Bango Wind Farm

Revised Environmental Noise Assessment

S3958.1C3

May 2019

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Reviewed by	:	Jason Turner, MAAS

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1 INTRODUCTION / BACKGROUND

An environmental noise assessment for the proposed Bango Wind Farm was conducted and detailed in the Sonus report S3958C9, dated June 2016 (the Principal Assessment).

A supplementary environmental noise assessment was later conducted to consider changes to the Project, which included a revision to the wind speed data used for correlation with background noise; a revision to the proposed wind turbine layout and minor corrections to the coordinates of some residences. The assessment was detailed in the Sonus report S3958C12, dated May 2017 (the Supplementary Assessment).

Development Consent for the Project (Application Number SSD 6686) has been granted, which includes a number of Conditions related to environmental noise.

The final turbine layout has now been chosen and microsited, consisting of 46 GE 5.3-158 wind turbines with 121m hub height. This report provides a preconstruction noise assessment of the final turbine layout, addressing conditions 3.8, 3.9 and 3.10 of the Development Consent.

2 WIND TURBINE LAYOUTS

The final wind turbine layout comprises 46 wind turbines. The coordinates of the wind turbines are provided in Table 1.

Table 1: Coordinates of final wind turbine layout.

Turbine ID	Approved ID	Coordinates (UTM WGS84 Z55)	
		Easting	Northing
B1	1	671635	6174823
B2	57	670573	6170852
B3	2	672560	6169425
B4	118	664891	6173842
B5	7	671261	6169953
B6	3	671248	6172699
B7	41	664951	6176135
B8	122	672545	6169104
B9	80	671391	6173455
B10	88	663812	6174702
B11	60	671510	6173115
B12	67	672214	6170549
B13	44	664776	6174251
B14	46	671384	6170372
B15	14	664750	6172775
B16	85	670977	6171358
B17	58	671293	6174210
B18	47	671146	6169219
B19	87	663792	6172165
B20	11	664960	6171750
B21	22	670538	6170541
B22	49	664807	6175836
B23	76	665339	6176746

Turbine ID	Approved ID	Coordinates (UTM WGS84 Z55)	
		Easting	Northing
B24	18	663626	6172806
B25	63	663076	6174017
B26	94	664805	6174568
B27	110	671330	6172395
B28	73	665139	6172053
B29	97	664759	6175524
B30	115	664639	6175026
B31	104	664803	6173538
B32	24	671223	6169599
B33	89	663654	6173124
B34	54	671371	6174603
B35	13	671700	6173807
B36	96	664074	6173460
B37	35	663776	6172480
B38	27	664754	6172456
B39	100	670759	6171107
B40	107	672456	6168507
B41	98	665160	6176395
B42	50	671008	6173930
B43	32	672679	6167892
B44	61	672662	6168208
B45	12	672646	6169751
B46	5	672415	6168817

3 RESIDENCES SURROUNDING THE WIND FARM

Residences located within 4km of the wind farm are listed in Table 2 and shown in the site layout provided as Appendix A. The status of the land owners (associated or non-associated) of the residences are indicated in the table.

Table 2: Residences within 4km of the wind turbines.

Receiver ID	Coordinates (UTM WGS84 Z55)		Associated Land Owner
	Easting	Northing	
BAN020	665722	6178761	Yes
BAN021	667884	6172737	Yes
BAN026	667373	6168710	Yes
BAN032	672635	6174096	Yes
BAN035	674957	6174740	No
BAN041	672598	6175449	Yes
BAN042	661039	6169519	No
BAN043	658490	6173393	No
BAN048	674793	6177078	No
BAN055	675055	6165317	Yes
BAN060	668962	6166711	No
BAN062	661390	6169789	No
BAN076	663854	6169306	Yes
BAN087	668133	6171952	Yes
BAN100	673030	6169297	Yes
BAN101	666370	6176268	Yes
BAN106	674765	6172626	No
BAN108	660693	6170275	Yes
BAN115	673902	6168649	Yes
BAN117	664596	6169872	Yes
BAN136	674135	6169504	Yes
BAN138	674728	6164928	No
BAN142	670364	6177556	No
BAN144	668769	6167707	Yes
BAN152	674475	6171888	No

Receiver ID	Coordinates (UTM WGS84 Z55)		Associated Land Owner
	Easting	Northing	
BAN154	667088	6176107	Yes
BAN155	666730	6176414	Yes
BAN158	666936	6175290	Yes
BAN159	667506	6168917	Yes
BAN162	660074	6173884	Yes
BAN164	667492	6168869	Yes
BAN165	667447	6168827	Yes
BAN166	667440	6168580	Yes
BAN170	669036	6176903	No
BAN173	674209	6165923	Yes
BAN176	665662	6180278	No
BAN179	663462	6168501	No
BAN181	661493	6168919	No
BAN182	660693	6170348	Yes
BAN187	661093	6169533	No
BAN188	661046	6169539	No
BAN189	660065	6173665	Yes
BAN225	662546	6179407	Yes
BAN235	663846	6169475	Yes
BAN238	670657	6166162	No
BAN243	674789	6172958	No
BAN260	661449	6169886	No
BAN276	668769	6167755	No
BAN282	666714	6178407	No

4 Condition 3.8

4.1 Blasting Criteria

Development Consent Condition 8 in *Schedule 3 Environmental Conditions – General* states the following operational noise requirements for blasting:

> *The applicant must ensure that any blasting carried out on site does not exceed the criteria in Table 1.*

Table 1: Blasting Criteria

Location	*Airblast overpressure (dB(Lin Peak))*	*Ground Vibration (mm/s)*	*Allowable exceedance*
Any Non-associated residence	*120*	*10*	*0%*
	115	*5*	*5% of the total number of blasts or events over a rolling period of 12 months*

4.2 Assessment

The levels of airblast and ground vibration experienced at residences from blasting operations are dependent on a number of factors, including:

- the distance between the blast site and the residence;
- the type, size and number of charges used, and
- the depth and manner in which the charge is installed.

The required locations for blasting and the design of the blasts have not yet been determined. However, with the potential blasting activity at turbine foundations, the separation distances to the nearest non-associated residences are likely to result in ground vibration and airblast levels below the criteria. Given the range of factors associated with both the generation and control of blasting noise and vibration, it is recommended that a monitoring regime be implemented to ensure the objective criteria are achieved.

During the first blasting activity, the following test regime will enable compliance with condition 3.8 to be determined:

- Measure the peak particle velocity and sound pressure level at a distance similar to the closest expected separation distance to enable comparison and confirmation of compliance with the requirements of condition 3.8;
- Adjust the blasting procedure if necessary to ensure compliance with the requirements.
- Prior to any blasting activity that differs from that tested, repeat the above procedure.

5 CONDITION 3.9

5.1 Wind Turbine Operation Criteria

Development Consent Condition 9 in *Schedule 3 Environmental Conditions – General* states the following operational noise requirements for the wind turbines:

> 9. *The Applicant must ensure that the noise generated by the operation of wind turbines does not exceed the relevant criteria in Table 2 at any non-associated residence.*

Table 2: Noise criteria dB(A)

Residence	***Criteria (dB(A) with Reference to Hub Height Wind Speed (m/s)***									
	3	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
26, 166	*35*	*35*	*35*	*35*	*35*	*35*	*36*	*38*	*39*	*42*
60	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*37*	*39*
62, 76, 179, 235, 260	*36*	*36*	*36*	*37*	*37*	*37*	*37*	*38*	*38*	*40*
106, 152, 243	*35*	*35*	*36*	*36*	*37*	*37*	*38*	*39*	*40*	*42*
144, 276	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*36*	*37*	*40*
165	*35*	*35*	*35*	*35*	*35*	*35*	*36*	*38*	*39*	*42*
170	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*36*	*38*
282	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*37*
43	*35*	*35*	*36*	*37*	*37*	*37*	*37*	*38*	*39*	*40*
48	*35*	*35*	*37*	*38*	*39*	*40*	*40*	*41*	*42*	*43*
138	*36*	*36*	*36*	*36*	*37*	*37*	*38*	*39*	*40*	*42*
All other non-associated residences	*The higher of 35 dB(A) or the existing background noise level ($L_{A90(10\text{-}minute)}$ plus 5 dB(A)*									

> *Noise generated by the operation of the wind turbines is to be measured in accordance with the relevant requirements of the Department's Wind Energy: Noise Assessment Bulletin (2016) (or its latest version), and the provisions in Appendix 5.*
>
> *However, these criteria do not apply if the Applicant has an agreement with the relevant owner/s of these residences to generate higher noise levels, and the Applicant has advised the Department in writing of the terms of this agreement.*

It is noted that six of the residences in the above table (26, 76, 144, 165, 166, 235) have since entered into agreements to generate higher noise levels (as designated in the previous section of this report as an "Associated Land Owner").

It is understood that location "276" is not considered to be a noise sensitive receiver. Notwithstanding, as it is identified by the Development Consent, the noise criteria must be met and for the purpose of this assessment, it has been considered to be a residence.

Condition 9 provides specific noise criteria for wind turbine noise at some non-associated residences and a requirement for "*the higher of 35 dB(A) or the existing background noise level ($L_{A90(10\text{-}minute)}$ plus 5 dB(A)* " at other non-associated residences. Where background noise monitoring has not occurred at a residence, and the residence is not specifically included in Table 2 (all other non-associated residences), the measured background noise levels at the closest monitoring location, on the same side of the wind farm, have been

used to derive the criteria. Table 4 summarises the noise criteria which have been used in the assessment for non-associated residences.

Table 4: Noise criteria at non-associated residences.

Residence ID	Representative Logging Location	Noise Criterion (dB(A)) at Integer Hub Wind Speed (m/s)									
		3	4	5	6	7	8	9	10	11	12
BAN035	BAN048	35	35	37	38	39	40	40	41	42	43
BAN042	BAN076	36	36	36	37	37	37	37	38	38	40
BAN043	BAN009	35	35	36	37	37	37	37	38	39	40
BAN048	BAN048	35	35	37	38	39	40	40	41	42	43
BAN060	BAN060	35	35	35	35	35	35	35	35	37	39
BAN062	BAN076	36	36	36	37	37	37	37	38	38	40
BAN106	BAN152	35	35	36	36	37	37	38	39	40	42
BAN138	BAN115	36	36	36	36	37	37	38	39	40	42
BAN142	BAN170	35	35	35	35	35	35	35	35	36	38
BAN152	BAN152	35	35	36	36	37	37	38	39	40	42
BAN170	BAN170	35	35	35	35	35	35	35	35	36	38
BAN172	BAN060	35	35	35	35	35	35	35	35	37	39
BAN176	BAN155	35	35	35	35	35	35	35	35	35	37
BAN179	BAN076	36	36	36	37	37	37	37	38	38	40
BAN0181	BAN0076	36	36	36	37	37	37	37	38	38	40
BAN187	BAN076	36	36	36	37	37	37	37	38	38	40
BAN0188	BAN0076	36	36	36	37	37	37	37	38	38	40
BAN238	BAN060	35	35	35	35	35	35	35	35	37	39
BAN243	BAN152	35	35	36	36	37	37	38	39	40	42
BAN260	BAN076	36	36	36	37	37	37	37	38	38	40
BAN0276	BAN0144	35	35	35	35	35	35	35	36	37	40
BAN282	BAN155	35	35	35	35	35	35	35	35	35	37

There are no specific noise requirements in the Development Consent Conditions for associated residences. Therefore, the predicted noise levels are provided without reference to criteria.

5.2 Assessment

The noise from the wind turbines has been predicted based on:

- the wind turbine layout, as summarised in Section 2;
- the GE 5.3-158 wind turbines with 121m hub height for both layouts. The total sound power level input of the wind turbine model is provided in Table 5, as provided in *Technical Documentation Wind Turbine Generator Systems 5.3-158-50Hz, Product Acoustic Specification*; and,
- the CONCAWE sound propagation model with the same inputs and assumptions as the Principal Assessment.

Table 5: GE5.3-158 total sound power level input to noise model.

Total Sound Power Level (dB(A)) at Integer Hub Wind Speed (m/s)									
3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
93.8	93.8	94.5	97.6	101.0	103.9	106.0	106.0	106.0	106.0

The predicted noise levels at non-associated residences were compared with the relevant noise criteria (as provided in Section 4) and summarised in Table 6. The predicted noise levels at associated residences are provided in Table 7.

A predicted noise level contour map corresponding to 9 m/s wind speed (results in the highest noise levels) is provided below.

Table 6: Predicted noise levels (dB(A)) and relevant criteria at non-associated residences.

Receiver ID	Representative Logging Location	Predicted Noise Level (dB(A)) at Integer Wind Speed																			
		3m/s		4m/s		5m/s		6m/s		7m/s		8m/s		9m/s		10m/s		11m/s		12m/s	
		Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction
BAN035	BAN0048	35	15	35	15	37	16	38	19	39	22	40	25	40	26	41	26	42	26	43	26
BAN042	BAN0076	36	11	36	11	36	12	37	15	37	18	37	21	37	22	38	22	38	22	40	22
BAN043	BAN0009	35	9	35	9	36	10	37	13	37	16	37	18	37	20	38	20	39	20	40	20
BAN048	BAN0048	35	11	35	11	37	12	38	15	39	18	40	20	40	22	41	22	42	22	43	22
BAN060	BAN0060	35	15	35	15	35	17	35	20	35	22	35	25	35	26	35	26	37	26	39	26
BAN062	BAN0076	36	14	36	14	36	16	37	19	37	21	37	24	37	25	38	25	38	25	40	25
BAN106	BAN0152	35	18	35	18	36	19	36	22	37	25	37	27	38	29	39	29	40	29	42	29
BAN138	BAN0115	36	12	36	12	36	13	36	16	37	19	37	21	38	23	39	23	40	23	42	23
BAN142	BAN0170	35	14	35	14	35	15	35	18	35	21	35	24	35	25	35	25	36	25	38	25
BAN152	BAN0152	35	20	35	20	36	21	36	24	37	27	37	29	38	31	39	31	40	31	42	31
BAN170	BAN0170	35	16	35	16	35	18	35	21	35	23	35	26	35	27	35	27	36	27	38	27
BAN172	BAN0060	35	18	35	18	35	19	35	22	35	25	35	27	35	29	35	29	37	29	39	29
BAN176	BAN0155	35	12	35	12	35	13	35	16	35	19	35	21	35	23	35	23	35	23	37	23
BAN179	BAN0076	36	13	36	13	36	15	37	18	37	21	37	23	37	25	38	25	38	25	40	25
BAN0181	BAN0076	36	12	36	12	36	13	37	17	37	19	37	21	37	23	38	23	38	23	40	23
BAN187	BAN0076	36	13	36	13	36	14	37	17	37	20	37	22	37	24	38	24	38	24	40	24
BAN0188	BAN0076	36	12	36	12	36	14	37	17	37	20	37	22	37	24	38	24	38	24	40	24
BAN238	BAN0060	35	18	35	18	35	19	35	22	35	25	35	28	35	29	35	29	37	29	39	29
BAN243	BAN0152	35	16	35	16	36	18	36	21	37	24	37	26	38	28	39	28	40	28	42	28
BAN260	BAN0076	36	15	36	15	36	16	37	19	37	22	37	24	37	26	38	26	38	26	40	26
BAN0276	BAN0144	35	18	35	18	35	19	35	22	35	25	35	27	35	29	36	29	37	29	40	29
BAN282	BAN0155	35	18	35	18	35	20	35	23	35	26	35	28	35	30	35	30	35	30	37	30

Based on the specification for the GE 5.3-158, a 0.8 dB(A) uncertainty should be applied to the predicted noise levels. Notwithstanding, the predictions indicate that the noise from the final wind turbine layout, will easily comply with the noise criteria at all non-associated residences, even with this addition.

Table 7: Predicted noise levels at associated residences.

Receiver ID	Representative Logging Location	Predicted Noise Level (dB(A)) at Integer Wind Speed									
		3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
BAN020	BAN0170	19	19	20	23	26	29	30	30	30	30
BAN021	BAN0158	21	21	22	25	28	31	32	32	32	32
BAN026	BAN0159	16	16	17	20	23	25	27	27	27	27
BAN032	BAN0032	29	29	30	33	37	39	41	41	41	41
BAN041	BAN0032	26	26	27	30	33	36	37	37	37	37
BAN055	BAN0115	12	12	14	16	19	22	23	23	23	23
BAN076	BAN0076	18	18	19	22	25	27	29	29	29	29
BAN087	BAN0159	21	21	22	25	28	31	32	32	32	32
BAN100	BAN0115	35	35	36	40	43	46	47	47	47	47
BAN101	BAN0155	28	28	29	32	35	38	39	39	39	39
BAN108	BAN0076	13	13	15	18	21	23	24	24	24	24
BAN115	BAN0115	28	28	29	32	35	38	39	39	39	39
BAN117	BAN0076	21	21	22	26	28	31	33	33	33	33
BAN136	BAN0136	26	26	27	30	33	36	37	37	37	37
BAN144	BAN0144	18	18	19	22	25	27	29	29	29	29
BAN154	BAN0155	23	23	24	27	30	33	34	34	34	34
BAN155	BAN0155	25	25	26	29	32	35	36	36	36	36
BAN158	BAN0158	24	24	25	28	31	34	35	35	35	35
BAN159	BAN0159	16	16	18	21	24	26	28	28	28	28
BAN162	BAN0009	15	15	17	20	22	25	26	26	26	26
BAN164	BAN0159	16	16	18	21	23	26	27	27	27	27
BAN165	BAN0159	16	16	18	20	23	26	27	27	27	27
BAN166	BAN0159	16	16	17	20	23	25	27	27	27	27
BAN173	BAN0115	17	17	18	21	24	26	28	28	28	28
BAN182	BAN0076	14	14	15	18	21	23	25	25	25	25
BAN189	BAN0009	15	15	17	20	22	25	26	26	26	26
BAN225	BAN0009	12	12	13	16	19	22	23	23	23	23
BAN235	BAN0076	18	18	20	23	26	28	30	30	30	30
BAN239	BAN0158	26	26	27	30	33	36	37	37	37	37

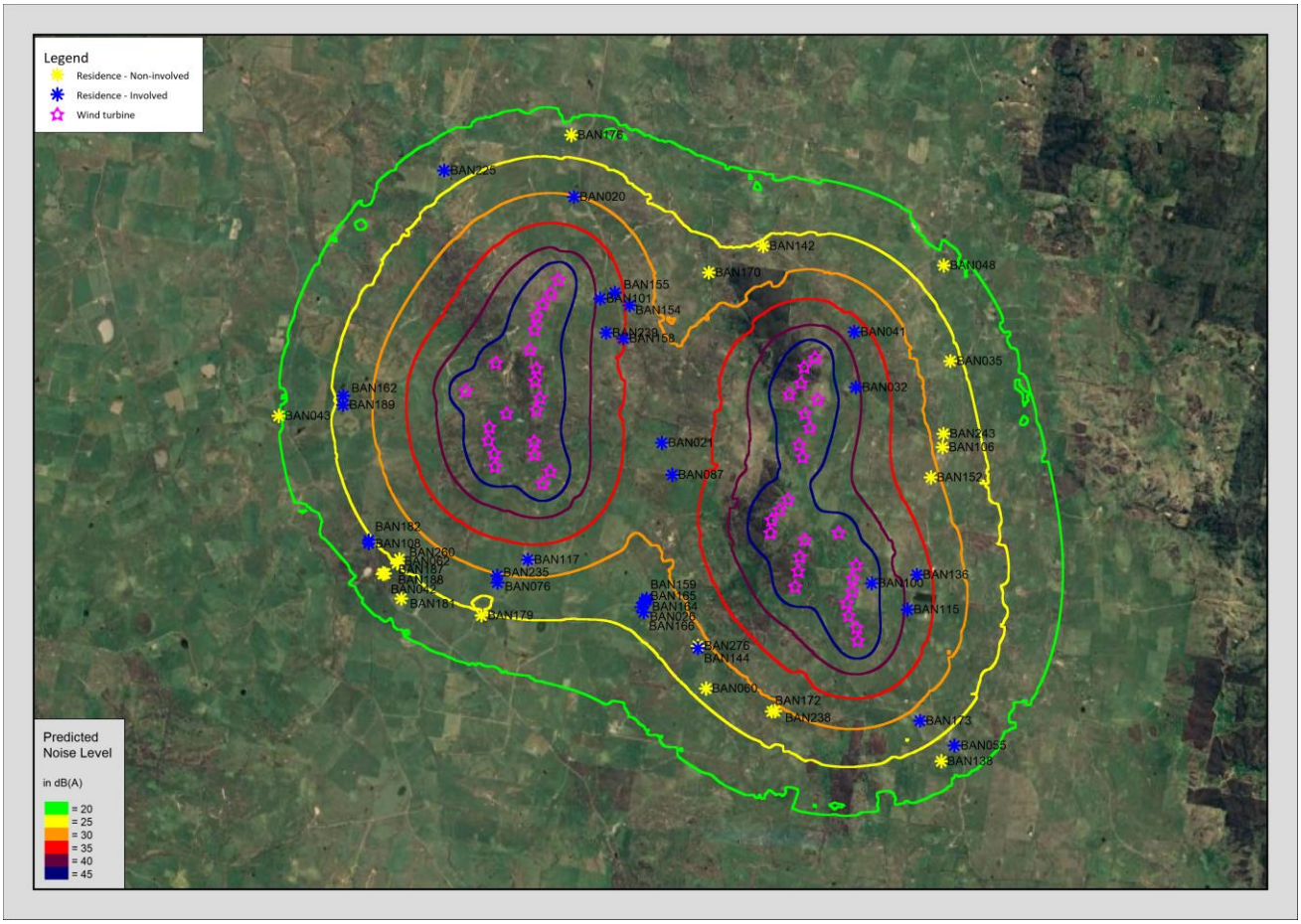


Figure 1: Predicted noise level contours at 9m/s wind speed.

6 CONDITION 3.10

6.1 Ancillary Infrastructure Criteria

Development Consent Condition 10 in *Schedule 3 Environmental Conditions – General* states the following operational noise requirements for the ancillary Infrastructure:

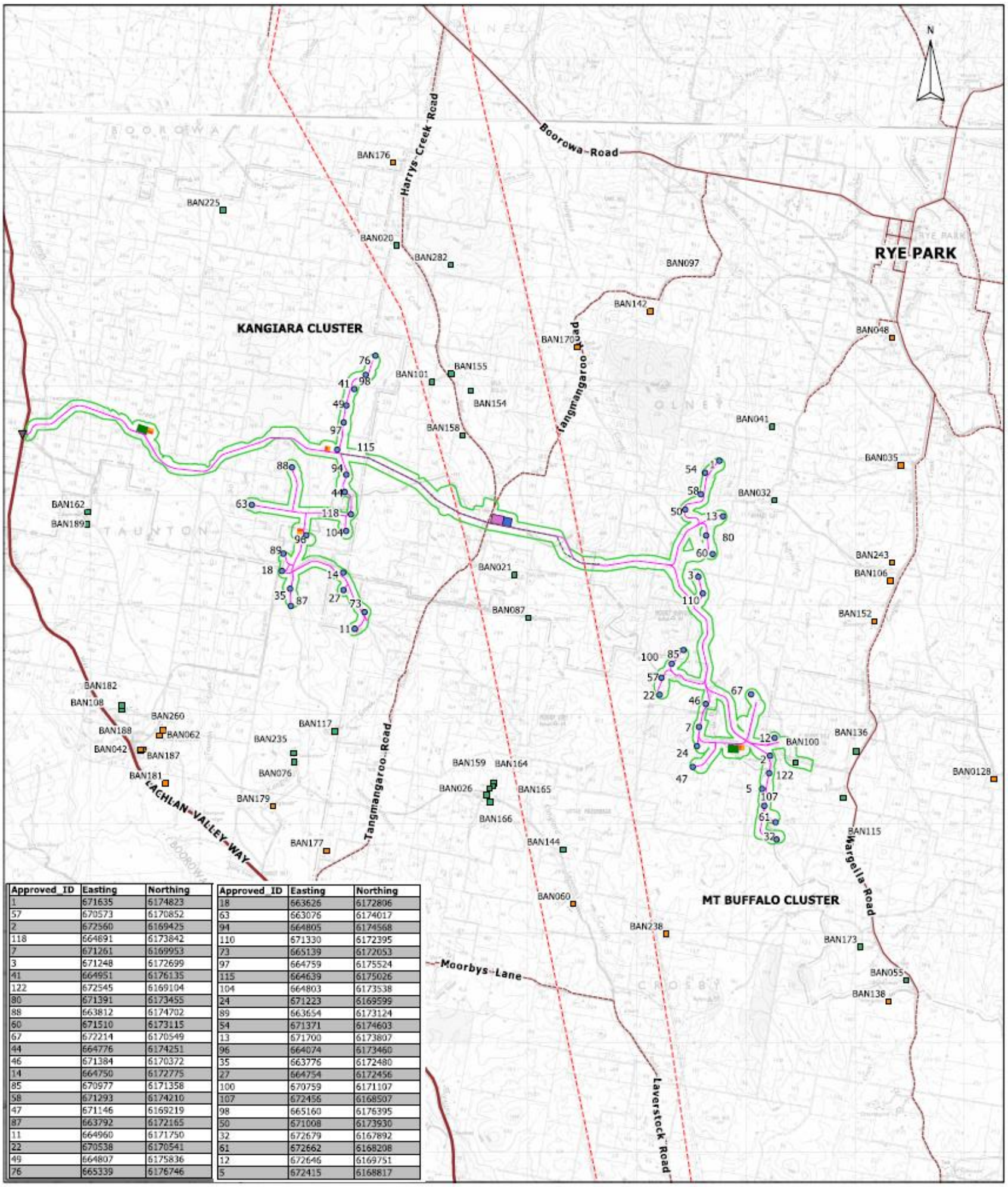
> *The Applicant must ensure that the noise generated by the operation of ancillary infrastructure does not exceed 35 dB(A) $L_{Aeq(15\ minute)}$ at any non-associated residence.*
>
> *Noise generated by the operation of ancillary infrastructure is to be measured in accordance with the relevant requirements of the NSW Noise Policy for Industry (or equivalent) as modified by the provisions of Appendix 5.*

6.2 Assessment

An assessment of the noise from substations at the Bango Wind Farm was detailed in the Principal Assessment. The assessment considered 3 collector substations with either a single 200MVA transformer or 2 100MVA transformers.

The assessment concluded that the highest predicted noise level at a non-associated residence from the substations under consideration was 26 dB(A). Therefore the criterion of 35 dB(A) under Condition 3.10 is predicted to be easily achieved, even where a 5 dB(A) correction is considered applicable for potential noise characters such as tonality.

APPENDIX A: Site Layout



Approved_ID	Easting	Northing
1	671635	6174823
57	670573	6170852
2	672560	6169425
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60	671510	6173115
67	672214	6170549
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14	664750	6172775
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47	671146	6169219
87	663792	6172165
11	664960	6171750
22	670538	6170541
49	664807	6175836
76	665339	6176746

Approved_ID	Easting	Northing
18	663626	6172806
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73	665139	6172053
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115	664639	6175026
104	664803	6173538
24	671223	6169599
89	663654	6173124
54	671371	6174603
13	671700	6173807
96	664074	6173460
35	663776	6172480
27	664754	6172456
100	670759	6171107
107	672456	6168507
98	665160	6176395
50	671008	6173930
32	672679	6167892
61	672662	6168208
12	672646	6169751
5	672415	6168817

LEGEND

Wind Farm:
- WTG
- Main Site Access Option
- Indicative Access Track
- Overhead Transmission Line
- Study Area

Residences:
- Associated Residence
- Non-Associated Residence

Construction Facilities
- Construction Compound Option
- Concrete Batching Plant Option
- Rock Crushing Facility Option
- Collector Substation Option
- Switching Station Option

Existing Infrastructure
- Unsealed Road
- Sealed Road
- 132 kV Transmission Line

0 — 5 km

COMPANY				
BANGO WIND FARM PTY LTD				
TITLE				
FINAL LAYOUT PLAN				
DATE	SCALE	DWG NO	REV	VER
15 MAY 2019	1:68000	BAN-262	B	1
DRAWN BY	CHECKED BY	SHEET	JOB NO	SIZE
K OLD	L CROSS	1 OF 1	080811	A3