



PEER REVIEW

MILL CREEK WIND FARM NOISE

for

WELLINGTON CITY COUNCIL

&

PORIRUA CITY COUNCIL

File No. N2096

Version Final F6

29th July 2008

ACOUSAPE CONSULTING & ENGINEERING LTD

A handwritten signature in black ink, appearing to read "Nigel Lloyd". The signature is written in a cursive, flowing style.

Nigel Lloyd
Director of Acoustic Services

E-mail: nigel@acousafe.co.nz

**Mill Creek Wind Farm
Peer Review of Noise Impact Assessment**

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1. Introduction

The resource consent application is by Meridian Energy Limited for the installation and operation of a wind farm on privately owned pastoral farm land north of Makara and west of the Ohariu Valley Road. The application seeks consent to establish a wind farm with a maximum of 31 wind turbines. The turbine layout has been configured around the Siemens 2.3MW wind turbine which will provide for a maximum installed capacity of 71.3MW.

The wind farm noise impact assessment (“**The NIA**”) has been undertaken by Hayes McKenzie Partnership Report Reference 1852-R1 dated March 2008.

The noise issues have been identified as:

- Sound emissions from the construction (and decommissioning) of the wind turbine generators (WTG’s);
- Sound emissions from the WTG’s themselves;
- Potential noise from traffic associated with the construction of the wind farm.

It is recognised that there is a great deal of public concern about wind farm noise and that there is likely to be conflicting information provided regarding the potential impacts both of the operational noise and any special audible characteristics that may be associated with the wind farm.

This review identifies potential noise issues and discusses the appropriateness of draft noise conditions that have been recommended in the NIA in the event that consent is granted to all or part of the wind farm. The draft conditions are based on the West Wind Noise Conditions that were formulated as part of expert witness caucusing that took place during the Environment Court hearing in 2006.

The draft conditions are designed to control noise to the limits set out in NZS6808:1998 *Acoustics - The Assessment and Measurement of Sound From Wind Turbine Generators* whilst recognising times when low background sound levels exist and controlling any special audible characteristics that may be present.

This review has been prepared by Nigel Lloyd who is an acoustical consultant with 30 year’s direct experience as a noise control engineer and who has advised Wellington City Council on the West Wind wind farm project, Palmerston North City Council on Te Rere Hau, Tararua 3 and Motorimu wind farms, Clutha District Council on Mahinerangi wind farm and Gore District Council on Kaiwera Downs wind farm.

As part of the assessment process the site of the proposed wind farm was visited in January 2008. A further visit to site was undertaken subsequent to the receipt of submissions.

2. The District Plan

The proposed wind farm is in the Rural Zone of the Wellington City District Plan.

The Wellington City District Plan Proposed District Plan Change 32 (which is subject to appeal) provides for wind energy facilities as Discretionary Activities

(Unrestricted) in the Rural Area. Council's assessment criteria in determining whether to grant consent and what conditions, if any, to impose include:

26.3.1 *The actual or potential noise effects of the proposal, with particular consideration of special audible characteristics and the proximity to and effect on settlements or residential locations, and the ability to meet NZS6808:1998 (Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators), and other relevant standards such as NZS6802.*

The District Plan has a two tier system of noise limits for permitted activities in the Rural Areas and these are found in Rule 15.1.1.1. The first tier establishes site boundary noise limits of:

| | |
|---------------------|------------------------|
| 7am to 7pm | 55dBA L ₁₀ |
| All other times | 45dBA L ₁₀ |
| All days 8pm to 7am | 75dBA L _{max} |

And the second tier applies at the notional (conceptual) boundary of residential dwellings:

| | |
|-------------------------------|------------------------|
| Monday to Saturday 7am to 8pm | 45dBA L ₁₀ |
| All other times | 35dBA L ₁₀ |
| All days 8pm to 7am | 60dBA L _{max} |

Thus stricter limits are applied at the dwellings while less stringent limits are applied to protect the enjoyment of land.

3. New Zealand Standard NZS6808:1998

NZS6808:1998 *Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators* provides the best methodology for assessing and controlling wind farm noise. It is appropriate to undertake assessments using NZS6808:1998 but it is also important that all impacts on the local communities are considered in this process.

There is no central policy direction available with respect to the listening ecology associated with such a large project as is proposed and some submitters will experience frustration with this. The approach in the District Plan is to “*reduce noise emissions to an acceptable level*” and this is the approach taken in NZS6808:1998. The Standard sets an upper limit of acceptable WTG sound levels outdoors that provides for “*acceptable*” indoor sound levels. The Standard does not prevent sound levels from being heard at neighbouring dwellings and at times the wind farm may be significantly audible and still meet the noise limits in NZS6808. These times would be when background sound levels are low at dwellings but when winds speeds are high enough at the wind farm to allow WTG's to enter production.

This may impact on some neighbours to the wind farm who value the quietness of the area.

Section 4.4.4 of NZS6808 provides for Territorial Local Authorities to specify alternative compliance levels on a site by site basis, taking into account individual circumstances and characteristics. The circumstances and characteristics that are

mentioned in the Standard are “*the distance to the WTG(s), other sound sources, amenity values, etc*”.

The NZS6808 criteria are based on a limit of 40dBA L_{95} or the background sound level plus 5dB whichever is the greater at a specific location and the Standard recommends that background sound level measurements be carried out where predicted sound levels of 35dBA or higher are calculated for the relevant locations.

The Standard anticipates that 10 to 14 days of continuous monitoring (of individual 10 minute samples) will be required to give a suitable range of data. If weather conditions during that time are not representative of those normally experienced in the area then longer periods of monitoring will be required. Typically therefore in excess of 1,440 data points are required for both the pre instalment and post instalment monitoring at each location.

The wind farm sound is measured as L_{95} which is the sound level that is equalled or exceeded for 95% of the time and is a measurement of all but the quietest environmental sounds during a measurement period. The use of this sound metric assumes that the wind farm sounds form a baseline level with other contaminating sounds being of shorter duration and thus not being represented by the L_{95} . Wind farm sounds are predicted as L_{eq} (the equivalent continuous sound level) and L_{eq} is typically 1.5-2.5dB higher than L_{95} over the same period. The District Plan noise limits are expressed in L_{10} and NZS6808:1998 states (in Note 2 to clause 4.4.2) that L_{95} is typically 5dB lower than L_{10} for wind farm sounds.

The methodology used in NZS6808 is to monitor background sound levels over a period and to correlate those levels with the wind speeds at the site of the proposed wind farm. The resultant data pairs are plotted onto a chart and regression curves are statistically determined. It is important that the regression curves appropriately represent the wind farm and background sound levels at the place and time of monitoring.

Subsequent to the construction of the wind farm this monitoring is repeated and compliance with the conditions can then be determined.

The wind farm sound levels are controlled at the notional boundary of dwellings. The notional boundary is defined as a location 20 metres from the façade of any rural dwelling or the legal boundary if this is closer to the dwelling. The use of notional boundary is reasonable with respect to providing for residential amenity at dwellings but does leave some uncertainty with respect to future noise sensitive developments that may occur. In the case of West Wind it was decided that the notional boundary condition should apply to “*dwellings existing or holding all resource consents and/or building consents necessary for construction at the date of consent, or able to be constructed as a permitted activity*”. Thus the applicant may need to ensure compliance with future residential developments that may be closer to the wind farm than existing dwellings.

In the case of Mill Creek, resource consent has been granted for a dwelling at No.1000 Makara Road subsequent to the issuing of the NIA and Meridian were asked to provide further information about the impacts on this future dwelling. The response to this request is discussed later in this report. Another two dwelling sites exist on Takarau Gorge Road being the T B Horrobin dwelling site which is to the

west of the other undeveloped site which is MCH-127 at 183 Takarau Gorge Road. These sites are both outside the L_{Aeq} 40dB contour but inside the L_{Aeq} 35dB contour.

4. Construction Noise

The construction noise assessment is set out in Section 3.5 of the NIA and noise predictions are made in Appendix 9.

The works will take place at locations remote from the nearest residential dwellings (that are not affected persons signatories) and this will ensure that noise levels are substantially below those that are provided for in New Zealand Standard NZS6803:1999 *Acoustics – Construction Noise*.

The Construction Noise Standard provides for minimal daytime noise limits to allow for construction activities to take place and these will easily be met by the predicted construction works.

The NIA (on page 40) offers Condition 9 that prevents concrete being manufactured outside of the hours of 6.00am and 10.00pm on any day and provides for other conditions that establish stricter noise limits for concrete manufacture than provided for by the construction noise standards.

5. Road Traffic Noise

The issues with road traffic are relevant to the construction phase which is predicted in the Assessment of Environmental Effects (“**The AEE**”) to last in the order of 18 months. This timeframe is based on the experience of Meridian at other wind farm sites.

As a new route is being constructed through the Spicer Forest it is assumed that all heavy construction traffic will access the site via Broken Hill Road in Porirua City. This will avoid the necessity for more heavy trucks to pass through Makara which has already experienced high noise levels from the construction of West Wind.

The NIA sets out the expected road traffic noise impacts starting at paragraph 5.3.1.5 on page 31. No mention is made in the NIA of the maximum HCV volumes assumed but the AEE identifies these as a combined (inbound and outbound) two-way daily traffic flow of approximately 68 vehicles. This is approximately 136 one way movements per day. The total HCV movements expected over the 18 month construction period is summarised as follows:

| Time | Heavy Truck Activity | Comments |
|--------------|----------------------|------------------------------------|
| 0-2 Months | 136 movements/day | Construction of site access tracks |
| 2-7 Months | 20-30 movements/day | |
| 8-10 months | 50-60 movements/day | Arrival of turbine components |
| 11-18 months | 15-20 movements/day | |

On page 99 of the AEE there is a statement that Meridian is proposing to restrict construction traffic in Ohariu Valley to 7am to 7pm Monday to Friday, 8am to 6pm on Saturday with no HCV’s on Sunday and Public Holidays. This is a reasonable approach and these restrictions have been provided as an additional noise condition.

The issue with Ohariu Valley Road is that currently there is little traffic on the northern end of the route. As a consequence the increase in heavy vehicles will be marked throughout the construction period but particularly in the first two months when the road access construction is underway. This construction traffic will be different from the nearby West Wind project because all of the components must come by road whereas at West Wind the turbine components can be barged to the site.

Appendix 10 of the NIA has two sets of noise contours that show the existing predicted noise levels with the predicted future noise resulting from the maximum HCV operation which, it is assumed, relates to the 136 HCV movements per day. The contours and Table 9.3 show that the construction traffic at the northern end of Ohariu Valley Road will generate around L_{Aeq} 50dB at the closest dwellings to the road. Overall this is a low level of road traffic noise. The increase in noise will be quite marked at these dwellings because currently the traffic flows are very light and existing traffic noise levels are consequently particularly low.

The L_{Aeq} equivalent continuous measurement is the level that is averaged over the reference period and individual vehicles will generate greater levels of noise than is implied by the average level. It is recommended that heavy construction vehicles not use these otherwise quiet roads at night.

A request for further information was made to Meridian regarding night time noise from the transportation of oversized components at key locations such as both ends of the Mungavin Bridge and the intersection of Kenepuru Drive and Raiha Street. This was required because difficult manoeuvres and traffic management activities could impact on noise sensitive residential activities and noise sensitive activities at Kenepuru Hospital.

In their response Meridian described the transportation of oversized vehicles along Mungavin Interchange - Kenepuru Drive - Raiha Street as involving the following:

1. Each overweight/over dimension load will have a pilot vehicle and trailing vehicle travelling in convoy. The pilot vehicle will have a flashing beacon but no siren;
2. Mitigation measures such as temporary removal of signs will be done on a nightly basis but should not involve any noise;
3. Other mitigation measures such as temporarily relocating a lamppost and/or constructing a running surface platform through a traffic island will be done on a semi permanent basis (i.e. once only-not nightly);
4. Other traffic management measures employed may be setting up temporary cones/barriers on a nightly basis. This is not regarded as a noise generating activity.

Meridian's noise consultant, Malcolm Hayes, has considered the potential noise effects associated with the movement of three oversized vehicles along Mungavin Interchange - Kenepuru Drive - Raiha Street each night to the site. He states that:

In general my predictions indicate that over the night-time period, 22.00-7.00 hours, the effects of noise associated with the movement of the three trucks is imperceptible. By this I mean that we have undertaken a prediction based upon the estimated night-time traffic flows within the Traffic Impact Report and find that the noise from the highway to the east is the dominant noise source.

Intermittent traffic along the main roads, Mungavin Interchange - Kenepuru Drive - Raiha Street, is of sufficient level combined with the highway, that predicted levels are in the region of 50dB L_{Aeq} . Typically, L_{A10} is around 3dB higher for traffic noise. The predicted greatest change along these roads is around 0.1dB(A) for the dwellings closest to the road near the hospital.

The potential change for a receiver along Broken Hill is around 0.2-0.3dB(A) over an 8 hour period. The potential noise impact associated with the movement of turbine parts during the night-time periods along this road system is therefore not considered significant.

Our predictions also indicate that it is unlikely that noise levels at neighbouring properties will exceed a level of 75dB L_{Amax} during the transit of a lorry towards the site past any dwelling beyond 20 metres from any road centre line.

The predictions so far assume flat earth, and no barrier effects associated with topography or buildings. The results from including contour information will be lower than those presented above, so the impact will be de minimis.

Given the presence of the State Highway to the east of the Kenepuru Drive, the generally commercial nature of the areas through which the route passes and the buffering provided to the hospital by distance and topography it is accepted that the passing oversized vehicles and additional manoeuvres that are required should not create a significant nighttime noise impact.

6. Wind Farm Operational Noise

The NIA makes predictions for the operational wind farm noise based both on the Mill Creek wind farm itself and also on the cumulative noise from Mill Creek and West Wind to the south.

The predictions have been made using International Standard ISO9613 *Acoustics – Attenuation of Sound during Propagation Outdoors*. Predictions are done for Mill Creek (Appendix 11) using both southerly and northerly winds and tables are provided that set out the predicted sound levels and also the degree of compliance with *derived* compliance limits. The predictions are shown for integer wind speeds between 4ms^{-1} and 12ms^{-1} inclusive at 10 metres above ground level (“AGL”) on the wind farm site.

The predictions are that the baseline L_{A95} 40dB noise limit from NZS6808 will be complied with for all existing dwellings with a significant margin of safety.

Appendix 13 shows the predictions for cumulative operational wind turbine noise from both West Wind and Mill Creek. These tables detail southerly wind and northerly wind predictions separately and the rationale for this is explained in section 6 of the NIA. One of the complicating factors, as pointed out in section 6, is the effect of the wind direction on the predicted noise levels. If only one wind farm is considered then a prediction can be undertaken for downwind conditions in all directions simultaneously, safe in the knowledge that this situation will never occur. Thus when the wind blows from the dwellings towards the wind farm then the noise levels will be less than those predicted. With two wind farms separated by 2kms though, it would be unrealistic to make the predictions as if dwellings between the wind farms were downwind of both at the same time. The NIA adopts directivity

corrections used in the UK to account for the potential attenuating effects of various wind directions.

The *derived* compliance levels selected in the NIA are:

| | | |
|-------------|---|-------------------------|
| Daytime - | 4ms ⁻¹ and 5ms ⁻¹ | L _{A95} 35dB |
| | 6ms ⁻¹ to 9ms ⁻¹ | L _{A95} 40dB |
| | 10ms ⁻¹ | L _{A95} 40.6dB |
| | 11ms ⁻¹ | L _{A95} 42.2dB |
| Nighttime - | 12ms ⁻¹ | L _{A95} 43.1dB |
| | 4ms ⁻¹ and 6ms ⁻¹ | L _{A95} 35dB |
| | 7ms ⁻¹ to 10ms ⁻¹ | L _{A95} 40dB |
| | 11ms ⁻¹ | L _{A95} 41.8dB |
| | 12ms ⁻¹ | L _{A95} 43.1dB |

The rationale for the derivation of the compliance levels is described in section 4 of the NIA. Table 4.2 contains minimum background sound monitoring results that identifies that the cut-off for the low background sound (sub-6808) condition is 6ms⁻¹. Care needs to be taken with the NIA that the wind farm wind speeds are not confused when comparing Table 4.2 with Regression Figure 2 in Appendix 5 and Table 11.3 in Appendix 11. Table 4.2 quotes the wind speeds at both 10 metres AGL and also at hub height while Regression Figure 2 quotes the wind speed at hub height and Table 11.3 quotes the wind speed at 10 metres AGL. The wind speed at 10 metres AGL correlates to the wind speed at WTG hub height but care needs to be taken as to which height is being referred to. The NIA makes the mistake of confusing “10 metres AGL” with “hub height” in the Conclusions paragraph 8.2. The wind speeds of 6m.s⁻¹ are at 10 metres AGL not hub height as stated in that paragraph.

If, when the background sound levels are actually monitored at individual sites, it is found that the cut-off for the quiet background condition of L_{A95} 35dB occurs at slightly higher wind farm wind speeds (e.g. 7ms⁻¹ rather than 6ms⁻¹) then there is potential for minor non compliance issues with this limit at baches in Smiths Bay and at MCH128 which is the undeveloped site at 535 Takarau Gorge Road. With respect to the baches though, their closeness to the sea makes it unlikely they will experience very low background sound levels because of the sounds associated with the ocean.

Analysis of dwellings in Table 13.4 indicates that the only existing dwellings likely to be exposed to wind farm sound levels in excess of 35dBA are:

- the baches at Smith’s Bay;
- dwellings on the wind farm site itself; and
- dwellings likely to be principally exposed the future West Wind wind farm noise rather than the Mill Creek wind farm noise.

This latter category can be ratified by consideration of Table 11.1 in the NIA.

Besides these locations the most exposed dwellings are likely to be those in Estuary Street which start to plateau at about L_{Aeq} 34dB. As a quirk of the prediction

methodology the cumulative noise predictions for some dwellings are slightly less than the predictions from Mill Creek without the influence of West Wind.

A number of dwellings are predicted to comply with the L_{A95} 35dB criterion with the smallest of safety margins and it is important that background sound levels be monitored at these dwellings as part of the Mill Creek development process to determine at what wind speeds the sub6808 criterion will apply. This will allow future checks on these properties to be made.

Dwellings that are predicted to experience noise levels close to L_{Aeq} 35dB are located principally on Makara Road either in the beach settlement or towards the northern (beach) end of Makara Road, and in Takarau Gorge Road in the area generally south east of turbines G01 to G04 inclusive.

The *Suggested Permit Noise Conditions* in the NIA requires pre-installment measurements to be taken at representative measurement locations for “*all dwellings within the predicted 35dBA L_{eq} contour*”. At Mill Creek there are no qualifying dwellings within this contour except for the baches at Smiths Bay.

However there is a requirement for a 35dBA limit to be met when background sound levels are at or below 25dBA determined from the appropriate regression curve. On that basis it is appropriate to monitor background sound levels at locations where predicted wind farm noise levels of less than L_{Aeq} 35dBA are predicted and this has been the approach taken for the pre-installment measurements at West Wind. To formalise the process it is recommended that representative monitoring be undertaken at a suitable number of dwellings beyond that provided for by NZS6808.

There are a number of undeveloped residential sites that would be exposed to wind farm noise. In the West Wind Environment Court Decision the noise conditions apply to existing dwellings and also to dwellings yet to be constructed but which hold all resource consents and/or building consents necessary for construction at the date of that consent. The West Wind conditions are proposed for Mill Creek and should any undeveloped sites have all required consents at the time the wind farm consent is granted (if that is to eventuate) then they will be protected by the noise conditions.

On Takarau Gorge Road the most exposed site is the T B Horrobin dwelling site which is to the west of undeveloped site MCH-127 at 183 Takarau Gorge Road. This site gains an expansive view of the wind farm and is generally between the predicted L_{Aeq} 35dB and L_{Aeq} 40dB contours. This site is not identified in the NIA. The Mill Creek wind farm is predicted to comply with the 40dBA L_{95} noise limit for a future dwelling on this site but could exceed the 35dBA L_{95} quiet background sound limit. Pre-installment monitoring would need to be undertaken at this site to determine whether low background sound levels exist at times when higher wind farm sounds are generated. The exposed nature of this site may mean that the wind conditions at the future dwelling may be not dissimilar to the wind speeds at the wind farm and it would then experience masking at times of higher wind farm sound levels.

Another site that has gained resource consent since the NIA was prepared is Site 3, 1000 Makara Road which is shown as being approximately 30 metres from the wind farm site boundary and close to the L_{Aeq} 40dB contour. A request for further information was made regarding the 1000 Makara Road site. A response to this request was included in correspondence dated 2 July 2008 from Meridian Energy. In that response Meridian indicated that the site of the dwelling had still to be exactly

determined and once that had been done then an accurate prediction could be undertaken taking into account the screening effects of terrain. The modelling in the NIA is undertaken with the noise source at 135 metres above the ground which is some 24 metres above the height of the top of the rotor blade of each WTG. This accounts for downwind noise propagation and screening implications. There is the potential for some screening of this dwelling by the hillside that may not be adequately represented by the contours.

The response also points out that this dwelling is in the same wind patterns as the wind farm and therefore only the L_{Aeq} 40dB part of the noise limits is likely to apply.

The lack of definitive information makes it difficult to be certain about the likely impacts at this dwelling site. From the contours it seems that the noise levels have the potential to exceed the proposed L_{Aeq} 40dB condition at this site.

Other undeveloped sites include MCH-126 (181 Takarau Gorge Road), MCH-127 (183 Takarau Gorge Road), MCH-128 (535 Takarau Gorge Road) and MCH-129 (579 Takarau Gorge Road) which are all included in the NIA. The predicted noise levels in Table 11.1 of the NIA for these sites are all approximately L_{Aeq} 35dB except for MCH-128 which is L_{Aeq} 37.2dB.

These dwellings sites will be protected by the proposed conditions if the future dwellings for the sites hold “*all resource consents and/or building consents necessary for construction*” at the date of the consent for the wind farm (in the event that consent is granted).

7. Refusing Consent for Turbines

With the possible exception of turbines close to the undeveloped dwelling site at Site 3, 1000 Makara Road which have yet to be determined, there is no significant instance of the wind farm not complying with the Recommended Noise Conditions to the extent that turbines need to be removed. However it is understood that Council planning officers have concerns about the G series of wind turbine and F12 and F13 in particular because of visual effects.

Removal of the G series would assist with reducing noise levels particularly to those dwellings on Takarau Gorge Road that are to the south and south east of these particular turbines including the undeveloped dwelling site at MCH-128, 535 Takarau Gorge Road which is only 829 metres from turbine G04 and which is predicted to experience a noise level of up to L_{Aeq} 37.2dB. There is no indication in the NIA as to what the individual contribution is from various turbines but with coarse modelling and various assumptions about topographical screening of the further turbines it is estimated that the difference in the noise prediction for dwelling MCH-109, for example, is likely to be about 3-4 decibels reduction as a result of removing the G series.

Any improvements from the removal of F12 and F13 would be gained for dwellings along Makara Road. This could be significant where a dwelling would only be exposed prominently to F12 and F13 and which would otherwise be screened from other wind turbines as is the case with dwelling reference WWH-099 at 1000 Makara Road.

8. Recommended Draft Noise Conditions

A set of draft noise conditions is recommended in Appendix A in the event that consent is granted. The numbering is nominal. These noise conditions have been adapted from the conditions that were decided for West Wind as part of the 2005/2006/2007 hearings. For completeness it should be said that at the time that agreement was reached, the experts for Makara Guardians (G P van den Berg and R Thorne) expressed concerns at that hearing about the set noise limits, preferring L_{Aeq} 30dBA as being more likely to provide complete protection to amenity. The agreed conditions, including the set baseline noise limit of L_{Aeq} 40dBA, were subsequently ratified though by the Environment Court.

Some suggested amendments are made to these conditions as they were adapted and included in the NIA and these differences are underlined in Appendix A.

The conditions separately control noise emissions from construction, non turbine operations and wind turbine operations on the wind farm. Off site noise controls are also provided by recommended restrictions on access to the site by heavy construction traffic.

The construction noise conditions do not apply to any on-site concrete manufacturing which shall comply with stricter conditions. The limits for concrete manufacture are more appropriately measured and assessed in accordance with NZS6801 and NZS6802 and this is provided for in condition 8.

No concrete shall be manufactured between the hours of 10pm and 8am the following day. This control also limits the on-site concrete truck movements that may occur at unsociable hours.

The construction noise conditions also provide for a noise management plan. At the outset of construction works at West Wind, Meridian provided Council with monitoring of representative construction noise levels. Council found this information to be useful and it has been recommended that a requirement for this monitoring be added to the noise management plan (condition 11).

The limits for Mill Creek wind farm are recommended in condition 12 and these are the same as agreed for West Wind. The condition is in two parts. The first part sets the limit as L_{Aeq} 40dB or the background sound level regression curve plus 5dB whichever is the greater. This assumes that as the background sound level increases then this will help to mask any wind farm noise and make it less perceptible.

The second part of condition 12 applies a noise limit of L_{Aeq} 35dB at times when the background sound regression curve is 25dBA or less and when the wind speed is less than 1.5ms^{-1} at a height of 10m above ground level. This provides for an additional (sub 6808) control measure in the event that it is windy at the wind farm but relatively calm and quiet at any receiver locations which may be protected in valleys at lower elevations than the wind farm.

The background sound level is to be measured without any influence from the West Wind wind farm. This prevents there being a relaxation in overall noise limits due to background creep in the area.

Changes have been made to condition 13(a) to clarify perceived ambiguities in the West Wind conditions. The need in this condition is for the consent holder to furnish a report that sets out the noise emissions for the type of turbine that will be used, in

the modes of operation that are assumed in the designs. If the WTG's are only to operate in one mode then noise for only one mode of operation is required to be reported.

Condition 14 sets out the requirements for pre instalment monitoring of background sound levels. Because there are no qualifying dwellings other than beach baches that are predicted to be inside the L_{Aeq} 35dB contour then there is a direction to undertake monitoring at 7-9 locations including 2-3 locations identified for continuous monitoring in condition 25. These sites would most likely be directed towards the Makara Beach settlement, Estuary Road, Makara Road, Takarau Gorge Road (2-4 locations), Smiths Bay (actual or at a representative location), and site 3 at 1000 Makara Road. Agreement for similar monitoring to take place outside the predicted L_{Aeq} 35dB contour has been reached between Meridian and Council for West Wind. The conditions for post installation testing require that the readings be taken at the same locations as the pre instalment measurements (where possible).

Condition 19 provides for results to be given to Council in their raw form if necessary. The only reason that this condition would need to be enacted would be if the noise levels from the wind farm were to be greater than expected. In that instance the raw data could be streamed directly to Council for analysis thus eliminating any possible accusation of tampering with the results by any party. Audio information could also be recorded as part of the sound monitoring and this could also be required by Council to help with the identification of the noise source.

Condition 25 provides for continuous monitoring to be undertaken. It is envisaged that two locations for continuous monitoring would initially be established one at each of the most exposed dwellings, with the potential for an additional location should the want arise. This requirement is in the West Wind conditions (with a minimum of 4 and maximum of 5 locations) but was not transferred over to Mill Creek in the NIA.

Conditions 29 to 31 provide for penalties should the wind farm noise contain special audible characteristics or modulations and these were agreed to by the experts at the West Wind caucusing.

The requirements for an operational wind turbine generator noise management plan are set out in conditions 34 and 35. This noise management plan requires the assessment of periods of low background sound to be made and for mitigation measures for WTG's to be identified. This includes the implementation of an automatic control mechanism to de-rate or stop the wind turbine generators to ensure compliance with the noise limits. The need for continued assessment of the success of the control measures is also provided for in the noise management plan. These conditions were also agreed to for West Wind. The process for dealing with complaints is also provided for in the operational noise management plan.

It is assumed that there will be a separate set of conditions for a Community Liaison Group to be established (as Conditions 107 and 108 in the West Wind Decision), which will include the consideration of noise control.

An addition has been made to the section 128 review condition whereby provision is made to review the Mill Creek noise conditions at any time after the commencement of West Wind should the noise emissions from West Wind differ from those that have been predicted. Some concern has been expressed by submitters about the veracity of

the noise predictions and this review clause may help to allay some of the concerns that have been expressed.

9. Submissions

There are approximately 303 submissions that oppose the wind farm that include noise as part of their concerns. One submission supports the wind farm but with noise as a concern.

Of the submissions most simply list noise as a concern but it is clear from reading the submissions that many people hold serious concerns about the impacts of noise on health and amenity values. In general terms the submissions cover:

- Low frequency noise;
- Infrasound;
- Traffic noise;
- Sleep deprivation;
- Difficulty in determining impacts;
- Health issues;
- Noise insulation of dwellings sought;
- Plant trees to mitigate noise;
- Loss of quietude/peace/tranquillity;
- Generation of excessive and dangerous noise;
- Inaudible components of noise;
- Minimum set back distances;
- Delay until West Wind can be assessed;
- NZS6808 is out of date;
- Conditions have been ineffective for West Wind;
- Loss of amenity;
- Exceed WHO Standards;
- Predictions inaccurate;
- Cumulative impacts with West Wind;
- Vibration;
- Most residents downwind of wind farm.

It is inevitable that there will be some loss of peace and tranquillity on land closest to the wind farm site. There is no claim that the wind farm will not be audible although the level of audibility will vary. Most dwellings will be predominantly downwind or neutral to the wind farm with the consequent increase in wind farm noise but this increase has been included in the predictions in the NIA.

The NIA discusses low frequency sound issues of wind farms in section 2.2.4. The report explains that, near to the wind farm, if the wind farm is heard then the sound will be broad band in nature meaning that there will be no particular weighting toward low or high frequency. Further from the farm however the high frequencies are reduced by air absorption so lower frequency sounds can become more predominant. Of course the further from the wind farm one gets the quieter the low frequency sounds will be. Because we are talking about sound levels that are low against any assessment criteria then a straight assessment provides for these levels to have no known impact on health in terms of criteria issued by the World Health Organisation.

The NIA also discusses infrasound which is sound at frequencies below those that are audible to humans. The report concludes that, according to a report within ETSU W/13/00392/REP the low frequency acoustic energy falls below recognised perception levels for such a noise source. A paper by Jorgen Jakobsen from the Danish Environmental Protection Agency entitled Infrasound Emission from Wind Turbines published in the Journal of Low frequency Noise, Vibration and Active Control (Vol.24 No.3 2005 pages 145-155) also concludes that wind turbines of contemporary design with the rotor placed upwind produce very low levels of infrasound. Even quite close to the turbines the infrasound level is far below relevant assessment criteria, including the limit of perception. The Jakobsen report identifies that wind turbines with a downwind rotor generate considerably higher infrasound levels. It is important to keep in mind that the proposed wind turbines for Mill Creek will be contemporary machines with upwind rotors and will not experience the problems associated from some older wind farms.

Construction noise issues will be generally limited to construction traffic with heavy trucks accessing the site via Northern Ohariu Valley Road. The actual predicted sound levels are not unusually high for a road however this stretch of Ohariu Valley Road only currently services the local area and local residents will therefore notice a marked increase in traffic noise during the 18 months of the construction period. To prevent sleep disturbance a condition is recommended that prevents nighttime use of this stretch of road. The condition also prevents heavy vehicles associated with the construction works from using Makara Road.

It is recognised that West Wind will come on stream before Mill Creek and it is proposed to provide for a review of Mill Creek conditions once the situation at West Wind is known. The noise control regime for Mill Creek is based on the West Wind consent conditions.

10. Health Effects

The predicted wind farm sound is such that it is highly unlikely that any impact on health will be caused. The wind farm sound levels are predicted to comply with the NZS6808:1998 criteria which will provide adequate protection to community health and the World Health Organisation Standards will be complied with if compliance with the conditions is achieved. Additional sub6808 measures are recommended to assist in providing some protection to the quiet background sound amenity levels that have been shown to exist in the area.

Health issues are appropriately dealt with in the NIA in Appendix 1 with respect to infrasound and low frequency noise and the levels that are being provided for are below those as set out by the World Health Organisation.

Noise criteria are recommended by the World Health Organisation (“WHO”) and by New Zealand Standards. A current WHO Fact Sheet No.258 Revised February 2001¹ recommends that a nighttime noise level of 30dBA L_{eq} inside bedrooms will protect against adverse health effects. The assumption is that with a 15dBA reduction of noise through an open window then noise levels inside bedrooms will always be well below this guideline with respect to sleep protection.

11. Conclusions

There are recommended draft conditions to control construction road traffic noise by way of restricting nighttime traffic movements in the Ohariu Valley and, in addition, by preventing such movement on Makara Road at all times. Oversize vehicles that need to move through Wellington and Porirua at night will need to park up before reaching Ohariu Valley until daytime to complete the journey to the site and this is seen as appropriate given the potential for nighttime sleep disturbance in this otherwise quiet area. The nighttime activity of oversize truck movements along the motorway and along Kenepuru Drive and Raiha Street in Porirua should not create a significant noise impact.

Other construction activities are controlled by reference to the Construction Noise Standard and by the application of a construction noise management plan. Concrete manufacturing and associated trucking around the site will only occur between 6am and 10pm.

The Noise Impact Assessment by Hayes MacKenzie Partnership concludes that the noise emissions from the proposed Mill Creek wind farm will comply with the noise limits set out in NZS6808:1998 *Acoustic - The Assessment & Measurement of Sound from Wind Turbine Generators*.

The noise predictions are based on the wind turbines for use at the consented West Wind wind farm i.e. the Siemens SWT-2.3-82 VS. The noise modelling has been based on the base sound power level for this type of WTG using a sound power level at the turbine of 102.3dBA. This turbine is considerably quieter than other larger turbines for example the VESTAS V90’s can have a sound power level of 110dBA.

A set of recommended draft noise conditions has been produced as part of this report. The conditions are based on the agreed noise conditions for the consented Project West Wind. Those conditions rely on the limits in NZS6808:1998 but with additional sub 6808 quiet background sound conditions at which times the noise limit is reduced from the baseline L_{Aeq} 40dBA to L_{Aeq} 35dBA. This criterion provides for noise limits that are significantly below the limits expressed by the World Health Organisation.

The Noise Impact Report describes two samples of existing ambient sound levels in the area and the report provides a good understanding of wind farm noise impacts. Given the World Health Organisation recommendations it is highly unlikely that the wind farm will cause any health issues (assuming compliance at least with NZS6808:1998) and these conditions will assist in protecting the aural amenity that exists in areas around the proposed Mill Creek wind farm site.

1. WHO Fact Sheet No.258 Revised February 2001.
<http://www.who.int/mediacentre/factsheets/fs258/en/>

The conditions provide for sound emission data to be provided to the Council for the individual WTG's and for a pre construction sound emissions report to be prepared by a suitably qualified and experienced person that shows that the wind farm will comply with the noise limits. It would be expected that uncertainties in the manufacturer's data and noise prediction techniques would be factored into this reporting and adequate safety factors provided for.

Noise monitoring will then be undertaken after the installation of the wind farm to demonstrate compliance.

If the wind farm exhibits any special audible characteristics then these will be penalised by conditions and the result will be that the wind farm may not comply with noise limits at the nearest dwellings. The conditions provide for any non compliant turbines to be operated such that they do comply or for them to cease to operate.

The extensive noise conditions are based on the conditions that were initially agreed to by experts at the West Wind hearings and which were included in the Environment Court Decision for that nearby wind farm and the Mill Creek noise has been considered cumulatively in the NIA with future Project West Wind noise. On that basis the conditions will appropriately control the noise from the Mill Creek wind farm operation.