MARSHALL DAY Acoustics

MAHINERANGI WIND FARM
NOISE EFFECTS ASSESSMENT

Rp 001 20241209 | 23 September 2025

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Project: **MAHINERANGI WIND FARM Stage 2**

Prepared for: **Tararua Wind Power Limited**

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1.0 SUMMARY

Tararua Wind Power Limited (TWP) is proposing to advance Stage 2 of the Mahinerangi Wind Farm and has engaged Marshall Day Acoustics to assess the noise effects to support the lodgement of the required resource consents.

The Mahinerangi Wind Farm Site is approximately 1723 ha and is located approximately 5 km north of Lake Mahinerangi and about 50 km west of Dunedin. TWP holds a land use consent for the development of the Mahinerangi Wind Farm up to 200MW installed capacity and up to 100 wind turbines, with a maximum tip height of 145m.

Stage 1 of the wind farm was completed in 2011 and involved the commissioning of 12 Vestas V90 turbines with a tip height of 125m and an installed capacity of 36MW. Stage 1 turbines are located in the western corner of the Wind Farm Site and are connected to the local transmission network associated with the Deep Stream Hydro Scheme.

TWP now wishes to complete the wind farm (Stage 2) and seeks changes to the conditions of consent to enable it to use larger and more efficient wind turbines now available. Relevant to this assessment, it also seeks new land use consents for a transmission infrastructure to connect with the National Grid and Battery Energy Storage System (BESS).

Stage 2 will consist of 44 additional 4.3MW turbines which will have a maximum tip height of 165m providing an additional 190MW capacity. To retain some flexibility for the detailed design, TWP proposes to construct the 44 wind turbines amongst 54 potential locations within a Contingency Zone. The remaining 34 of the approved 100 wind turbine locations would be removed from the consent. This report reviews the original consent conditions, recommends updates to the conditions where appropriate, compares predicted operational noise from the proposed Stage 2 with the original design, and assesses the potential noise effects of these changes. This report also assessed the noise impact from the proposed new activities includes the BESS and the new transmission line.

Mahinerangi Wind Farm consent applications were advanced in 2006 on the basis that the turbines were to be selected at the detailed design stage. The resource consent applications considered two realistic options - a 100 x 2 MW turbine layout, or a 67 x 3MW turbine layout. The land use consent does not limit the activities in that manner. While 2MW turbines were realistic at the time of the Environment Court decision in 2008/09, given the advancement in wind technology since that time, it is no longer realistic to advance an 82 x 2MW (164MW being the balance of 200MW following the construction of Stage 1) turbine layout for assessment purposes as such small turbines are not readily available on the international market. Therefore, TPW have adopted a real-world configuration for assessment purposes as follows:

- **The Consented Layout**: Stage 1 turbines + 47 x 3.45MW turbines with a 145m tip height
- **The Proposed Stage 2**: Stage 1 turbines + 44 x 4.3MW turbines with a 165m tip height

This assessment confirms that all construction and operational noise will comply with the relevant noise limits set by the 2009 consent conditions and the proposed updated conditions referencing the current (2010) wind farm noise standard. Predicted noise levels for the combined Stage 1 and amended Stage 2 have either negligible or beneficial effects at all receivers compared to the Consented Layout. Five receivers are predicted to experience lower noise levels, while the remaining receivers show a difference of less than 0.1 dB. Noise levels at all nearby receivers are within the lower design limits of the consent conditions (35 or 40 dB L_{A90}), with most sites experiencing turbine noise levels more than 10 dB below ambient noise levels.

The proposed changes to the Stage 2 turbines are considered reasonable, as the noise impact remains unchanged for the surrounding community compared to the existing consent.

The report is also intended to fulfil, as far as available, the requirements of Consent Condition 37 by discussing the acoustic emissions for the selected wind turbine generators, noise predictions from

the wind farm being compliant with the relevant noise limits of Consent Conditions 35 and 36, and the results of any pre-installation testing in accordance with Consent Condition 38.

A glossary of terminology is included in Appendix A.

2.0 SCOPE OF THE REPORT

This report discusses the following issues:

- consent conditions and relevant noise limits, as well as recommended updates to the conditions
- Pre-installation existing noise environment
- Proposed Stage 2 turbine locations
- Construction noise effects
- Operational noise effects, specifically comparing the predicted sound pressure levels between the consented design and the proposed Stage 2 design.
- Noise assessment for newly proposed activities includes BESS and the new transmission line
- Consent condition 37 requirements

3.0 AUTHOR QUALIFICATION AND EXPERIENCE

This report has been prepared by Owen Li, who holds a Master of Engineering (Mechanical) degree from the University of Melbourne. Owen is an Affiliate Member of the Acoustical Society of New Zealand and has over five years of experience in acoustic consulting.

His professional background includes involvement in a wide range of infrastructure projects across New Zealand, including wind farms, geothermal power generation facilities, and major roading developments. His work encompasses environmental noise assessments, compliance monitoring, and the development of noise mitigation strategies for complex, large-scale projects.

4.0 CONSENT CONDITIONS

The Mahinerangi Wind Farm was consented in 2008/2009. The acoustic assessment at the time was undertaken by Hegley Acoustic Consultants and the Hegley reports are referenced throughout this assessment.

4.1 Construction Noise

Conditions 31, 32, and 33 of the consent relate to construction noise.

Condition 31 requires a Construction Noise Management Plan (CNMP) to be prepared prior to the commencement of and implemented throughout construction. A revised CNMP relating to the Stage 2 works is included in Appendix B.

Condition 32 requires construction noise to be measured and assessed in accordance with NZS 6803:1999 (Acoustic – Construction Noise), NZS 6801:1991 (Measurement of Sound), and NZS 6802:1991 (Assessment of Environmental Sound). It is recommended that reference to NZS 6801 and NZS 6802 be updated from the outdated versions referenced in the consent to the current standards, namely NZS 6801:2008 Acoustics – Measurement of Environmental Sound and NZS 6802:2008 Acoustics –Environmental Noise. The current standards are based on international best practice in the field of environmental noise measurements and assessment.

General construction noise should comply with the limits in Table 2 of NZS 6803 for “long term” duration. Although the limits specified in NZS 6803 Table 2 are not explicitly detailed in Condition 32, for ease of reference these limits are shown in Table 1 overleaf.

Table 1: Noise limits for construction works of "long term" duration adapted from the Table 2 of NZS 6803

Time of week	Time period	Long-term duration	
		dB L_{Aeq}	dB L_{AFmax}
Weekdays	0630 – 0730	55	75
	0730 – 1800	70	85
	1800 – 2000	65	80
	2000 – 0630	45	75
Saturdays	0730 – 1800	70	85
	1800 – 0630	45	75
Sundays and public holidays	0730 – 1800	55	85
	1800 – 0630	45	75

Condition 33 sets specific noise limits measured at or within the notional boundary for concrete manufacturing.

The noise limits are described as L_{max} and L_{10}. The L_{10} descriptor is and is not used anymore for the assessment of environmental noise. The L_{10} descriptor has been replaced with the L_{Aeq} descriptor that is also used in the construction noise limits referenced in Condition 32 above. The outcome for any receives would not change as the predictions show that compliance can be achieved with either descriptor.

It is recommended that the noise descriptor in Condition 33 be updated to L_{eq} to reflect current best practice and integrate seamlessly with the updated standards NZS 6801:2008 and NZS 6802:2008. This means that the condition would require the noise limits of Table 2 to be complied with (i.e. the numerical value remains unchanged, but the descriptor is changed from L_{10} to L_{eq}).

Table 2: Proposed updated noise limits for condition 33

Time period	Noise limit
7:00 am to 10:00 pm	55 dBA L_{eq}
10:00 pm to 7:00 am	45 dBA L_{eq}
10:00 pm to 7:00 am	75 dBA L_{max}

Condition 33 also requires that concrete shall not be manufactured outside of the hours of 6.30am to 8.00pm from Monday to Friday, and 7.30am to 6.00pm on Saturdays. This is further discussed in Section 7.0.

4.2 Operational Noise (Non-turbine)

Condition 34 states that noise from all other activities on the site (other than wind turbine generator operation and construction activities) shall not exceed the certain limits within the notional boundary of any dwelling (excluding any dwelling on the wind farm site).

As for Condition 33 above, the descriptors are set out in L_{10} and L_{max}. It is recommended that the L_{10} descriptor is changed to L_{eq} to reflect best practice and integrate with the latest standards as set out in Table 3.

Table 3: Proposed updated noise limits for condition 34

Time period	Noise limit
7:00 am to 10:00 pm	55 dBA L_{eq}
10:00 pm to 7:00 am	45 dBA L_{eq}
10:00 pm to 7:00 am	75 dBA L_{max}

The number and location of dwellings not associated with the wind farm site has changed, with the dwelling on the Thomas Block now a sensitive receiver positions while it previously was a participating dwelling.

Noise levels are required to be measured and assessed in accordance with NZS 6801:1991 and NZS 6802:1991. As discussed in Section 4.1 above, it is recommended that the references be updated in the conditions to refer to the currently applicable standards NZS 6801:2008 and NZS 6802:2008 as they reflect best practice.

4.3 Operational Noise (Turbines)

Conditions 35 and 36 relate to the operational noise of the wind turbines.

- Condition 35 states that at all locations except the ones listed in Condition 36, turbine noise at the notional boundary must not exceed the appropriate regression curve of the A-weighted ambient sound level (L_{95}) by more than 5 dBA, or 40 dBA L_{95}, whichever is greater.
- Condition 36 states that at Sites 5 and 6 (referenced in Figure 2 of the Hegley report[1]), turbine noise must not exceed the appropriate regression curve of the A-weighted ambient sound level (L_{95}) by more than 5 dBA, or 35 dBA L_{95}, whichever is greater.

It is recommended that descriptors of the above criteria are updated the from L_{95} to L_{90}. This change has no material effect on the outcomes achieved but aligns the criteria with those of the current standard NZS 6808:2010 Acoustics – Wind Farm Noise. The L_{95} descriptor is referenced in the outdated version of this standard from 1998.

This assessment also takes account of receiver locations that were previously not assessed as sensitive receivers, including the Thomas crib which previously was a participating dwelling. For all dwellings not previously assessed, the standard noise limits of conditions 36 has been applied.

4.4 Condition 37

Condition 37 outlines the requirements that must be fulfilled prior to installation of any wind turbine on site (in this case, any turbine of Stage 2 of the Project). The condition remains appropriate for Stage 2. The condition requires the following aspects to be reported to Council prior to wind turbine installation:

- 37(i): An acoustic emissions report to the Council for each of the selected wind turbine generators. The report shall be in accordance with *IEC6 l 400- l l, Wind Turbine Generator Systems Part 11, Acoustic noise measurement techniques*, and shall include the A-weighted sound power levels, spectra, and tonality at integer wind speeds from 6 to 10 m/s and up to 95% of rated power for each type and mode of individual wind turbine to be installed. We have included the relevant available information in this assessment report in Section 8.2. Then the final information

[1] Proposed Wind Farm at Mahinerangi – Assessment of Noise Effects (Report No. 7511), November 2006

is available, i.e. the final selection of the wind turbine type, an updated emissions report in accordance with condition 37(i) will be prepared.

- 37(ii): A noise prediction report from an independent and suitably qualified and experienced acoustical consultant that demonstrates that the sound levels from the wind farm will not exceed those levels set out in Conditions 35 and 36 above. Modes of operation and the type of turbine must be specified. For the avoidance of doubt, this resource consent does not authorise the use of a stall turbine design. We have included the currently available information in this report in Section 8.4. Then the final information is available, i.e. the final selection of the wind turbine type, the relevant assessment in accordance with condition 37(ii) will be updated.
- 37(iii): A report setting out the results of pre-installation testing in accordance with Condition 38. Upon receiving this report Council may consider the background sound levels at the qualifying dwellings at times when wind turbine generators would be operating and review whether these dwellings are appropriately protected by the provisions of Condition 36. Qualifying dwellings are those dwellings that are not already referred to in Condition 36, that are inside the predicted 35dBA contour, and from which written approval for the wind farm has not been obtained. We have included the relevant information in this report in Section 5.0.

We consider that the only additional separate report required will be relating to the chosen wind turbine type in accordance with conditions 37(i) and (ii). The remaining information required by condition 37 is included in this report.

4.5 Other noise conditions

Conditions 38 to 60 outline controls for pre-installation measurements, post-installation testing, assessment of special audible characteristics, non-compliance with noise conditions, noise management plans, contact and complaints procedures, and the review of noise conditions.

Condition 38 outlines the approach for measuring background sound levels prior to turbine installation. The Hegley report provided survey information undertaken at the time, and it is considered that the data collected prior to Stage 1 turbine installation remains applicable for Stage 2. In addition, background sound level survey in the vicinity of the dwelling on the Thomas Block has been undertaken (refer Section 5.3).

Conditions 39 to 60 relate to post installation testing and remain appropriate and to manage noise for Stage 2, provided that the reference to NZS 6808:1998 is updated to NZS 6808:2010 (discussed below).

The consent requires compliance with wind farm noise standard NZS 6808:1998. This standard has since been superseded by a new version in 2010. The versions do not significantly differ from one another and retain the main characteristic of assessing wind turbine noise dependent on ambient noise levels at different wind speeds. Therefore, this report has updated the descriptor to L_{90}, as referenced in the 2010 version of the standard, instead of the L_{95} descriptor from 1998. This change makes no material difference to the noise predictions.

This assessment has employed the current best practice in predicting wind farm noise (refer Section 8.3). These conditions are not discussed further in this report but are provided in Appendix B.

5.0 EXISTING ENVIRONMENT AND PRE-INSTALLATION AMBIENT SOUND MONITORING

5.1 Existing Environment

The existing noise environment in 2025 includes contributions from the operational Stage 1 turbines for some receivers, while others remain generally unaffected by noise from Stage 1 turbines.

The environment has not materially changed from 2006 to now, with ambient noise levels generally controlled by natural sounds such as water, wind in vegetation and some manmade noise such as traffic on local roads (albeit intermittently).

The 2006 assessment undertaken by Hegley referred to six receivers not associated with the wind farm (refer Figure 1). The 2025 assessment has assessed 13 receivers not associated with the wind farm and has predicted noise levels for all these locations (refer to the red receivers in Appendix E).

5.2 2006 measurements

The Hegley report[1] sets out that the existing noise environment was measured at six sites in 2006, before the commencement of Stage 1. Sites 1 to 4 were measured from 11 to 21 January 2006, while Sites 5 and 6 were measured from 1 to 9 June 2006. Monitoring locations from 2006 are shown in Figure 1. Noting that the environment has not materially changed from 2006 to now it is considered that these surveys remain valid to determine the ambient noise environment.

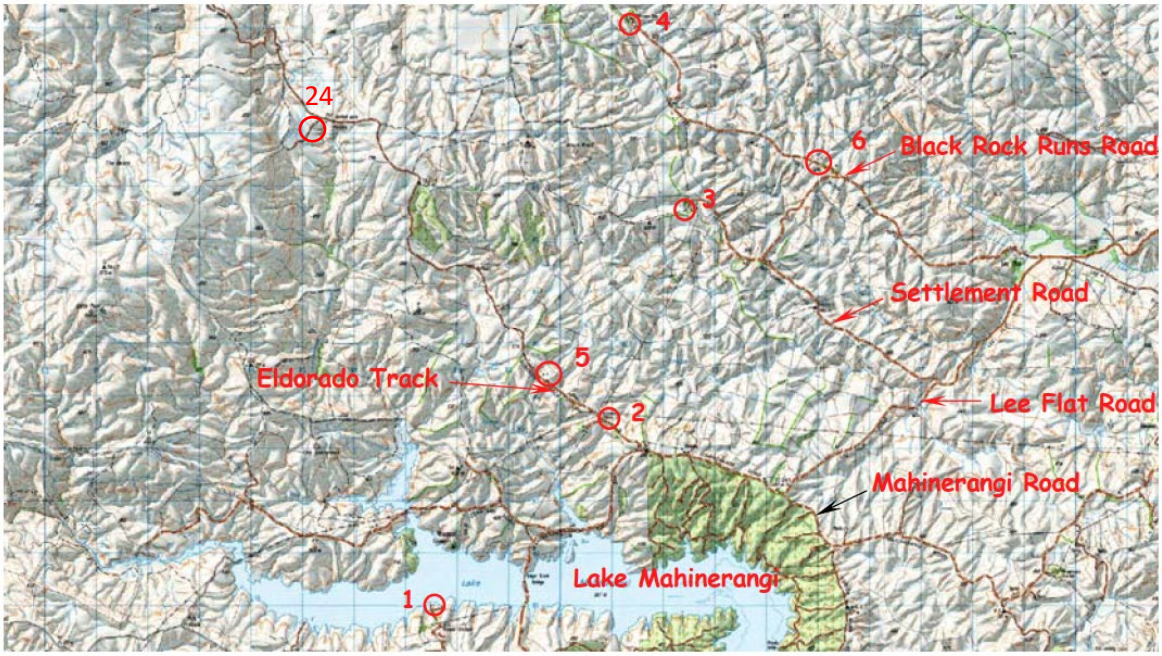
Regression analysis of the ambient noise and predicted turbine levels at each site, as undertaken by Hegley, are presented in Appendix D. The analysis found a positive correlation between wind speed and noise levels at Sites 1 to 4. This trend was less evident at Sites 5 and 6, potentially due to seasonal variations and a smaller sample size.

The regression curve has been interpreted and extracted the ambient noise level at each measured site. These are summarised in Table 4.

Table 4: Pre-installation ambient noise level ranges from the regression analysis

	Background noise level range dB L_{A95} (with wind farm wind speed between 2 m/s to 10 m/s)
Site 1	36 – 44
Site 2	44 – 58
Site 3	34 – 44
Site 4	38 – 44
Site 5	32 – 36
Site 6	32 – 38

Figure 1: Monitoring locations (Captured from Figure 2 of the Hegley report[1] and including 2025 position 24)



5.3 2025 ambient sound monitoring at Site 24

The predicted noise levels for Stage 2 including Stage 1 turbines at all nearby receivers were equal to or below 35 dB L_{Aeq}, except at Site 24. Site 24 is located to the south-west of the wind farm on land known as the "Thomas Block". Formally a participating landowner during the consenting process, the existing consent currently provides for four wind turbine locations in this area. The Stage 2 layout removes the Thomas Block (and the potential turbine locations) from the wind farm site, meaning the landowner is no longer a participating landowner. No ambient noise level survey had been undertaken by Hegley at this site as it was a participating landowner.

Therefore, in accordance with Condition 38, we have undertaken ambient noise level measurements at this site. The reported data in this section of the report fulfils the requirements of conditions 37(iii) and 38.

To assess the compliance and potential impact of the proposed Stage 2 turbine noise, an ambient noise measurement near Site 24 was conducted from 28 March 2025 to 7 May 2025. Due to site access constraints, the measurement was carried out approximately 120 m northwest of Site 24 further away from the existing Stage 1 wind turbine locations. This location remains within a suitable range for effective monitoring.

The noise monitoring was conducted in accordance with New Zealand Standard NZS 6801:2008 Acoustics – Measurement of environmental sound. This is the current noise monitoring standard and has superseded the 1991 version referenced in the conditions. In addition, NZS 6801:2008 is referenced by NZS 6808:2010, which is the relevant current standard and should be updated in the conditions (refer to the discussions in Section 3.0).

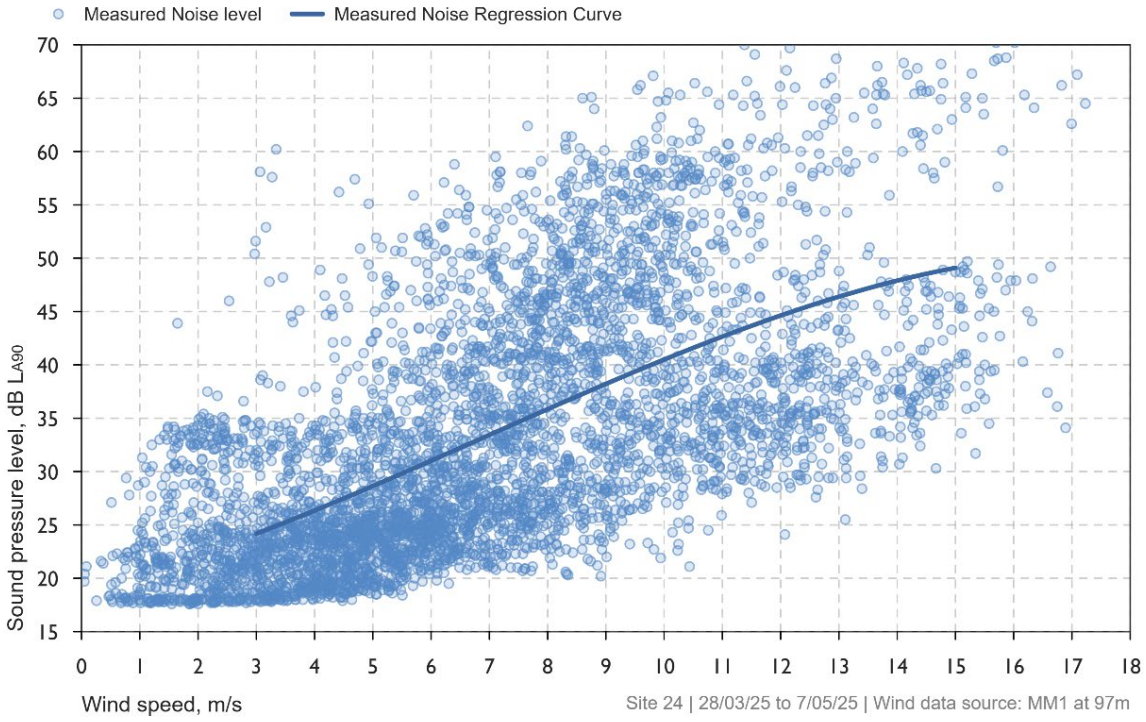
Noise levels were measured at 10-minute intervals continuously throughout the monitoring period. Corresponding 10-minute rainfall data was obtained from the NIWA weather station at Middlemarch (the closest weather station from which data was available), and any samples recorded during rainfall were excluded from the analysis.

A total of 5,844 valid data points were collected, excluding periods affected by rain, and invalid measurements.

The wind speed and direction at 97 m — the likely hub height of the proposed Stage 2 turbines — were based on measurements taken at the meteorological mast located within the wind farm site and provide by TWP.

As required by NZS 6808:2008, a regression analysis of the measured noise levels against wind speed at hub height is shown as the blue line in Figure 2. The regression curve is used to determine the appropriate noise limits for the assessment location, depending on wind speed, in accordance with NZS 6808:2010. This is further described in Section 8.4.2.

Figure 2: Ambient noise measurement and regression analysis near Site 24



6.0 CONSENTED VS PROPOSED STAGE 2 LAYOUT AND DESIGN

6.1 Consented design

Resource consents for the construction and operation of the Mahinerangi Wind Farm were granted in 2009, authorising the development of up to 100 turbines with a maximum generation capacity of 200 MW.

Stage 1 of the Mahinerangi Wind Farm was commissioned in 2011 and established 12 turbines, each with a capacity of 3 MW. This leaves 164 MW of capacity still available for development—equivalent to a maximum of 82 turbines at 2 MW each. For the reasons explained earlier, a realistic consented layout is 47 turbines at 3.45 MW each.

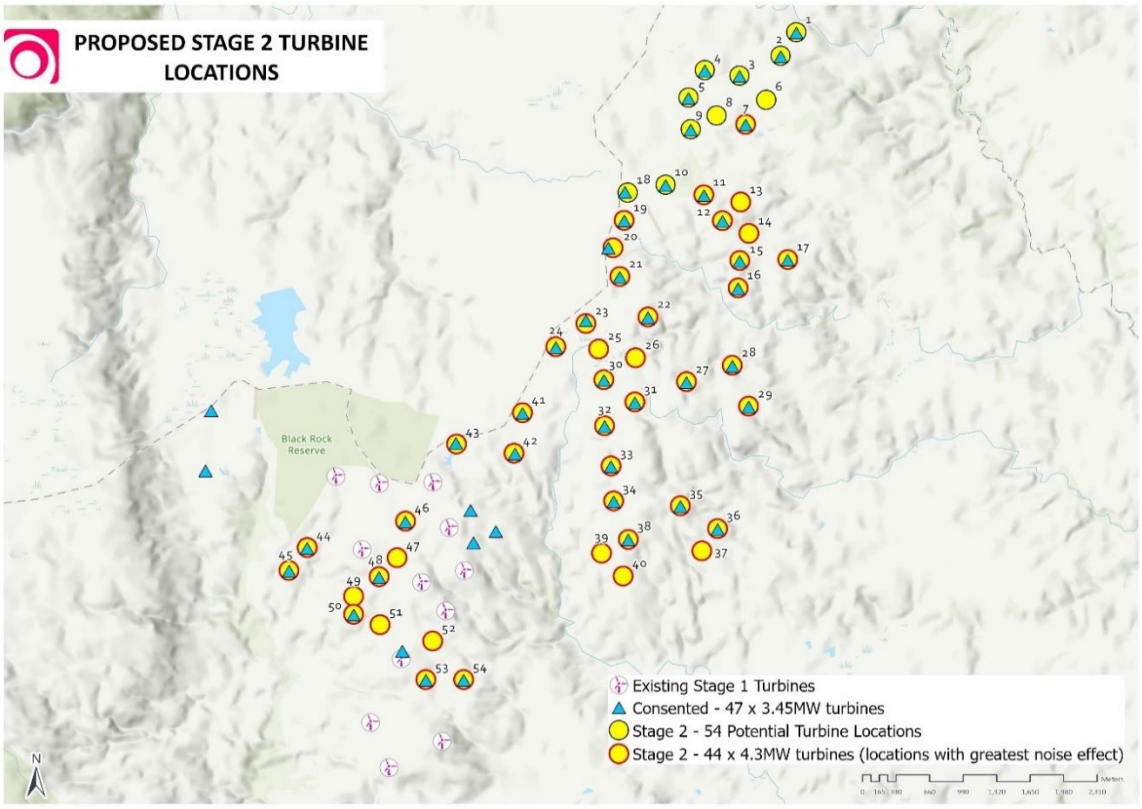
As a result, the noise effects comparison has been made between the 47 x 3.45 MW turbine configuration (within the consented locations and tip height) and the proposed new Stage 2 design and location. The locations for the consented 47 x 3.45 MW turbines are shown in Figure 3.

6.2 Proposed Stage 2 Design

To facilitate the use of larger and more efficient turbines, there are some turbine layout changes proposed from the consented turbine layout. As depicted in Figure 3, many of the Stage 2 turbine locations remain in the same location as those consented, although some of the Contingency Zones have been reinstated to a full 100m radius circle.

There are 54 potential locations identified for the new Stage 2 turbines. For the purposes of modelling a worst-case scenario, the locations with the greatest potential noise impact were selected. The turbine locations are shown in Figure 3.

Figure 3: Turbine locations for Stage 2



7.0 CONSTRUCTION NOISE

As discussed in Section 4.1, Conditions 31 and 32 require that a CNMP be prepared and implemented, and that construction noise and decommissioning works be in accordance with NZS 6803:1999.

A CNMP is provided as a separate report appended to the Construction Management Plan. We have prepared a CNMP which is included in Appendix E.

Noise limits for all construction activities except concrete manufacture are set out in Condition 32. All construction activities, including the new transmission line route, are at least 900 m from the nearest non-participating dwellings. The loudest activity associated with construction of Stage 2 of the wind farm (concrete cutting) is predicted to reach only 43 dBA at the closest receiver, well within the daytime limits and still compliant with the night-time noise limit of 45 dB L_{Aeq}.

Condition 33 controls concrete batching. It sets noise limits and requires that noise levels be measured and assessed in accordance with NZS 6801:1991. As discussed in Section 4.1, it is recommended that the standard reference be updated to the current version of this standard NZS 6801:2008 to reflect best practice. The outcome will not be materially different.

Condition 33 currently limits concrete batching to daytime only (6.30am to 8pm Monday to Friday and 7.30am to 6pm Saturday). Concrete batching is proposed to be undertaken without time restrictions, i.e. are enabled 24 hours a day Monday to Sunday, to enable concrete pours (controlled by Condition 32) can be undertaken at any time.

This means that an amendment to the conditions will be required. In order to understand the effects of concrete batching and concrete pouring activities, the noise levels from these activities at the closest dwellings have been assessed.

The concrete batching plant is located at least 2000 m from the nearest receiver, with predicted noise levels of up to 27 dB L_{Aeq}, readily complying with both day and night-time limits in Condition 33. While a noise level of 27 dB L_{Aeq} may be audible at times, this noise level is not likely to cause adverse acoustic effects on closest dwellings. The noise source is broad band, not containing any tones or other special audible characteristics that could lead to annoyance. In addition, an external noise level of 27 dBA would result in an internal noise level of less than 15 dBA even with windows open for ventilation. These levels are below the most stringent noise criteria recommended by the World Health Organisation and are not considered to cause adverse effects. This means that the construction and decommissioning works and concrete batching associated with Stage 2 will be able to readily comply with the noise limits in Conditions 31-33, but that the conditions should be updated to reference the most current standards (NZS 6801:2008 and NZS 6802:2008). In this regard, the removal of the time restrictions on concrete batching is appropriate.

Overall, the conditions, with minor amendments discussed above, remain relevant and appropriate to manage construction and decommissioning works, and concrete batching associated with Stage 2 of Mahinerangi Wind Farm.

8.0 TURBINE OPERATIONAL NOISE

8.1 Noise prediction model

The software package SoundPLAN (v9.1) was used to model the Mahinerangi Wind Farm noise in accordance the NZS 6808. The prediction method uses ISO 9613-2:1996 "*Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*" (**ISO 9613-2**) for calculating wind farm sound for light downwind propagation in all directions simultaneously. Noise levels for the following scenarios were modelled:

- The consented design: Existing 12 x 3 MW Turbines (125 m Tip height) + 47 x 3.45 MW Turbines (145 m Tip height)
- The proposed Stage 2: Existing 12 x 3 MW Turbines (125 m Tip height) + 44 x 4.3 MW Turbines[2] (165 m Tip height)

8.2 Turbines Sound Power Levels

The Vestas V90-3MW turbines were selected for the original design, and 12 were installed during Stage 1.

For the purpose of assessing the potential noise effects of Stage 2 noise data from the Vestas V136 turbines have been used. We used the data for this wind turbine to compare the effect of the change in design is as follows:

- A turbine with a 136 m rotor diameter, 3.45 MW generation capacity and a tip height of 145 m to provide a realistic consented layout
- A turbine with a 136 m rotor diameter, 4.3 MW generation capacity and increased tip height of 165 m to provide for proposed Stage 2 layout

For both scenarios, the existing Stage 1 turbines have been included in the assessment.

For each turbine, noise levels increase with wind speed but plateau at around 10 m/s as shown in Appendix E. The data in Appendix E is intended to fulfil the requirements of condition 37(i).

[2] At the locations with greatest noise effect

To assess the worst-case scenario, turbines were modelled at their maximum noise output, i.e. any other mode would result in lower noise levels. The modelled sound power levels for each turbine type are summarised in Table 4.

The same V136 sound power level for all 136 m rotor diameter turbines has been assumed, regardless of whether their rated power output is 3.45 MW or 4.3 MW. This assumption is based on the fact that both versions share the same rotor diameter (136 metres), and their noise levels plateau at wind speeds above 10 m/s. However, because turbines with different power outputs are designed with different hub heights, this has been accounted for in the modelling.

Table 5: Sound power level for each turbine

	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	Sum dB(A)
V90 (L_w dBA)[1]	96.3	98.2	101.6	102.6	103.9	100.1	97.3	109.2
V136 (L_w dBA)[1]	86.2	95.4	101.4	104.1	103.6	99.8	92.9	108.9

[1] Noise levels for each frequency band have been increased by 2 dB to allow for a warranty allowance.

8.3 Modelling conservatism

The following points highlight the conservatism in the predicted sound levels in accordance with current best practice:

- The predicted L_{Aeq} wind farm sound levels have been taken as the predicted L_{A90} wind farm sound levels. This results in approximately 2 dB of conservatism in predicted wind farm sound levels.
- Topographic screening effects of the terrain have been limited to a reduction of no more than 2dB in accordance with Section 4.3.11 of the IOA Good Practice Guideline.
- A 2 dB safety factor has been applied to the proposed Stage 2 turbines to allow for a warranty allowance.

These conservatisms add up to a level that will ensure that wind turbine noise levels will be lower than predicted.

8.4 Operational noise prediction and comparison

8.4.1 All sites

The proposed Stage 2 turbines are larger than the Stage 1 turbines (Vestas V90). Despite their increased size, the noise levels of the proposed turbines remain comparable to those of the existing ones. This similarity is demonstrated in the noise contour predictions presented in Appendix F.

Twenty-four noise-sensitive receivers are located near the Mahinerangi Wind Farm, as detailed in Appendix F. Of these, eleven are now participating properties, and therefore their noise levels have not been assessed. The predicted noise levels at the remaining thirteen non-participating receivers are summarised in Table 6 overleaf. For the labelling of the assessment sites for the current and original resource consent assessment, refer to Appendix F and Figure 1 respectively. This data is intended to fulfil the requirements of Condition 37(ii).

The modelling shows that the cumulative noise from the proposed Stage 2 turbines and the existing Stage 1 turbines will comply with the lower design noise limits of 35 or 40 dBA L_{90}, as required by Conditions 35 and 36.

Table 6: Predicted highest noise level comparison between the 2009 consented design and proposed Stage 2

Assessment sites	Site name in 2009 consent	Measured Pre-installation ambient noise (at 10 m/s wind speed at wind farm)	The lower design limit in Conditions 35 and 36	Predicted highest noise level	
				Consented design	Cumulative Stage 1 and Stage 2
		dB L_{A90}	dB L_{A90}	dB L_{A90}	dB L_{A90}
1	Site 7	N/A	40	25	24
2		N/A	40	24	23
3		N/A	40	17	15
9	Site 6	38	35	29	29
11		N/A	40	32	32
12		N/A	40	31	31
13		N/A	40	26	26
14		N/A	40	30	30
17		N/A	40	35	35
19		N/A	40	29	29
22		N/A	40	27	27
23	Site 1	44	40	28	28
24	Site 8	40*	40	57	38

* The noise level was derived by removing the predicted Stage 1 turbine noise from the 2025 ambient noise measurements. Ambient noise levels with the Stage 1 turbines are higher.

At all assessed locations, the predicted noise impact from the proposed Stage 2 turbines—compared to the consented design—is either negligible or beneficial. Five receivers are predicted to experience lower noise levels, while the remaining receivers show a difference of up to 0.1 dB.[3]

Predicted noise levels remain at or below 35 dB L_{A90} at all nearby receivers, except at Site 24 (which is discussed below). According to NZS 6808:2010, if a wind farm is predicted to generate sound levels of 35 dB L_{A90} or less at a noise-sensitive location, it should be assumed that the wind farm will comply with the noise limit.

Appendix F includes the L_{A90} noise contour predictions of the Mahinerangi Wind Farm for the wind speed (10 m/s) at which the highest noise levels are emitted from the selected turbines.

8.4.2 Site 24

The owner of Site 24 was originally a participant in the wind farm development; however, they are no longer participating which means that the site has been included in this assessment.

The consented wind farm layout included four turbines located at proximity to the existing crib on Site 24. The closest turbine is approximately 20m from the crib. Stage 2 no longer includes these

[3] While the result for position 14 suggests a 1 dB noise level increase, this is a function of rounding to the full number. The noise level change is 0.1 dB.

turbines. As a result, the predicted noise level at Site 24 under the proposed Stage 2 layout is nearly 20 dB lower than under the consented layout.

The predicted cumulative turbine noise level at Site 24 for Stage 2 (including Stage 1) is 38 dB L_{A90}. To assess compliance with the noise limit and evaluate potential noise effects, ambient noise measurements were undertaken near Site 24 between 28 March 2025 and 7 May 2025.

During the monitoring period, the Stage 1 turbines were operational. The Stage 1 noise contribution based on the predicted turbine noise level at the measurement location, was removed from the data. The adjusted regression curve — representing the background noise without Stage 1 turbine influence — is shown as the purple line in Figure 4.

The noise limit was developed based on this adjusted regression curve. This approach is considered conservative as it assumes downwind conditions from the wind farm to the receiver; this condition rarely occurs at Site 24 as the wind rose from the meteorological mast on the wind farm site shows in Figure 5. As a result, the ambient baseline is lower, leading to a more stringent noise limit, than would occur regularly at the site.

The predicted turbine noise level at Site 24, including both Stage 1 and proposed Stage 2 turbines, is below the derived noise limit, as shown by the green line in Figure 4.

The predicted Stage 2 noise alone is well below the noise limit and is 3–5 dB lower than the existing noise environment.

Figure 4: Regression analysis at Site 24

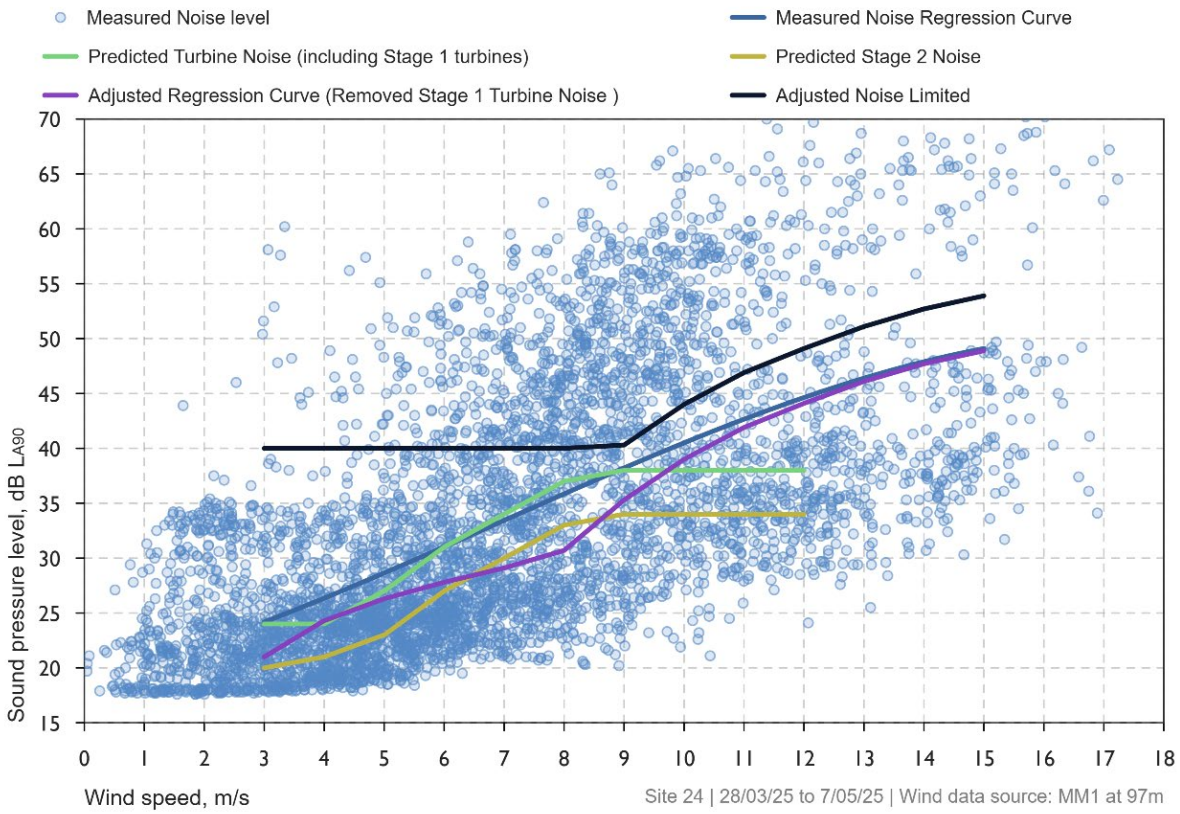
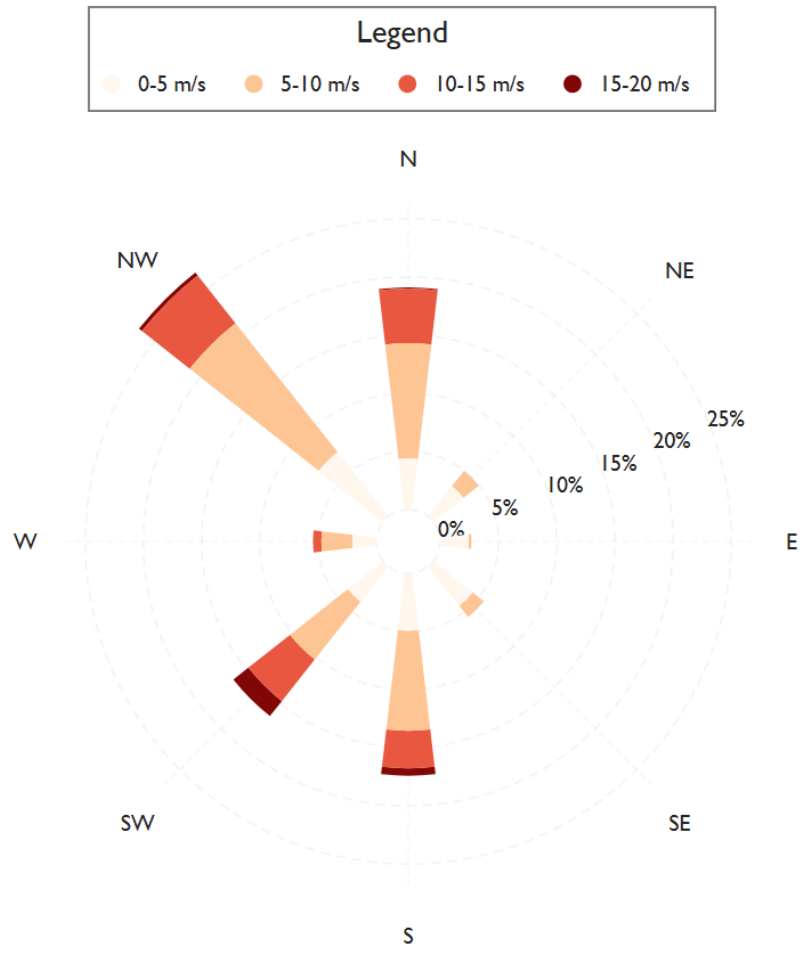


Figure 5: Wind rose at wind farm meteorological mast (28/03/2025 to 07/05/2025)



During the measurement period, only 5% of recorded wind directions corresponded to downwind conditions from the wind farm to Site 24. These conditions—defined as wind directions between 45° and 180° (primarily southeasterly)—are consistent with historic wind rose data recorded in the Dunedin region[4].

Downwind conditions are critical at Site 24, as they have the potential to amplify turbine noise and make it more noticeable when local ambient noise levels are low. A separate regression analysis for downwind conditions during both day and night periods was conducted and is presented in Appendix G. The results confirm that ambient noise increases with wind speed at the wind farm, and similar conclusions can be drawn compared to the overall regression analysis.

Under downwind conditions, both the total predicted turbine noise level and the Stage 2 only turbine noise remain well below the applicable noise limit of 40 d L_{A90}.

8.5 Battery Energy Storage System Noise

As set out in Section 4.2, Condition 34 requires operational noise from non-turbine activities to comply with the noise limits set out. Noise levels should be measured and assessed in accordance with NZS 6802:1991 and NZS 6802:1991. As discussed in Section 4.2, it is recommended that the standard references be updated to the current 2008 versions to reflect best practice. There will be no material change in outcome.

[4] Source: E. Brenstrum, The New Zealand weather book. Nelson: Craig Potton, 1998, p. 98. https://teara.govt.nz/en/interactive/47384/wind-roses

A new BESS is proposed as part of the new transmission line associated with Stage 2 of the wind farm. The system will consist of 32 battery containers, each mounted on concrete foundation pads. The primary noise source from each container is expected to be the cooling fans, which are typically installed on top of the units.

While the specific BESS has not yet been selected, a sound power level of 95 dBA (L_w) per container has been assumed for assessment purposes. Modelling indicates that the predicted noise contribution from the BESS at all nearby receivers is negligible and will comply with the noise limit set in Condition 34.

The BESS associated with the transmission line will operate in accordance Condition 34. This condition remains relevant and appropriate to manage operational noise from non-turbine activities associated with Stage 2 of Mahinerangi Wind Farm.

8.6 Transmission Line Operation Noise

The operation of the transmission line typically does not generate noise. However, under high wind conditions, the glass insulators on the towers can potentially produce a tonal sound, which may cause annoyance to nearby receivers. To minimise this risk, the use of composite insulators on the transmission towers is recommended, as they are less likely to generate tonal noise.

APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
dB	Decibel The unit of sound level.
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
L_{A10}	The A-weighted sound level exceeded for 10% of the measurement period, measured in dB. Commonly referred to as the average maximum noise level. Can also be expressed as dBA L_{10}.
$L_{Aeq(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. Can also be expressed as dBA L_{eq}.
$L_{A95(t)}$	The A-weighted noise level equalled or exceeded for 95% of the measurement period. This used to be commonly referred to as the background sound level. Can also be expressed as dBA L_{95}.
$L_{A90(t)}$	The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is more recently referred to as the background sound level. Can also be expressed as dBA L_{90}.
(t)	The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
NZS 6801:1991	New Zealand Standard 6801:1991 "*Measurement of Sound*"
NZS 6801:2008	New Zealand Standard 6801:2008 "*Acoustics – Measurement of Environmental Sound"*
NZS 6802:1991	New Zealand Standard 6802:1991 "*Assessment of Environmental Sound*"
NZS 6802:2008	New Zealand Standard 6802:2008 "*Acoustics –Environmental Noise"*
NZS 6803:1999	New Zealand Standard 6803:1999 "*Acoustics – Construction Noise*"
NZS 6808:1998	New Zealand Standard 6808:1998 *"Acoustics – The assessment and measurement of sound from wind turbine generators"*
NZS 6808:2010	New Zealand Standard 6808:2010 *"Acoustics – Wind farm noise"*
IOA GPG	Institute of Acoustic – Good Practice Guide
SWL or L_W	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.

APPENDIX B CONSTRUCTION NOISE MANAGEMENT PLAN

APPENDIX C RESOURCE CONSENT CONDTION 37 – 60

37. Prior to installation of any wind turbine generator the consent holder shall submit the following to the Planning and Environment Manager, Clutha District Council:

i) An acoustic emissions report to the Council for each of the selected wind turbine generators. The report shall be in accordance with IEC61 400-11, *Wind Turbine Generator Systems Part 11, Acoustic noise measurement techniques,* and shall include the A-weighted sound power levels, spectra, and tonality at integer wind speeds from 6 to 10 m/s and up to 95% of rated power for each type and mode of individual wind turbine to be installed.

ii) A noise prediction report from an independent and suitably qualified and experienced acoustical consultant that demonstrates that the sound levels from the wind farm will not exceed those levels set out in Conditions 35 and 36 above. Modes of operation and the type of turbine must be specified. For the avoidance of doubt, this resource consent does not authorise the use of a stall turbine design.

iii) A report setting out the results of pre-installation testing in accordance with Condition 38. Upon receiving this report Council may consider the background sound levels at the qualifying dwellings at times when wind turbine generators would be operating and review whether these dwellings are appropriately protected by the provisions of Condition 36. Qualifying dwellings are those dwellings that are not already referred to in Condition 36, that are inside the predicted 35dBA contour, and from which written approval for the wind farm has not been obtained.

PRE-INSTALLATION MEASUREMENTS

38. Background sound levels shall be measured and assessed using NZS6808:~~1998~~2010 *Acoustics - The Assessment and Measurement of Sound from Wind Turbine Generators* within the notional boundary of any dwelling, except for lots where written approval has been obtained, but with the following requirements to be met. Where these differ from NZS6808:~~1998~~2010, the

following requirements shall prevail:

i) Representative measurement locations shall be selected for all dwellings within the predicted 35dBA L_{95} noise contour.

ii) The requirements for background sound level measurements under this condition shall not apply to any property where:
- written approval has been obtained; or
- where access for measurement purposes has been refused by the property owner or tenant, and monitoring cannot take place at a nearby representative location.

iii) Sufficient data must be collected to assess the background sound levels in accordance with NZS6808: ~~1998~~2010 but also specifically at the following times:
- when operational wind speeds of the wind turbines are fairly representative of the cut- in wind speed and the rated power wind speed at the wind farm and at wind speeds in between; and
- between 10pm and 5am, to allow a separate analysis to be undertaken during this time period.

Sufficient data is when regression curves are representative of the range of wind speeds and wind directions generally expected at the wind farm site.

iv) Care will be taken to eliminate periods of contamination of the noise data by other noise sources, i.e. seasonal cicadas, crickets, frogs, rainfall periods, etc.

POST-INSTALLATION TESTING

39. Post-installation compliance testing shall commence as soon as practicable once turbines are installed and *commissioned*. If possible the testing shall be carried out at the same locations as the background sound monitoring or, if that position is not available, then at a nearby location where the background sound monitoring is still representative.

40. The same *requirements* as in Condition 38 for the background noise monitoring shall also be measured for the post-installation compliance testing. The cut-in operation times of the wind turbine generators shall also be recorded and this shall be indicated on the results.

41. The best fit *regression* curves shall be provided in accordance with Condition 38.

42. The appropriate regression curve of the L95, 10 min of the wind turbine generator sound levels corrected for any special audible characteristics is not to exceed the noise limits specified in Conditions 35 and 36.

43. As compliance testing takes place at each site, the consent holder shall make available the raw results of noise and wind monitoring to the Planning and Environment Manager, Clutha District Council, in a form that will allow the Council to undertake its own analysis and assessment of the results should it choose to do so.

44. The consent holder shall provide reports to the Planning and Environment Manager, Clutha District Council, as soon as possible following testing at each location but no longer than 21 days after the completion of each test.

45. In the event that substantiated complaints are received in circumstances not

specifically provided for in these conditions, Clutha District Council may reasonably direct testing to take place at any location, and nothing in these conditions shall prevent compliance monitoring of wind farm noise from being undertaken at any wind speed and direction, or time of day.

46. If Clutha District Council wishes to undertake separate compliance testing of part, or of all of the wind farm operation then the consent holder shall share with Clutha District Council any wind data to allow noise monitoring to be analysed in accordance with the requirements of these conditions.

47. Thereafter, compliance testing shall be carried out following any reasonable request by Clutha District Council. This may be as a result of what the council considers to be substantiated complaints regarding increased levels of noise from the wind farm, or any change in the character of the noise emanating from the wind turbine generators.

48. Sound monitoring shall conform to the following measurement standards:

i) The complete measurement and analysis system shall conform to the requirements of NZS6808:~~1998~~2010 *Acoustics - The Assessment and Measurement of Sound from Wind Turbine Generators* and the Standards referred to by NZS6808.

ii) Microphones shall be fitted with a wind shield such that the noise generated by wind on the wind shield is, to the extent practicable, at least 10dBA below the noise being measured.

iii) All sound monitoring shall be carried out by independent and suitably qualified and experienced persons.

49. The operator of the wind turbines shall pay all costs associated with compliance testing.

ASSESSMENT OF SPECIAL AUDIBLE CHARACTERISTIC

50. When wind farm sound within the notional boundary of a dwelling has a special audible characteristic, i.e. impulsiveness, tonality and/or an audible modulation, the measured sound level of the source shall have a 5dB penalty applied by adjustment of the measured sound level by the arithmetic addition of the penalty. If the Joint Nordic Method Version 2 is used to assess tonality then the penalty shall be as described in that Standard. If more than one penalty is relevant to any measured sound level then only the penalty with the greatest numerical value shall be applied.

51. Sound with a special audible characteristic includes clearly audible tones. A test for the presence of tonality shall be made by comparing the levels of neighbouring one-third octave bands in the sound spectrum. An adjustment of +5dB for tonality shall be applied if the level (Leq) in any one third octave band exceeds the arithmetic mean of the Leq levels in the two adjacent bands by more than the values given in Table 1.

Table 1- One-third Octave Band Level Differences

One-third octave band	Level difference
25 - 125Hz	12dB
160 - 400Hz	8dB
500 - 10,000Hz	5dB

52. There might be cases where this analysis does not result in a tonal component being defined although the sound is in fact tonal. For these cases it will be necessary to undertake a narrow band analysis in order to determine if a sound is tonal using Joint Nordic Method Version 2 with the penalties in that document applied.

53. A test for modulation is if the measured peak to trough levels exceed 5dBA on a regularly varying basis or if the spectral characteristics, third octave band levels, exhibit a peak to trough variation that exceeds 6dB on a regular basis in respect of the blade pass frequency.

NON-COMPLIANCE WITH NOISE CONDITIONS

54. Where compliance is not achieved with these Noise Conditions then the consent holder shall operate the wind turbine generators at reduced noise output until remedies are identified and implemented. If sound emissions cannot be reduced such that they comply, then the consent holder shall cease to operate the non-compliant wind turbine generators until modifications are made to reduce the noise. Further operation of the non-compliant wind turbine generators shall only be for sound measurement checks as specifically agreed with Planning and Environment Manager, Clutha District Council, to demonstrate compliance. This condition shall not limit or restrict any statutory right or power to take enforcement action that Clutha District Council may have under the provisions of the Resource Management Act 1991.

NOISE MANAGEMENT PLAN

55. Prior to the commencing operation of either Stage 1 or 2 of the wind farm the consent holder shall prepare and implement a Noise Management Plan to manage the potential effects of noise. The Noise Management Plan shall be prepared by an independent person suitably qualified and experienced in noise assessment and control. That person shall act in liaison with the consent holder.

56. The Noise Management Plans shall include, but not be limited to, the following:

    i) An assessment of the contribution to the overall sound levels from individual wind turbine generators.

    ii) An assessment of how individual wind turbine generators can be made to comply with Conditions 35 and 36.

57. The information collected as part of the implementation of the Noise Management Plans shall be provided to the Planning and Environment Manager, Clutha District Council.

CONTACT AND COMPLAINTS PROCEDURE

58. The consent holder shall establish and publicise a local telephone number or internet site so that members of the local community have a specified and known point of contact should they ~~to raise~~ have any noise related issues that may arise during construction and operation of the wind farm. A log book of all calls made shall be kept, and details of all calls received and any action taken shall be made available to the Planning and Environment Manager, Clutha District Council, within five working days. Any issues arising shall be reviewed and addressed by revising the Noise Management Plan where appropriate.

59. The consent holder shall nominate an appropriately experienced staff member to be responsible for the following:

i) Liaison with residents.

ii) Overseeing the assessment procedure.

iii) Receiving and dealing with complaints.

REVIEW OF NOISE CONDITIONS

60. Notwithstanding the provisions in Condition 8, Clutha District Council may review the noise conditions set out above, by giving notice of its intention to do so under s.128 of the Resource Management Act 1991, one, three and five years after the wind farm completion or, if the wind turbine generators are installed in stages, then one year after the completion of each stage and then three and five years after the final completion, for the following purposes:

i) To deal with any adverse effects on the environment resulting from wind farm sound, including sound with any special audible characteristics, which may arise from the operation of the wind turbines.

ii) To review the adequacy of any recommendations of the Noise Management Plan.

iii) To address any issues arising out of complaints.

iv) Such reviews may take place within six months of the specified dates.

APPENDIX D PRE-INSTALLATION AMBIENT NOISE

The following charts were taken from the Hegley report, the figures number associated with the chart are from the original report.

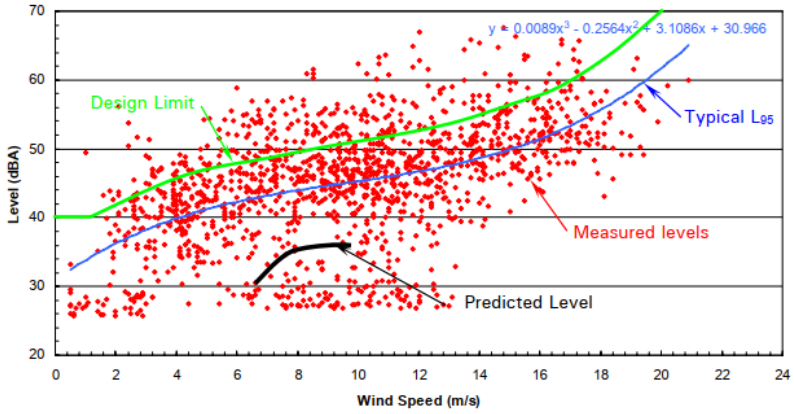


Figure 10. Wind Farm Design Limits at Site 1

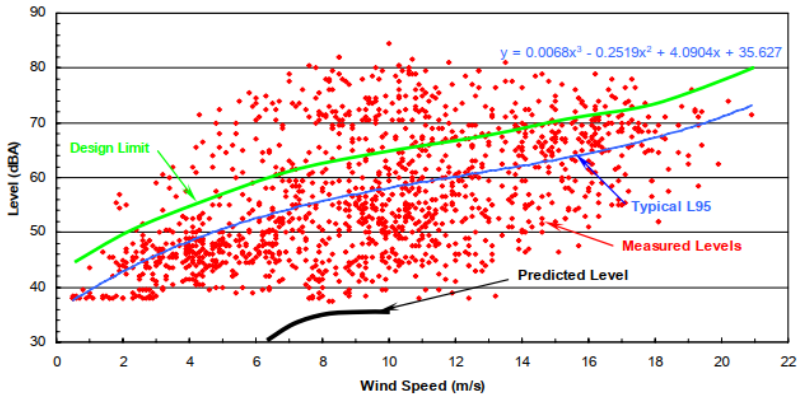


Figure 11. Wind Farm Design Limits at Site 2

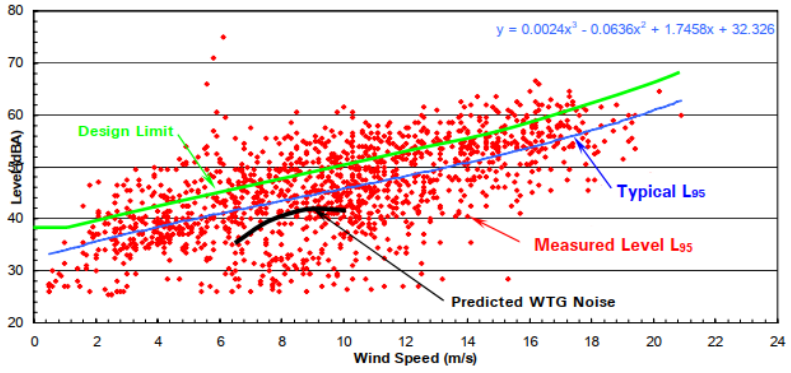


Figure12. Wind Farm Design Limits at Site 3

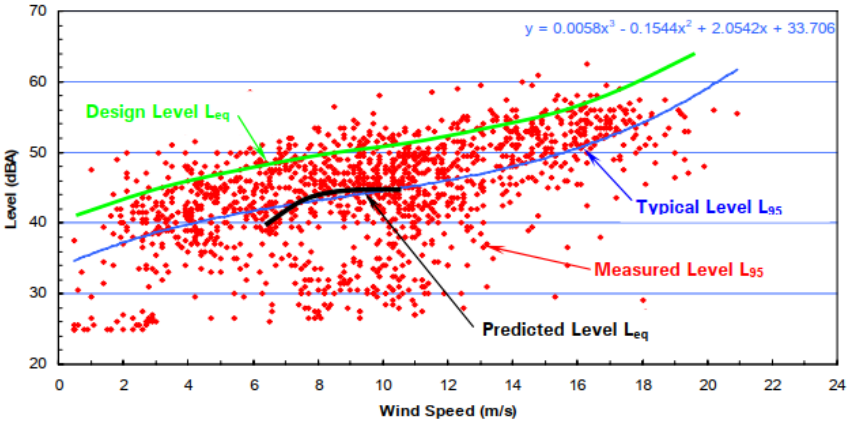


Figure 13. Wind Farm Design Limits at Site 4

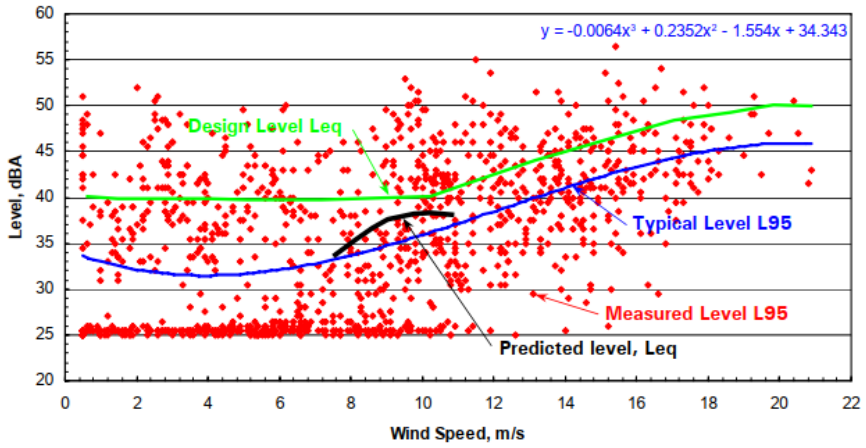


Figure 14. Wind Farm Design Limits at Site 5

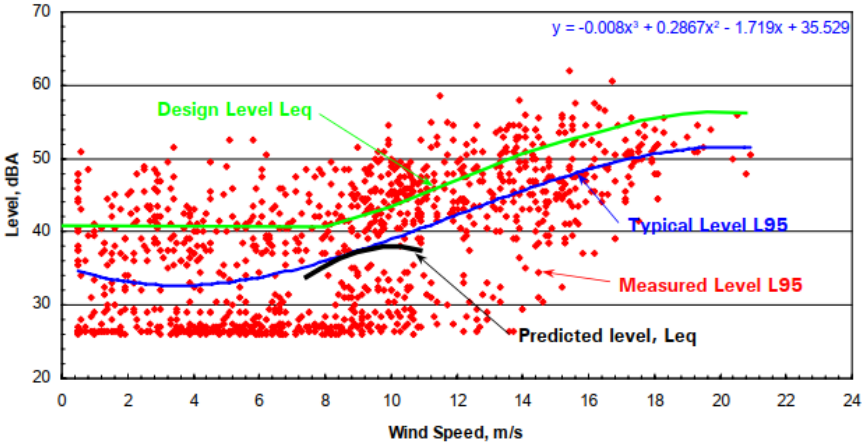


Figure 15. Wind Farm Design Limits at Site 6

APPENDIX E TURBINE SOUND POWER LEVEL AT DIFFERENT WIND SPEED AT HUB HEIGHT

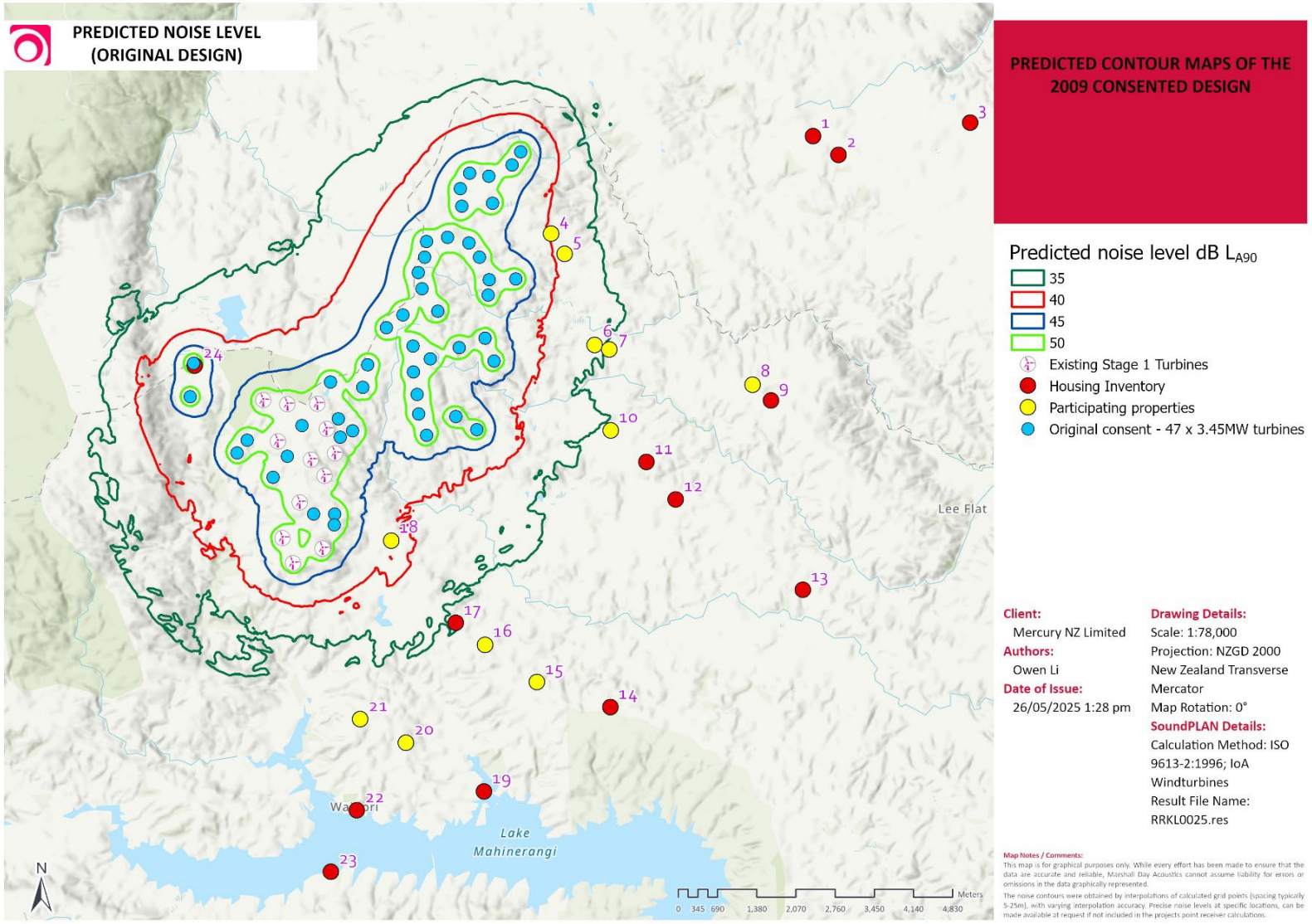
V136-4.3MW[5]

Hub Height Wind Speed (m/s)	Sound Power Level (dBA)
3	93.1
4	93.6
5	96.4
6	99.9
7	103.1
8	105.9
9	106.8
10	106.8
11	106.8
12	106.8
13	106.8
14	106.8
15	106.8
16	106.8
17	106.8
18	106.8

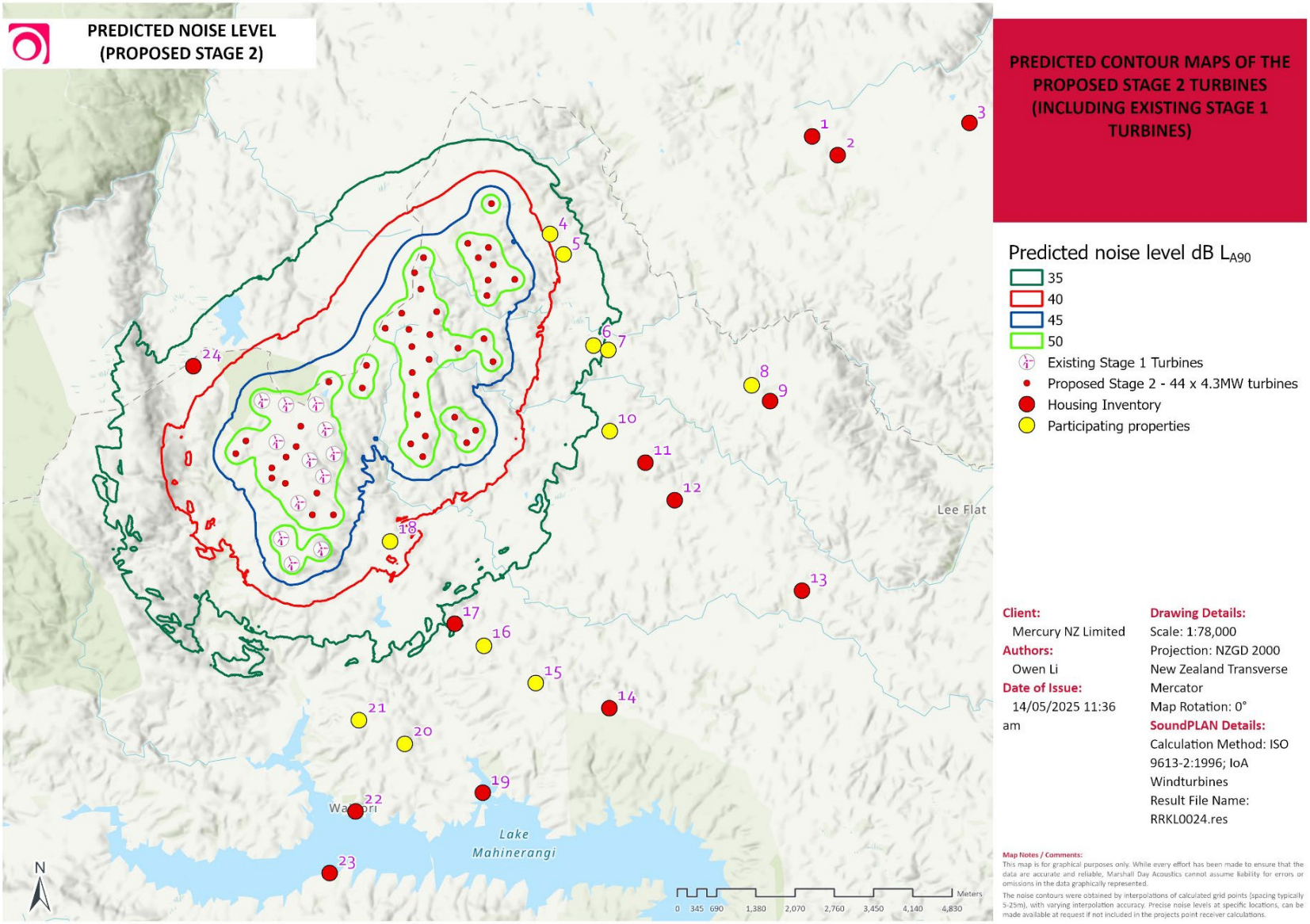
[5] V136-4.3 MW, Low HH Third octave noise emission, T05 0080-9147 Ver 00 – Approved – Exported from DMS: 2021-12-08 by CHWIS

APPENDIX F MAPS SHOWING TURBINES, RECEIVER LOCATIONS NOISE CONTOURS

F1 Predicted Noise contour of the original design

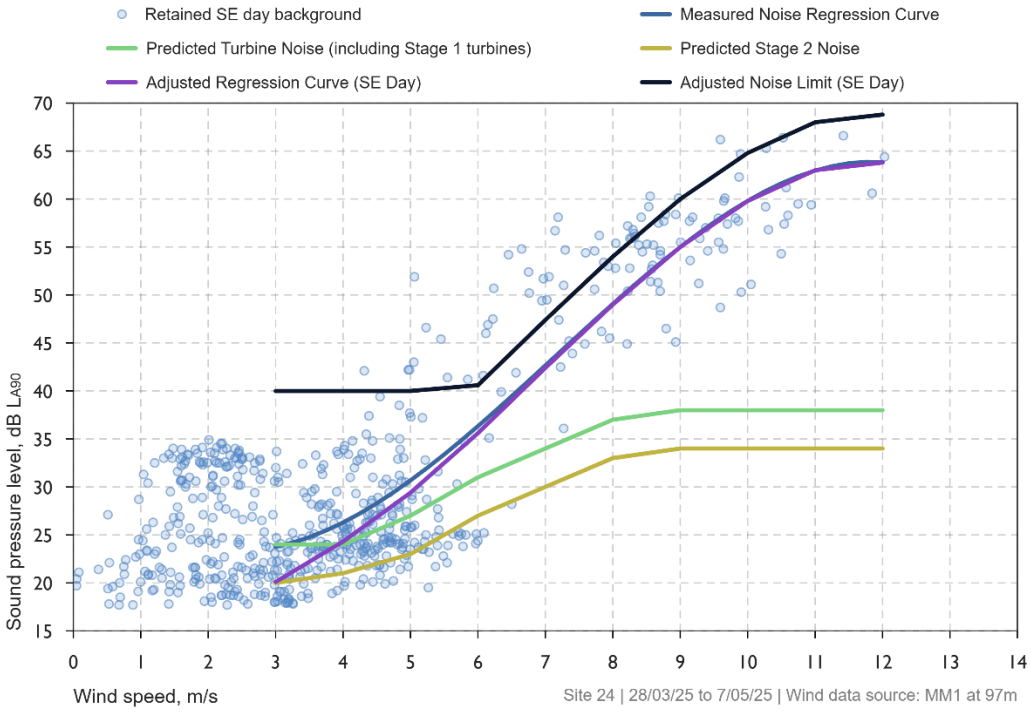


F2 Predicted Noise contour of the proposed Stage 2 including the existing Stage 1 turbines



APPENDIX G REGRESSION ANALYSIS AT SITE 24 FOR DOWNWIND CONDITIONS (SOUTHEAST WIND)

G1 Regression analysis at Site 24: Day time southeast wind direction at wind farm



G2 Regression analysis at Site 24: Nighttime southeast wind direction at wind farm