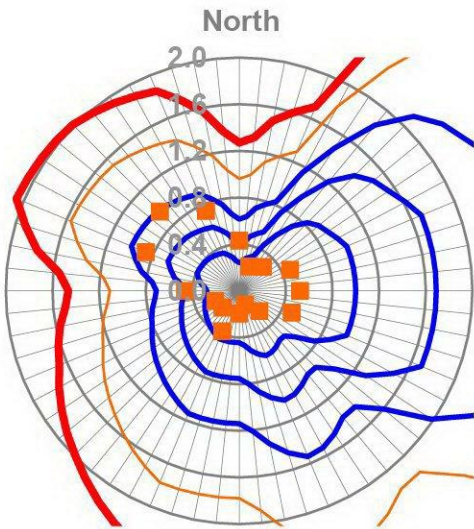
Figure A15 - Adjacent to East side of development (Continued)



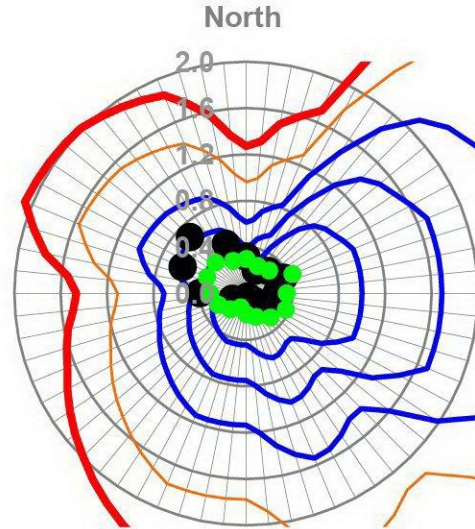
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Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction

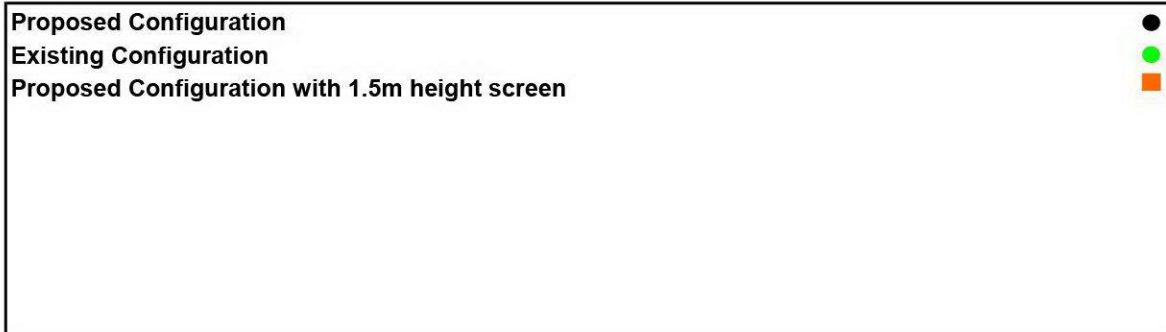
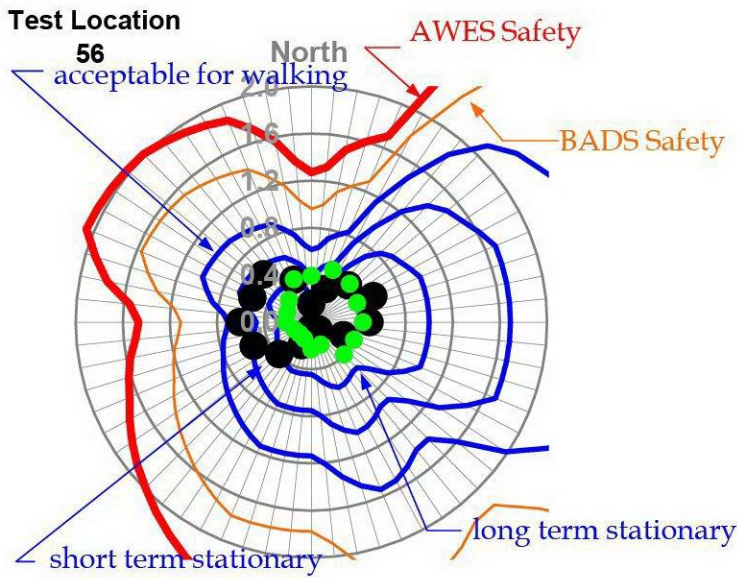
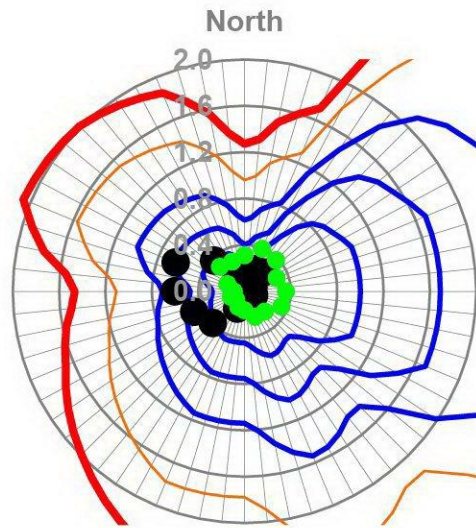


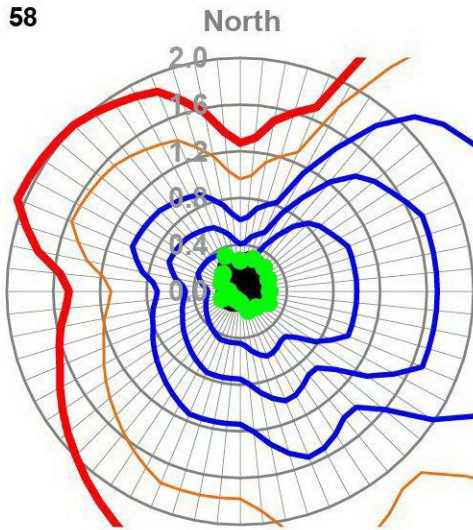
Figure A16 - Adjacent to North side of development



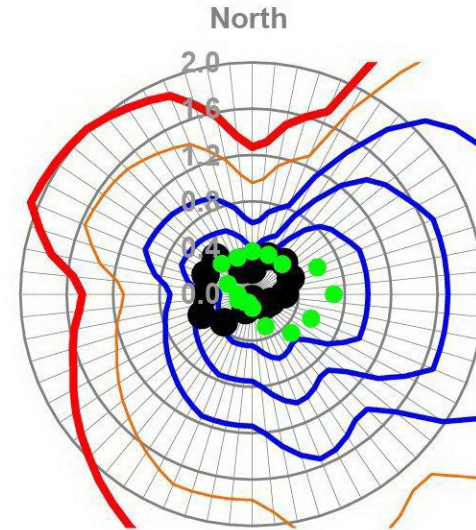
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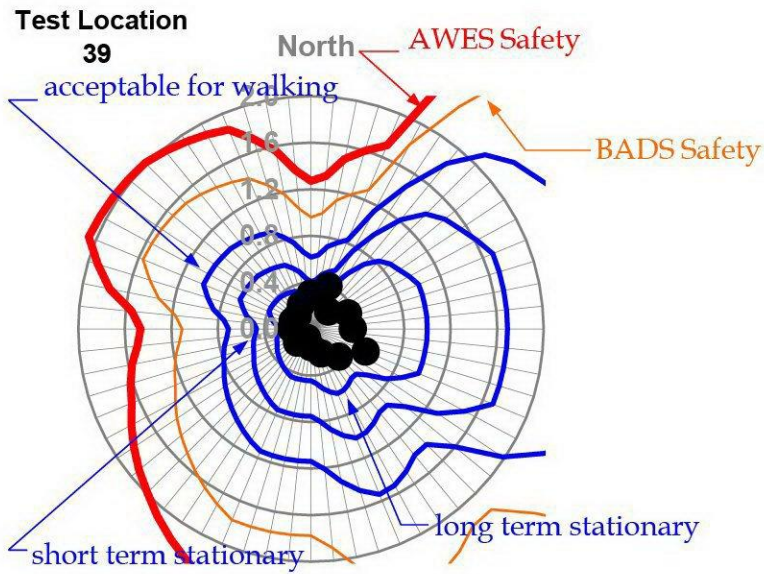
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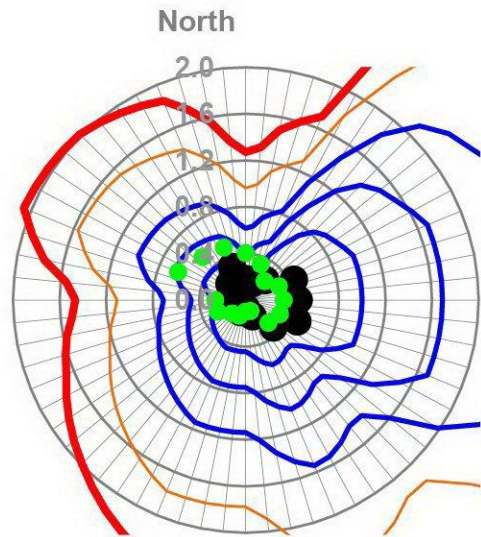
Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\bar{V}_{300m}} \right|^2$ as a function of wind direction



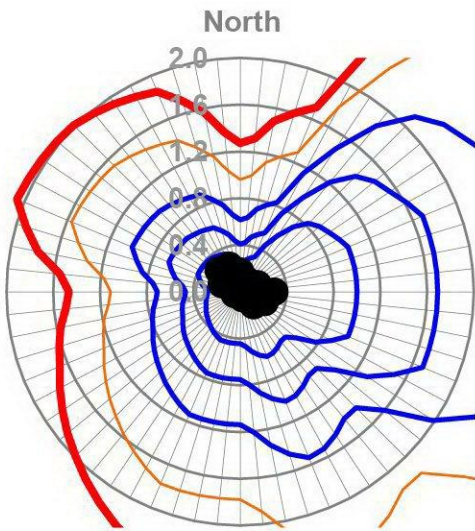
Figure A17 - Adjacent to North side of development (Continued)



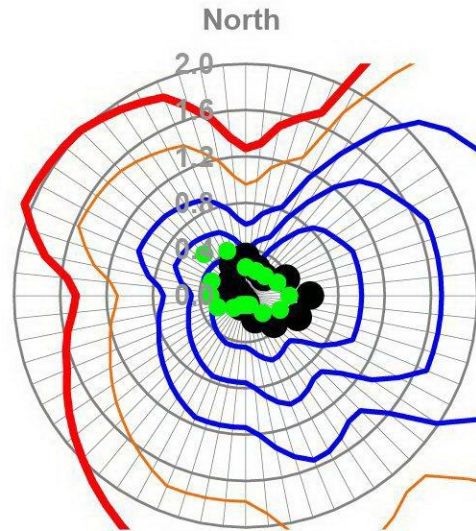
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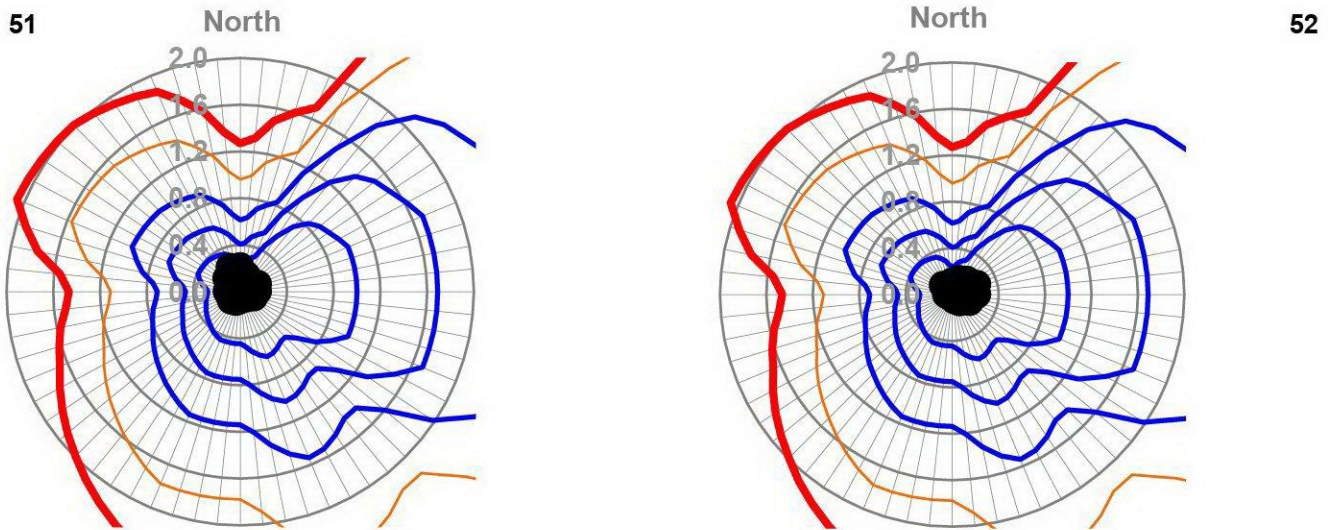
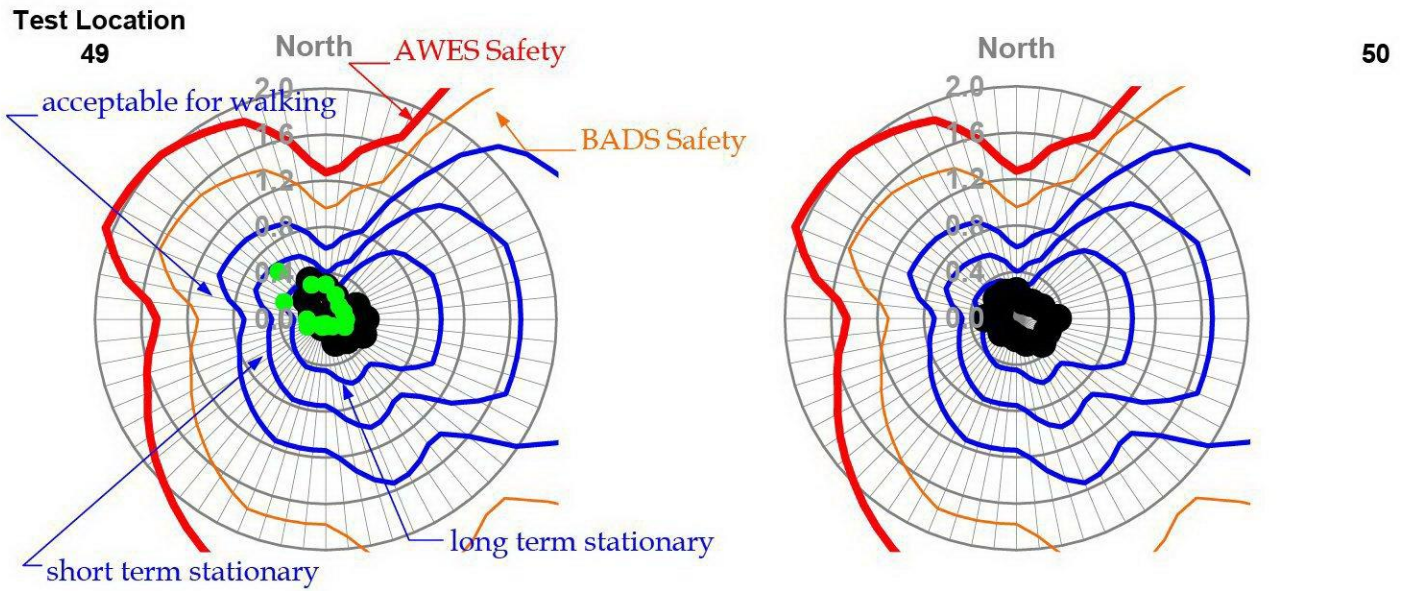
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Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



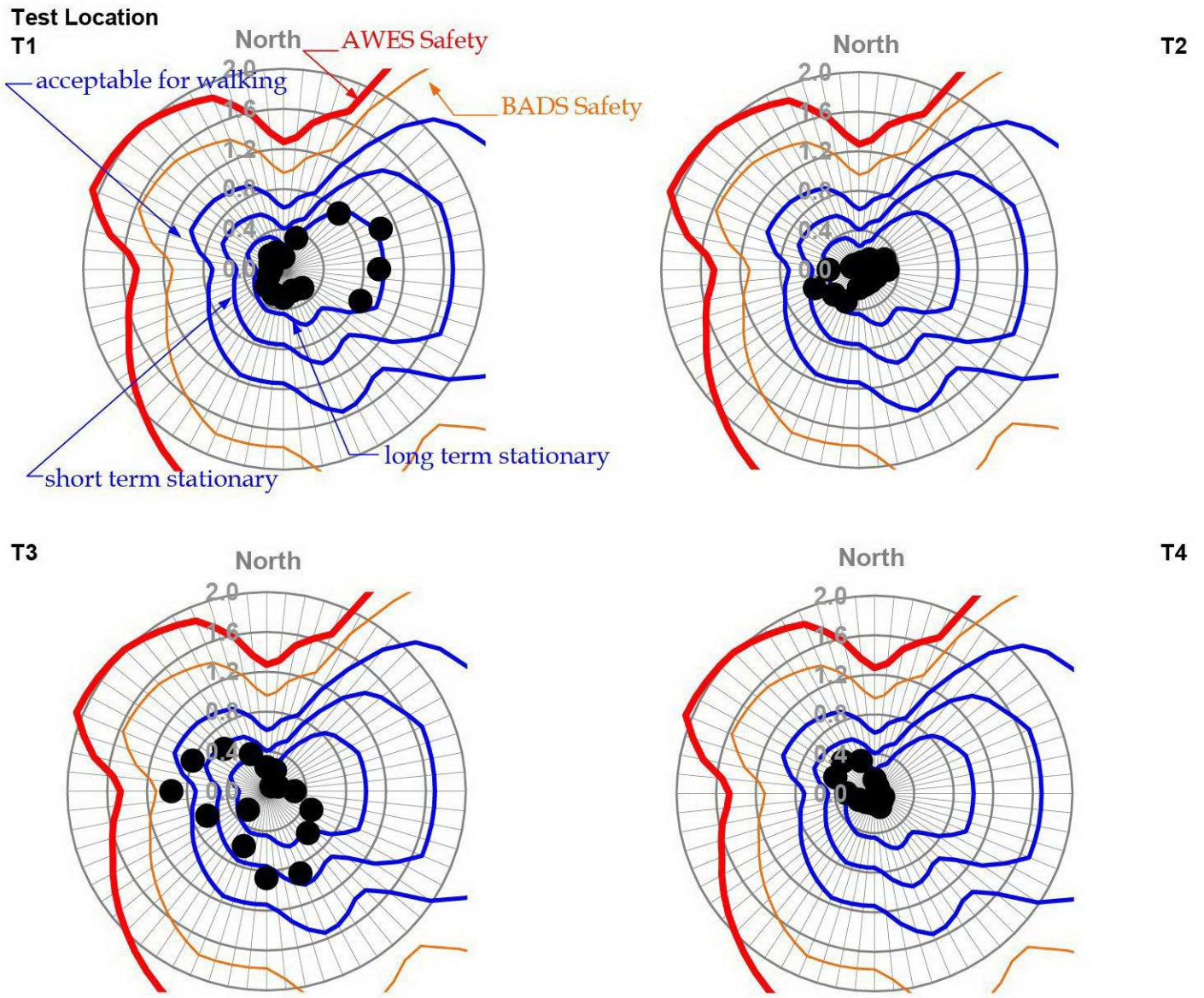
Figure A18 - Under-croft Passage



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



Figure A19 - Under-croft Passage (Continued)



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction

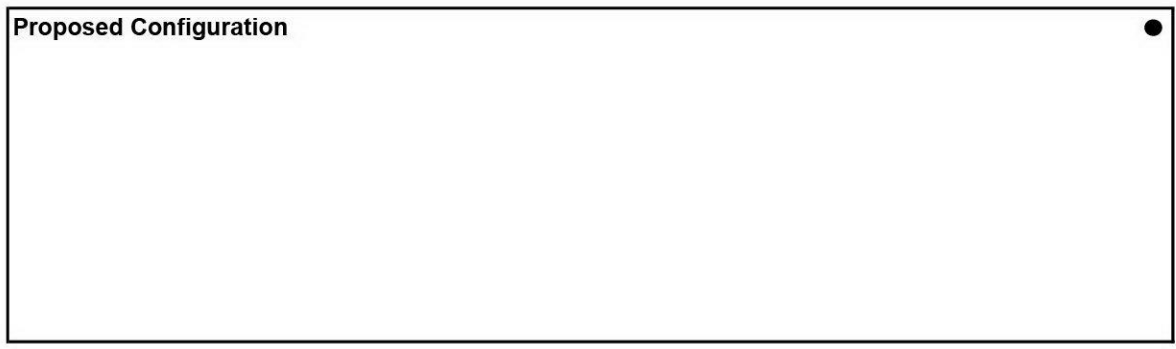
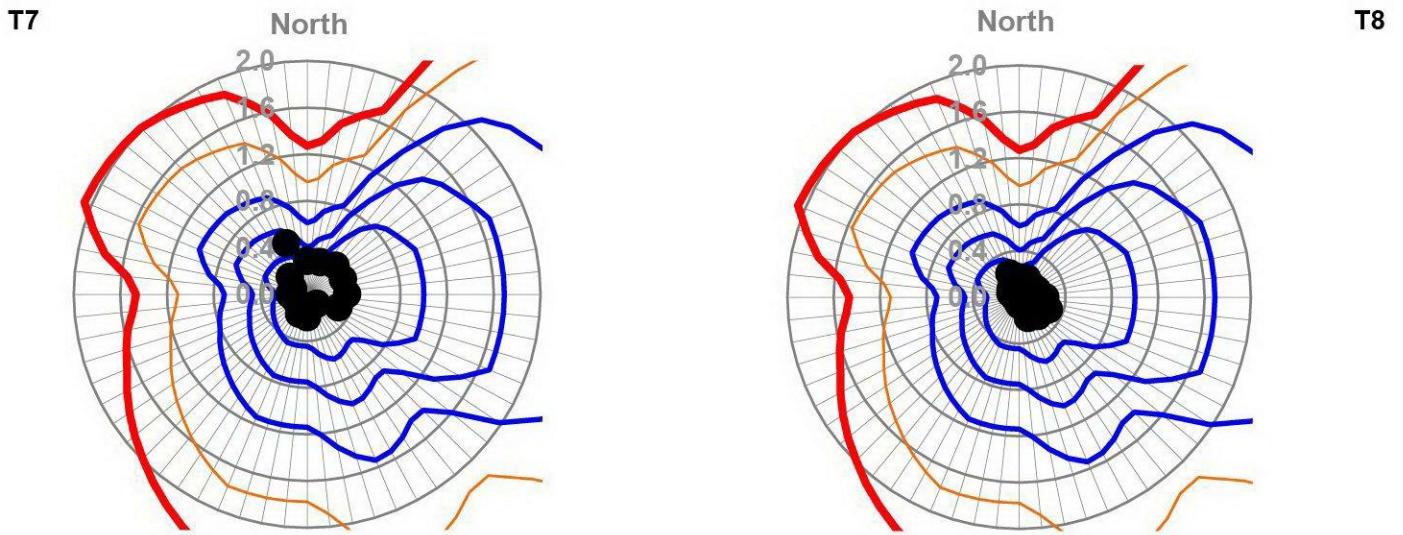
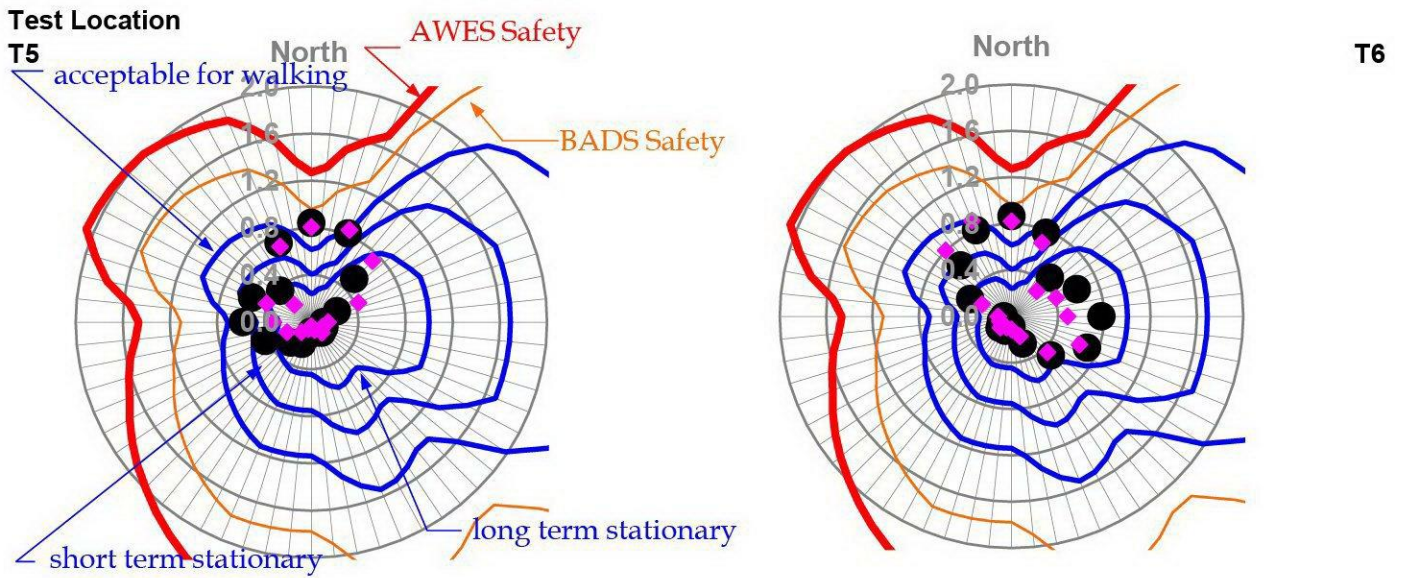


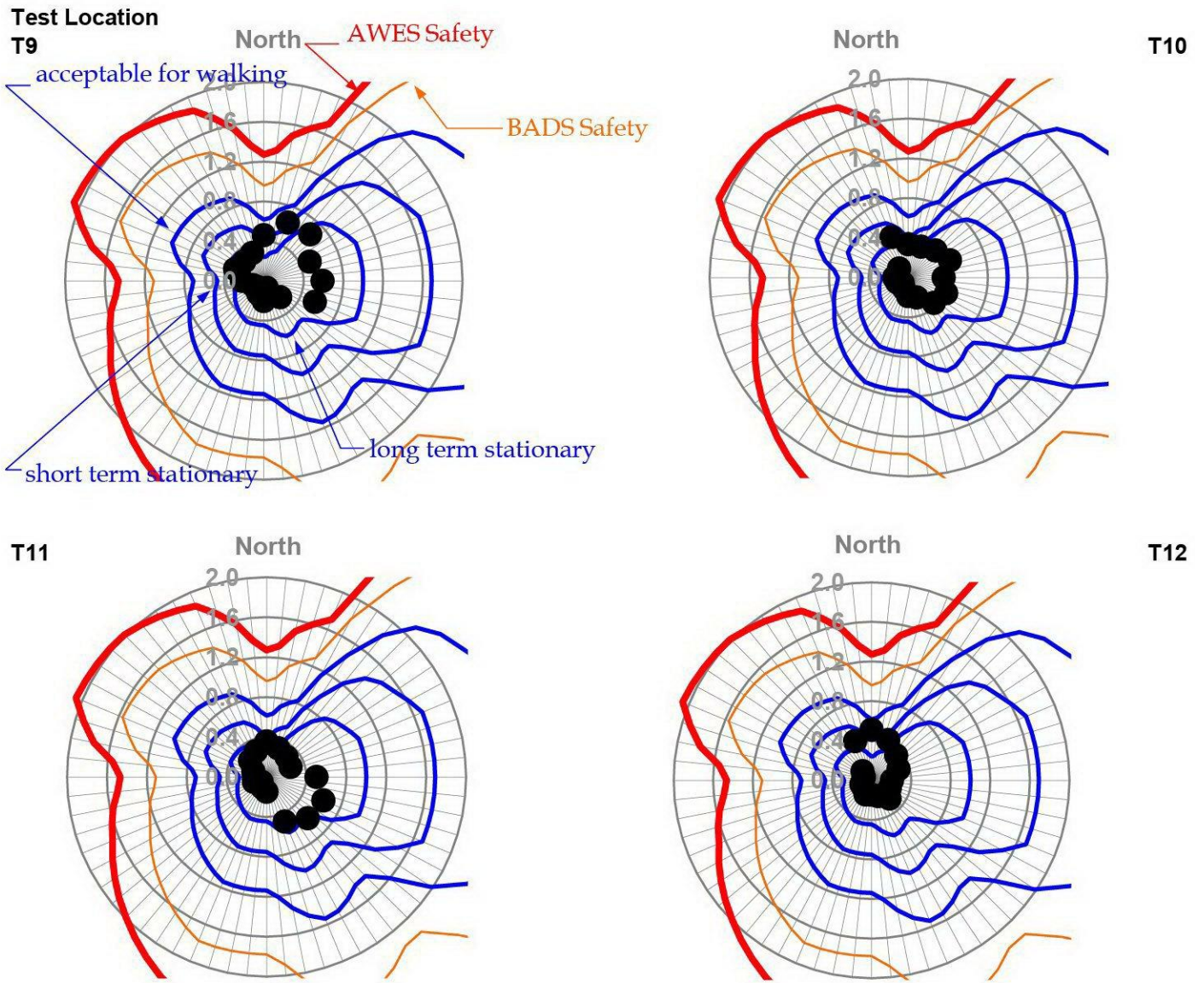
Figure A20 - Terraces & Podium Garden at Level 1



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction

Proposed Configuration	●
Proposed Configuration with 2.1m height balustrade	◆

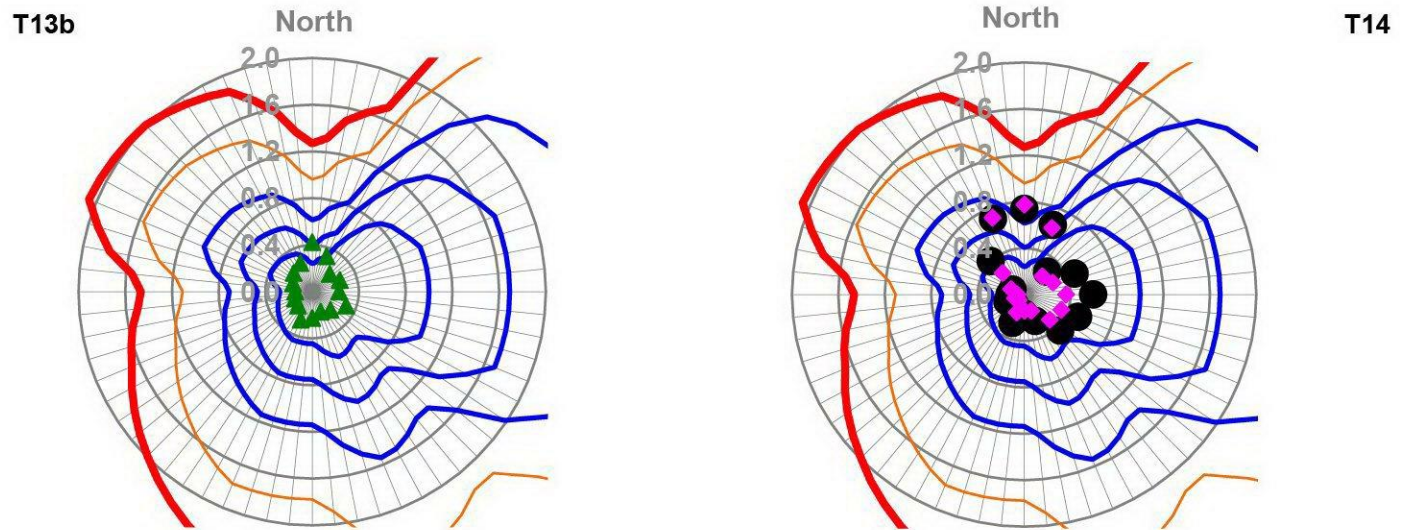
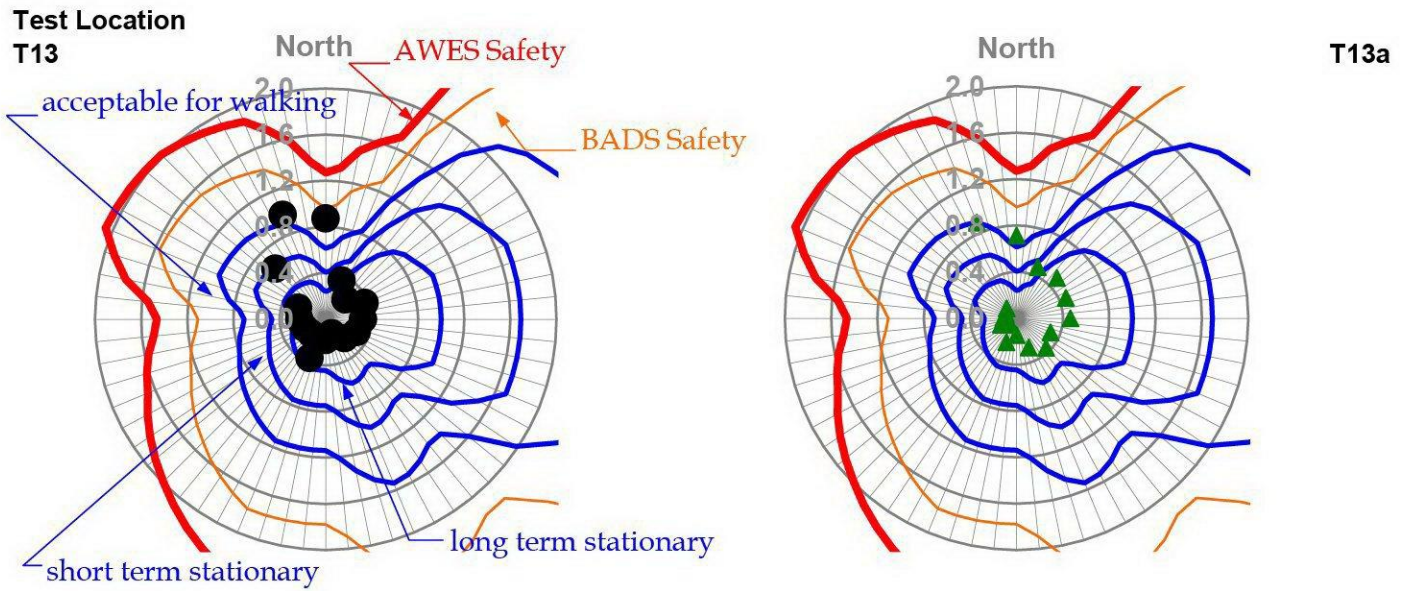
Figure A21 - Terraces & Podium Garden at Level 1 (Continued)



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



Figure A22 - Terraces & Podium Garden at Level 1 (Continued)



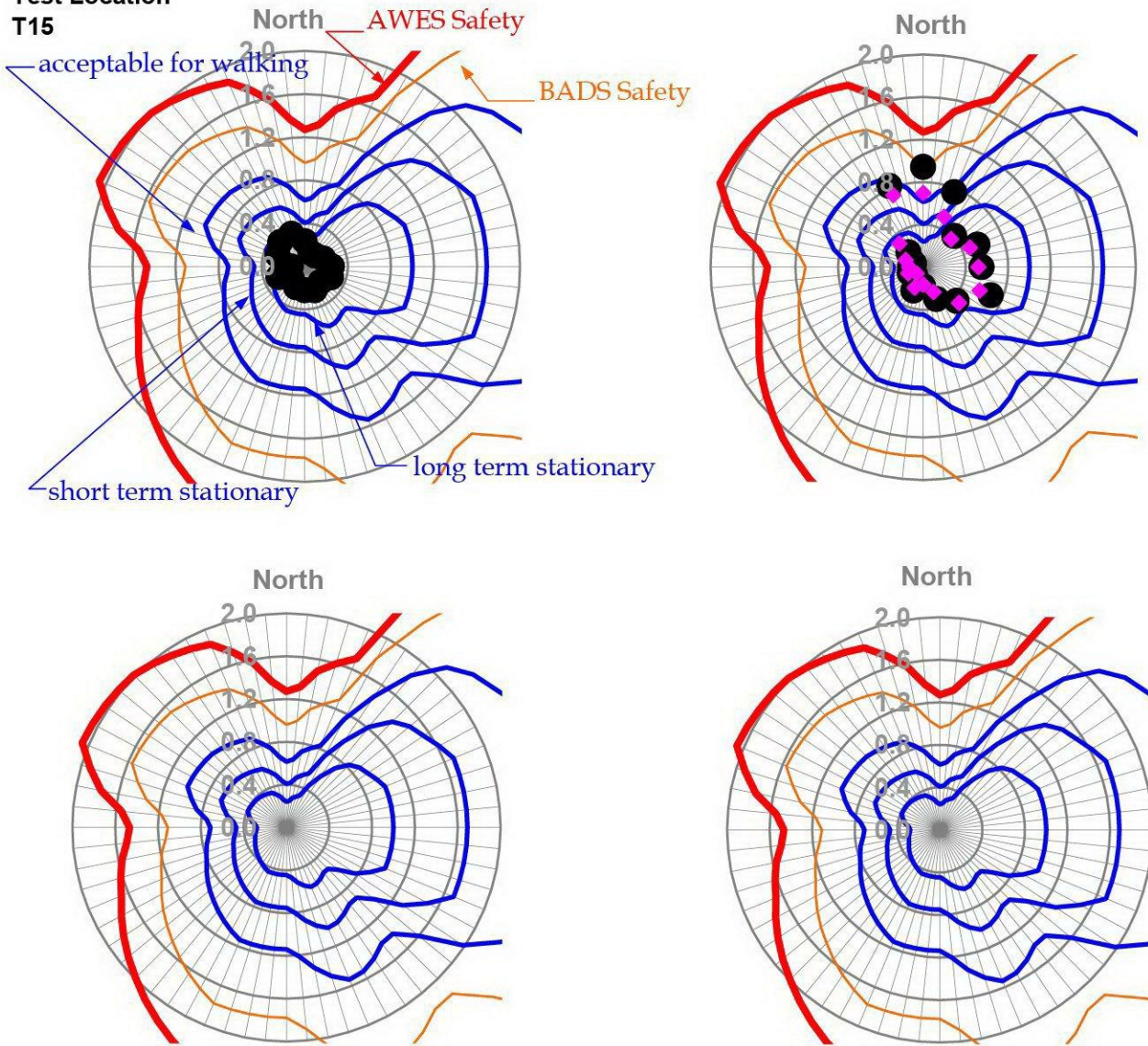
Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



Figure A23 - Terraces & Podium Garden at Level 1 (Continued)

Test Location
T15

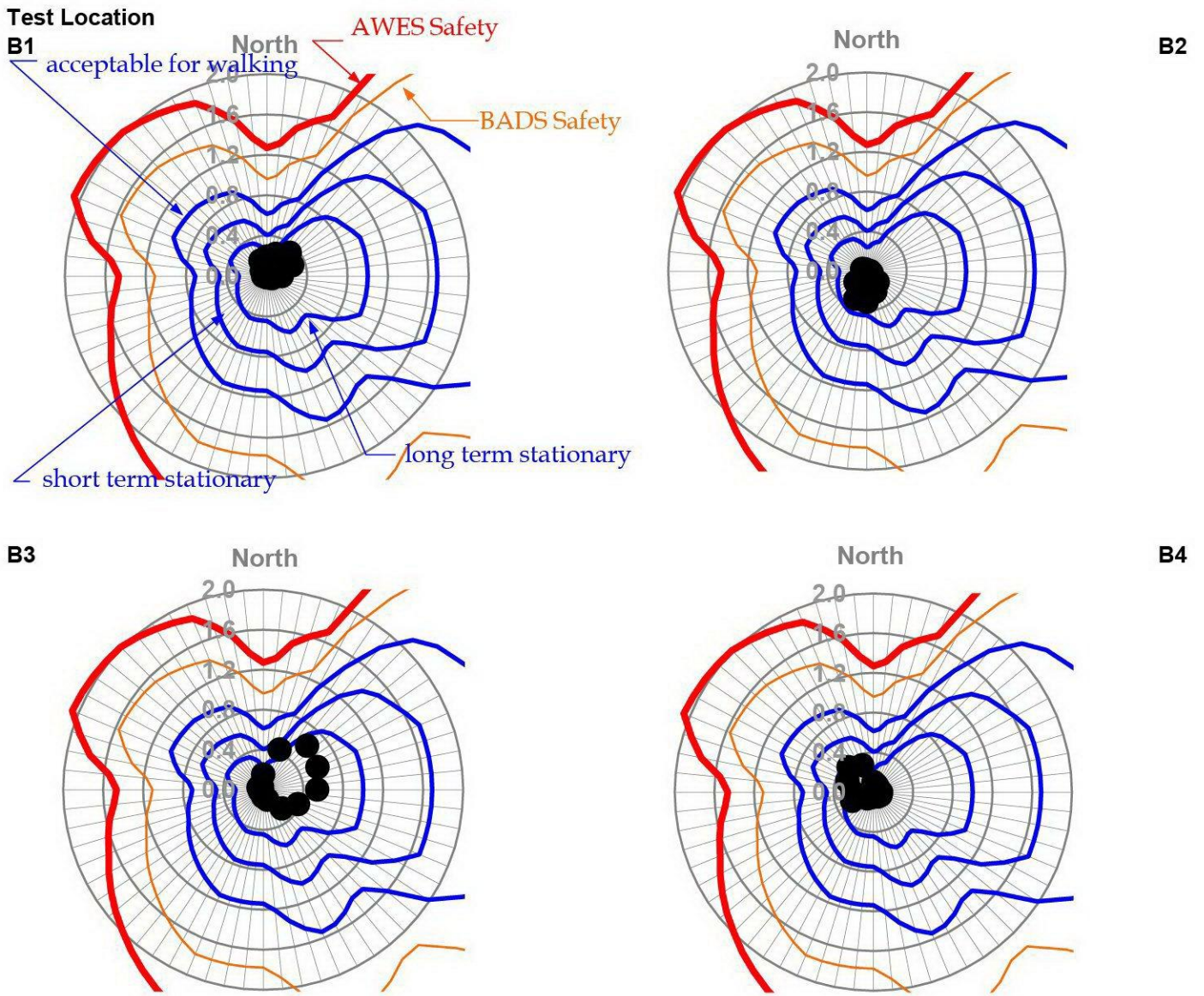
T16



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction

Proposed Configuration	●
Proposed Configuration with 2.1m height balustrade	◆

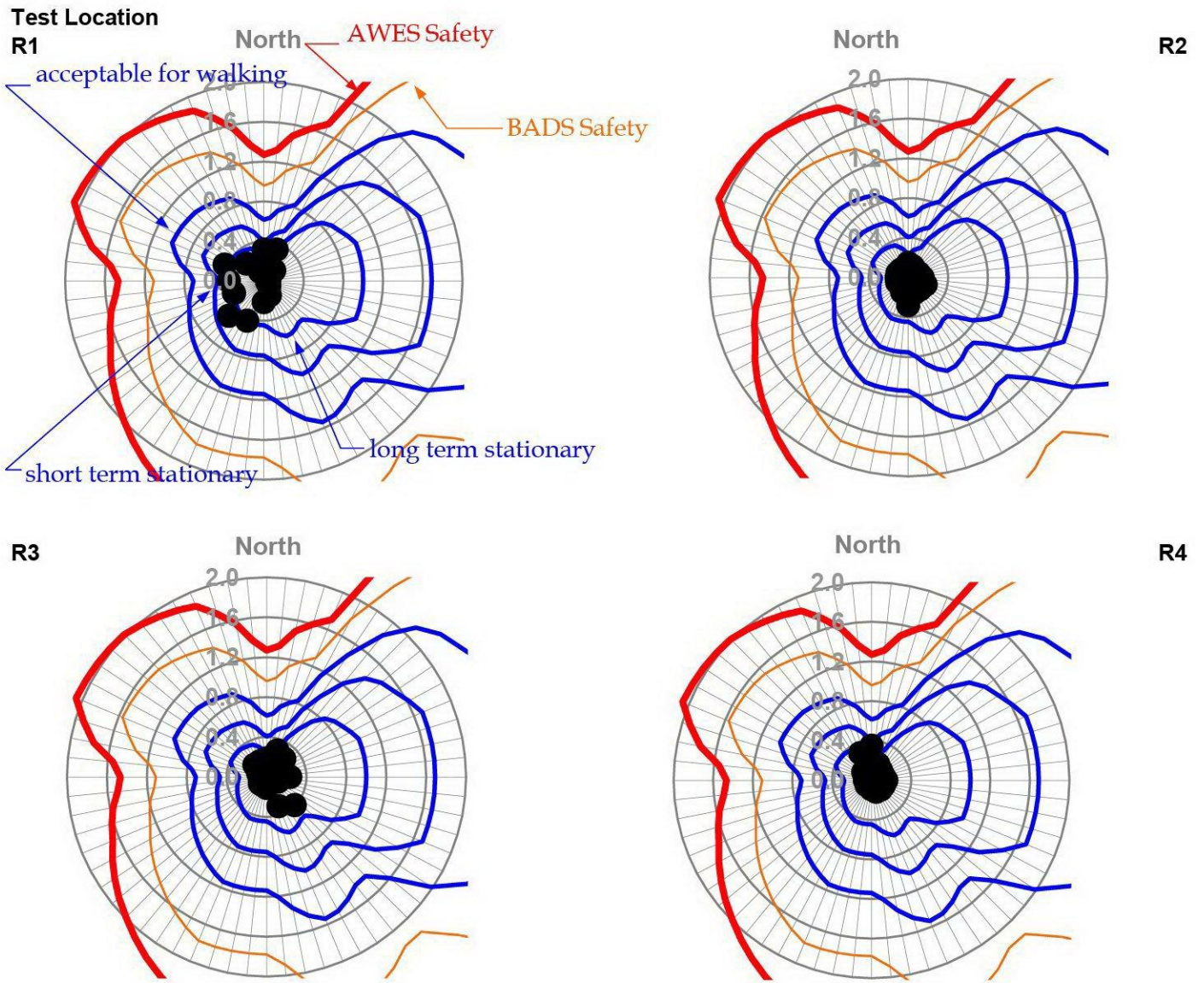
Figure A24 - Terraces & Podium Garden at Level 1 (Continued)



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



Figure A25 - Balconies at Level 5



Peak velocity squared ratio $\left| \frac{\hat{V}_{local}}{\hat{V}_{300m}} \right|^2$ as a function of wind direction



Figure A26 - Rooftop Amenity Space