This entire chapter has been notified as part of an Intensification Planning Instrument, using the Intensification Streamlined Planning Process (ISPP) in accordance with Section 80E of the RMA.

APP8 – Rangahau Inerahi ā-Hau me te Aromatawai Inekounga ā-Hau - Ngā Herenga mō te Whakatauiratanga me te Tuku Pūrongo

APP8 – Quantitative Wind Study and Qualitative Wind Assessment – Modelling and Reporting Requirements

This appendix details the requirements for both quantitative wind studies and qualitative wind assessments in accordance with the Wind Chapter requirements.

Rule WIND-R1 details the height thresholds and development triggers when either a qualitative or quantitative wind assessment is required to show compliance with standards WIND-S1, WIND-S2 and WIND-S3 as relevant.

~~For the City Centre Zone, Metropolitan Centre Zone - Height Control Area 1, Special Purpose Port Zone, Multi-User Ferry Precinct, Inner Harbour Port Precinct, Special Purpose Stadium Zone and Special Purpose Waterfront Zone, a quantitative wind study will usually be required to show compliance with the wind standards. Council may accept a qualitative wind assessment when a development is likely to have little, if any, impact on wind conditions – refer to the Wind Chapter Best Practice Guidance Document (Appendix 14) for likely wind effects of buildings.~~

~~For the Local Centre Zone, Neighbourhood Centre Zone, Metropolitan Centre Zone - excluding Metropolitan Centre Zone Height Control Area 1, Special Purpose Hospital Zone and Special Purpose Tertiary Education Zone a qualitative wind assessment is usually all that is required to show compliance with the wind standards. However, if a development is assessed to have a large negative impact on wind conditions, then a quantitative wind study may be required to enable the wind effects of the development to be fully understood.~~

~~It is up to the discretion of the resource consent planner to decide whether a quantitative wind study or a qualitative wind assessment is required.~~

Appendix 8 Wind-A1: Modelling and reporting requirements for a Quantitative Wind Study

This Appendix details the minimum requirements for quantitative wind studies required by rules in the Wind Chapter.

1 Aims of a wind study

The aims of a wind study are:

1.1 To quantify the extent and magnitude of the effect of a building proposal on the surrounding pedestrian level wind environment by measuring and comparing the existing and proposed wind conditions;

1.2 To provide documentary evidence of the proposed building's effect on the local wind environment and level of compliance with the wind standards; and

1.3 To demonstrate, where the proposed building will cause wind conditions to deteriorate, to show that every reasonable alternative design has been explored and that the proposed building is the best practical aerodynamic design for the site.

2 Minimum requirements for a wind tunnel study

Wind tunnel studies must meet the following conditions:

2.1 Wind studies must comply with the requirements of Australasian Wind Engineering Society Quality Assurance Manual, Wind Engineering Studies of Buildings, AWES-QAM-1-2019, except where the rules and requirements of the Wind Chapter supersede them.

2.2 The model scale used in the wind tunnel test must not be smaller than 1:300.

2.3 The atmospheric boundary-layer simulation must represent the local upwind terrain, as defined in the Australia/New Zealand Loading Standard, AS/NZS 1170.2:2021.

2.4 All wind speeds must be measured at a full-scale height of 2 metres.

2.5 Wind speeds must be measured for wind directions at no greater than 20° intervals for the prevailing wind directions at the site. The measurements must be scaled to full-scale wind speeds using reference wind data corresponding to 20°sectors.

2.6 For Wellington CBD, reference wind conditions have been measured in a previous study (refer Jackson, P. S.: 1976, ‘Thorndon Wind Tower. Part I: Data Collection; Part 2: Wind Structure’, N.Z. Ministry of Works and Development, Central Laboratories Rept. 3–76/4), and are derived from Wellington Airport wind data, with the following corrections applied:

a. Winds at a height of 10m at Wellington Airport have an equivalent mean speed to winds at a height of 150m above Wellington City, and
b. Wind directions over Wellington City are the same as those at Wellington Airport, except that the northerly wind directions (i.e. 0°-80° and 280°-360°) are rotated to the west by 10° (e.g. 360° at the airport becomes 350° over the city).

2.6.1 For the Wellington CBD, the following reference mean speeds and wind directions are deriv from the Wellington Airport data (1985-1998), using the corrections in a) and b) above. The reference wind speeds correspond to the annual maximum hourly mean wind speeds at a height of 150m

150° 15m/s	170° 20m/s	190° 22m/s	210° 22m/s
320° 19m/s	340° 22m/s	360° 20m/s	020° 15m/s

2.6.2 For Wellington CBD, the hours of occurrence of the hourly mean wind speeds must be deri using wind data from Wellington Airport with the corrections described in a and b above.

2.7 The annual maximum gust speeds in WIND-S1 must be calculated from measurements at each location for each wind direction, using the following equation:

$$gust = v + 3.7\sigma,$$

where v = the annual maximum hourly mean wind speed for the particular wind direction and

σ = the standard deviation of the wind speed.

For Wellington CBD, the reference wind speeds and wind directions in 2.6.1 must be used to derive the annual maximum gust speeds.

2.8 The number of hours that the hourly mean wind speed equals or exceeds 2.5 m/s in a year must be calculated to assess compliance with WIND-S1, WIND-S2, and where applicable WIND-S3. For Wellington CBD, the reference wind data in 2.6.2 must be used to derive the number of hours, equalled or exceeded.

2.9 Flow visualisation tests of the existing situation and of the proposed development must be undertaken. Results from the testing must show the full spatial extent of any change in wind conditions with the proposed building and the spatial extent of windy areas around the development site. At a minimum, flow visualisation must show effects on:

a. Two building heights upwind of the site; and
b. Four building heights either side of the site; and
c. Six building heights downwind.

The testing must produce at least six different wind speed contours, and be undertaken for at least two representative northerly wind directions and two representative southerly wind directions that show the likely worst wind effects.

2.10 Where the standards WIND-S1, WIND-S2, or where applicable WIND-S3, are not complied with, and evidence for applying discretion is required, alternative building designs and/or modifications must be investigated to demonstrate that the proposed building is the best practical attempt to comply with the wind standards. While the investigation of alternative designs need only focus on those areas, and those wind directions, where non-compliance occurs, sufficient measurements must be taken elsewhere to quantify all the significant changes in wind conditions with the alternative designs (i.e. measurements must not provide a misleading picture of the overall effect of any building configuration by ignoring public spaces where significant changes in wind speeds occur).

2.10.1 Where the standards WIND-S1, WIND-S2, or where applicable WIND-S3, are not complied with because the wind conditions for the existing situation are already non-compliant, and w conditions cannot be practically improved by changing the design of the proposed building example, because wind conditions are too far away to be influenced by the design), an analysis of the wind tunnel data must be provided to demonstrate this.

3 Form of wind tunnel test report

A wind tunnel test report must contain:

3.1 A description of the atmospheric boundary layer simulation that is used in the wind tunnel, including plots of the mean wind speed profile and turbulence intensity profile.

3.2 A description of the reference wind speeds used to derive the wind speeds listed in the wind report. Any assumptions and limitations of the reference wind speed analysis and a description of the meteorological data used must be provided.

3.3 A calibration section, which contains the results of flow visualisation tests of a calibration building model, performed using the same wind tunnel setup and procedures as those used for the wind study. The calibration building model must be an isolated square prism, 15 metres square in plan and 60 metres high, at the same model scale used for the wind study. Flow visualisation erosion testing must use at least six different wind speeds, and the final wind speed must correspond to an area of influence (identified by the flow visualisation) equal to 80% of a circular area centred on the back face of the model, with a full-scale diameter of 50 m diameter. The intermediate speeds will be chosen to equally divide this maximum speed.

3.4 An analysis of the error limits and the precision that is achievable in the wind speeds and the frequency of occurrence that are listed in the wind report. The relationship of the model (wind tunnel) to full-scale Wellington conditions, as far as it is known, should also be documented through reference to externally refereed papers or reports.

3.5 A diagram that clearly shows and identifies the locations/areas that were measured during testing.

3.6 A table of the annual maximum gust wind speeds for each wind direction, measurement location, and each building configuration. This will include listings for the existing situation as well as the proposed building configuration(s).

3.7 A table of number of hours that the mean hourly wind speed equals or exceeds 2.5 m/s each year, for each measurement location and each building configuration. This will include listings for the existing situation as well as the proposed building option(s).

3.8 Records/diagrams of the flow visualisation tests.

3.9 A description of the effects of the proposed development on wind conditions in the surrounding area. This must include a description of the 3-dimensional wind flows around the proposed building, indicating the way these wind flows affect pedestrian-level winds. This should clarify:

3.9.1 The cause(s) of any observed non-compliance with the wind standards - WIND-S1, WIND- and WIND-S3;

3.9.2 The ways in which the wind problems might be avoided; and

3.9.3 The ways in which these wind problems might be mitigated.

Notes
For example, at its simplest this might be a statement that:
- The root cause is the downwash caused by the proposed building being very much bigger in scale than its neighbours;
- Reducing the size of the proposed building would remove this root cause; and
- Large canopies around the proposed building could provide shelter from the downwash in the immediate vicinity of the entry ways, although this may result in the carparking area beyond the canopy being made uncomfortable.

3.10 Where the standards WIND-S1, WIND-S2, or where applicable WIND-S3, are not complied with, results of wind tunnel tests of alternative building designs and/or modifications must be provided to show the proposed building is the best practical attempt to achieve these standards. Results for the alternative designs and/or modifications need only be for those areas, and for those wind directions, where problems have been identified. However, sufficient measurements must be taken to quantify all the changes with the alternative designs and/or modifications.

3.11 Where the standard WIND-S1, or where applicable WIND-S3, is not complied with because the existing wind conditions already do not comply, an analysis of the wind tunnel results must be provided to show that the existing wind conditions cannot be practically improved by changing the design of the proposed building. For example, the location of the proposed building could be too far away to influence the windy location or the wind is channeled along the street. and no modification of bulk or form could alter the wind flow.

4 Modelling and reporting requirements for CFD (Computational Fluid Dynamics) Studies

CFD studies must meet the following conditions:

4.1 CFD modelling must meet the requirements of section 2, except that 2.2 is replaced with the requirement to model wind flows and buildings at full-scale. Requirements written for wind tunnel testing (for example “measurements”) must be interpreted and applied to CFD modelling so that an equivalent quality and accuracy is achieved in the model output.

4.2 CFD modelling must resolve unsteady, three-dimensional wind flows through small spaces (i.e. less than 0.5 metres in dimension) at locations where wind speeds are affected by the proposed development. The density of the mesh/cells used in the CFD modelling may be optimised by increasing mesh/cell spacing further from the proposed development, but must remain sufficiently dense to accurately resolve turbulent wind flows affected by the proposed development.

4.3 A suitable turbulence model must be used that can accurately predict gust wind speeds with an averaging period of 3 seconds. The gust equivalent mean (GEM) speed, or other approximations based on the mean wind speed, must not be used to estimate the gust wind speeds in WIND-S1.

A CFD report must contain:

4.4 All information and reporting required in section 3. Requirements in section 3 that are written for wind tunnel testing must be interpreted and applied to the CFD modelling so that equivalent information is available for quality assurance checking and interpretation of the CFD output.

4.5 Documentation of the turbulence model and the rationale for its selection through reference to externally refereed papers or reports.

4.6 A validation section, which provides a comparison of the CFD predictions of high rise cases D, E or F in the Architectural Institute of Japan publication “Benchmarks for Validation of CFD Simulations Applied to Pedestrian Wind Environment around Buildings” (2016) and the corresponding benchmark data. The benchmark data is available at https://www.aij.or.jp/jpn/publish/cfdguide/index_e.htm . The difference between predicted and benchmark values must on average be less than 10%, with a maximum difference of 15% in parts of the wake of the taller buildings.

4.7 Plots or tables of convergence and stability parameters to demonstrate that the output of each simulation used in the study is stable and converged throughout the flow-field.

Appendix 8 Wind-A2: Reporting requirements for a Qualitative Wind Assessment

This Appendix describes the form and content of qualitative wind assessments, required by rules in the Wind Chapter.

1 Form of Qualitative Wind Assessment Report

A qualitative wind assessment report is not based on the results of a wind tunnel test. It is based on and so ultimately relies on a wind specialist’s expert knowledge of the interaction of buildings with the wind, and of any prior evidence of local wind speeds. It must contain the following:

1.1 A description of the existing wind conditions, including sources and limitations of information used in the assessment. Results from previous quantitative wind studies, in the vicinity of the development site, should be used when available.

1.2 A description of the interaction of the existing buildings with the wind that leads to the existing wind conditions.

1.3 A review of the design of the proposed development, and its appropriateness for a windy environment, including a description of how the scale and form of the proposed building relates to the prototypical building forms documented in the Wind Chapter Best Practice Guidance Document.

1.4 A description of the influence of the proposed development on pedestrian level wind speeds in public areas, and its compliance with standards WIND-S1, WIND-S2, and where required WIND-S3. This part of the assessment should, where possible, be quantified by comparison with the wind effects of the prototypical buildings documented in the Wind Chapter Best Practice Guidance Document.

1.5 A discussion of the building design and the effectiveness of wind mitigation measures is recommended when the proposed development will lead to a deterioration in the existing wind conditions., The wind assessment must be based as far as possible on the data in the wind design guide, and must provide a clear rationale that the proposed design is the best practical aerodynamic design to achieve compliance with standards WIND-S1, WIND-S2, and where required WIND-S3.

1.6 A statement at the conclusion of the report that assesses the proposed developments level of compliance in the professional opinion of the wind specialist, with standards WIND-S1, WIND-S2, and where required WIND-S3.