PLANNING PANELS VICTORIA
541 GRAHAM STREET, PORT MELBOURNE
PROPOSED AMENDMENT GC81

ENVIRONMENTAL WIND CONDITIONS

by

M. Eaddy

and

W. H. Melbourne

Instructed by:

Russell Kennedy Lawyers

On Behalf of:

Frank Walker and Sel Reklaw Pty Ltd

MEL CONSULTANTS

Report: 40-18-DE-VCAT-00

CONTENTS

1. INTRODUCTION

1.1. Details of Authors

The names, addresses, and qualifications of the authors are as follows:

Dr Michael J. Eaddy B.E.(Hons), M.E.(Dist), PhD
Prof William H Melbourne BE, DIC, PhD, FIEAust, FTSE

We are both directors of the Wind Engineering Consultancy firm MEL Consultants Pty Ltd that operates a wind tunnel testing facility at 22 Cleeland Road, Oakleigh South.

Michael Eaddy joined MEL Consultants in 2002 as an engineer and became a director of the company in 2006. He is a member of the Australasian Wind Engineering Society and Engineers Australia. He has completed numerous wind tunnel and full scale investigations of environmental wind conditions around buildings and structures within Australia and overseas. Details of Michael Eaddy's experience are given in Appendix A.

William Melbourne was the founder of MEL Consultants in the early 1980's and operated the company whilst he was a Professor of Fluid Mechanics at Monash University. He has undertaken and published research in the area of wind engineering and been a member of national and international wind engineering committees that develop wind engineering standards and guidelines. He is a Fellow of Engineers Australia and a life member of the Australasian Wind Engineering Society. Details of William Melbourne's experience are given in Appendix A.

MEL Consultants undertakes desktop analyses/assessments and wind tunnel testing of buildings and structures for wind engineering areas such as environmental wind conditions, structural wind loads, and pollutant dispersion. We are consulted by developers and state and local government, such as the City of Melbourne and the Victorian Department of Planning to provide expert wind engineering advice.

2. PROPOSED AMENDMENT GC81

The objective of the changes proposed in the proposed Amendment GC81 for the Fishermans Bend Urban Renewal Project is underpinned by 18 background reports and translates the draft Framework by identifying:

- The preferred land use, form and intensity of urban development in each of the four mixed use precincts, including new floor area ratios and maximum height and setback controls; and
- Potential key transport alignments and services and the preferred locations for public open space and community infrastructure.

The changes by the proposed Amendment GC81 to the Melbourne Planning scheme with respect to the environmental wind conditions apply to Schedule 67 to Clause 43.02 Design and Development Overlay with the introduction of wind comfort criteria bringing it in line with the criteria used for other Design and Development Overlay areas. The same change is proposed to the Port Phillip Planning Scheme Schedule 30 to Clause 43.02-Design and Development Overlay.

3. FISHERMANS BEND FRAMEWORK

The changes proposed by Amendment GC81 are based on the Fishermans Bend Vision, September 2016, and the Fishermans Bend Framework and, as noted earlier, is underpinned by 18 background reports. Reviewing these reports, there is no mention of the environmental wind effects in any of the discussion of activation of spaces, built form design, and vision. Considering the Docklands urban renewal area to the north and the reputation of it as an unpleasant wind-swept precinct, it would have been expected that the wind climate would be included as one of the environmental constraints for the Fishermans Bend Strategic Framework.

Fishermans Bend is located on the west side of the city and, like Docklands, would be exposed to the strong and prevailing south through west to north wind directions for Melbourne. Additionally, the Wirraway precinct is close to the edge of Port Phillip Bay, which would result in higher wind speeds at lower elevations due to the approach over the water of Port Phillip Bay. Unfortunately, the roads in Fishermans Bend are aligned with the strong wind directions. This means that strong winds will be funnelled by the buildings along streets intended to be activated for stationary pedestrian activities.

The expectation is that the wind environment is likely to control the built form design for the four precincts of Fishermans Bend. The proposed built form controls would be expected to result in lower adversely shaped buildings from a wind perspective to maximise floor area, which could have more impact compared to a taller aerodynamically wind engineered built form.

Therefore, it is our opinion that the Fishermans Bend Strategic Framework Plan has ignored an important factor of wind effects in coming up with the urban design principles and there is a likelihood of the mistakes of Docklands being repeated.

4. AMENDMENT GC81

The proposed Amendment GC81 changes with respect to wind in the Melbourne Planning Scheme and the Port Philip Planning Scheme have been to include the wind comfort criteria that was implemented in the Melbourne Planning Scheme as part of the C270 and C311 Amendments. Applying consistent wind comfort criteria across the Melbourne and Port Phillip Planning Schemes is supported.

However, the definition of the comfortable wind criteria has an error - the mean wind speed from any wind direction in Melbourne does not occur for more than 20% of the time. MEL Consultants have a wind climate probability distribution as a function of wind direction that would support this position. There is significant intellectual property in the creation and maintaining of these wind climate probability distributions so it will not be provided with this publicly available evidence but can be shown to the members of the Planning Panel at the hearing. Given that the wind does not occur from any wind direction in Melbourne for more than 20% of the time, the criteria as stated in proposed Amendment GC81 means all locations would pass the criteria for every activation down to the sittings area criterion. This was surely not the intention.

We are currently independently working on a revised version of the wind criteria to address the above issue.

5. 541 GRAHAM STREET DEVELOPMENT

The 541 Graham Street development is located in the Capital City Zone – Schedule 1 and is affected by Design Development Overlay – Schedule 30 with respect to the environmental wind conditions. A permit application for the site was submitted for a development with four towers ranging in height between 15 and 18 levels. During the course of the design of the development I worked with the design team to develop the podium and tower configuration to mitigate the wind impacts on the public realm and the private resident amenities areas at Level 15. The development was wind tunnel tested by MEL Consultants and shown to achieve the proposed wind criteria for Fishermans Bend, and the previous criteria of the Amendment C270.

The proposed Amendment GC81 will impact the proposed 541 Graham Street Development by (features influencing wind effects):

- A reduction of the building height from 18 storeys to 6;
- Other built form controls in relation to, inter alia, setbacks, street wall heights, building separation.

MEL Consultants Report 40-18-WT-ENV-00 demonstrated that the permit application scheme would achieve the proposed wind comfort criteria with the current building and street wall heights and setbacks. This also demonstrates that a built form developed in collaboration with a wind engineer during the concept design stage can mitigate the wind effects. A proposal for the 541 Graham Street site that conforms to the proposed Amendment GC81 controls has not been wind tunnel tested. MEL Consultants Report 40-18-WT-ENV-00 is provided in Appendix B.

6. SUMMARY

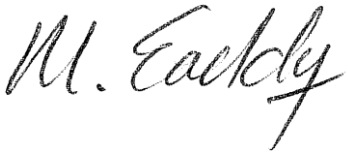
In summary, the main points of this evidence are as follows:

- The background reports that form the basis of the Fishermans Bend Framework have neglected to consider the environmental constraints of the Melbourne wind climate and this could lead to the mistakes of Docklands being repeated in Fishermans Bend.
- The expectation is that the wind environment is likely to control the built form design for the four precincts of Fishermans Bend. The proposed built form controls would be expected to result in lower adversely shaped buildings from a wind perspective to maximise floor area, which could have more impact compared to a taller aerodynamically wind engineered built form.
- The proposed Amendment GC81 has used the wind criteria from the Melbourne Planning Scheme implemented by Amendments C270 and C311.
- The proposed scheme for 541 Graham Street submitted for a planning permit would achieve the wind criteria proposed by proposed Amendment GC81 and demonstrates that a properly wind engineered built form can mitigate the wind effects on the surrounding streetscapes without the need for the significant built form restrictions of proposed Amendment GC81.

7. DECLARATION

We have made all the inquiries that we believe are desirable and appropriate and no matters of significance which we regard as relevant have to our knowledge been withheld from the Panel.

For MEL Consultants Pty Ltd:



M. Eaddy

W. H. Melbourne

29 March 2018

Appendix A – Author Curricula Vitae

Michael J Eaddy
B.E., M.E., PhD, MIEAust
Director
MEL Consultants Pty Ltd
17 Kingston Street
East Malvern
VIC 3145

Senior Research Fellow (2003 - 2009)
Department of Mechanical Engineering
Monash University
Vic 3800

Research and Consulting Fields

Wind Engineering and Industrial Aerodynamics
Environmental Studies
Pressure Measurements and Structural Aeroelastic Modelling
Wind Tunnel Testing
Instrumentation and Acquisition Systems Development

Professional Committees

Australasian Wind Engineering Society (1999 - 2009)

Previous Experience and Qualifications

The University of Auckland, New Zealand (1993 – 1998)

- Bachelor of Engineering, Mechanical Engineering, Honours Class 1
- Masters of Engineering, Mechanical Engineering, Distinction
- UniServices – Wind Tunnel Consulting

Monash University, Australia (1999 – 2004)

- Doctor of Philosophy : Lift Forces on Smooth and Rough Circular Cylinders in Low and High Turbulence Flows.

MEL Consultants Pty Ltd

Commercial Wind Engineering (2002 -)

Scholarships and Awards

Monash Graduate Scholarship (1999 – 2004)

Publications (including with co-authors)

Published papers:

Over 10 in the Wind Engineering Field

Propriety Reports

Over 150 for Wind Engineering Consulting

PROFESSOR W H MELBOURNE

BE, DIC, PhD, FIEAust, AFRAeS, FRGS, FTSE

Professor of Fluid Mechanics (1975 - 99)

Chairman, Department of Mechanical Engineering (1976-1994, 1996-98)

Dean, Faculty of Engineering (1994)

Associate Dean, Faculty of Engineering (1995-1996)

Monash University Council (1987-1994)

Founder/Director MEL Consultants Pty Ltd (1981-)

Lawrence Hargrave Medallist (1981)

AGM Michell Award (1993)

Research and Consulting Fields:

Environmental Fluid Mechanics; turbulent flows and their interaction with bluff bodies; the loading and response of structures to wind action; modelling wind flow over complex terrain; dispersion of atmospheric pollutants.

International Committees:

International Journal of Wind Engineering and Industrial Aerodynamics, Elsevier Holland - Regional Editor Australasia (1974 -)

American Council on Tall Buildings and Urban Habitat - Vice Chairman and Editor Wind Loading Committee (1972 -)

Commonwealth Aeronautical Advisory Council - Coordinator, Low Speed Aerodynamics (1967-1983)

International Association for Wind Engineering - Chairman (1979-1983)

International Standards Organisation - Chairman 'Wind Action on Structures (2001 -)

Australian Committees:

Standards Association of Australia Committees - BD/5 : General Requirements for Structural Design, and BD/6 : Loading on Structures (1970 -)

National Committee Thermodynamics & Fluid Mechanics, IEAust (1970-1978, 1991-1995)

Australian Electrical Services Industry Research Board (1986-1994)

Secretary, Royal Aeronautical Society, Victoria (1964 - 1966)

Publications:

Texts:

Journal of Wind Engineering & Industrial Aerodynamics, (Proc 4th Asia Pacific Symposium on Wind Engineering 1997), Guest Editor of Vol 83, 1999.

Tall building design from linear mode force balance model data, Collected Papers of Habitat and the High Rise, Council of Tall Buildings & Urban Habitat, 557 pp, 1996

Bluff Body Aerodynamics for Wind Engineering, A State of the Art in Wind Engineering, Wiley Eastern Ltd, pp 47-64, 1994

Designing to Reduce Perceptible Wind-Induced Motions, Structural Systems for Tall Buildings Monograph, McGraw-Hill, pp 341-352, 1994

A Commentary on the Australian Standard for Wind Loads, (with J D Holmes & G R Walker), Publisher Australian Wind Engineering Society, 1990

Wind Engineering 1983, (with J D Holmes & P S Jackson) Editors, (Elsevier Proc 6th Int Conference on Wind Engineering, Gold Coast, Australia, 21-25 March, and Auckland, New Zealand, 6-7 April, 1983)

Wind loading and wind effects, Editor of chapter in Monograph on Design of Tall Buildings, Publisher ASCE, pp 145-248, 1980

Architectural Aerodynamics (with R Aynsley & B J Vickery), Applied Science Publishers, 1977

Published Papers:

Over 200 in the aerodynamics field generally and wind engineering in particular.

Unpublished Papers, Lectures, Course Notes:

Over 100.

Major Consulting Reports (Restricted Circulation)

Over 500.

Appendix B – MEL Consultants Report 40-18-WT-ENV-00

ENVIRONMENTAL WIND SPEED MEASUREMENTS ON A WIND TUNNEL MODEL OF THE 541 GRAHAM STREET DEVELOPMENT, PORT MELBOURNE

By

M. Eaddy

SUMMARY

Wind tunnel tests have been conducted on a 1/400 scale model of the proposed 541 Graham Street Development, Port Melbourne. The model of the Development within surrounding buildings 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 criteria developed for the Melbourne region as a function of wind direction.

For the Proposed Configuration, the wind conditions for all Test Locations in the streetscapes surrounding the Development have been shown to pass the walking criterion, with many locations achieving the standing and sitting criteria. The Existing Configuration wind conditions have also been provided for comparison. These wind conditions comply with the wind criteria defined in Schedule 4 of the Melbourne Planning Schedule Design Development Overlay.

The wind conditions at all Test Locations in the surrounding streetscapes satisfy the safety criterion.

MEL CONSULTANTS

Report 40-18-WT-ENV-00

541 GRAHAM STREET, PORT MELBOURNE
ENVIRONMENTAL WIND TUNNEL MODELLING

MEL CONSULTANTS REPORT NO: **40-18-WT-ENV-00**

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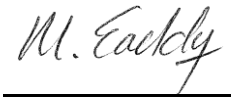

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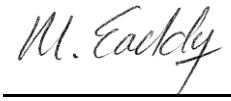
REVIEWED BY:

J.Kostas
Director Date: 7 Mar 2018

RELEASED BY:



M. Eaddy
Managing Director Date: 8 Mar 2018

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Revision No:	Date Issued	Reason/Comment
0	8 March 2018	Report

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CONTENTS

1. INTRODUCTION

The proposed development at 541 Graham Street, Port Melbourne, will consist of four 18 level residential towers located on two common podiums adjacent to the freeway offramp to the Bolte Bridge.

A wind tunnel model study was commissioned by Spargo Property to undertake measurements of environmental wind conditions around the proposed redevelopment and, if necessary, to develop wind amelioration features to achieve conditions satisfying the recommended environmental wind criteria as defined in Schedule 4 of the Melbourne Planning Scheme Design Development Overlay.

These tests were carried out in the MEL Consultants 400kW Boundary Layer Wind Tunnel during February/March, 2018.

2. 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 Schedule 4 of the Melbourne Planning Scheme Design Development Overlay has defined wind comfort criteria for the assessment of the wind conditions in Melbourne City. The definition of the criteria is as follows:

Unsafe wind conditions means the hourly maximum 3 second gust which exceeds 20 metres/second with a probability of exceedance of 0.1% from all wind directions combined.

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

- 3 metres/second for sitting areas
- 4 metres/second for standing areas
- 5 metres/second for walking 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 criteria are pass/fail criteria as they only assess the integrated probability of all wind directions to determine whether a location passes or fails the threshold criterion. These criteria do not consider the criteria achieved for individual wind directions and this may be different to the integrated all wind directions criteria achieved. For completeness, this report will provide data for each Test Location as a function of wind direction in Appendix A.

The Melbourne Planning scheme does 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 Melbourne Planning Scheme

uses 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 has been corrected for the approach terrain at the location of the automatic weather station and referenced at 10m in Terrain Category 2. This is the standard reference height of AS/NZS1170.2:2011.

2.1 Suggested Pedestrian Comfort Criteria.

The 541 Graham Street Development will have street frontages along Graham Street and to the new internal services laneways within the site. The drawings indicate building entries on this street. Therefore, the following wind criteria are suggested for the surrounding streetscapes:

- Pedestrian transit areas — Walking Criterion
- Building/Tenancy entrances — Standing Criterion
- Roof Terraces — Walking Criterion

3. MODEL AND EXPERIMENTAL TECHNIQUES

A 1/400 scale model of the 541 Graham Street Development was constructed from architectural drawings provided by Rothe Lowman dated to 27th February 2018.

The 1/400 scale model of the 541 Graham Street Development, surrounding buildings, and off ramp topography 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, the characteristics of which are given in Figure 1. The surrounding wind tunnel model, exceeding the minimum radius of 300m, 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

$$\left(\hat{V}_{local} / \overline{V}_{300m}\right)^2$$

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 2 and 3. The Test Locations in the surrounding streetscapes and roof terraces are shown in Figure 4. The Test Locations have been chosen out to a radius of approximately 70m (i.e. at least half of the building height or the building width) from the site as required by Schedule 4 of the Melbourne Planning Scheme Design Development Overlay.

4. DISCUSSION OF RESULTS

The wind tunnel model study of the environmental wind conditions around the 541 Graham Street Development has been undertaken for two configurations as follows:

- Existing Configuration
- Proposed Configuration

The Proposed Configuration for the 541 Graham Street Development is as outlined in the drawings supplied by Rothe Lowman dated to 27th February, 2018. The Existing Configuration comprises the existing buildings, prior to any demolition, at the site at the time of the wind tunnel study. This study did not include or rely on existing or proposed street trees for wind mitigation.

Velocity measurements were made at various locations around the 541 Graham Street Development for different wind directions at 22.5° intervals. As discussed in Section 2, the Melbourne Planning Scheme wind criteria are pass/fail criteria based on an assessment of the integrated probability for all wind directions combined. Therefore, to assess the wind conditions the results will be presented in tabular form in Tables 1 – 4.

4.1 Summary of Results

To assist with the assessment of the wind conditions, a summary diagram of the wind conditions achieved at the Test Locations for the Existing and Proposed Configurations have been provided in Figures 5 and 6 respectively. Different colours have been used to represent the wind criteria achieved at the respective Test Locations.

4.2 Graham Street

The wind conditions for the Proposed Configuration along Graham Street (Test Locations 1 to 11) have all been shown to pass the walking criterion, with conditions at many of the Test Locations satisfying the standing criteria. The wind conditions at these Test Locations have been shown to increase or decrease compared to those of the Existing Configuration in terms of the wind criteria achieved depending on the shielding provided by the proposed development to the particular location. The criteria achieved have been presented in Table 1. The wind conditions at all the indicated Test Locations satisfy the safety criterion.

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

Table 1: Pedestrian Wind Comfort and Safety – Graham Street

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
1	Existing	43%	27%	16%	Pass
	Proposed	36%	22%	13%	Pass
2	Existing	34%	21%	13%	Pass
	Proposed	30%	18%	11%	Pass
3	Existing	39%	25%	15%	Pass
	Proposed	30%	18%	11%	Pass
4	Existing	31%	16%	7%	Pass
	Proposed	37%	23%	14%	Pass
5	Existing	34%	19%	10%	Pass
	Proposed	22%	10%	4%	Pass
6	Existing	34%	19%	11%	Pass
	Proposed	25%	13%	7%	Pass
7	Existing	26%	13%	6%	Pass
	Proposed	35%	22%	13%	Pass
8	Proposed	34%	21%	13%	Pass
9	Proposed	31%	14%	13%	Pass
10	Existing	30%	17%	10%	Pass
	Proposed	28%	16%	10%	Pass

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
11	Existing	34%	21%	13%	Pass
	Proposed	33%	23%	17%	Pass

4.3 Laneways and Easement

The wind conditions for the Proposed Configuration along Laneways (Test Locations 12 to 26) have been shown to pass the walking criterion and, at some locations, the sitting and standing criteria. The wind conditions in the Existing Configuration yard area (Test Locations 24 to 26) have been shown to improve due to the shielding provided by the proposed development. The criteria achieved have been presented in Table 2. The wind conditions at all the indicated Test Locations satisfy the safety criterion.

The wind Conditions for the Proposed Configuration along the Easement to the west of the site (Test Locations 27 and 28) have been shown to pass the standing criterion.

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

Table 2: Pedestrian Wind Comfort and Safety – Internal Laneways

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
12	Proposed	17%	8%	4%	Pass
13	Proposed	22%	11%	5%	Pass
14	Proposed	14%	6%	3%	Pass
15	Proposed	21%	12%	6%	Pass
16	Proposed	41%	26%	15%	Pass
17	Proposed	28%	15%	9%	Pass
18	Proposed	2%	0%	0%	Pass
19	Proposed	28%	19%	14%	Pass
20	Proposed	36%	21%	11%	Pass
21	Proposed	25%	12%	5%	Pass

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
22	Proposed	49%	34%	19%	Pass
23	Proposed	11%	4%	2%	Pass
24	Existing	20%	10%	4%	Pass
	Proposed	26%	13%	5%	Pass
25	Existing	36%	21%	11%	Pass
	Proposed	21%	10%	4%	Pass
26	Existing	42%	27%	16%	Pass
	Proposed	7%	2%	0%	Pass
27	Proposed	25%	13%	7%	Pass
28	Proposed	9%	3%	1%	Pass

4.4 525 Graham Street

The wind conditions for the Proposed Configuration in the yard area of 525 Graham Street (Test Locations 29 to 32) have all been shown to pass the walking criterion with many locations achieving the standing criterion. The wind conditions for the Existing Configuration have been provided for comparison. The criteria achieved have been presented in Table 3. The wind conditions at all the indicated Test Locations satisfy the safety criterion.

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

Table 3: Pedestrian Wind Comfort and Safety – 525 Graham Street

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
29	Existing	45%	29%	18%	Pass
	Proposed	39%	23%	12%	Pass
30	Existing	38%	22%	11%	Pass
	Proposed	22%	9%	0%	Pass
31	Existing	23%	13%	1%	Pass
	Proposed	27%	16%	9%	Pass
32	Existing	29%	17%	1%	Pass
	Proposed	24%	13%	7%	Pass

4.5 Roof Terraces

The wind conditions for the Proposed Configuration on the Roof Terrace for the four towers (Test Locations T1 to T4) have all been shown to pass the walking criterion. The criteria achieved have been presented in Table 4. The wind conditions at all the indicated Test Locations satisfy the safety criterion.

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

Table 4: Pedestrian Wind Comfort and Safety – Roof Terraces

Test Location	Configuration	Wind Comfort Criteria			
		Sitting	Standing	Walking	Safety
T1	Proposed	44%	30%	19%	Pass
T2	Proposed	38%	22%	12%	Pass
T3	Proposed	41%	28%	18%	Pass
T4	Proposed	28%	18%	12%	Pass

5. CONCLUSIONS

Wind tunnel tests have been conducted on a 1/400 scale model of the proposed 541 Graham Street Development, Port Melbourne. The model of the Development within surrounding buildings 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 criteria developed for the Melbourne region as a function of wind direction.

For the Proposed Configuration, the wind conditions for all Test Locations in the streetscapes surrounding the Development have been shown to pass the walking criterion, with many locations achieving the standing and sitting criteria. The Existing Configuration wind conditions have also been provided for comparison. These wind conditions comply with the wind criteria defined in Schedule 4 of the Melbourne Planning Schedule Design Development Overlay.

The wind conditions at all Test Locations in the surrounding streetscapes satisfy the safety criterion.

M. Eaddy

M. Eaddy

MEL CONSULTANTS

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

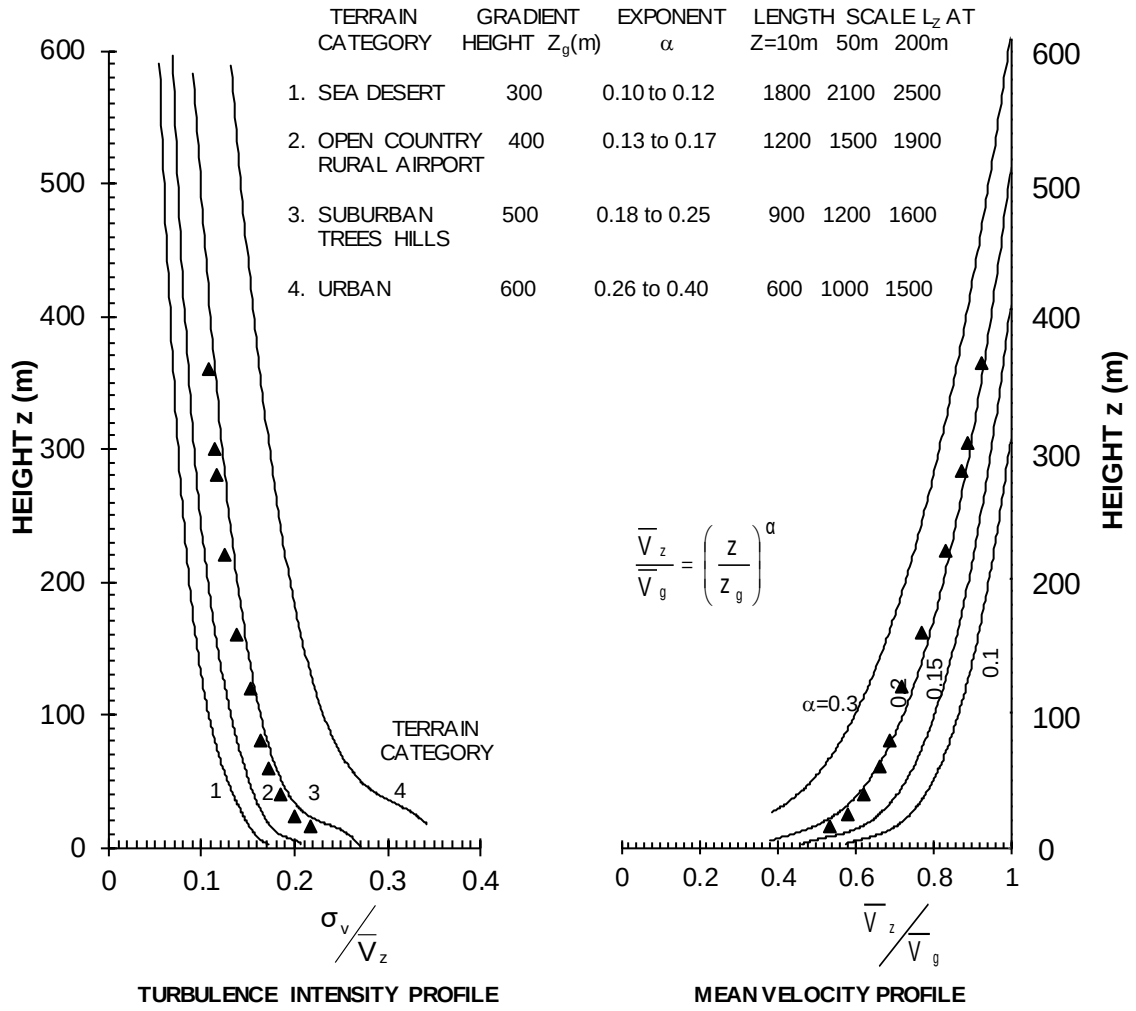


Figure 1 - 1/400 scale TC3 boundary layer turbulence intensity and mean velocity profiles and spectra in the MEL Consultants Boundary Layer Wind Tunnel 5m x 2.4m working section, scaled to full scale dimensions

Figure 2 – View from the south of the 1/400 scale Proposed Configuration model of the 541 Graham Street Development in the wind tunnel

Figure 3 – Close-up view from the northeast of the 1/400 scale Proposed Configuration model of the 541 Graham Street Development in the wind tunnel.

Figure 4 - Ground Level and Roof Terrace Test Locations around the proposed 541 Graham Street Development.

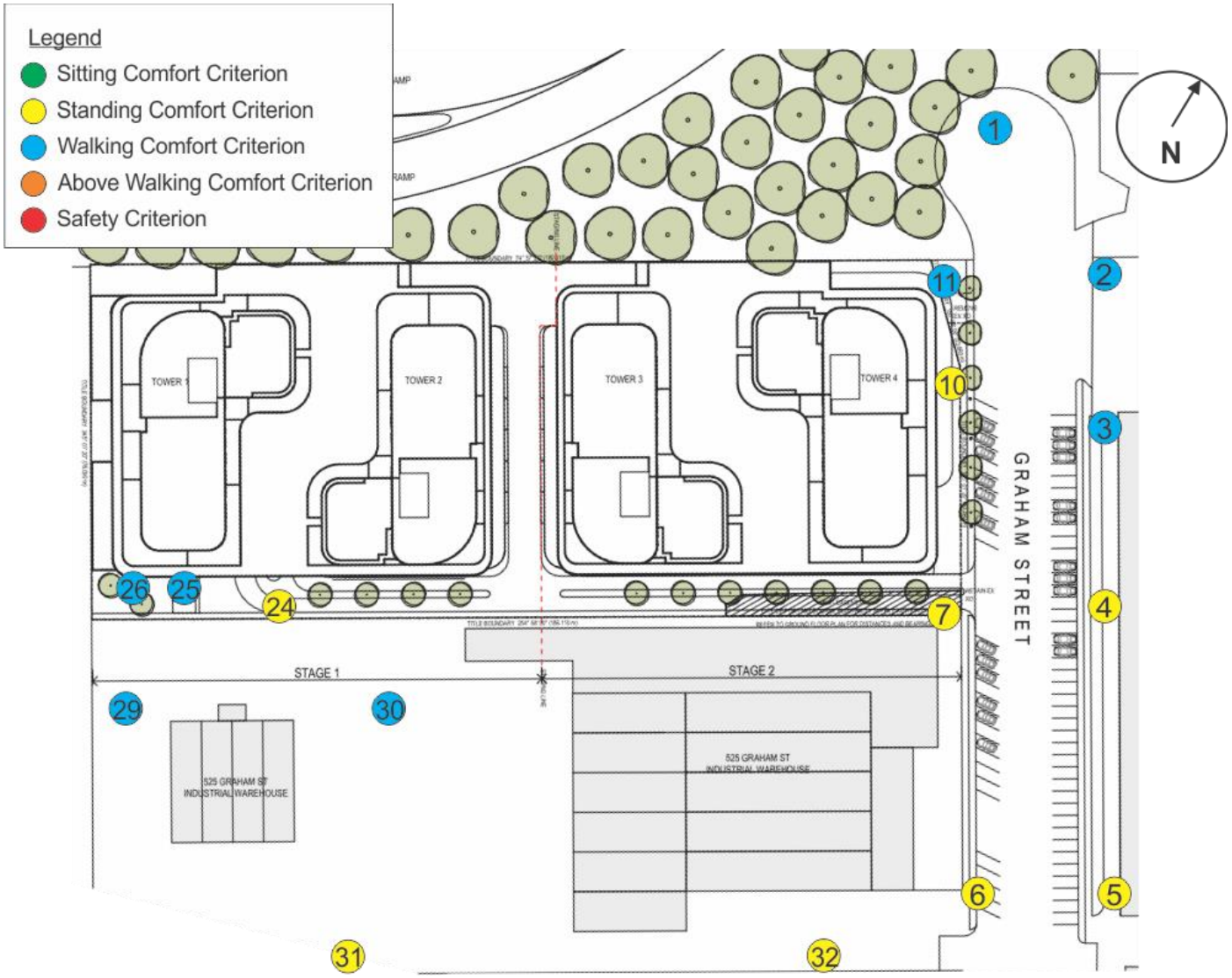


Figure 5 - Summary of Ground Level wind conditions over 360° of wind directions for the Existing Configuration.

Figure 6 - Summary of Ground Level and Roof Terrace wind conditions over 360° of wind directions for the Proposed Configuration.

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

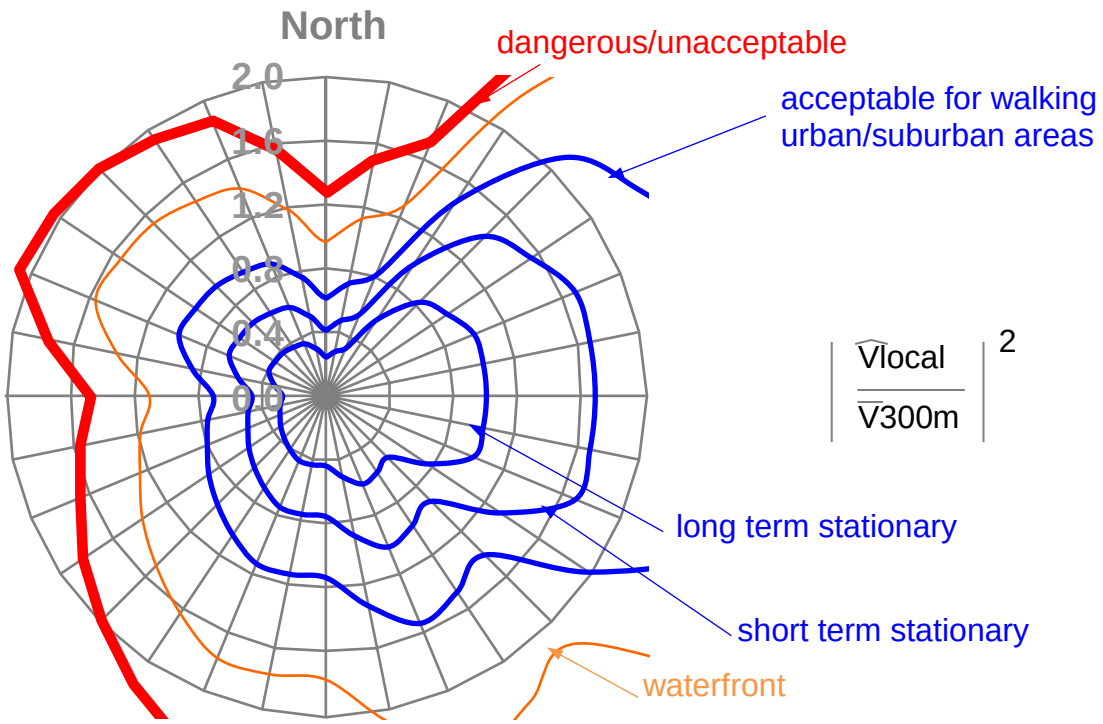
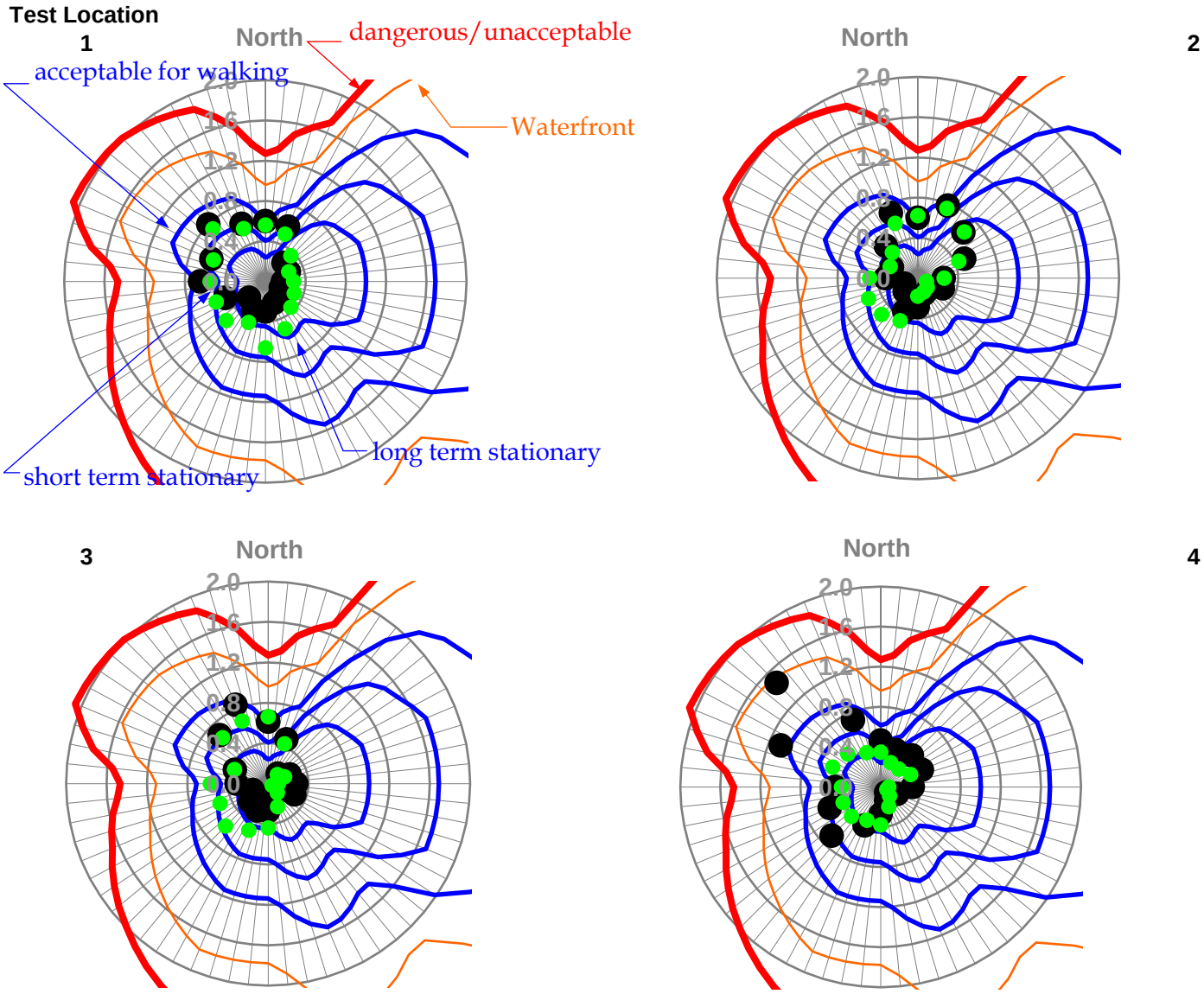


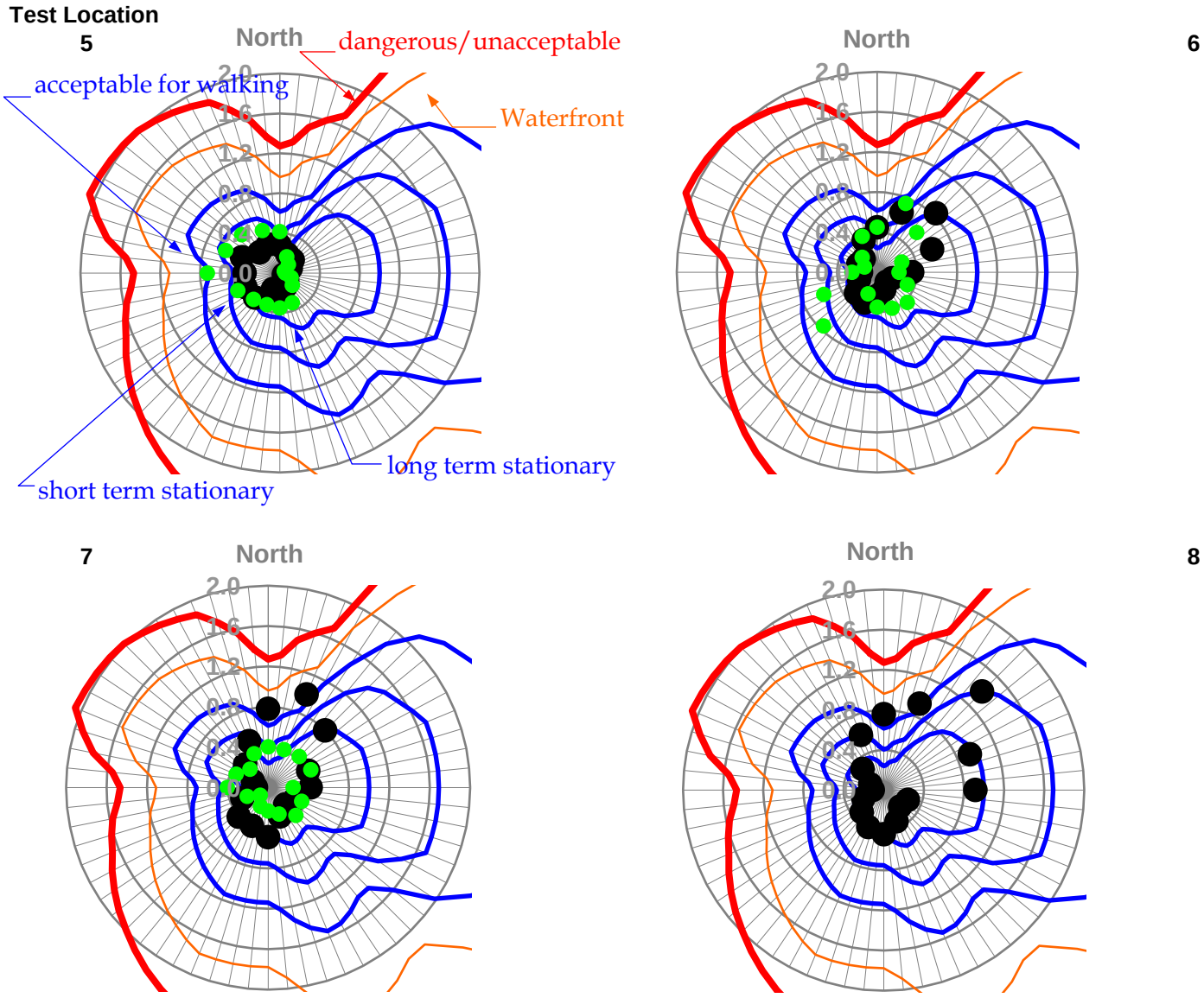
Figure A1 - Environmental wind criteria for Melbourne as a function of wind direction based on a 3 second gust



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

Proposed Configuration ●
Existing Configuration ●

Figure A2 - Graham Street



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

Proposed Configuration ●
Existing Configuration ●

Figure A3 - Graham Street

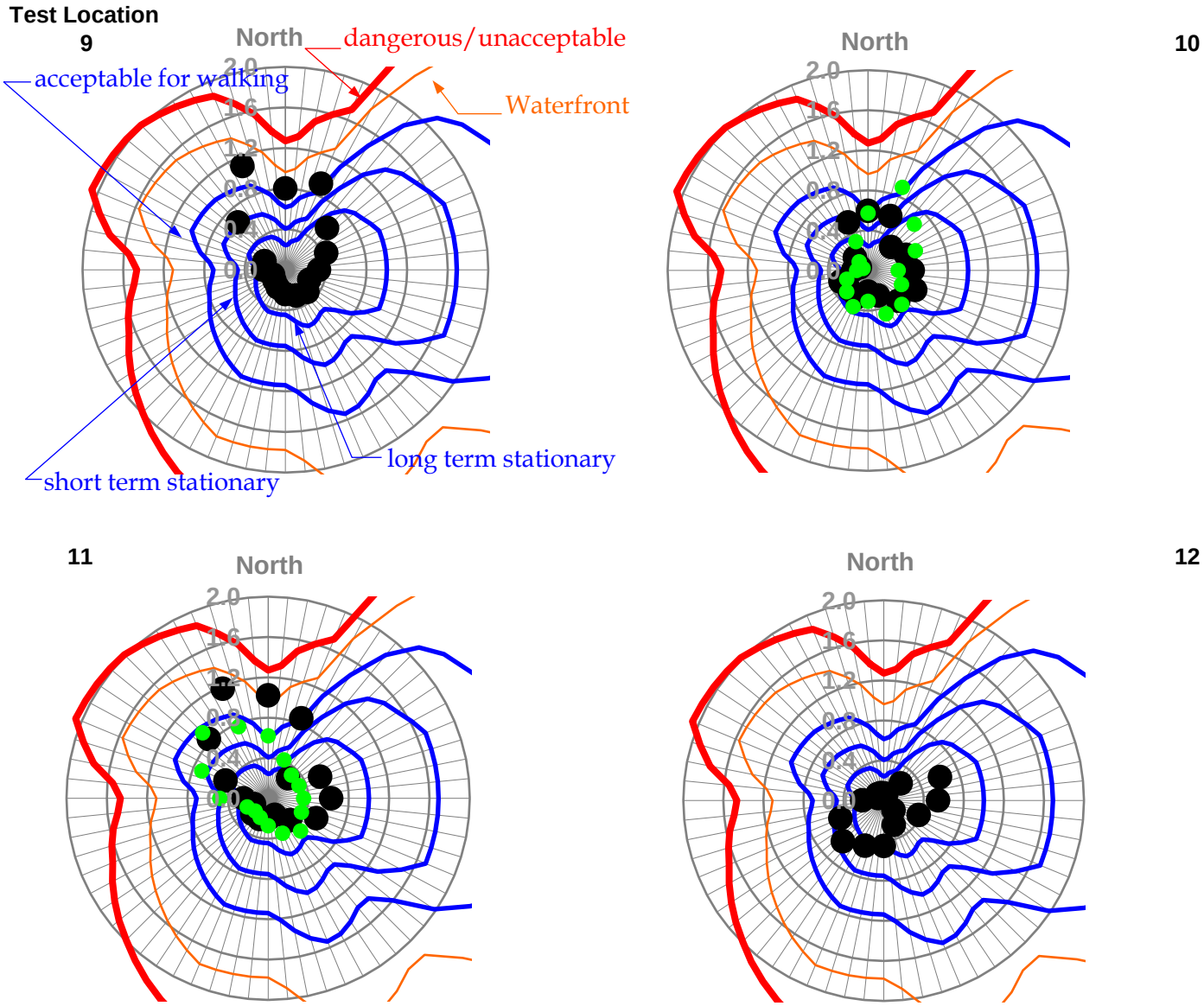
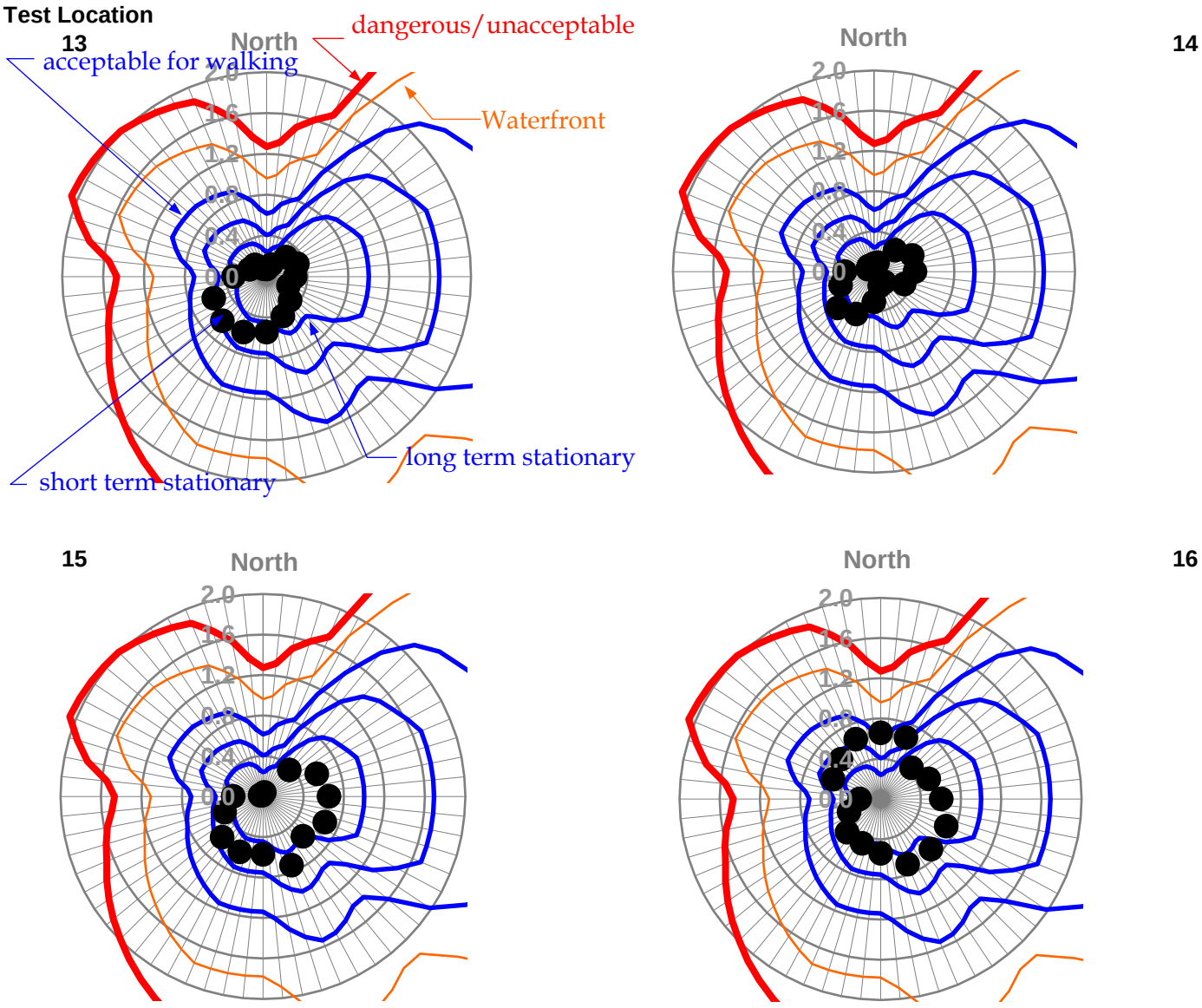


Figure A4 - Graham Street and Laneway



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

Proposed Configuration
Existing Configuration

Figure A5 - Laneway

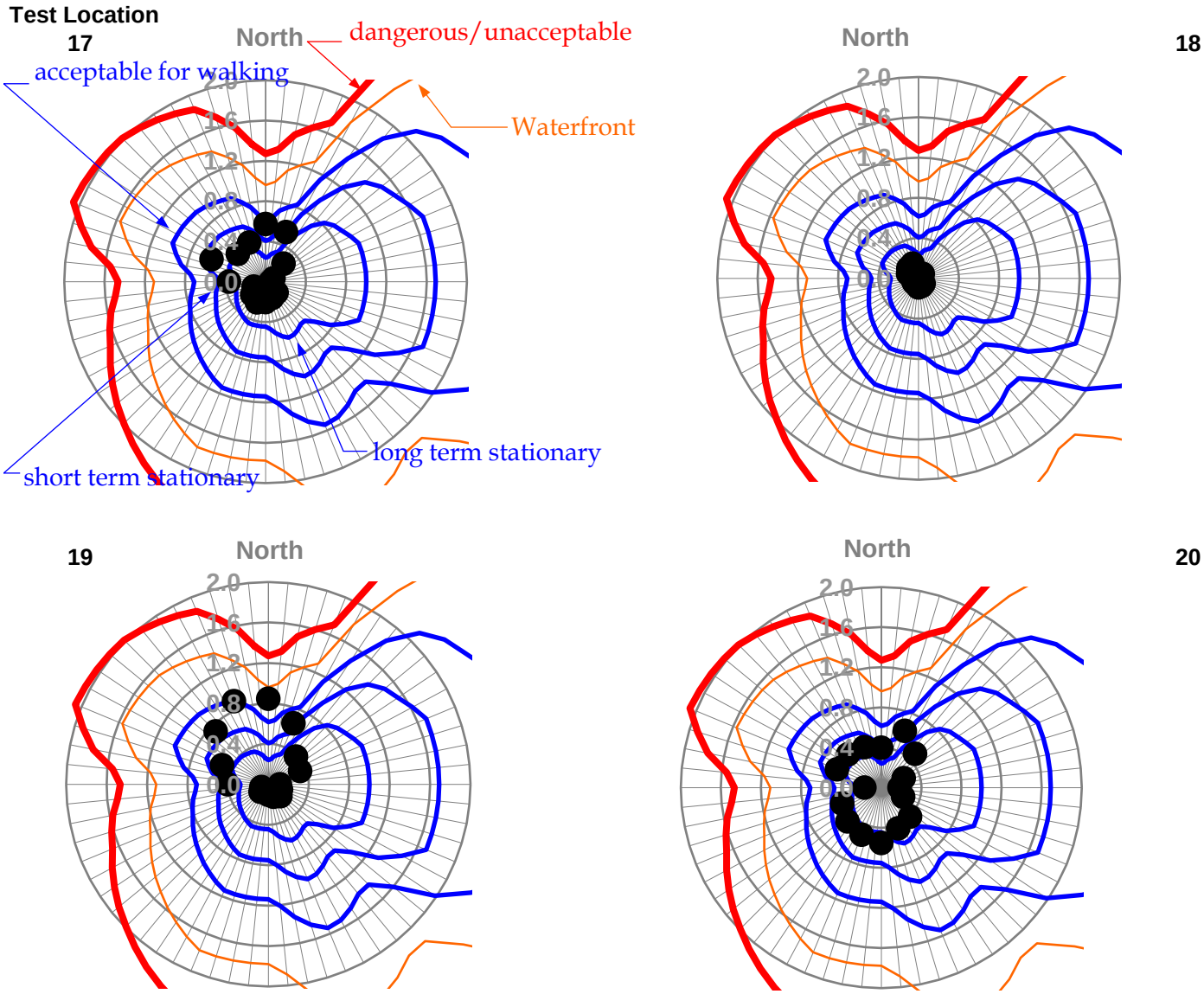
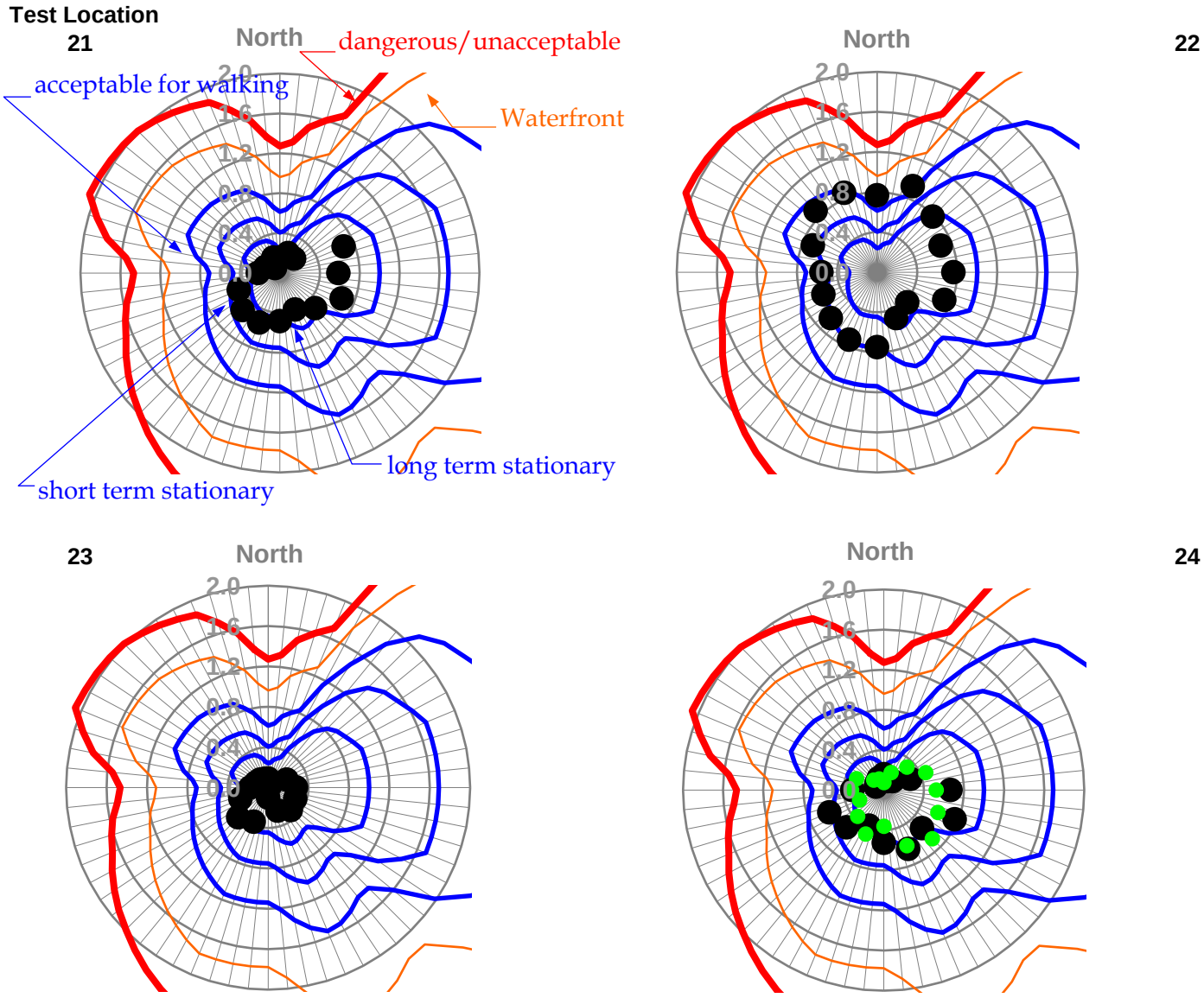


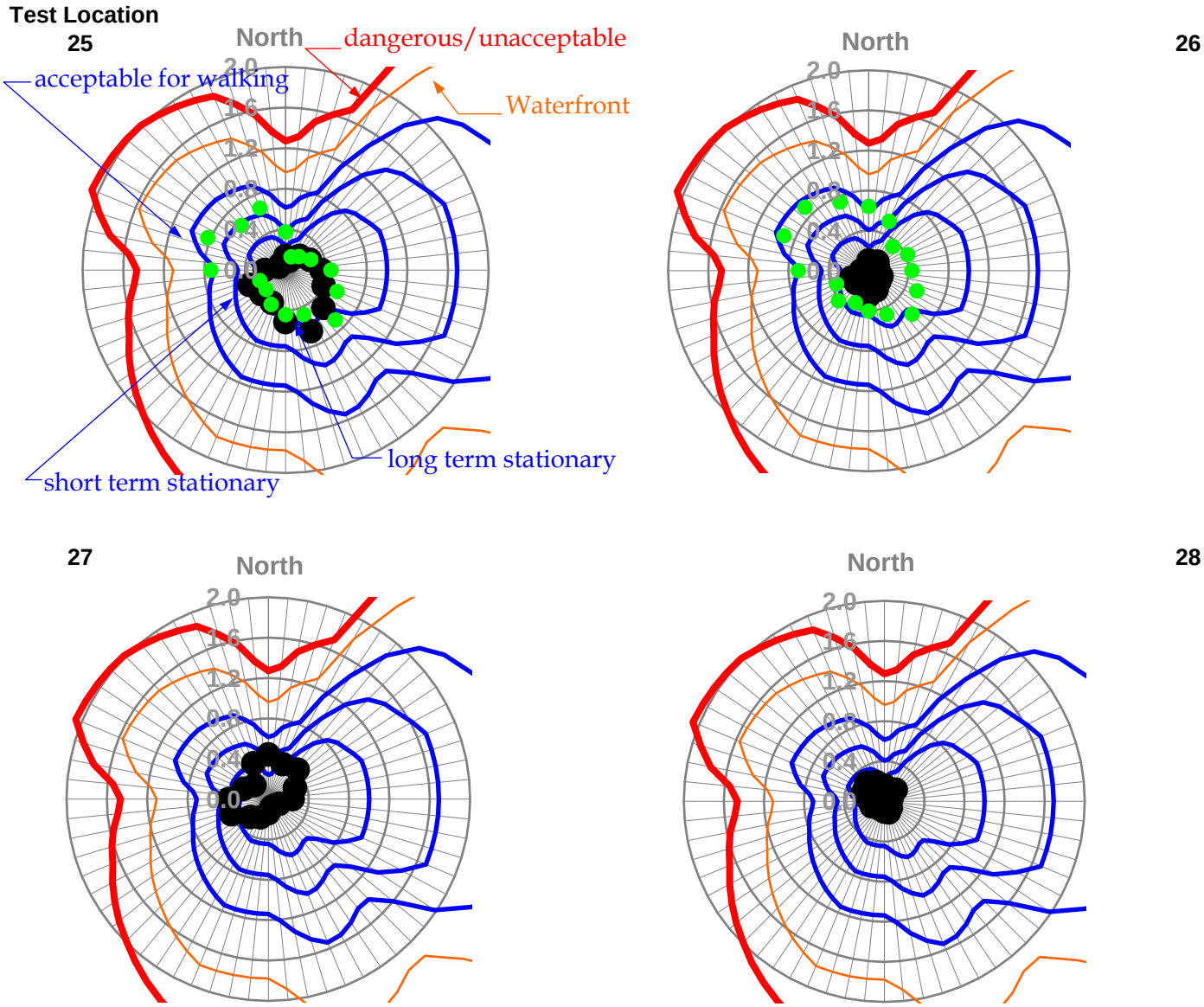
Figure A6 - Laneway



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

Proposed Configuration	●
Existing Configuration	●

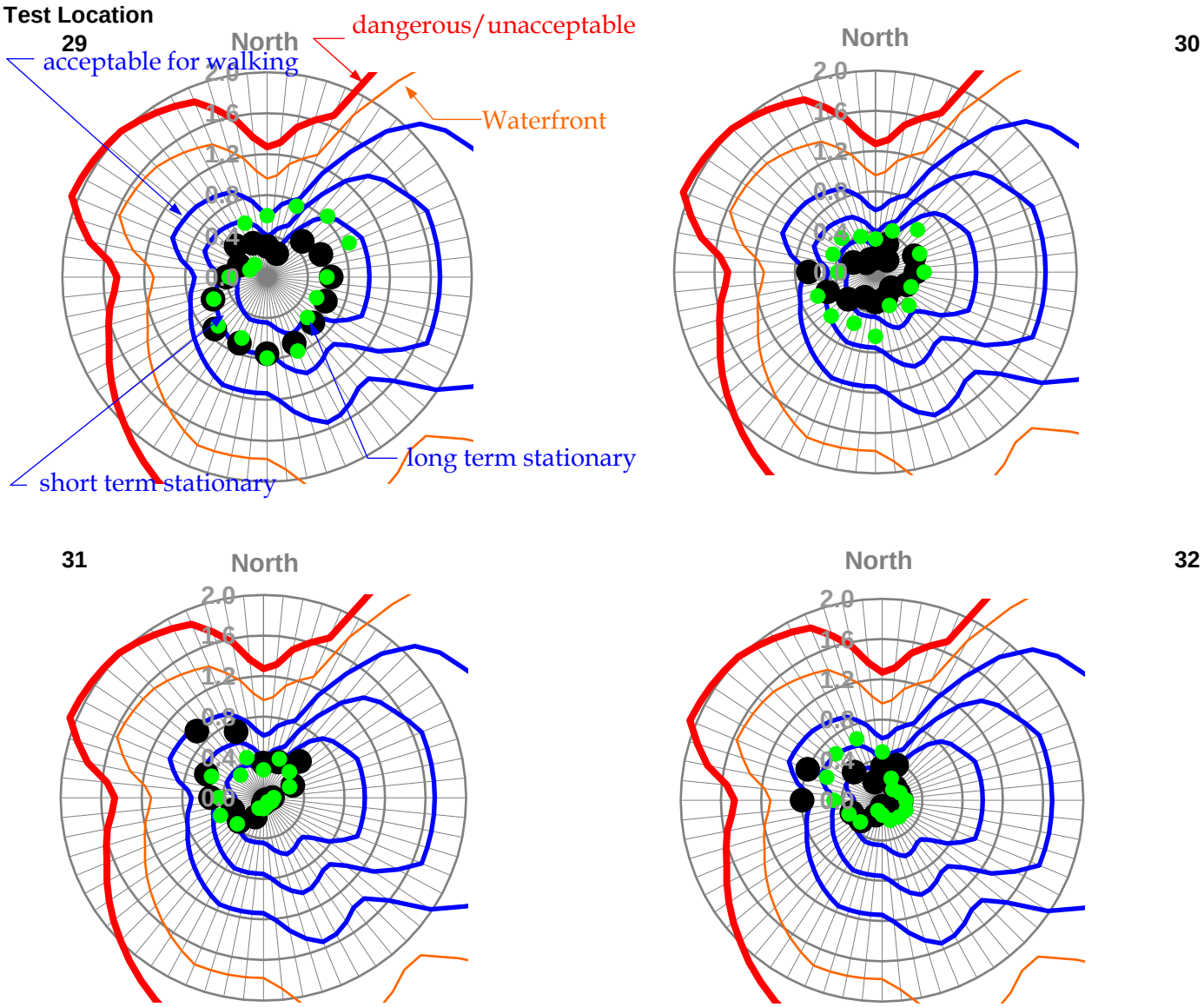
Figure A7 - Laneway



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

Proposed Configuration	●
Existing Configuration	●

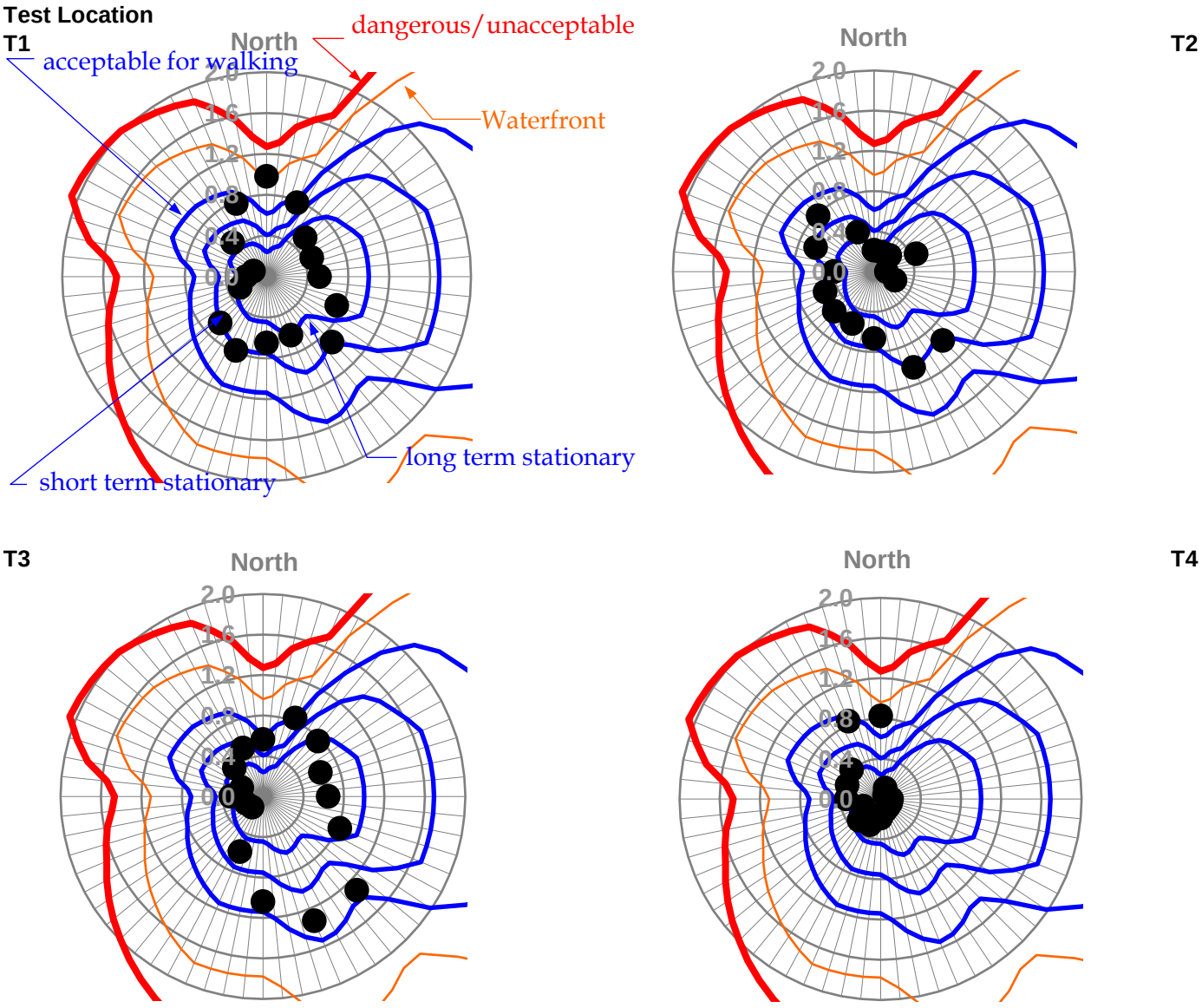
Figure A8 - Laneway and Easement



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

Proposed Configuration
Existing Configuration

Figure A9 - 525 Graham Street



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

Proposed Configuration ●

Figure A10 - Roof Terraces