DESIGN ADVICE MEMO

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ACOUSTIC

Memo No	**A01**
Job Name	**Hokonui Wind Farm**
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To	**Hokonui Energy Ltd**
Address	s 9(2)(a)
Attention	**Dougal McQueen**
Issued By	**Sam Jackson**

Initial Acoustic Assessment - Fast Track Referral Stage

1. Introduction

Powell Fenwick has been engaged by Hokonui Energy Ltd to assess noise and provide design advice for a proposed wind farm to be established in the Hokonui Hills in Southland, 20 km northwest of Gore.

This memorandum is prepared to accompany an application for Fast Track Referral.

The proposal is for a wind farm of capacity 500 MW. The development will consist of up to 83 wind turbines each with a capacity of 6-8 MW. Turbines are expected to have a hub height of around 130 m and a diameter of around 170 m depending on model selection. Two transformers will also be constructed as part of the development.

The are 40 identified existing residential dwellings within the Hokonui Hills area and the surrounding areas. These dwellings will be subject to noise both from the construction and operation of the wind farm. Several of these residential dwellings are owned by parties that will be part of the wind farm development, and can be expected to provide affected party approval for elevated noise if required.

The development and all identified existing residential dwellings that will be subject to noise from the wind farm are within Southland District. The development and the surrounding land is zoned General Rural. The boundary with Gore District is directly to the east of the development area.

In this memo, we provide a high-level summary of initial modelling outcomes and provide comment on the feasibility of the proposed wind farm to achieve acceptable noise outcomes to existing residential dwellings. This assessment is provisional only, for the purpose of concluding where noise outcomes are expected to be compared to appropriate noise criteria.

2. Criteria

2.1 Resource Management Act

Under the Resource Management Act 1991, local authorities are required to put in place district plans to manage the effects of land use activities. The principal tool in New Zealand to manage noise impacts is by zoning land to both sensitive and noise-producing areas and separating them, providing reasonable mitigation (acoustic insulation), and setting noise limits such that they are compatible and do not unreasonably interfere with each other's amenity and/or business operation.

Section 16 of the RMA also places a duty on the land occupier to avoid creating unreasonable noise effects by using the best practicable option for mitigation; this is additional to any district plan rule.

2.2 Southland District Plan

The Southland District Plan sets a framework for sustainable development and management of resources in the District. It includes objectives, policies and rules for the management of environmental effects of land use activities.

Rule NOISE-R8 of the Southland District Plan governs noise generated by wind farms in the District, and is reproduced below.

NOISE-R8	***Noise from Wind Turbines***	
	Noise from wind turbines shall comply with NZS 6808:2010 Acoustics – Wind Farm Noise.	*Activity status where compliance not achieved: DIS*

Performance Standard GRUZ-PS4 governs noise generated by other operational activities associated with the wind farm, for example noise from transformers, and is reproduced below in part only.

GRUZ-PS4	***Noise***			
	Except as provided in NOISE-R3 and NOISE-R4 to NOISE-R11, noise from all activities shall not exceed the following limits:	*Activity Status when compliance not achieved: RDIS*		
	Table 15 - GRUZ Noise Limits Within Adjoining Property Boundary			
	When measured at any point within the notional boundary of any dwelling on an adjoining property zoned:	*Day time (7.00 am - 10.00 pm inclusive)*		*Night time (All other times)*
		LAeq (15 min)	*LAF, max*	*LAeq (15 min)*	*LAF, max*
	General Rural Zone	*50 dB*	*75 dB*	*40 dB*	*70 dB*

2.3 NZS 6808:2010 Acoustics – Wind Farm Noise

NZS 6808:2010 Acoustics – Wind Farm Noise covers the prediction, measurement, and assessment of the received sound from wind farms.

Section 5.2 of the Standard sets out the noise limits that are applicable to a wind farm development.

As a guide to the limits of acceptability at a noise sensitive location, at any wind speed wind farm sound levels ($L_{A90(10\ min)}$) should not exceed the background sound level by more than 5 dB, or a level of 40 dB $L_{A90(10\ min)}$, whichever is greater.

Noise sensitive locations are defined in the Standard and reproduced below:

a) *Any part of land zoned predominantly for residential use in a district plan;*

b) *Any point within the notional boundary of buildings containing spaces defined in (c) to (f);*

c) *Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities, papakainga and marae, excluding habitable spaces in buildings where the predominant activity is commercial or industrial (Residential buildings designed for permanent habitation on land zoned for predominantly rural or rural-residential use are not classified as commercial or industrial for the purposes of this standard);*

d) *Teaching areas and sleeping rooms in educational institutions, including public and private primary, intermediate, and secondary schools, universities, polytechnics, and other tertiary institutions;*

e) *Teaching areas and sleeping rooms in buildings used for licensed kindergartens, childcare, and day-care centres; and*

f) *Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses.*

Section 5.4 of the Standard sets out requirements for assessment and penalties for generation of special audible characteristics.

Wind farms shall be designed so that wind farm sound does not have special audible characteristics at noise sensitive locations. However, as special audible characteristics cannot always be predicted, consideration shall be given to whether there are any special audible characteristics of the wind farm sound when comparing measured levels with noise limits.

Wind turbine sound levels with special audible characteristics (such as, tonality, impulsiveness, and amplitude modulation) shall be adjusted by arithmetically adding up to +6 dB to the measured level at a noise sensitive location (see 5.4.3). This adjustment is a penalty to account for the adverse subjective response likely to be aroused by sounds containing such characteristics.

Section 6.1.3 of the Standard sets out the methodology that shall be used to calculate noise exposure from wind turbines.

There is not a standardised sound propagation calculation method directly applicable to wind turbines. However, an example of a prediction method (from ISO 9613-2) that has been shown to correlate well with measured data for wind farms is detailed in Appendix D. This method provides a good balance between accuracy and completeness on one hand, and the effort of obtaining data to enter into the model on the other. Other prediction methods that can be shown to be appropriate for a given situation may be used, provided the details, assumptions, and limitations of the model are stated.

Section 7.1.4 of the Standard sets out the criteria for conducting background noise measurements

Background sound level measurements and subsequent analysis to define the relative noise limits should be carried out where wind farm sound levels of 35 dB $L_{A90(10\ min)}$ or higher are predicted for noise sensitive locations, where the wind turbines are at 95% rated power. If there are no noise sensitive locations within the 35 dB $L_{A90(10\ min)}$ predicted wind farm sound level contour then background sound level measurements are not required.

2.4 NZS 6803:1999 Acoustics – Construction Noise

NZS 6803:1999 Acoustics – Construction noise is the national standard for the assessment of noise from general construction work. NZS 6803:1999 Acoustics – Construction noise, covers noise from construction work that is of a limited duration. Noise limits are presented in Table 2 and Table 3 within the Standard, which are reproduced in Tables 3.4 and 3.5 below in part only:

Table 2.1: NZS 6803 (TABLE 2) Recommended upper limits for construction noise received in residential zones.

Time of week	Time period	Long-term duration	
		dB L_{Aeq}	dB L_{Amax}
Weekdays	0630 - 0730	55	75
	0730 - 1800	70	85
	1800 - 2000	65	80
	2000 - 0630	45	75
Saturdays	0630 - 0730	45	75
	0730 - 1800	70	85
	1800 - 2000	45	75
	2000 - 0630	45	75
Sundays & Public Holidays	0630 - 0730	45	75
	0730 - 1800	55	85
	1800 - 2000	45	75
	2000 - 0630	45	75

Table 2.2: NZS 6803 (TABLE 3) Recommended upper limits for construction noise received in industrial or commercial areas.

Time Period	Long-term duration
	dB L_{Aeq}
0630 - 0730	55
0730 - 1800	70

In sub-section 7.2.1 of the standard the duration periods are clarified:

+ "Short-term" means construction work at any one location for up to 14 calendar days.
+ "Typical duration" means construction work at any one location for more than 14 calendar days but less than 20 weeks.
+ "Long-term" means construction work at any one location with a duration exceeding 20 weeks.

As construction will exceed 20 weeks in duration, the Long-term noise limits apply.

Guidance notes to consider when reviewing the standard are that:

+ The limits apply 1 m from the applicable building façade and between 1.2-1.5 m above the relevant floor level.
+ Penalties for special audible characteristics as per NZS 6802:2008 do not apply.
+ Under all durations of construction the night-time residential noise limit is 45 dB LAeq. This is also applicable at other premises with similar sensitive activities e.g. where sleeping is expected.

Section 7.4 Compliance with noise limits states the following:

> *"Other than for emergency works, every effort shall be made by the contractor to comply with the applicable noise limits. Where the best practicable options for noise avoidance or mitigation have been applied to construction activities and the activity does not comply with the relevant noise limits, the contractor may need to apply to the local authority for a resource consent or variation of resource consent. A resource consent may also be required if it is predicted that noise from a proposed construction activity will not comply with the relevant noise limits.*
>
> *C7.4*
>
> *Applications should be made at an early stage to ensure the proposal can be fully examined by the relevant local authority and to ensure adequate consultation and notification of affected parties can occur (see community relations). Application should be accompanied by an assessment of effects at a sufficient level of detail to allow the local authority to assess the effects of the proposed activity. Conditions may be imposed to minimise the effects on neighbours."*

3. Proposal

A site plan of the proposed wind farm (plan developed by Hokonui Energy Ltd) is presented in Figure 3.1 below. Proposed wind turbine locations are shown as red dots and identified residential properties are shown as blue dots.

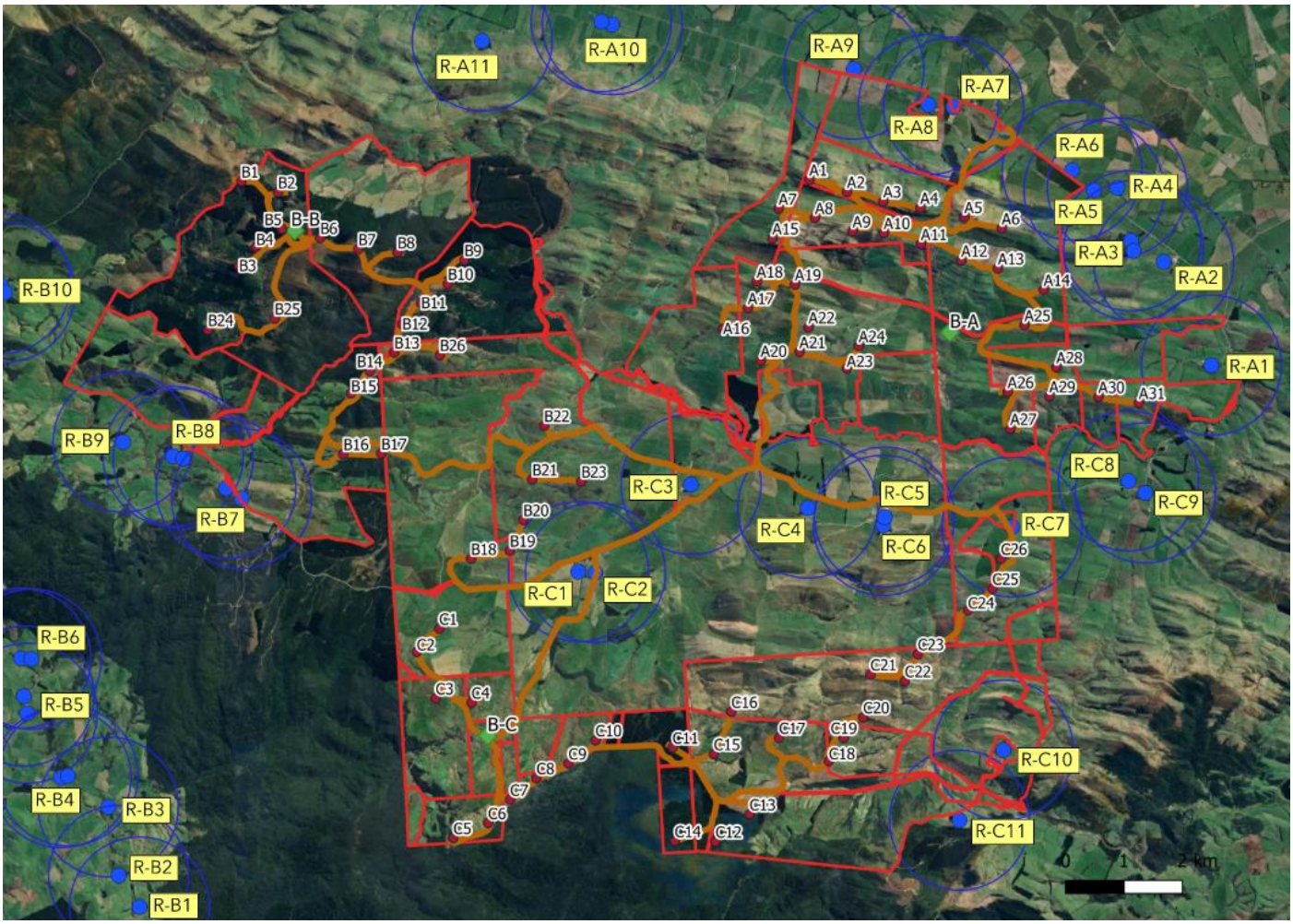

Figure 3.1: Layout of the proposed wind farm with turbine locations shown as red dots and residential dwellings shown as blue dots.

The selection of a wind turbine model, including rated capacity, has not yet been finalised. We have based our initial modelling on an indicative model of a Vestas V172-7.2, which has a rated capacity of 7.2 MW and a rated sound power of 107.8 dBA. The sound power of 6-8 MW turbines typically varies from 105-115 dBA depending on the make, model, capacity and application of any low noise operating mode. We consider the V172-7.2 to be a reasonable model selection for initial assessment to demonstrate feasibility to meet noise limits and to meet the capacity requirements of the wind farm.

4. Assessment – Turbine Noise

Proprietary software SoundPLAN has been used to model noise from the proposed wind turbines to determine noise exposure at identified sensitive receivers. SoundPLAN implements the principles of ISO 9613-2:1996 Attenuation of sound during propagation outdoors. We have used the built in wind turbine source in SoundPLAN. We have accounted for ground absorption effects, which is predominantly soft ground. We have not incorporated the local topography into the model at this initial stage, which will be accounted as part of our detailed assessment. Calculated noise levels are indicative only to demonstrate the feasibility of meeting NZS 6808:2010 noise limits.

In Table 4.1 below we present calculated noise levels at dwellings C1 to C6 (excluding C3) from Figure 3.1, which represent the dwellings that are most exposed to noise from wind turbines and that are not currently party to the development. As per NZS 6808:2010, predicted levels are in dB L_{Aeq} and are considered to be equivalent to dB L_{A90} levels.

Table 4.1: Calculated noise levels

Receiver	**Noise Level (dB L_{Aeq})**
R-C1	36.5
R-C2	34.9
R-C4	32.0
R-C5	33.2
R-C6	33.3

In all cases, calculated noise levels are below the 40 dB L_{A90} limit (equivalent to 40 dB L_{Aeq} as per the standard) set out in NZS 6808:2010, demonstrating that the wind farm can be designed to meet acceptable noise criteria while achieving the required capacity rating. This represents a reasonable worst case scenario, as there is scope to consider alternative turbine models as well as have noise/capacity limits for specific turbines nearest to residential dwellings to further reduce noise exposure if required.

We do not consider the high amenity noise limit of 35 dB L_{A90} from NZS 6808:2010 will apply to any of the identified residential dwellings. The underlying rural night time noise limit of the Southland District Plan which applies to the area is 40 dB L_{Aeq}. Furthermore the area in which there are residential dwellings appears to be actively used for farming. We expect there to be relatively consistent background noise from farming activities, particularly from vehicles both on public roads and on farm land.

If deemed necessary as per the requirements of NZS 6808:2010, background noise measurements within the development area will be undertaken as part of the detailed assessment.

Special audible characteristics have not generally been identified at other wind farms in New Zealand and where identified have been mitigated. The supplier(s) should be required to provide supporting evidence that special audible characteristics are not present with the operation of their turbines.

5. Assessment – Operational Noise

All other sources of noise from the operation of the wind farm excluding the turbines will need to comply with the underlying rural zone noise limits of the Southland district Plan. We expect the following operational noise generating activities will be required:

+ Transformers
+ Turbine maintenance and maintenance facilities
+ Vehicle access for maintenance

Transformers can be located sufficiently clear of existing residential dwellings such that noise levels can be kept below daytime and night time noise limits at all residential dwellings.

Turbines are located sufficiently far from residential dwellings that noise from regular maintenance activities should be below daytime noise limits in all cases. We expect routine maintenance to be carried out during daytime hours only.

Vehicle movements on public roads to access the turbines for maintenance purposes will be infrequent and should not significantly add to the time averaged background noise levels of the area.

In summary, noise from operational activities associated with the wind turbine (excluding the wind turbines themselves which are addressed in accordance with NZS 6808) can be made compliant with the rural zone noise limits of the Southland District Plan in all cases.

6. Assessment – Construction Noise

Noise from activities associated with construction of the wind farm will need to meet the long term noise limits from Table 3.4 of NZS 6803:1999. The following main construction activities are expected to be required:

+ Construction of turbine foundations
+ Operation of concrete batching plants
+ Construction of new internal roads
+ Transportation of construction equipment and turbine components new internal roads and existing public roads.

Construction activities associated with turbine foundations will generate the highest noise, however as all turbine sites are 1.2 km or more from residential dwellings that are not party to the development, the daytime construction noise limit of 70 dB L_{Aeq} should be met with a significant margin. Construction during night time hours should still meet night time limits of 45 dB L_{Aeq}, however further analysis will be required. If needed, construction activities that must occur during night time hours at turbine sites closest to residential receivers can be minimised in duration as far as practicable.

All concrete batching plants will be 3 km or more from any residential dwellings. Daytime and night time construction noise limits should be readily met with minimal or no mitigation measures.

Construction of new internal roads will take place away from residential dwellings, which are all adjacent to existing roads.

Construction traffic will use existing public roads as well as new internal roads to access the turbine sites. The majority of construction traffic will operate during the day and should comply with daytime construction noise limits. We expect some construction vehicle movements will be required during night time hours. This would be predominantly associated with early morning concrete pours. The location of batching plants are such that concrete trucks should not have to use roads that are adjacent to residential dwellings for the majority of turbine sites. Noise from night time movements of vehicles can be controlled to meet night time construction noise limits, and the effects of night time noise generation can be controlled through good management practices.

In summary, noise from activities associated with the construction of the wind turbine can comply with the requirements of NZS 6803:1999, and the effects of noise managed through a good management process.

7. Summary

Based on initial modelling of noise from an indicative turbine model as presented in Section 4, we consider that the wind farm can be designed to meet the requirements of NZS 6808:2010 Acoustics – Wind Farm Noise while also meeting the development requirement for 500 MW of generation capacity.

We also consider that the site can be designed so that operational activities associated with the wind farm (excluding the turbines themselves) will meet the underlying zone noise limits of the Southland District Plan.

Activities associated with the construction of the wind turbine can comply with the requirements of NZS6803:1999, and the effects of noise managed through a good management process.

This memorandum is suitable for submission to Ministry as part of a fast-track referral application.