



UNION FENOSA WIND AUSTRALIA

Crookwell 3 Wind Farm
Chapter 10

NOISE IMPACTS

10 Noise

10.1 Introduction

SLR Consulting Australia Pty Ltd, formerly Heggies Pty Ltd, was engaged to prepare a noise impact assessment of the proposed Crookwell 3 Wind Farm. The noise impact assessment report and memorandum for the report can be found at **Appendix 7**. The report details the main aspects of the proposed wind farm project, the acoustic criteria, the background noise measurements and the predicted noise level at all potentially impacted receivers from the operation of the proposed wind farm. It also addresses the acoustic impact of the wind farm during the construction phase, including blasting and traffic noise.

As requested by the Director General on 18 April 2012, further assessment work has been undertaken to address the additional requirements of the proposed *Draft NSW Wind Farm Planning Guidelines – Appendix B: NSW wind farm noise guidelines* issued by DoPI in December 2011. This involves consideration of separate daytime and night-time periods and alternative methods of evaluation for ‘Special Audible Character’, discussed in **Chapter 10.4** below.

10.2 Methodology

The methodology and criteria used in the noise impact assessment are supported by the South Australian Environmental Protection Authority *Environment Noise Guidelines for Wind Farms (February 2003)* (SA EPA Guideline), World Health Organization *Guidelines for Community Noise* (WHO Guideline), construction noise guidelines (DECCW Interim Construction Noise Guideline 2009) and blasting impact guidelines (ANZECC guideline *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*).

The methodology and acceptability limit criteria that were applied to in the noise assessment are based upon the SA EPA Guidelines. The principal acceptability limit criteria in the SA EPA Guidelines are that the wind farm LA90 (10 min) noise should not exceed the greater of:

- an amenity limit of 35 dBA; or
- the pre-existing background noise by more than 5 dBA (for any given wind speed).

The noise emission model used in the noise impact assessment to predict wind farm noise levels at sensitive receptors is based on ISO 9613, as implemented in the SoundPLAN computer noise model. The model predicts noise levels through spherical spreading and includes the effect of air absorption (as per ISO 9613), ground attenuation and shielding.

Noise monitoring was conducted from 30 June to 16 July 2010 at eleven nearby locations to determine baseline conditions and establish indicative criteria for surrounding residential receivers. The assessment identified 116 residential receivers surrounding the site, the names and locations of which are listed in the report.

Predictions for cumulative WTG noise levels were completed for two alternative possibilities:

- the existing Crookwell 1 Wind Farm and the proposed Crookwell 3 Wind Farm; and
- the existing Crookwell 1 Wind Farm, approved Crookwell 2 Wind Farm and proposed Crookwell 3 Wind Farm.

In general, the assessment procedure was based on the following steps:

- Predict and plot the LAeq 35 dBA noise level contour from the wind farm under reference conditions.
- Receivers outside the contour are considered to be within acceptable wind farm noise levels.

- *Establish the pre-existing background noise level at each of the relevant assessment receivers within the LAeq 35 dBA noise level contour through background noise monitoring.*
- *Predict wind farm noise levels at all relevant assessment receivers for the wind range from cut-in of the WTG to approximately 10 m/s.*
- *Assess the acceptability of wind farm noise at each relevant assessment receiver to the established limits.*

Noise predictions were made for receptors within a 6 km radius of the indicative location of each wind turbine proposed for the Crookwell 3 Wind Farm.

Four alternative turbine models were considered and assessed as part of the noise impact assessment:

- GE 2.5xl, 100m rotor diameter, 100m hub height, 2.5 MW;
- Vestas V90, 90m rotor diameter, 105m hub height, 2.0 MW;
- Vestas V100, 100m rotor diameter, 95m hub height, 1.8 MW; and
- REpower MM92, 93m rotor diameter, 100m hub height, 2.0 MW.

As described in **Chapter 5.2** of this EA, the turbine models above, as well as another four models (N100, E101, SWT101 and M104) are listed as the turbine models under consideration. The noise impact assessment considered GE 2.5xl, Vestas V90, Vestas V100 and Repower, as these have been selected as the preferred models for this project at this stage. The remaining models, if chosen, will be subject to further noise assessment.

Where modelling was conducted for the purposes of the noise impact assessment, the modelled hub height represents the maximum height in the range being considered for that particular turbine model.

10.3 Results

Noise generated by the turbine indicative layout of the four selected turbine models was predicted and assessed by SLR Consulting against the relevant criteria prescribed by the SA EPA Guideline and the WHO Guideline goals where appropriate.

Cumulative noise from the existing Crookwell 1 Wind Farm and the proposed Crookwell 3 Wind Farm

SLR Consulting assessed the potential cumulative noise generated from the turbines from the existing Crookwell 1 and proposed Crookwell 3 Wind Farms. Exceedances of the SA EPA Guideline limit were predicted for all four investigated WTGs, with the Vestas V90 turbine layout resulting in 2 exceedances of the SA EPA Guideline limit. Of the 116 identified receivers surrounding the site, 10 houses were predicted to receive noise levels above the limit prescribed by the SA EPA Guideline by one or more of the turbine models. The results are presented in **Table 16** below.

A mitigated operation scenario was considered where one turbine is turned off and a select few WTG's are operated in a 'low noise' mode for a limited range of wind speeds. In this scenario, the predicted reduction in noise levels *"resulted in no exceedances of the SA EPA Guideline limit"*.

Table 16 – Summary of receptors predicted to exceed limits based on Crookwell 1 and Crookwell 3 Wind Farms

	GE 2.5xl	V90	V100	MM92
House	Exceedance	Exceedance	Exceedance	Exceedance
House 8	1.1 dBA@8.2 m/s	-	-	2.4 dBA@8.2 m/s
House 19	1.0 dBA@8.2 m/s	-	-	2.4 dBA@8.2 m/s
House 59	-	-	-	0.6 dBA@8.2 m/s
House 61	0.1 dBA@8.2 m/s	-	-	1.1 dBA@8.2 m/s
House 62	-	-	-	1.2 dBA@8.2 m/s
House 64	-	-	-	0.7 dBA@8.2 m/s
House 65	-	-	-	0.6 dBA@8.2 m/s
House 66	6.3 dBA@9.6 m/s	3.0 dBA@9.6 m/s	3.3 dBA@9.6 m/s	6.5 dBA@9.6 m/s
House 67	3.9 dBA@9.6 m/s	0.8 dBA@9.6 m/s	0.6 dBA@9.6 m/s	4.1 dBA@9.6 m/s
House 69	1.1 dBA@8.2 m/s			2.5 dBA@8.2 m/s
Exceedances	6	2	2	10

Cumulative noise from the existing Crookwell 1 Wind Farm, the approved Crookwell 2 Wind Farm and proposed Crookwell 3 Wind Farm.

SLR Consulting then assessed the potential cumulative noise generated from the turbines from the existing Crookwell 1 Wind Farm, approved Crookwell 2 Wind Farm and the proposed Crookwell 3 Wind Farm. Please refer to **Figures 39, 40, 41 and 42 – Noise Contour Maps** for the noise modelling of the four WTG models and the surrounding receivers.

Exceedances of the SA EPA Guideline limit were predicted for all four investigated WTGs, with the Vestas V90 WTG layout resulting in 7 exceedances. Of the 116 identified receivers surrounding the site, 10 houses were predicted to receive noise levels above the limit prescribed by the SA EPA Guideline by one or more of the WTG models. The results are presented in **Table 17** below.

The report notes that CDPL proposes to negotiate noise agreements with House 8, House 20, House 66 and House 67 as well with as the host properties.

A mitigated operation scenario was considered where a select few turbines (Vestas V90) from both the approved Crookwell 2 Wind Farm and the proposed Crookwell 3 Wind Farm are operated in a 'low noise' mode. The resulting reduction in cumulative noise levels at potentially affected receptors *"was sufficient to reduce the total number of cumulative noise exceedances to 1 (House 70 Exceedance of 0.3 dBA at 8.2 m/s) which would be considered only marginal"*.

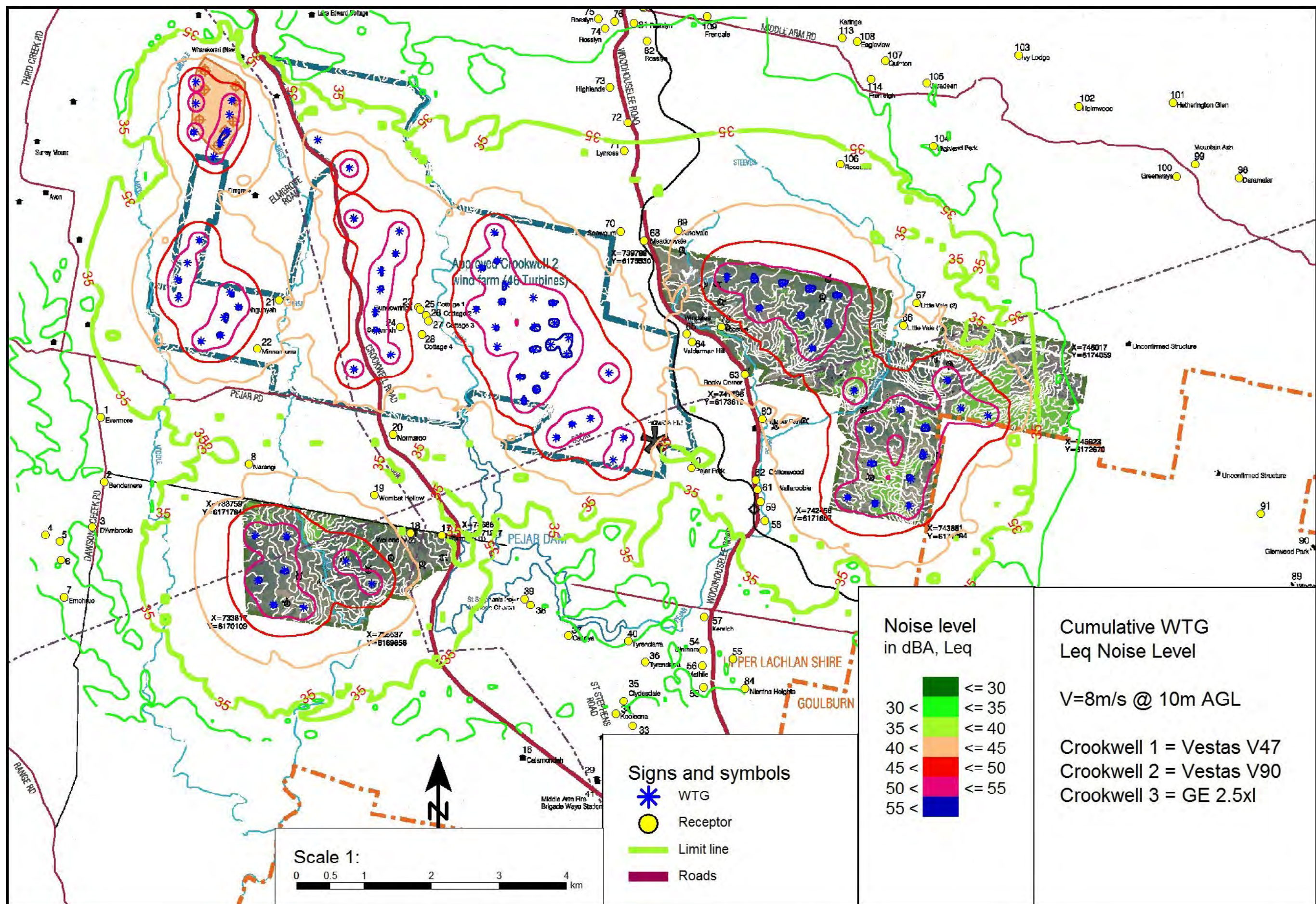


FIGURE 39 GE 2.5xl 2.5MW, LAeq Noise Contour Map for Crookwell 1, Crookwell 2 and Crookwell 3 Wind Farms

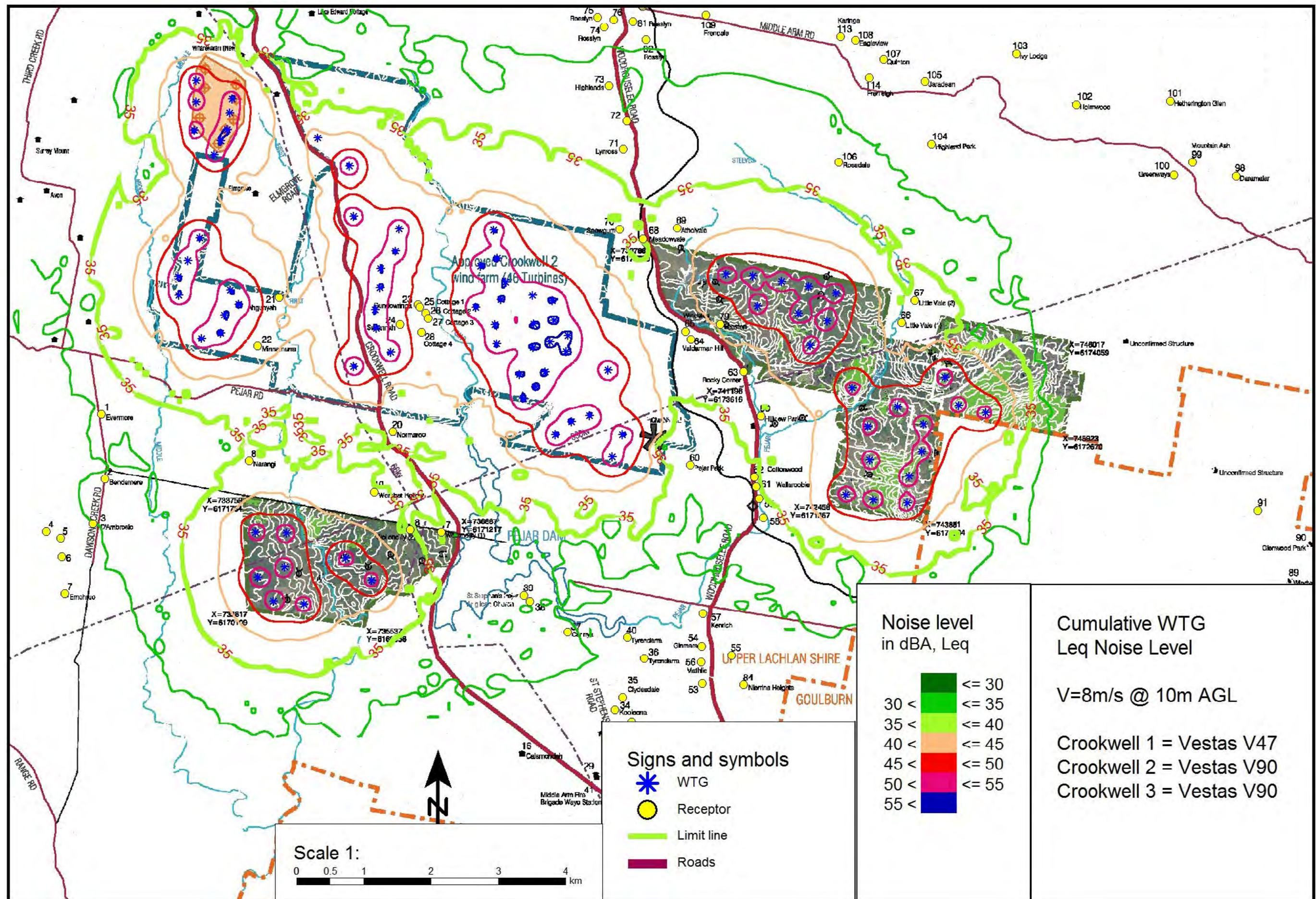


FIGURE 40 Vestas V90 2MW, LAeq Noise Contour Map for Crookwell 1, Crookwell 2 and Crookwell 3 Wind Farms

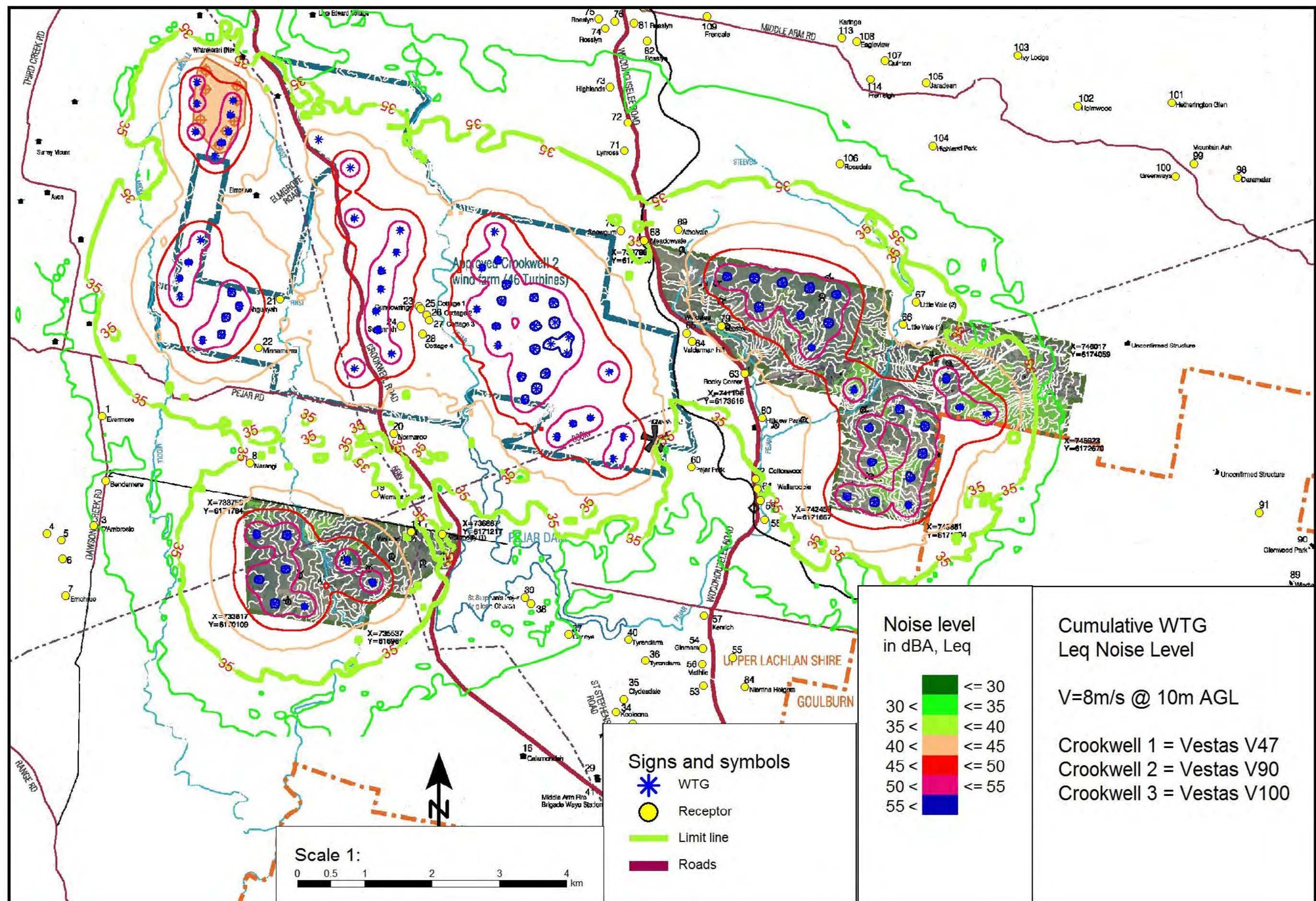


FIGURE 41 Vestas V100 1.8MW, LAeq Noise Contour Map for Crookwell 1, Crookwell 2 and Crookwell 3 Wind Farms

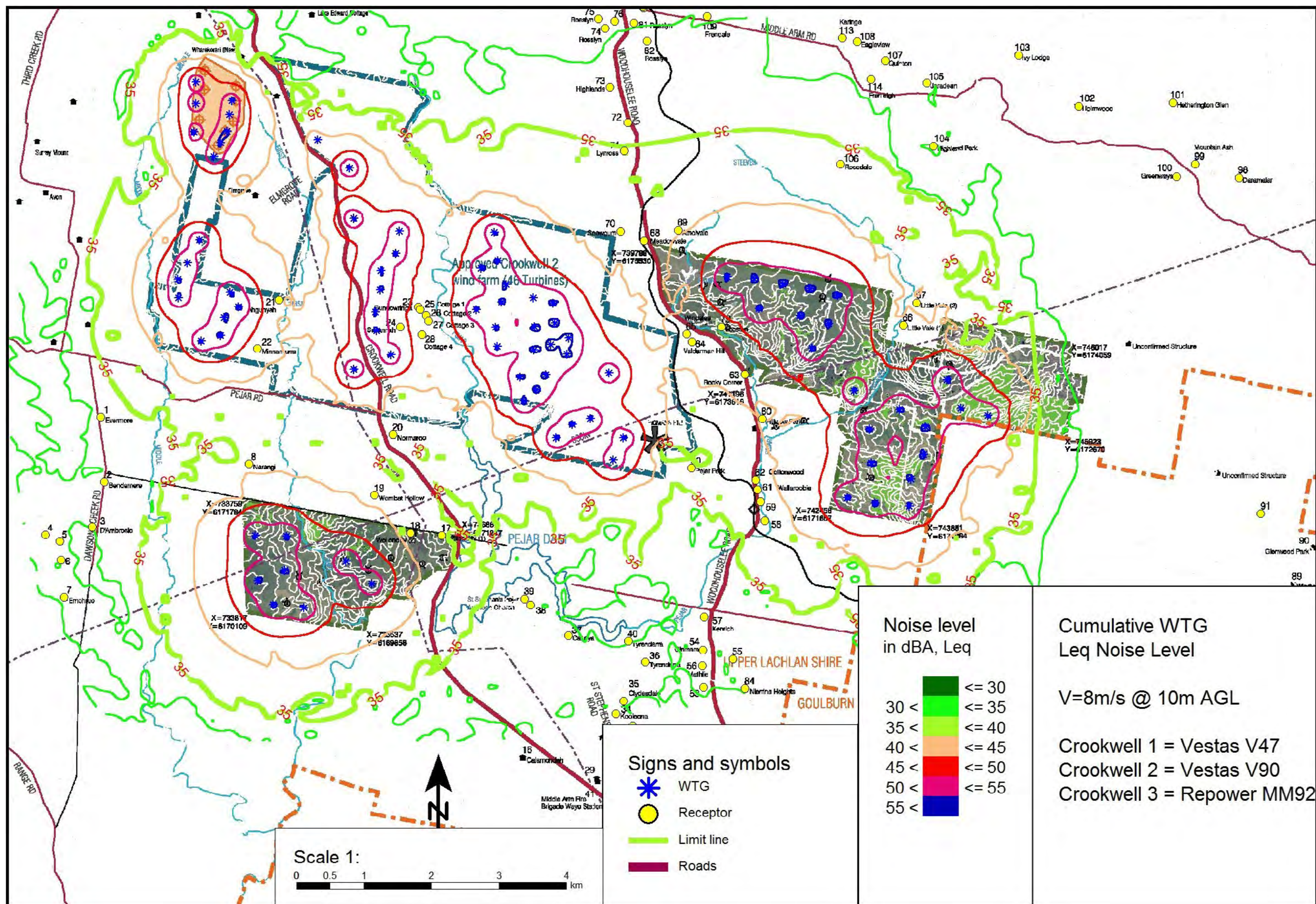


FIGURE 42 Repower MM92 2MW, LAeq Noise Contour Map for Crookwell 1, Crookwell 2 and Crookwell 3 Wind Farms

Table 17 – Summary of receptors predicted to exceed limits based on Crookwell 1, Crookwell 2 and Crookwell 3 Wind Farms

	GE 2.5xl	V90	V100	MM92
House	Exceedance	Exceedance	Exceedance	Exceedance
House 8	2.6 dBA@8.2 m/s	1.3 dBA@8.2 m/s	1.5 dBA@8.2 m/s	3.6 dBA@8.2 m/s
House 17	0.6 dBA@8.2 m/s	-	-	1.5 dBA@8.2 m/s
House 19	2.5 dBA@8.2 m/s	1.1 dBA@8.2 m/s	1.2 dBA@8.2 m/s	3.5 dBA@8.2 m/s
House 20	2.9 dBA@8.2 m/s	2.4 dBA@8.2 m/s	2.2 dBA@8.2 m/s	3.2 dBA@8.2 m/s
House 58	-	-	-	0.2 dBA@8.2 m/s
House 59	-	-	-	0.9 dBA@8.2 m/s
House 61	0.1 dBA@8.2 m/s	-	-	1.4 dBA@8.2 m/s
House 62	-	-	-	1.4 dBA@8.2 m/s
House 64	0.9 dBA@8.2 m/s	-	-	1.9 dBA@8.2 m/s
House 65	0.8 dBA@8.2 m/s	-	-	1.8 dBA@8.2 m/s
House 66	6.3 dBA@9.6 m/s	3.0 dBA@9.6 m/s	3.3 dBA@9.6 m/s	6.3 dBA@9.6 m/s
House 67	3.9 dBA@9.6 m/s	0.9 dBA@9.6 m/s	0.7 dBA@9.6 m/s	3.9 dBA@9.6 m/s
House 68	1.0 dBA@8.2 m/s	-	-	1.8 dBA@8.2 m/s
House 69	2.7 dBA@8.2 m/s	1.4 dBA@8.2 m/s	1.4 dBA@8.2 m/s	3.7 dBA@8.2 m/s
House 70	2.2 dBA@8.2 m/s	1.7 dBA@8.2 m/s	1.5 dBA@8.2 m/s	2.7 dBA@8.2 m/s
Exceedances	12	7	7	15

Based on the investigation of the sound profiles of all turbine models under consideration, a summary of the results from the combined noise impact of the Crookwell 1, 2 and 3 Wind Farms is shown below in **Table 18**.

Table 18 – Summary of WTG model and predicted noise level for Crookwell 1, Crookwell 2 and Crookwell 3 Wind Farms

Vestas V90	V90 WTG model equipped with 90m rotor diameter and a capacity of 2.0 MW. Using this model in the layout, 7 receivers were above the 'Background + 5 dBA' intrusive criteria. All non-host properties are predicted to be within the nominated WHO Guideline noise limits.
Vestas V100	V100 WTG model equipped with 100m rotor diameter and a capacity of 1.8 MW. Using this model in the layout, 7 receivers were above the 'Background + 5 dBA' intrusive criteria. All non-host properties are predicted to be within the nominated WHO Guideline noise limits.
GE 2.5xl	GE 2.5xl WTG model equipped with 100m rotor diameter and a capacity of 2.5 MW. Using this model in the layout, 12 receivers were above the 'Background + 5 dBA' intrusive criteria. All non-host properties are predicted to be within the nominated WHO Guideline noise limits.
REPower MM92	MM92 WTG model equipped with 93m rotor diameter and a capacity of 2.0 MW. Using this model in the layout 10 receivers were above the 'Background + 5 dBA' intrusive criteria. All non-host Properties are predicted to be within the nominated WHO Guideline noise limits.

The results of the assessment found that “*all non-host properties are predicted to be within the nominated World Health Organisation (WHO) Guideline noise limits*”. The noise impact for the receivers that are predicted to experience noise levels exceeding the 'Background + 5 dBA' intrusive criteria is expected to be minimised by the mitigation measures proposed in the report, which are summarised in **Chapter 10.5** below.

The assessment also found that:

- *Construction noise impact has been assessed and the 'worst case' scenarios modelled were found to be generally acceptable.*
- *Blasting impact has been assessed and found to be acceptable. With a maximum instantaneous charge (MIC) of up to 21 kg, the airblast overpressure is anticipated to be below the acceptable level of 115 dB Linear for all existing residences.*
- *The 'worst case' maximum construction traffic generated scenario modelled would increase existing traffic noise levels when measured along local roads by up to 3-7 dBA.*
- *Due to the typically large setback of dwellings from the road network in the area, it is considered that the construction traffic noise would result in noise level that would be considered acceptable under the NSW DECCW Environmental criteria for Road Traffic Noise (ECRTN).*

The noise impact assessment states that:

"The noise modelling procedure undertaken as part of the noise impact assessment relies on a number of conservative assumptions, the foremost being that noise propagates downwind from each source. This will overestimate the predicted noise level where receptors have WTGs located around them in more than a singular direction or quadrant as wind is not able to blow in more than one directional quadrant simultaneously. This exact scenario describes the relative positioning the receptors identified as exceeding SA EPA Guideline levels have with respect to WTGs from Crookwell 2 and Crookwell 3. The degree to which this conservative assumption potentially over-estimates noise levels has been evaluated by predicting noise at compliance critical receptors using alternative algorithms and specific wind directions of easterly and westerly versus all downwind. The predicted degree of conservatism of the all downwind assumption is expected to be greater than the predicted exceedances."

For this reason, SLR Consulting concluded that:

"During commissioning of the proposed Crookwell 3 Wind Farm the actual received WTG noise level will need to be verified and determined through extensive monitoring."

Construction Noise

The construction noise assessment conducted by SLR Consulting found that:

"The predicted 'worst case' construction noise impacts ... are, for most receiver locations, below management level and indeed below the existing typical daytime rating background level and so are unlikely to result in adverse reaction".

The highest noise levels are "a result of the operation of a rock-breaker during turbine foundation establishment". However this would be operated 'intermittently at most'.

The CEMP will contain mechanisms to prevent any unreasonable impact of construction noise on sensitive receivers.

No receptors are predicted to exceed 75 dBA or in the category of highly noise affected.

Blasting

The blasting impact assessment conducted by SLR Consulting concluded that:

"Blasting impact has been assessed and found to be acceptable. With a maximum instantaneous charge (MIC) of up to 21 kg, the airblast overpressure is anticipated to be below the acceptable level of 115 dB Linear for all existing residences."

Traffic Noise

SLR Consulting concluded the following in relation to construction traffic noise assessment:

"It is considered that the construction traffic noise would result in noise level that would be considered acceptable under the NSW DECCW Environmental criteria for Road Traffic Noise (ECRTN)."

10.4 Draft NSW Wind Farm Planning Guidelines (December 2011)

SLR Consulting has addressed to a number of additional requirements of the *Draft NSW Wind Farm Planning Guidelines*. Refer to Chapter 12 of the Noise Assessment found at **Appendix 7** of this report for full details and results of the assessment.

10.4.1 Daytime and night-time background noise

The background noise data was reprocessed to define background noise curves for the daytime period (7.00 am to 10.00 pm) and night-time period (10.00 pm to 7.00 am), in accordance with the draft guidelines. The new background noise curves were used to update the noise limit curves for all receptors and all predicted

results were assessed against these criteria. The set of assessment graphs are presented in Appendix F of the Noise Assessment, found at **Appendix 7** of this report.

The assessment found that the noise exceedances for the *Draft NSW Wind Farm Planning Guidelines* Daytime Criteria at the non-host properties were all smaller in total and magnitude for all WTG model layouts than the previous assessment that was based on the 24 hour all-data set.

The noise exceedances for the Night-Time Criteria at the non-host properties were greater in total and magnitude for all layouts. This was due to the lower night-time background noise at the critical lower wind speeds (6 - 7 metres per second) compared to the 24 hour all-data set in the previous assessment.

Table 19 below summarises the noise exceedances for each WTG model at non-host properties using the *Draft NSW Wind Farm Planning Guidelines* criteria compared to the exceedances found from the previous assessment.

Table 19 –Noise exceedances at non-associated households (daytime vs. night-time)

Draft guidelines criteria	GE 2.5x1 2	V90	V100	MM92
Daytime exceedances	7 (5 less than previous assessment)	5 (2 less than previous assessment)	4 (4 less than previous assessment)	11 (4 less than previous assessment)
Night-time exceedances	13 (1 more than previous assessment)	9 (2 more than previous assessment)	8 (Same as previous assessment)	16 (1 more than previous assessment)

Overall, the assessment found the noise exceedances to be acceptable.

10.4.2 Special Audible Characteristics

SLR Consulting assessed the predicted levels of levels of swish, modulation, discrete tones and low frequency noise, otherwise known as 'Special Audible Characteristics', for the proposed wind farm.

The assessment found that:

- *The results from the SoundPlan model [low frequency noise] predict that wind turbine noise would not exceed 60 dBC for any receiver location.*
- *The tonality tests showed no presence of tonality in the predicted results.*
- *There currently is no means to predict the eventuality, severity or frequency of occurrence of excessive amplitude modulation... excessive amplitude modulation has only been confirmed at a small number of wind farm sites and when it occurs it is relatively infrequent.*
- *Nevertheless, should excessive amplitude modulation be found to be a problem with the wind farm, it would be possible to limit the impact on the residents through adaptive management techniques.*

Therefore it is found that the predicted 'Special Audible Characteristics' for the proposed wind farm are acceptable and manageable.

10.5 Mitigation

In circumstances where undue turbine noise impacts are identified during operations due to temperature inversion, atmospheric stability or excessive level then an '*adaptive management*' approach can be implemented, which includes:

- *Identifying exactly what conditions or times lead to undue impacts.*
- *Operating selected WTGs in a reduced 'noise optimised' mode during identified times and conditions (sector management).*

- *Providing acoustic upgrades (glazing, façade, masking noise etc) to affected dwellings.*
- *Turning off WTGs that are identified as causing the undue impact during identified times and conditions.*

When the turbine model is known, a Noise Management Plan will be prepared and implemented to ensure that if the selected turbine does not comply under the predictive noise modelling, mitigation would be undertaken so that the applicable standards are met.

SLR Consulting has developed noise impact mitigation strategy in order to address the cumulative noise impacts arising from the operational Crookwell 1 Wind Farm, the approved Crookwell 2 Wind Farm and the proposed Crookwell 3 Wind Farm which includes:

- *Developing a mitigated noise operation layout.*
- *Entering into agreements, in accordance with Section 2.3 of the SA EPA Guideline, with selected neighbouring landowners.*
- *Applying acoustic treatment to impacted dwellings.*

10.5.2 Mitigated noise operation layout

The 'mitigated noise operation layout' would involve a number of WTG operating in 'low noise' mode. In this instance, *"the control mechanism effectively modifies the blade angle to reduce rotor and inflow air speed and results in lower noise emissions at slightly reduced energy recovery"*.

SLR Consulting has modelled the mitigated noise operation by selecting certain WTGs to operate in 'low noise' mode. The modelling shows that *"general compliance for cumulative noise impacts can be achieved at all receptors with marginal exceedances predicted at House 8 (1 dBA@8.2 m/s), House 20 (1.3 dBA@8.2 m/s), House 66 (3 dBA@9.6 m/s), House 67 (0.4dBA@9.6 m/s), House 70 (0.3 dBA @ 8.2 m/s)"*.

SLR Consulting notes that:

"The most effective method for mitigating the impact of cumulative noise of all wind farms would be a collaborative noise management approach. The proponent of the proposed Crookwell 3 Wind farm has committed to entering into an arrangement with the proponent of the approved Crookwell 2 Wind Farm to address cumulative noise impacts."

10.5.3 Agreements

SLR Consulting notes that:

"Agreements with the landowners of House 8, House 20, House 66 and House 67 are proposed by the proponent. Should negotiations succeed and agreements be entered into then these properties would be treated in the same consideration as host properties. These properties are predicted to comply with World Health Organisation based limits".

"If negotiations for agreements are unsuccessful then the following adaptive management approach is proposed:

- *Verify actual WTG noise levels through comprehensive noise monitoring.*
- *Evaluate turning off WTG(s) during specific wind direction and speed that are identified as causing the exceedances and undue impact on the affected dwellings.*
- *Evaluate the acoustic design of the dwellings and provide acoustic upgrades (glazing, façade, masking noise etc) to the affected dwellings.*
- *Upon landowner initiated acquisition request, proceed with negotiations and give consideration to acquire the affected dwelling.*

- *If the above options are unsuccessful, the WTG(s) will be taken offline for further investigation and if impact is not able to be resolved then remove the WTG(s) causing the unresolved exceedances from the layout”.*

10.5.4 Acoustic treatment to impacted dwellings

Where properties have been found to exceed the relevant SA EPA Guideline criteria CDPL “*will commit to, at the dwelling owner’s request, undertaking a detailed acoustic assessment of the dwelling and designing and installing appropriate building acoustic treatments to reduce the impact of WTG noise*”.

The type of acoustic treatment required will depend upon the construction of dwelling and desired noise reduction, however, treatment may include;

- *Provision for mechanical ventilation.*
- *Upgraded glazing and seals.*
- *Upgraded doors and seals.*
- *Provision for low level noise masking.*

Improvement in the sound transmission loss of a typical dwelling of between 5-10 dBA would be possible.