

IN THE MATTER of the Resource Management
Act 1991

AND

IN THE MATTER of a notice of requirement
issued by WEL NETWORKS
LIMITED pursuant to section
168(2) of the Act for
designations (3) to authorise
the implementation of the
Western Network Upgrade
Project

STATEMENT OF EVIDENCE OF N I HEGLEY

1. INTRODUCTION

- 1.1 My name is NEVIL IAN HEGLEY. I am the Principal of Hegley Acoustic Consultants. I have more than 35 years experience in civil engineering and for the last 30 years I have specialised in acoustics. I have an MSc from Southampton University where I undertook research in acoustics. I am a Chartered Professional Engineer, a Member of the Institution of Professional Engineers New Zealand, the Institution of Civil Engineers United Kingdom and the Acoustical Society of America. I have been on the majority of the Standards sub-committees since 1978 and I was the Chairman of one of these committees.
- 1.2 I have been involved with more than 30 substations and six transmission lines throughout the country. This includes the design of new sites and compliance monitoring of newly constructed facilities.

Expert Witness Code of Conduct

- 1.3 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Note 2006 [2006] NZRMA 357. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Involvement in the project

- 1.4 I have been asked to advise WEL Networks Limited on the noise aspects of a proposal to develop and operate:
- (a) A new substation directly adjacent to the existing Transpower grid exit point at Te Kowhai;
 - (b) An 110kV electricity line (including several different types of pole) over a 25 kilometre corridor; and
 - (c) A new substation to be built at the site of the recently-consented Te Uku Wind Park.
- 1.5 I am familiar with both substation sites and the general alignment of the proposed electricity line, having undertaken site visits in relation to each aspect of the project.

Purpose and scope of evidence

- 1.6 The purpose of my evidence is to address the potential noise effects associated with the construction and operation of the proposed substations and sub-transmission line. In this evidence I address:
- (a) The design criteria for the Te Kowhai Substation, Wind Park substation and the sub-transmission line (Section 3).
 - (b) Construction noise effects (Section 4).
 - (c) Operation noise effects (Section 5).

(d) Proposed conditions (Section 6).

(e) Conclusions (Section 7).

1.7 A summary of my evidence is contained in Section 2.

2. **SUMMARY OF EVIDENCE**

Te Kowhai substation

2.1 By selecting the appropriate transformers it is practical to control the cumulative noise effects of the existing consented substation at Te Kowhai and the proposed transformers to within the existing noise conditions for the site.

Te Uku Wind Park substation

2.2 The proposed Te Uku Wind Park substation is well clear of all dwellings and the site boundary. Consequentially, the noise from this substation will be well below the existing background sound in the area at all times so there will not be any noise nuisance for neighbours.

Sub-transmission line - construction

2.3 Both the underground and overhead construction of the proposed lines and removal of the redundant lines will be well clear of any houses for the majority of the route. Thus, there will not be any possible noise nuisance for the majority of the selected route.

2.4 There are a few houses close to the proposed line and at these houses the construction noise will be well within the requirements of the construction noise rule in the Proposed District Plan at all times.

2.5 Construction noise, including helicopter noise, should be addressed via the Construction Management Plan. In that regard, helicopter noise falls within the scope of NZS6803: 1999 Acoustics – Construction Noise and does not need to be addressed via a specific condition.

Sub-transmission line - operation

- 2.6 The normal operation of the lines will be a silent operation for the majority of the time.
- 2.7 Noise will potentially be intrusive for a few residents living adjacent to the new lines during periods when there are high winds. However, at these times the wind generated noise at the houses will be above the noise from the wind in the lines. Corona, surface discharge and wind generated noise will all be within a reasonable limit for the few people who live adjacent to the line. Those people also live adjacent to the highway so the ambient sound will also be higher for them due to passing traffic.

Proposed conditions

- 2.8 I have suggested an amendment to the proposed conditions for both substation NORs to appropriately reflect the tonal penalty that applies to transformers. The proposed conditions have noise levels that have been reduced by 5 dBA, compared to the applicable District Plan noise levels. This is not necessary as the proposed conditions also require the noise to be assessed in accordance with NZS6802, and the tonal penalty is addressed by this standard. I agree that all other conditions are appropriate and consider that they will address any potential noise related issues arising from the proposal.

Conclusion

- 2.9 Based on the above, noise is not expected to be a nuisance from any of the three phases of work on the proposed development.

3. DESIGN CRITERIA

- 3.1 In order to assess any noise effects it is first of all necessary to establish what would be a reasonable level of noise for the proposed activities to comply with.

Operation noise

- 3.2 The transmission line, Te Kowhai Substation and Te Uku Wind Park Substation are all located in a rural zone so both the Operative and Proposed District Plans need to be considered. The noise requirements of the Operative District Plan are set out in Rule 48.5.4(c). This rule states:

All activities, excluding farming, shall be conducted and buildings located, designed and used to ensure that noise levels at or within the notional boundary do not exceed the following limits:

<i>Monday to Friday</i>	<i>7:00am – 7:00pm</i>	<i>50dBA (L₁₀)</i>
<i>Saturday</i>	<i>7:00am - 6.00pm</i>	<i>50dBA (L₁₀)</i>
<i>At all other times including Public Holidays</i>		<i>40dBA (L₁₀)</i>

- 3.3 Rule 25.17.1 of the Proposed District Plan sets the following noise limits of a Rural Zone:

Any activity is a permitted activity if it is designed and conducted so that noise from the activity, other than construction noise, farming noise, forest harvesting noise, extractive industry noise and emergency sirens, measured at any other site does not exceed:

- (a) 50dBA (L₁₀), 7am to 7 pm every day, and*
- (b) 45dBA (L₁₀), 7pm to 10pm every day, and*
- (c) 40dBA (L₁₀), and 65dBA (L_{max}) at all other times.*

- 3.4 These two rules set similar noise levels with the main difference being the location of the noise monitoring position. The Proposed District Plan adopts the assessment position as being *measured at any other site*. The Operative District Plan requires assessment to be undertaken *at or within the notional boundary*. It is noted that the Proposed District Plan rule is subject to appeal so has not been used in this evidence although the effects of this rule are considered as part of the assessment.

- 3.5 With respect to the proposed Te Kowhai substation at the existing Transpower substation there is already a designation for the site with a noise condition that sets the following limits when measured at the site boundary:

Monday to Friday	7:00am – 7:00pm	50dBA (L ₁₀)
Saturday	7:00am - 6:00pm	50dBA (L ₁₀)
At all other times including Public Holidays		40dBA (L ₁₀)

- 3.6 Based on the above it would be logical and consistent to adopt the same condition for the proposed Te Kowhai Substation.

Construction noise

- 3.7 Any construction activity in a Rural Zone must comply with the requirements of the Proposed District Plan Rule 25.18.1 (which is not subject to appeal), and states:

Any activity is a permitted activity if:

- (a) *it is designed and conducted so that construction noise from the activity complies with Appendix N (Construction Noise).*

- 3.8 Appendix N: Construction Noise states:

N2.1 All construction work, including maintenance and demolition work, on any site shall be designed and conducted to ensure that noise from the site does not exceed the noise limits in table 1. Sound levels shall be measured and assessed outside buildings affected by construction noise in accordance with the provisions of NZS6803:1999 Acoustics – Construction Noise.

TABLE 1

Time period	Weekdays (dBA)		Saturdays (dBA)		Sundays and Public Holidays (dBA)	
	L _{eq}	L _{max}	L _{eq}	L _{max}	L _{eq}	L _{max}
06:30 - 07:30	60*	75	45	75	45	75
07:30 - 18:00	75*	90*	75*	90*	55	85
18:00 - 06:30	45	75	45	75	45	75

*N2.2 * Where a site is exposed to construction work for a duration exceeding 20 weeks then 5dBA shall be subtracted from the noise limits marked.*

N2.3 The air-blast noise limit from the use of explosives shall not exceed a peak sound level of 120dBC measured and assessed outside affected buildings in accordance with

the provisions of NZS6803:1999 Acoustics – Construction Noise. Blasting practices shall conform to the provisions of AS2187: Part 2.

N2.4 Construction noise shall be managed using the methods set out in section 8 of NZS6803:1999 Acoustics – Construction Noise.

4. **CONSTRUCTION NOISE**

4.1 This section of my evidence will address potential noise issues arising from the construction phase of the project.

Te Kowhai Substation

4.2 The proposed Te Kowhai Substation is over 500m from the closest house so any equipment used during the construction of this substation will comply with the requirements of construction noise standard with a large factor of safety, assuming that no night time work is undertaken.

Te Uku Wind Park Substation

4.3 The Te Uku Wind Park Substation is well over 2km from the closest house, so that any construction work at this substation will comply with the requirements of the construction noise standard with a large factor of safety regardless of when the work is undertaken.

Sub-transmission line

4.4 During the construction of the sub-transmission lines, the work will be well clear of any houses for most of the time so the work will comply with the construction noise rule.

4.5 The poles may come as close as approximately 30m to a house, such as pole 196A (close to the Clarke house). The placement of the pole will be the noisiest part of the construction work and this will be carried out using a bulldozer with an auger to drill the hole and a crane to lift the pole into the hole, which will be filled with concrete. From my experience, the noise from this work will be up to 63dBA L_{eq} and 71dBA L_{max} , which is well within the noise limits of the construction noise standard of 75dBA L_{eq} and 90dBA L_{max} .

- 4.6 The construction work related to removing lines and placing lines will be quieter than the placing of poles so that work will also achieve the construction noise standard.

Helicopter Noise

- 4.7 There may be helicopters used to assist with some stages of the construction activities. As this would be part of the construction work it is appropriate to consider such noise effects in the same manner as any other construction activity.
- 4.8 In addition to the normal construction noise limits, it is recommended that any helicopter activity is required to operate in accordance with the recommendations of the Helicopter Association International Fly Neighborly Guidelines.

5. OPERATION NOISE

- 5.1 The purpose of this section of my evidence is to address the potential noise issues arising from the operation of the substations and lines.

Te Kowhai Substation

- 5.2 Noise from the proposed Te Kowhai substation will depend on the cumulative noise effects from the proposed substation plus the existing substation. It is therefore important to establish the amount of noise at the moment and from that information the amount of noise from the proposed substation can be determined.
- 5.3 The noise from the existing Te Kowhai substation was determined by visiting the site in the late afternoon when it was understood that the noise would be relatively high as the electric load was high. By adopting these measurements for the night time period, when the District Plan noise limits are the lowest, a factor of safety will be included in the analysis.
- 5.4 As it was impractical to measure the transformer noise at the site boundary due to the low noise level and relatively high background environment, measurements were undertaken close to the transformers and the site boundary level was predicted based on these measurements.

- 5.5 The noise from the existing transformers at the Te Kowhai site was measured at 23m from T1 and 27m from T2. As shown on Figure 1 the measured noise level was 50dBA L_{10} .

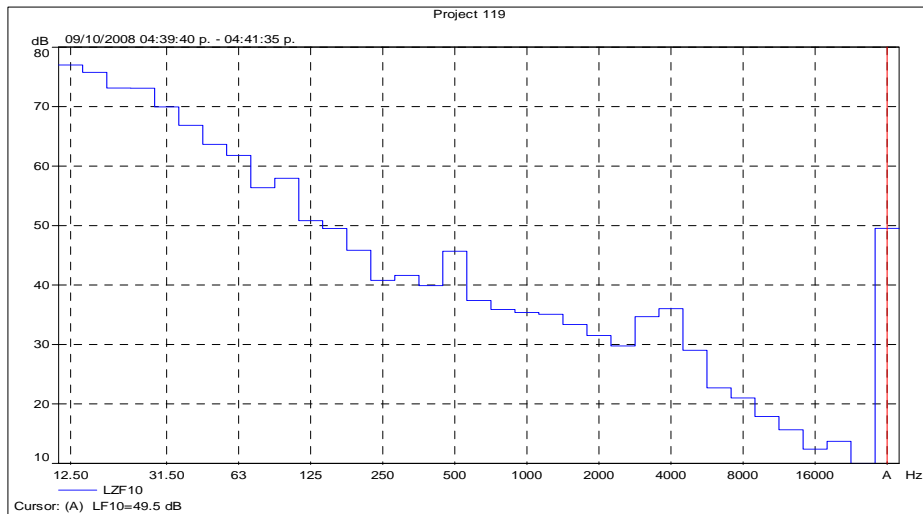


Figure 1. Transformer T1 at 23m & T2 at 27m

- 5.6 The only other significant noise source on site is from the injection signaling (ripple control). Although this is an intermittent sound, measurements were undertaken over a number of cycles of this equipment to achieve a meaningful result. The result of these measurements is 46dBA as shown on Figure 2.

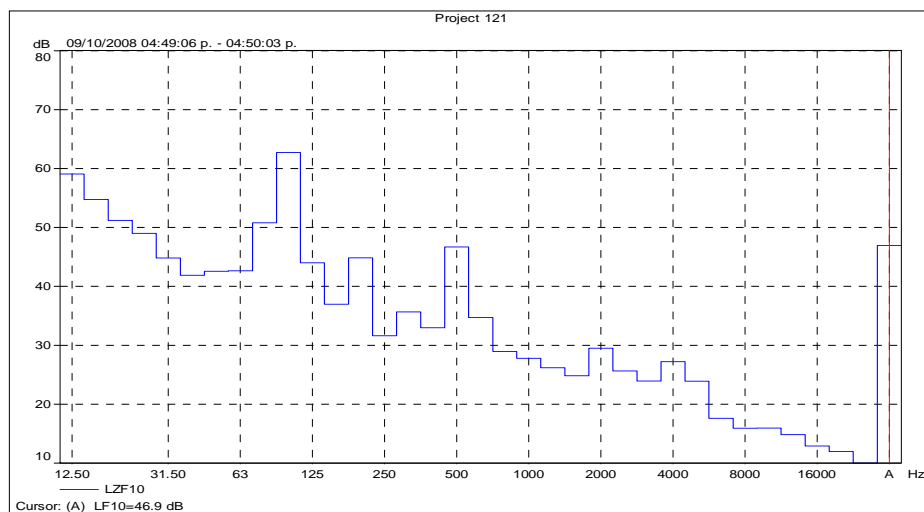


Figure 2. Injection Signalling at 3m

- 5.7 Based on the above measurements of the existing substation transformers the noise level (L_{10}) at the various site boundaries has been calculated at:

Northern Boundary	32dBA
Eastern Boundary	38dBA
Southern Boundary	34dBA
Western Boundary	32dBA

- 5.8 Based on these levels, and taking the additive effects of the existing substation into account, the noise from the proposed transformer will need to be no more than 60dBA L_{10} when measured at 5m from the transformer. This assumes the noise from the transformer has a tonal component so would attract a 5dBA penalty.
- 5.9 This is a similar level to the transformers already on site. Based on this, I calculate that the cumulative noise levels at the site boundaries will be within the 40dBA L_{10} night time requirements of the existing conditions.

Te Uku Wind Park Substation

- 5.10 Based on the noise as measured at various existing substations the resulting noise level at the closest notional boundary to the Te Uku Wind Park Substation will be below a calculated 5dBA. Even at the boundary of the Wind Park site the level will not exceed 15dBA. Based on this analysis, the Te Uku substation will be well within the proposed design requirements.

Lines Operation

- 5.11 Under normal conditions the lines themselves will be silent once they are in use. However, there is the potential of wind generated noise and noise from corona and surface discharging along the line insulation. While calculations can be undertaken to determine these effects the line voltage and size is at the bottom range of reliability for predictions so field measurements have been used in conjunction with technical literature available on the effects of corona and surface electrical discharging.

Corona

- 5.12 Corona is generated when the electrical voltage stress in the air close to energised components is so high that the air breaks down and becomes conductive. It causes electrical energy losses, and an audible 'hissing' or 'buzzing' noise. Because of the energy loss associated with both of these effects it is in the interests of the line designer and owner of the line to minimise them.
- 5.13 The proposed 110kV operating voltage for the overhead link is on the lower limit of voltages able to generate corona. This means that the potential for corona generated noise is small.

Surface Discharging (insulator noise)

- 5.14 Surface discharging results when conductive pollutants deposited on the surface of the insulators cause electricity to leak along the external surface. The accompanying noise is usually described as a 'crackling' or 'frying' sound. The level of this surface discharge is affected by the type of insulator used, the insulator design, and the level of contamination from the surrounding environment.
- 5.15 The insulators to be used on this line will be a modern design such as a high strength fibreglass core rod, jacketed with weather sheds of silicon rubber. The silicone rubber material acts to suppress surface discharging and results in an insulator that is very quiet.
- 5.16 The pollution level is critical to the operational noise level of the insulation. In particular, any location near the sea coast and where the prevailing winds carry sea salt inland can be expected to be noisier in operation, due to the increased leakage current down the conductive layer of damp surface salt. The overhead line is expected to get some wind blown salt and general pollution and these effects have been taken into account in the noise analysis.

Corona and insulator noise assessment

- 5.17 Measurements of lines similar to those proposed in this corridor have been undertaken at a number of existing sites on the outskirts of Christchurch and

in Auckland to determine both corona and insulator noise. From this work it is practical to check the prediction techniques used, which has demonstrated the level of accuracy of the predictions and hence provides a good level of confidence on the accuracy of the predictions for this project.

- 5.18 Some low level sounds were heard from the line at Albany during light rain conditions (one of the conditions considered most favourable for corona noise. Rain noise and a light wind (1 - 3m/s) generated some masking noise with the background sound (L_{95}) of 42dBA and the corona noise was audible below the existing background sound when standing approximately 3m to one side of the lines at the Albany site.
- 5.19 During the measurements of the existing Christchurch lines a light shower of rain fell. This shower was sufficient to make everything damp, although there was no resulting audible corona noise beneath these lines on this occasion.
- 5.20 Measurements of lines in the corridor from the Albany Substation to the North Shore Oxidation Ponds were undertaken during calm conditions and light rain. On this occasion, the corona noise was measured at the base of the poles at 42dBA (L_{10}).
- 5.21 In order to check any insulator noise, measurements were undertaken at the base of a 110kV line in central Auckland. When at the base of the poles at a quiet site at the back of Parnell, and in identical weather conditions as set out above for the Albany line, there was no audible noise from the insulators, which were older, and hence potentially noisier ones than will be used along this route.

Wind Noise

- 5.22 Wind generated noise in the lines is the other potential noise that may be experienced. Potential problem areas of wind noise can come from the insulators, conductors and components with hollow sections.
- 5.23 Wind noise from the wires, or moaning, is mainly associated with large conductors of 30mm or more in diameter compared to the 21mm diameter line to be used for this project.

- 5.24 Measurements of wind at an estimated 20m/s speed with gusts as high as approximately 30m/s in a line have been undertaken at the Christchurch site. To give an idea of the wind, this was sufficient to give a distinctive outward bend to the lines.
- 5.25 Noise is difficult to record in these conditions due to the wind effects on both the measuring equipment and the noise from wind in the trees. When the noise was measured in these conditions, well clear of any large trees (although there was a hedge nearby) and on open flat terrain, the wind noise in the lines was audible directly beneath the line. However, the main noise on this occasion was from noise generated in the general environment rather than the lines.
- 5.26 Measurements were also undertaken in a position well screened from the wind by a 4 - 5m high earth berm located 3 - 4m upwind of the transmission lines. This enabled measurements to be carried out beneath the lines where it was sheltered from the wind although the lines themselves were in the same relatively strong wind as set out above.
- 5.27 From this measurement and after taking into account the wind generated noise, the actual noise from the wind in the lines was established at 43dBA directly under the lines. The environmental noise generated around a house in wind speeds of 12 – 15m/s will be typically 50 - 55dBA so generally any wind noise from the lines will be masked by other wind generated sounds.
- 5.28 In stronger winds the noise in the transmission lines will increase. However, the background noise in the environment will also increase and as a result it is predicted that the relative noise between the background sound and line generated noise will remain about the same.
- 5.29 Generally the lines will be a minimum of 50m from any dwelling so there would not be any noise from the lines. However, where the lines are on the road reserve there are some houses within approximately 15m of the lines and within 4 - 5m of the site boundary.
- 5.30 The only time there is the potential to exceed the District Plan limit of 40dBA (L_{10}) at night time is when there is a high wind blowing. Under these

conditions general environmental noise will be greater than any wind generated noise from the lines.

6. PLANNER'S REPORT AND PROPOSED CONDITIONS

6.1 I have read the planner's report and generally agree with her findings and recommendations.

6.2 My only comment relates to the proposed noise conditions for the substation NORs and is suggested for the purpose of clarifying the conditions, not changing the aim of them. The proposed conditions set the following noise levels:

- | | | | |
|-----|--|-----------------|--------------------------|
| (a) | Monday to Friday | 7.00am – 7.00pm | 45dBA (L ₁₀) |
| (b) | Saturday | 7.00am – 6.00pm | 45dBA (L ₁₀) |
| (c) | At all other times including Public Holidays | | 35dBA (L ₁₀) |

6.3 These levels have been set at 5 dBA below the noise levels set by the District Plan on the basis that a tonal adjustment is required for transformer noise. However, the tonal adjustment is addressed by the requirement to assess the noise in accordance with NZS6802, and I note that this standard for assessment is required by the proposed conditions. Therefore, there is no need to provide for the 5 dBA reduction in the proposed conditions and they should be amended accordingly to read as follows (with additions underlined and deletions struck through):

Te Kowhai

Noise levels from the operation of the substation shall not exceed the following limits when measured on the boundary of the sited designated for the Transpower New Zealand Ltd Te Kowhai Substation:

- | | | | |
|----|--|-----------------|--|
| a) | Monday to Friday | 7.00am – 7.00pm | 45 <u>50</u> dBA (L ₁₀) |
| b) | Saturday | 7.00am – 6.00pm | 45 <u>50</u> dBA (L ₁₀) |
| c) | At all other times including Public Holidays | | 35 <u>40</u> dBA (L ₁₀) |

Noise shall be measured in accordance with NZS 6801:1991 – Measurement of Sound. Noise shall be assessed in accordance with NZS 6802:1991 – Assessment of Environmental Sound.

~~Advice Note~~

- ~~i) The above limits include a 5 dBA penalty for the tonal component of noise emissions from transformer. No further adjustment for the presence of special audible characteristics is required.~~

Te Uku

Noise levels from the operation of the substation shall not exceed the following limits when measured at or within the notional boundary:

- a) Monday to Friday 7.00am – 7.00pm ~~4550~~450dBA (L₁₀)
- b) Saturday 7.00am – 6.00pm ~~4550~~450dBA (L₁₀)
- c) At all other times including Public Holidays ~~3540~~350dBA (L₁₀)

Noise shall be measured in accordance with NZS 6801:1991 – Measurement of Sound. Noise shall be assessed in accordance with NZS 6802:1991 – Assessment of Environmental Sound.

Advice Note

- ~~i) The above limits include a 5 dBA penalty for the tonal component of noise emissions from transformer. No further adjustment for the presence of special audible characteristics is required.~~

- 6.4 All other noise related conditions are, in my opinion, appropriate and will address any noise related effects arising from the proposal.

7. CONCLUSIONS

- 7.1 Based on the noise analysis of the proposal to construct two substations and associated lines, I conclude that any construction noise will be able to be controlled to within the noise requirements of the Construction Standard (NZS6803:1999 Acoustics – Construction Noise) as set out in the Proposed District Plan at all times.
- 7.2 Once operating, the noise from the proposed development will be well within the recommended noise controls (as set out in the District Plan) and below the existing noise environment.

Nevil Hegley
March 2009