WIND ENVIRONMENT ANALYSIS FOR THE PROPOSED DUNEDIN HOTEL DEVELOPMENT AT MORAY PLACE, DUNEDIN

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(Report prepared for NZ Horizons)

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JDH Consulting

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CONTENTS

1. INTRODUCTION

JDH Consulting has been engaged by NZ Horizons, through GHD, Christchurch, to provide an analysis of the wind environment adjacent to the proposed Dunedin Hotel development at the corner of Filleul Street and Moray Place, Dunedin, New Zealand ("the proposed development").

The proposed development consists of a 16-level tower structure with a hexagonal plan-form.

The objective of the study was to consider the likely wind conditions in ground level outdoor areas adjacent to the proposed development in relation to criteria for human comfort and safety.

The study was based on the plan, elevation and perspective drawings of the proposed development supplied to JDH Consulting by GHD dated 19/12/2016 (refer to the Drawing List on page 11).

Note that this is an opinion statement, and is not based on scale-model wind-tunnel testing, or computational analyses. The findings of this study are based on empirical, generic architectural aerodynamics data, a wind climate assessment of the site of the proposed development as well as the authors' experience of scale wind-tunnel model testing and full scale assessments of other similar developments.

2. WIND CRITERIA FOR HUMAN COMFORT AND SAFETY

The Dunedin City District Plan [1] was reviewed in this study. The review found the District Plan makes no reference to applicable wind criteria for use in this type of assessment. In this case, JDH Consulting recommends using the criteria for human comfort stated in the Wellington District Plan [2], Section *13.6.3.5 Wind*. These criteria are summarized in the following table:

Table 2.1 – *Summary of recommended pedestrian wind criteria*

Criterion	Description	Requirements on developer
Cumulative Effect: The cumulative criteria shall apply to all public space. Any proposed development must meet the requirements for both of the following wind strengths, at each measurement location.	Moderate: If days that 2.5m/s is equalled or exceeded increase by more than 20 days/year (i.e. 5.5% of the year)	Reduce change in days to a maximum of 20 days.
	Strong: If days that 3.5 m/s is equalled or exceeded increase by more than 20 days/year (i.e. 5.5% of the year)	Reduce change in days to a maximum of 20 days.
Safety: The safety criteria shall apply to all public space.	The maximum gust speed shall not exceed 20 m/s.	If the speed exceeds 20 m/s with the proposed development, it must be reduced to 20 m/s or below.

Note that 20m/s safety limit will be interpreted in this study as 20m/s annual maximum 3 second gust wind speed at 2m height in accordance with widely-accepted wind engineering practice. The averaging times for the values of 2.5m/s and 3.5 m/s specified for the cumulative effect (i.e. comfort criteria) are not completely clear; however daily averages will be assumed here.

3. ANALYSIS METHOD

The wind conditions about any structure or group of structures when considered in relation to human comfort and safety are influenced by five main factors:

- The regional wind climate,
- The relative exposure of the structure(s) to wind,
- The overall form of the structure(s) including size, shape and orientation,
- The overall form and proximity of nearby structures,
- The proposed use of habitable outdoor areas adjacent to the structure(s).

In this study, each of these five factors were considered when determining whether ground level outdoor areas in and adjacent to the proposed development would be likely to meet the relevant comfort and safety criteria.

3.1 Regional Wind Climate

3-hourly wind records from Dunedin Airport meteorological station for the period 1991 to 2013 have been obtained from National Institute of Water and Atmospheric Research (NIWA) [3] and statistically analyzed to produce the directional distribution of mean (averaged over 10 minutes) wind speed thresholds at a reference height of 10m in Terrain Category 2 [4], annual maximum and 5.5% exceedence probability. Figures 1a and 1b show the results of the regional wind climate analyses for the airport location. Note that thunderstorm wind events of short duration will not contribute to the values shown in Figures 1a and 1b, which includes only sustained (synoptic) winds of relevance to pedestrian comfort.

It can be seen that the strongest annual maximum winds of the Dunedin region originate from the west-south-westerly and north-westerly directions. Prevailing wind directions for the more common winds are south-west, west-south-west and east-north-east.

Figure 1c shows the predicted values of annual maximum 3-second gust speeds at the height of pedestrians (2 metres) in the urban terrain of central Dunedin (assumed as Terrain Category 3 in [4]). The all-direction gust speed of 18.0 m/s is quite close to the Wellington safety criterion of 20 m/s (Table 2.1), even without a large development such as the proposed hotel.

Daily average wind records from NIWA for the period 1991 to 2017 were also processed. When the airport data were converted to typical urban conditions at pedestrian height (i.e. Terrain Category 3 at 2 m height, but without the effect of any large structure), the 'strong' cumulative effect limit of 3.5 m/s of the Wellington criteria (Table 2.1) is exceeded about 8.5% of the time, or on 31 days per year on average. The 'moderate' value of 2.5 m/s is exceeded about 29% of the time, or 106 days per year. This indicates that central Dunedin is quite a windy place even without the presence of a tall building such as the proposed Hotel.

To satisfy the 'strong' criterion in Table 2.1 that limits the additional days of average speeds of 3.5 m/s, or greater, created by a development, to 20 per year, amplification of wind speeds near the ground by a new building in Dunedin, should not exceed 12% (averaged over all wind directions). To satisfy the 'moderate' criterion for 2.5m/s, the limiting amplification is found to be 8%.

3.2 Exposure to Wind

The proposed development is located on a site on the western edge of the Dunedin central business district, bounded by Moray Place to the south, an existing car park to the west, existing low-rise developments to the north and Filleul Street to the east.

The surrounding terrain within a 1.2km radius of the site to the north-north-east, through north to the south-west consists of low-rise developments and parkland. To the south-south-west through south to the north-east are low and occasional medium-rise developments.

The surrounding topography within 1.2km of the site to the south-west through south to the north-east is flat. To the west-south-west through west to north-north-east the terrain slopes upward with gradients of the order of 10%, however, the site of the proposed development is not considered to be within a Local Topographic Zone as defined in Australian/New Zealand Standard for Wind Actions [4].

There is no significant shielding as defined in [4] of the proposed development from winds by surrounding developments due to the height of the proposed development being significantly greater than surrounding developments.

Satellite photographs of the Project site and surrounding terrain are shown in Figures 2 and 3.

3.3 Overall Form of the Proposed Development

The proposed development is composed of a 55m high (roof height to average ground level), hotel and residential tower structure. The tower footprint at ground levels is hexagonal, changing on level six to a form that may be described as three rectangular towers at 120° intervals to each other, backing on to each other and sharing a central lift core. The resulting multi-faceted form of the building facades is a positive from the point-of-view of resulting ground level winds in that it will tend to reduce downwash flows from the facades to ground level areas.

The main facades of the tower face approximately north-west, south-west and east. There is a substantial canopy structure over the ground level main hotel entrance to the proposed development on the west side of the tower, a main entrance to the retail area on the south-western side of the development and a ground level outdoor café terrace on the eastern side of the tower. There is significant terrain height variation over the site with the northern side of the site being some 10m higher than the southern side.

A drawing showing the overall form of the proposed development is reproduced in this report in Figure 4.

3.4 Form of Nearby Structures

Existing nearby developments are all significantly lower in height than the proposed development, and so are unlikely to provide a high degree of shielding of the proposed development from incident winds.

The size and proximity of the Town Hall immediately across the road to the south of the proposed development could interact with the proposed development during easterly, westerly and south-westerly winds to generate some flow channeling effects in ground level areas between the buildings (on Moray Place). Similarly, some flow channeling is expected on Filleul Street between the proposed development and the existing five-storey development immediately across the road to the east during northerly and south-westerly winds. Flow channeling is a localized acceleration of wind in a gap between two or more structures.

3.5 Use of Proposed Outdoor Areas

The proposed development is located in a commercial area with a small number of active street-frontages nearby on Filleul Street (i.e. pedestrian window shopping). In the proposed development it is proposed to make use of the street frontage with a café terrace on the south-eastern side and retail frontage on the western side with some landscaping, public seating, play areas and water features.

Elsewhere the nearby business frontages at ground level appear to have little or no retail at ground level.

As noted in the Wellington City Council criteria (reproduced in Section 2 of this report) the application of the wind criteria is as follows:

Table 3.5.1 – *Application of recommended criteria*

Criterion	**Applicable Areas**
Safety	All adjacent public areas
Strong cumulative	All adjacent public areas
Moderate cumulative	All adjacent public areas

4. PREDICTED WIND ENVIRONMENT

4.1 Summary

The wind speeds presented in Figure 1 can be factored for height above ground, estimated local terrain roughness, local turbulence and the influence of buildings to produce estimated annual maximum 3-second gust wind speeds and 5.5% probability (20-days per year) mean wind speeds adjacent to the proposed development. These estimates can then be compared with the applicable criteria to determine whether they would be acceptable or not.

Wind conditions at the south-western corner area of the proposed development during a west-south-westerly wind scenario were considered for these estimates as west-south-westerly winds are predicted to be the worst case for ground level wind conditions adjacent to the proposed development.

These estimates indicate the proposed development is likely to result in some localized increases in ground level wind conditions over existing wind conditions at the site. Combined with the predicted aerodynamic interactions with the large existing Town Hall building adjacent to the south, JDH Consulting estimates wind conditions on the Moray Place footpaths would be likely to exceed the recommended criterion for safety during and south-westerly and west-south-westerly winds.

However, it should be noted that the bare-site wind speeds (i.e. the wind speeds at the vacant site of the proposed development) are predicted to be close to the safety criterion already, and that the predicted increases in wind speed due the proposed development are on top of relatively high site wind speeds.

Estimates also suggest the ‘cumulative - moderate’ criterion could be exceeded by the proposed development, i.e. augmentation of winds by the proposed development greater than 8% may result in the frequency of average daily wind speeds of 2.5m/s, or more, being increased by more than 20 days per year.

4.2. Discussion of Analyses

The proposed development is located within a high-density metropolitan terrain which reduces the site wind speeds from all directions. There are no nearby buildings of comparable height that would provide significant direct shielding of the proposed development. There are some existing buildings to the south and east which may interact to produce higher wind conditions about the proposed development for some wind directions.

Estimates of ground level wind speeds have been made based on Dunedin region wind climate data, empirical aerodynamics data in [5] and upstream exposure. A west-south-westerly and south-westerly wind scenario at the south-western corner of the proposed development was considered for these estimates, as these winds are likely to be the worst case for ground level wind conditions adjacent to the proposed development for several reasons:

- They are the strongest wind direction in the Dunedin wind climate
- They are incident on a broad façade of the proposed development
- One of the windward building corners is adjacent to a public footpath
- There may be significant and potentially unfavourable aerodynamic interactions with the adjacent Town Hall building to the south.

These estimates indicate the proposed development is likely to result in some localized increases in ground level wind conditions which are likely to exceed the recommended criteria.

The estimates conducted began by predicting the wind speeds at the site of the proposed development without the influence of the development, i.e. a bare site in suburban terrain. The predicted annual maximum 3-second-average gusts are 18 m/s (65 km/h), as shown in Figure 1c, i.e. the existing winds speeds at the site are approaching the criterion for safety. This existing site wind speed can be considered a lower limit of the predicted maximum wind speeds near the proposed development, as it is very unlikely the proposed development will result in a sheltering effect for all ground level locations and all wind directions.

The estimates conducted then used empirical data available for a tower building without immediately adjacent developments to consider the likely effects of the proposed development on the wind flows in addition to those already existing at the site.

The influence of the proposed development on the local wind environment will vary with wind direction and ground level locations. Depending on wind direction, some ground level areas near the proposed development will be more sheltered than before and some areas will experience wind flows accelerated over and above the existing site wind speeds due to the influence of the proposed development. There is empirical aerodynamics data available for the speed-up effect of an isolated tower on ground level winds in certain locations, such as upstream corner areas, and some of this data has been used to estimate some localized wind speed up effects by the proposed development.

When the site wind speeds and local speed-up effects of an isolated tower are combined, the estimated ground level wind speed values in the vicinity of the south-western building corner of the proposed development range from 22m/s to 26m/s annual maximum 3 second gust, i.e. between 2m/s and 6m/s (10% and 30%) in excess of the criterion for safety. It is likely these flows may be further accelerated by aerodynamic interactions with adjacent developments, for example, being channeled between the proposed development and an adjacent development such as the Town Hall to the south or the large building on the corner of Filleul Street and Moray Place to the east.

When the effects of the adjacent Town Hall building to the south are considered in combination with the predicted speed-up effects for the proposed development as an isolated tower, JDH

Consulting considers that there is a fairly high probability that wind conditions on the Moray Place footpaths, adjacent to the proposed development, will be in excess of the criterion for safety with some possibility of the cumulative (comfort) criteria also being exceeded.

The main entrance of the hotel is apparently planned to be located on the western side of the ground floor – i.e. exposed to the main prevailing wind directions (see Figure 1); this may lead to problems with the operation of doors on some days of the year. A better orientation for the main entrance would be facing the NNE direction which will experience relatively low wind speeds.

The elevated balconies and rooftop of the proposed development may also be affected by elevated wind conditions. Loose and lightweight items left unattended on high-rise balconies can pose a significant risk during high winds, with examples of furniture, and even pot plants, being removed from medium and high-rise balconies by wind.

5. MITIGATION MEASURES

It is important to be aware that almost any development over two storeys in height on this site could potentially generate wind conditions in excess of the criteria. It is also likely that there are already existing wind conditions in some localized areas in the Dunedin CBD in excess of the Wellington criteria due to speed-up effects by the local built form.

In short, these criteria would be difficult for almost any substantial development in Dunedin to meet without careful consideration in the building design for wind.

The analyses conducted in this current assessment predict that amplification wind conditions adjacent to the proposed development, by the new building, will likely exceed the recommended (Wellington) criteria. The proposed development includes a number of wind mitigating features, such as the articulated facades and ground level canopy structures. However, further measures may be needed to mitigate the predicted wind conditions. Several potential mitigation measures are shown in Appendix B. A scale-model wind-tunnel study could investigate and accurately determine the form and location of modifications required to achieve acceptable wind conditions. Successful and architecturally pleasing designs solutions have been developed in similar circumstances.

Therefore, at this initial stage, JDH Consulting support the overall size and form of the proposed development and consider that, with additional wind mitigating measures in the design, it may well be possible to achieve acceptable wind conditions. In this case, it is suggested that from a pedestrian wind effects point-of-view, the development be granted an approval conditional on a successful scale-model wind-tunnel study.

6. CONCLUSIONS

JDH Consulting has carefully considered the form and exposure of the proposed development, the nearby existing developments, the local wind climate and the proposed use of ground level areas in, and adjacent to, the proposed development. Using empirical architectural aerodynamics data, analysis of the Dunedin region wind climate, and experience, estimates of ground level wind speeds were made and then compared, in relation to the Wellington City Council criteria for comfort and safety.

This study concludes that some localized increases in ground level wind conditions due to the proposed development alone are likely. This in combination with probable aerodynamic interactions with some of the larger adjacent buildings such as the Town Hall to the south have the potential to result in exceedences of the recommended criteria at some locations adjacent to the proposed development.

In JDH Consulting's experience, it is possible for developments of this size, form and exposure to achieve acceptable ground level wind conditions through further development of wind mitigating features. Successful and architecturally pleasing designs solutions have been developed in similar circumstances using scale model wind tunnel testing. In JDH Consulting's opinion, it may be possible for the proposed development to maintain the overall height and form and achieve wind conditions meeting the criteria by further refinements in the design. In this case, it is suggested that from a pedestrian wind effects point-of-view, the development be granted a development approval conditional on a successful scale model wind tunnel study.

Note that this is an opinion statement and is not based on wind-tunnel model testing or computational analyses of the project. The findings of this study are based on generic architectural aerodynamics data, a wind climate assessment of the site of the proposed development, as well as the authors' experience of scale-model wind-tunnel testing and full-scale assessments of other similar developments. If an assessment with a higher degree of certainty is required, a scale-model wind-tunnel test is recommended.

DRAWING LIST

The following drawing package dated 19/12/2017 was received by JDH Consulting from GHD. The drawings were not numbered but have the file name *DUNEDIN HOTEL 19-12-16.pdf.*

DUNEDIN HOTEL 19-12-16.pdf	1/01/2017 9:26 PM	Adobe Acrobat Document	3,908 KB

REFERENCES

[1] - *Dunedin City District Plan* (current), Dunedin City Council, http://www.dunedin.govt.nz/your-council/district-plan

[2] - *Wellington District Plan* (current), Wellington City Council, http://wellington.govt.nz/your-council/plans-policies-and-bylaws/district-plan

[3] - Historical weather data, National Institute of Water and Atmospheric Research, https://www.niwa.co.nz/

[4] - *Structural Design Actions, Part 2: Wind Actions*, Australian/New Zealand Standard 1170.2:2011, Standards Australia.

[5] - *Architectural Aerodynamics*, Aynsley, Melbourne & Vickery, Applied Science Publishers

[6] - *Guidelines for Pedestrian Wind Effects Criteria* (2014), Australasian Wind Engineering Society, http://www.awes.org/product/guidelines-for-pedestrian-wind-effects-criteria/

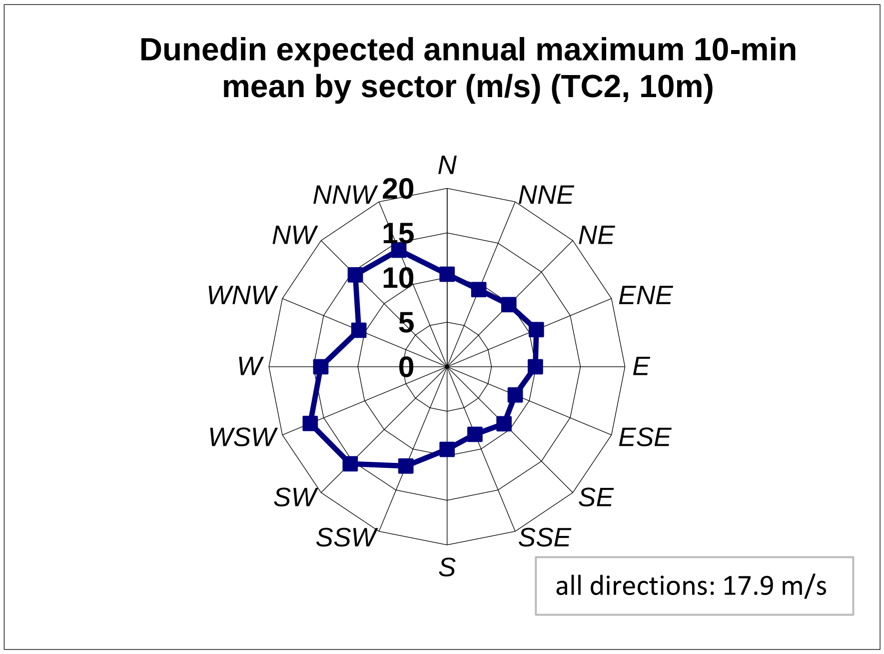

Figure 1a. **Directional distribution of annual maximum 10 minute mean wind speeds (m/s) in the Dunedin region at a reference height of 10m in Terrain Category 2.**

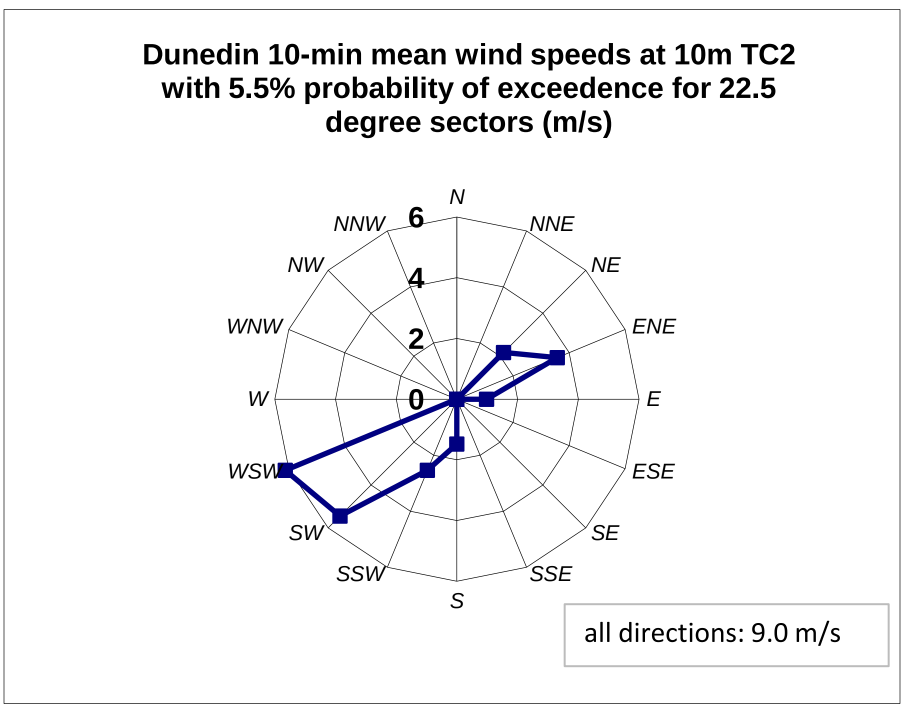

Figure 1b. **Directional distribution of 10-min mean wind speeds (m/s), with 5.5% probability of exceedence, in the Dunedin region at a reference height of 10m in Terrain Category 2.**

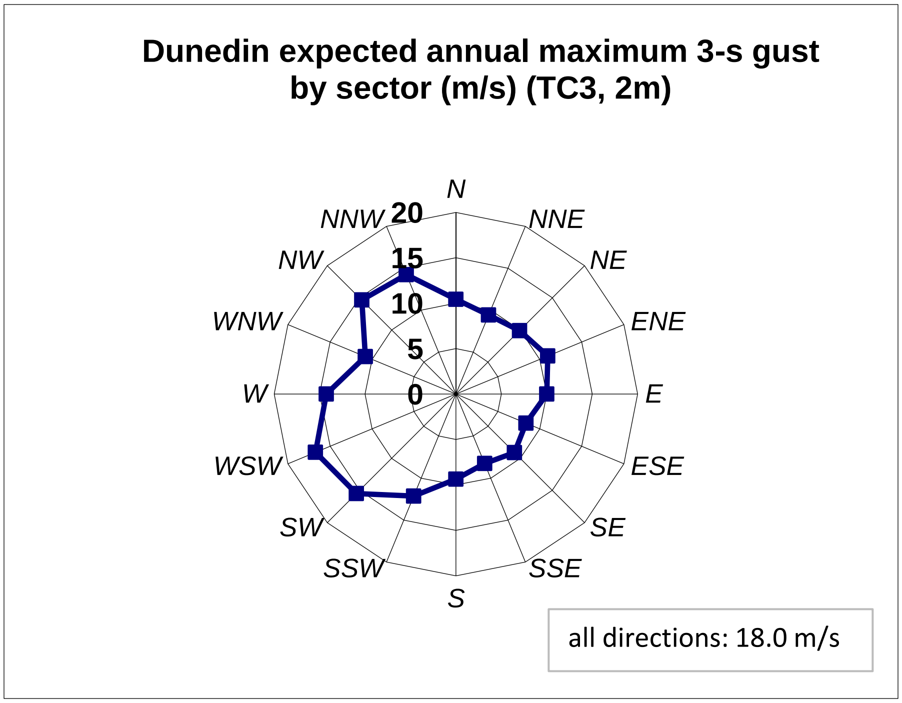

Figure 1c. **Predicted annual maximum 3-second gust speeds (m/s) at a height of 2m at the site in the absence of the development (Terrain Category 3).**

Figure 2. **Satellite image of the site of the proposed development (circled) and immediately surrounding terrain.**

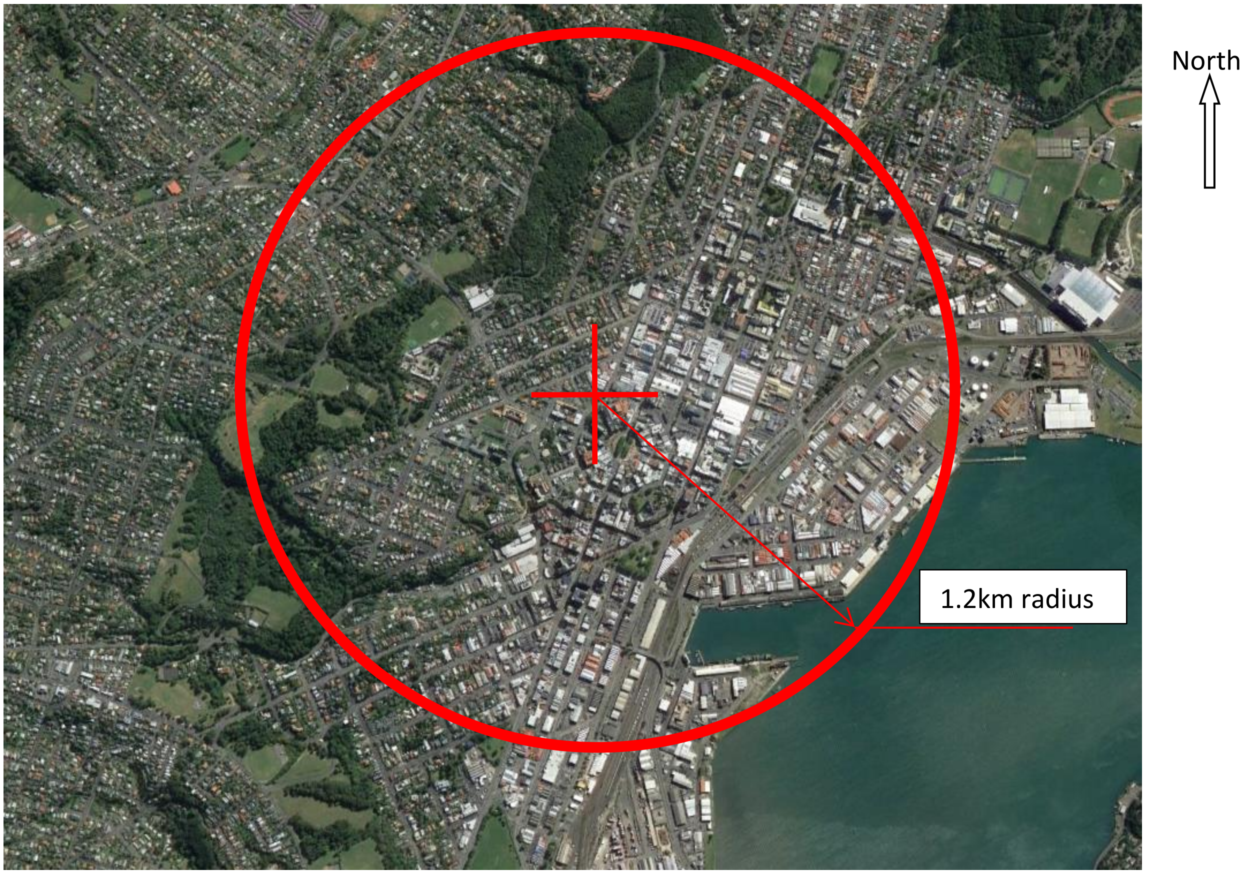

Figure 3. **Satellite image of the site of the proposed development and surrounding terrain within a radius of approximately 1.2km (circled).**

Figure 4. **View of the proposed development from the south-west as provided to JDH Consulting.**

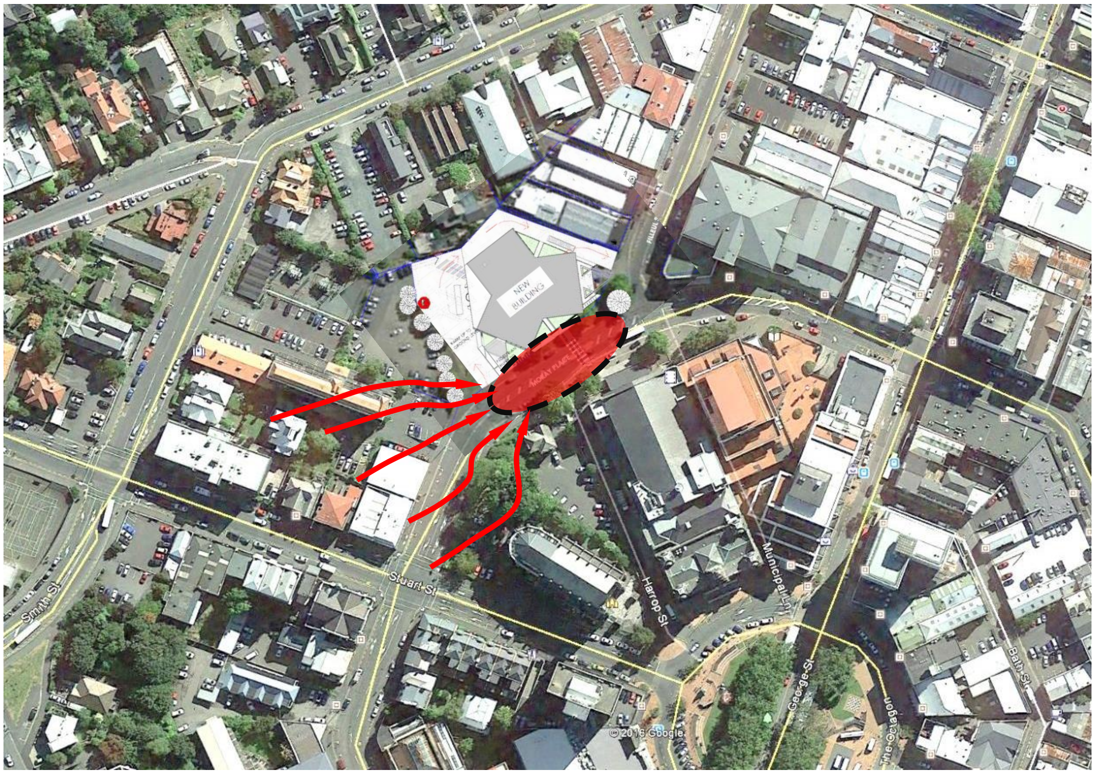

Figure 5. **Schematic view of the proposed development and surrounding developments showing the potential result of west-south-westerly winds incident on the south-western facade of the proposed development and medium-rise adjacent development to the south: wind flows (shown by arrows) may be channeled between the two developments leading to elevated ground level wind conditions in Moray Place.**

APPENDIX A – Methodology for Wind Climate Analysis

The methodology described following was used to derive the polar plots of wind speeds for the airport anemometer (10m height) and the urban site location (45m), presented in the main report.

Wind data for the period 1-1-1991 to 1-1-2013 from the Dunedin Airport anemometer were obtained through the website of the New Zealand National Institute of Water and Atmospheric Research (NIWA). The data consisted of ten-minute-average wind speeds (metres per second), and directions, sampled every three hours, that is eight per day. The total number of speed and direction values for the 22-year period was 44145. When the 'calms' (wind speeds recorded as 'zero') were removed the total of samples reduced to 38691.

Dunedin Airport is located about 20 kilometres east of the city centre, and after correction for changes in height and terrain, the data becomes representative of that at the site of the proposed hotel. The nature of the data is such that essentially only synoptic scale wind events are sampled, and shorter duration events from thunderstorms are not included. It is generally accepted that, when assessing pedestrian-level wind events, only synoptic winds are included.

Wind directions were recorded by NIWA at ten-degree intervals, and the data was first sorted into 36 direction sectors. Counting of the number of samples of wind speeds exceeding defined values at 1 m/s intervals, i.e. 0, 1, 2 ….. 23 m/s. The maximum value in the data set was 23.2 m/s. For ease of presentation, the direction sectors were then reduced to sixteen at 22.5 degree intervals by rationally assigning the data from adjacent sectors to the cardinal directions: N, NNE, NE, ENE etc… A weighting system was devised that gave more weight to the ten-degree sectors closer to the nominal cardinal direction.

The nominal exceedance probabilities for each 22.5^{o} direction sector, and for all sectors combined, were fitted with Weibull probability distributions, using a logarithmic least-squares approach. This enabled wind speeds with defined probability levels (e.g. 5.5%) to be determined. Annual maximum values were determined using a 'level-crossing' approach e.g. Holmes [A1] – *Appendix C5*. This approach requires a 'cycling rate' to be defined; in this case 700 per annum was used – this is a nominal value, but is consistent with the value of 675 per annum determined by Gomes and Vickery [A2] for Sydney, Australia.

References

A1 J.D. Holmes, *Wind Loading of Structures*, 3rd Edition, CRC Press, Boca Raton, Florida, 2015.

A2. L Gomes and B.J. Vickery, On the prediction of extreme winds from the parent distribution, *Journal of Industrial Aerodynamics*, Vol. 2, pp 21-36, 1977.

APPENDIX B – SOME POSSIBLE WIND MITIGATION MEASURES

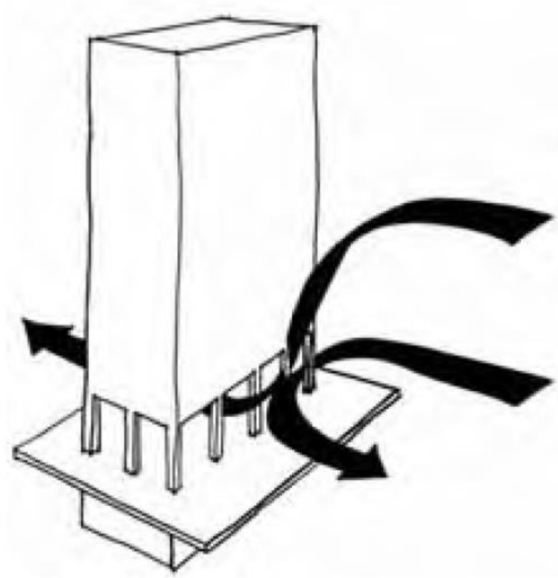

Figure B1 – Canopy and elevated open floor(s) above

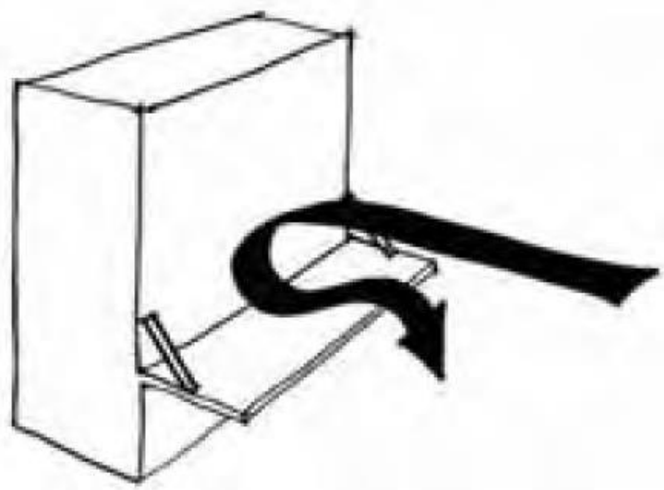

Figure B2 – Canopy sheltering adjacent footpath areas

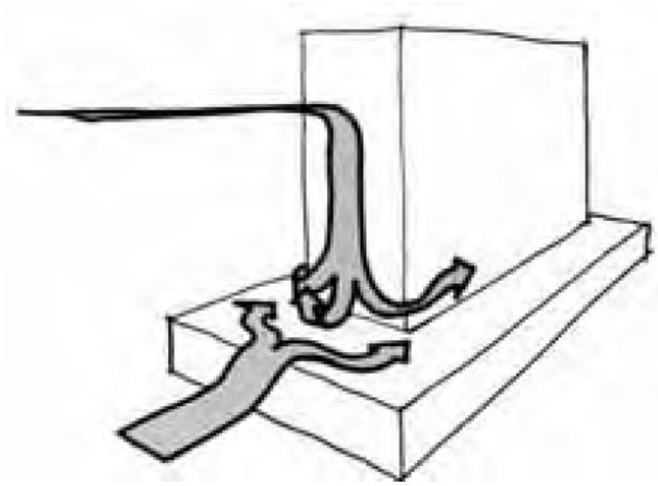

Figure B3 – Tower on a podium format sheltering adjacent footpath areas

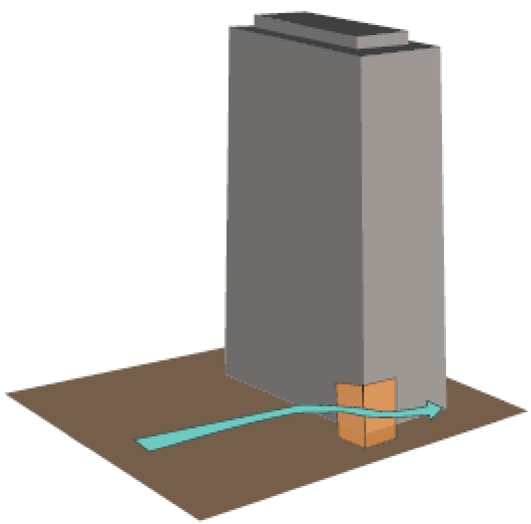

Figure B4 – Screen located at a windy corner

Reference

B1 Wellington City Council (2016), *Wellington City Council District Plan Non Statutory Design Guides* http://wellington.govt.nz/~/media/your-council/plans-policies-and-bylaws/district-plan/volume02/files/v2wind.pdf?la=en

APPENDIX C - JDH CONSULTING

JDH Consulting, founded in 1996, is a specialist engineering consultancy which provides services in the fields of wind engineering, structural dynamics and risk analysis to other consultants, large companies and utilities, universities, other wind engineering groups, etc. Examples of some of the services provided are as follows:

- Computer analysis of the dynamic response of towers, chimneys and masts to wind action
- Assessment reports on environmental wind effects
- Site assessment for terrain, shielding and topographic effects on design wind speeds
- Specification of wind pressure coefficients and shape factors for unusual structural shapes
- Design of structure and foundations for wind loads
- Contract writing of codes, standards and design guides for wind action
- Analysis of historical wind speeds and failure risk of transmission line systems
- Wind-tunnel design
- Supply of advice and equipment for measurement of fluctuating pressures
- Advice, quality assurance and analysis services for wind-tunnel operators, or clients of wind tunnels
- Analysis of wind storm risk for insurance purposes
- Expert witness services for failures under wind action
- Delivery of seminars and workshops on wind loading and use of standards

The principal of JDH Consulting is Dr. John D. Holmes, who is an internationally-recognized expert in wind engineering, Chair of the Wind Actions Sub-Committee for Standards Australia, and author of ‘Wind loading of structures’ published in 2001, 2007 and 2013 (third edition).

JDH Consulting has professional indemnity insurance cover for $4 million.

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C.V. - DR. J.D. HOLMES

Dr. John Holmes is Director, JDH Consulting. He is also an Adjunct and Visiting Professor at Louisiana State University, U.S.A. and James Cook University, Queensland, Australia. He was previously a Senior Lecturer at James Cook University, Townsville for seven years, CSIRO, Divisions of Building Research, and Building, Construction and Engineering for fourteen years, reaching the level of Chief Research Scientist, and a Principal Research Fellow at Monash University for five years. He has been engaged in research, testing and consulting in wind loads and wind effects for more than 30 years. He was actively involved in the writing of Australian Standards AS1170.2-1989, AS/NZS1170.2:2002 and :2011 (Wind loads) and AS3995-1994 (Design of steel lattice towers and masts). He is the author or co-author of some 300 journal papers, conference presentations, and research and consulting reports, and was the principal author of the Commentary on the Australian Standard for Wind Loads. He is the author of: "*Wind Loading of Structures*", published in 2001 by Spon Press of London, 2007 (Taylor and Francis) and in 2015 (third edition) by CRC Press, and a co-author of '*A Guide to AS/NZS1170.2:2002- Wind actions*', published by Warreen Publishing in 2005.

He has been a consultant for, or carried out collaborative research with, many companies or organisations, including ABB-EPT, BHP, Telstra, Stramit Industries and Woodside Petroleum. He was awarded a Fulbright Senior Fellowship in 1989, the Warren Medal by the Institution of Engineers in 1990, a Senior Fellowship by the Japan Society for Promotion of Science in 1996, the John P. Laborde Visiting Chair at Louisiana State University, 2003-4, and a Senior Award (A.G. Davenport Medal) by the International Association for Wind Engineering in 2011. He has been an advisor to the Engineering Sciences Data Unit of London, U.K. and the Technical Committee on Wind Loading of Malaysia.

As a consultant, he has also been involved in the determination of design wind loads for many major structures including: West Gate Bridge, Melbourne; CityCorp Building, New York; Stadium Australia, Sydney; My Thuan Bridge, Vietnam; Docklands Stadium, Melbourne; Baram Bridge, Malaysia; Macau Tower, China; Nanjing Stadium, China; Wembley Stadium redevelopment, London, U.K.; Chevron redevelopment, Gold Coast, Australia; Woodside offshore platforms, Mauritania, West Africa; Pluto, Wheatstone and Gorgon LNG Plants, Western Australia; Melbourne Rectangular (AAMI) Stadium, Australia.

C.V. - HARRY FRICKE

Since graduating from the University of Sydney's School of Aeronautical Engineering, Harry has spent most of his career in architectural aerodynamics first as a test engineer with MEL Consultants, then at Vipac Engineers and Scientists where he finished as a senior consulting wind engineer.

During this time he has been in charge of the delivery of wind loading and pedestrian wind effects advice for many well-known Australia buildings including Riparian Plaza (Brisbane), Eureka Tower (Melbourne), VS1 (Adelaide), Southern Cross Station (Melbourne), Melbourne Convention Centre and Darwin Convention Centre. Internationally, he has been responsible for wind engineering advice for, among others, Mall of the Emirates, Ski Dubai, Reflections at Keppel Bay (Singapore), Raffles Dubai and the Kuala Lumpur Convention Centre

Harry has successfully consulted on a number of post construction wind noise and building internal flow problems in high-rise developments. He has conducted approximately ten aero-acoustic wind tunnel studies of full scale façade elements. With this experience he is able to contribute guidelines for designers to assist them to avoid known wind noise and building leakage problems.

Harry designed and built a full scale façade element wind load test facility while at Vipac and tested many roof and wall cladding products gaining strong working knowledge of the effects of wind loading on real structures, how they behave and modes of failure.

Harry has a keen interest in sustainable design and has significant experience in wind loading of solar arrays and has consulted on the solar array for the Australian Parliament House. He has a good working knowledge of natural ventilation, its benefits and limitations.

Harry is a member of the Australasian Wind Engineering Society and has contributed several research papers at AWES Workshops since 2003.

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ABB Engineering Construction
ABB-Worley Joint Venture
Ainley-Nixon (structural engineers)
Alan Reay Consultants (NZ)
AMEC Australia Pty. Ltd. (structural engineers)
Arup Pty. Ltd.
Bill Jordan & Associates (structural engineers)
Bluescope Steel
BMT – Fluid Mechanics (U.K.)
Bruce Young Partners (consulting engineers)
Buchanan & Fletcher (structural engineers (N.Z.))
Building Research Association of New Zealand
Bureau of Meteorology – Special Services Unit
Burchill Partners Pty.Ltd.
Burns,Hamilton & Ptnrs. Pty.Ltd.(structural engineers)
Cardno – MBK (NSW) Pty. Ltd.
City University of Hong Kong
Connell Wagner Pty. Ltd. (consulting engineers)
CLP Wind/wave Testing Facility, Hong Kong University of Science & Technology
CMPS&F (consulting engineers)
Crown Castle International (communication structures)
CSIRO – Division of Building, Construction and Engineering
Cumulus Consulting
Cyclone Testing Station
DLA Phillips Fox (solicitors)
Dennis Southam & Assoc. (structural engineers)
ESDU International (London U.K.)
Electranet (South Australia)
Electricity Supply Association of Australia
Fluor Daniel Ltd.
Gale Pacific Ltd.
Geoscience Australia
G.J.James Australia
Global Environmental Modelling Systems Pty. Ltd.
Glynn Tucker (consulting engineers)
GHD Pty. Ltd. (consulting engineers)
GM Poles Pty. Ltd.
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Healey and Castle (consulting engineers)
Hong Kong University of Science and Technology
I-cubed
James Cook University Cyclone Structural Testing Station
J&H Marsh & McLennan
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Jones and Jones (consulting engineers)
Koukourou Engineers
Larkin-Teys (consulting engineers)
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Meinhardt (Vic.) Pty. Ltd. (consulting engineers)
Meinhardt (Qld.) Pty. Ltd.(consulting engineers)
MEL Consultants Pty. Ltd.
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Mott McDonald (consulting engineers, U.K.)
Howard Morley and Assoc.(consulting structural engineers)
Office of Major Projects (Victoria)
Pacific Solar Pty. Ltd.
Permasteelisa Pty. Ltd.
Peter Blacker & Assoc. (consulting engineer)
Powerlink (Queensland)
Qld. Dept. of Public Works and Housing
Radio Frequency Systems Australia (antennas)
Rapcivic Contractors
Raytheon Australia Pty.Ltd.
RED Consultants (Hong Kong)
Research Grants Council, Hong Kong
Roads and Traffic Authority of NSW
Robert Elks & Associates
Rocla Pty.Ltd.
Robert J. Roy (consulting engineer)
Rowell, Forrest & Co.(solicitors)
SAI-Global Ltd.
Saunders Pty.Ltd. (tank manufacturers)
Seminar Services Australia
Standards Australia
Steel Construction NZ
Stramit Industries
Structural Engineering Society (New Zealand)
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Suncorp (insurance)
Taperline Australia
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University of Western Ontario, Canada
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Wave Engineering
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