Appendix E Noise and Vibration Assessment

21 December 2009

Document No. NSW-B10-239

Holroyd Substation

Construction and Operational Noise Assessment

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Prepared for

TransGrid

Prepared by

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Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	07-Dec-2009	Draft for Client Review	Matthew Verth Senior Acoustic Engineer	
01	21-Dec-2009	One-third octave band sound power data included	Matthew Verth Senior Acoustic Engineer	

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1.0 Introduction

1.1 Scope of commission

AECOM, (previously Bassett Consulting Engineers) has been commissioned by TransGrid to undertake a construction and operational noise assessment of the proposed Substation at Hyland Road, Holroyd NSW.

AECOM has previously undertaken a construction noise assessment for this site, and measured noise levels in the vicinity of the site to derive environmental noise emission criteria (refer Bassett Consulting Engineers (BCE) report 60050599.RPT01.02).

The purpose of the current commission is to:

- Update the construction noise assessment to address the most up-to-date construction noise criteria (The Department of Environment, Climate Change and Water (DECCW) *Interim Construction Noise Guidelines* (ICNG); and
- Conduct and present findings of an operational noise assessment for the site based on the latest and best understanding of proposed equipment against criteria previously established for the site in accordance with the NSW DECCW Industrial Noise Policy (INP).

1.2 Site and surrounds

Holroyd City Council has confirmed that the land immediately to the north and west of Hyland Road is zoned as 'SEPP 59 – State Environmental Planning Policy Number 59 –*'Central Western Sydney Economic and Employment Area'*. To the north of this zone is an area zoned as 'Residential' but Holroyd City Council has confirmed that there are currently no pending development applications for this site.

The proposed substation site and acoustically-relevant receiver locations (from the previous report,60050599.RPT01.02) are identified in Figure 1:

Figure 1 – Proposed substation site and receiver locations

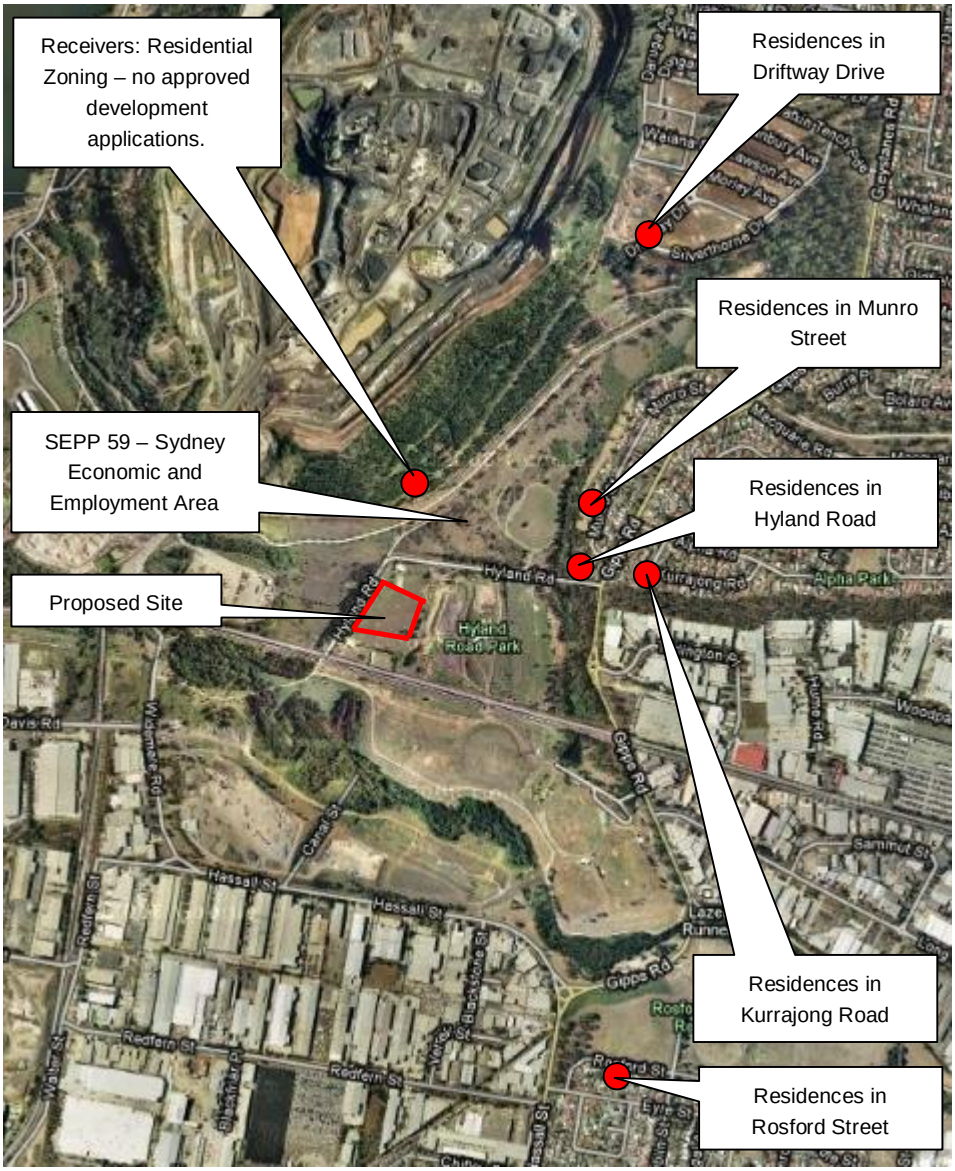


Image courtesy of Google

2.0 Noise criteria

2.1 NSW DECCW Industrial Noise Policy criteria

Environmental noise emission criteria were derived and presented as part of the commission documented in BCE report 60050599.RPT01.02. The criteria were derived based on unattended noise logging undertaken and attended measurements during the period 3 November to 14 November, 2008.

The respective noise environments at the unattended noise logging locations were deemed representative of the nearest potentially affected receivers in the vicinity of the proposed substation.

Based on BCE report 60050599.RPT01.02, the environmental noise emission criteria against which noise emission from the proposed substation site shall be assessed, are represented as follows:

Table 1 - Summary of Environmental Noise Criteria, dB(A)

Period	Rating Background Level (RBL) (L_{A90})	Intrusive Criterion = RBL + 5 dB(A)	Amenity Criterion, dB(A)	Final Environmental Criterion, dB(A)
Hyland Road				
Day	46	51	55	51
Evening	38	43	45	43
Night	32	37	40	37
Kurrajong Road, Munro Street, Driftway Drive and residentially-zoned land to north of proposed site				
Day	40	45	55	45
Evening	40	45	45	45
Night	35	40	40	40
Rosford Street				
Day	48	53	55	53
Evening	42	47	45	45
Night	38	43	40	40

2.2 Tonality

The DECCW Industrial Noise Policy provides additional guidance and criteria for assessing noise emission from sources defined (by procedures contained within the Policy) as 'tonal' in nature. Of significance to substation noise is that penalties of up to 5 dB(A) may be applied where the subject noise emission is tonal or with significant low frequency content at the receiver.

A penalty is applied when the level of a one-third octave band exceeds the level of each adjacent band by:

- 5 dB(A) or more if the frequency band containing the tone is above 400 Hz
- 8 dB(A) or more if the frequency band containing the tone is below 400 Hz and above 160 Hz inclusive
- 15 dB(A) or more if the frequency band containing the tone is below 160 Hz

As part of this assessment, a 'screening test' to determine the potential for tonality has been conducted. The methodology and outcome of this process is presented in Section 5.4.

2.3 Construction Noise Criteria

2.3.1 DECCW Interim Construction Noise Guidelines

In July 2009, the NSW DECCW published their *Interim Construction Noise Guidelines (ICNG)* for use in construction noise assessments. This document replaces their previous publication, the *Environmental Noise Control Manual (ENCM)* and is used as the basis for establishing construction Noise Management Levels (NMLs).

Under the ICNG a construction noise management plan is required to be compiled by the Contractor, prior to construction commencing. Noise level objectives must be set for the daytime and evening periods, and must be complied with where reasonably practicable. Work that is proposed outside of standard working hours, as defined in the *ICNG*, generally requires strong justification.

The noise management plan should detail the "best practice" construction methods to be used, presenting a reasonable and feasible approach. The plan should identify the extent of residential areas affected and assess the impact on residents. The plan should detail any community relation programs that are planned e.g. prior notification for particularly noisy activities, letter box drop regarding out-of-hours construction work to be undertaken and a 24 hour contact phone number for residents to call should they have any complaints or questions.

The *ICNG* defines what is considered to be feasible and reasonable as follows:

Feasible

> *A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*

Reasonable

> *Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.*

The *ICNG* recommends that a quantitative assessment is carried out for all *'major construction projects that are typically subject to the EIA process'*. A quantitative assessment, based on a likely 'worst case' construction scenario, has been carried out for the proposed development.

Predicted noise levels at nearby noise-sensitive residential receivers are compared to the levels provided in Section 4 of the *ICNG*. Where an exceedance of the NMLs is predicted the *ICNG* advises that the proponent should apply all feasible and reasonable work practises to minimise the noise impact.

Criteria for residential receivers are set using the information in Table 2:

Table 2 - Noise at residences using quantitative assessment

Time of Day	Noise Management Level $L_{Aeq\ (15min)}$*	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected >75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

2.3.2 Construction noise management levels

It is assumed that the construction activities will take place during recommended standard working hours (07.00 am – 6.00 pm Monday to Friday and 8.00 am – 1.00 pm Saturday).

Construction noise management levels for the residential receivers considered in this assessment are shown in Table 3.

Table 3 - Daytime construction noise management levels

Receiver Location	Background Noise Level, Daytime, L_{A90} dB(A)	Daytime Construction Noise Management Levels, L_{Aeq} dB(A)
Hyland Road	46	56
Kurrajong Road, Munro Street, Driftway Drive and residentially-zoned land to north of proposed site	40	50
Rosford Street	48	58

Construction Noise Management Levels for other nearby noise-sensitive land uses relevant to this assessment are shown in Table 4:

Table 4 - Construction noise management levels – noise-sensitive land uses other than residential

Land Use	Management Level, LAeq (15 min) (applies when properties are in use)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas(characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in Australian/New Zealand Standard *AS/NZS 2107* for specific uses.

Construction noise is not considered to be an issue at the boundary of the land to the north which is zoned as 'residential', as it is likely that construction will be finished prior to any development on this site.

3.0 Construction noise assessment

The noise impact resulting from construction of the substation has been assessed.

The likely plant associated with the construction is shown in Table 5. If the number of plant, type of plant or 'on time' of plant varies from that shown in Table 5, then the assessment will also change.

Table 5 - Description of expected construction equipment and associated L_{Aeq} Sound Power level

Equipment	Number of Plant Items	Sound Power Level dB(A)	L_{Aeq} sound pressure level at 7m	Time On In Any 15 minute period(%)
Excavator[*1]	2	95	70	100%
Compactor	2	108	83	100%
Mobile Crane	1	110	85	100%
Dump Truck	2	108	83	100%
Hand Tools	3	110	85	75%

Note 1: Assumes DECC residential grade muffler in use

The likely impact from construction noise at the closest receiver is shown in Table 6:

Table 6 - Predicted Construction Noise Level at Closest Receiver

Receiver	Distance from Site Boundary (m)	Daytime Construction Noise Management Level dB(A)	Predicted L_{Aeq} Noise Levels, dB(A)	Compliance with NMLs
Hyland Road	400	56	52	Yes
Kurrajong Road	475	50	50	Yes
Munro Street	500	50	49	Yes
Driftway Drive	1050	50	42	Yes
Rosford Street	1250	58	40	Yes

The construction noise impact at all receivers is shown to comply with the Noise Management Levels derived from procedures set out in the DECC Interim Construction Noise Guidelines.

4.0 Construction noise mitigation

Notwithstanding the demonstration of compliance presented above, it is recommended that the contractor includes noise mitigation measures in any Construction Management Plan for the site. The DECCW, in the ICNG suggests that the work practices described below should be used to minimise the construction noise impact at noise-sensitive receivers:

Community notification:

- Contact potentially noise-affected neighbours at the earliest possible time before any site work begins.
- Inform potentially noise-affected neighbours about the nature of the construction stages and the noisier activities – for example excavation and rock-breaking.
- Give clear indication to potentially noise-affected neighbours of how long noisy activities will take.
- Describe any noise controls, such as walls to be built first that will reduce noise, temporary noise walls, or use of silenced equipment.
- Keep potentially noise-affected neighbours up to date on progress.
- Provide contact details on a site board at the front of the site, and keep a complaints register suited to the scale of works.
- Ask about any concerns that potentially noise-affected neighbours may have and discuss possible solutions.
- Provide a copy of the noise management plan, if available, to potentially noise-affected neighbours.

Operate plant in a quiet and efficient manner:

- Turn off plant that is not being used.
- Examine, and implement where feasible and reasonable, alternative work practices which generate less noise – for example use hydraulic rock splitters instead of rock breakers, or electric equipment instead of diesel or petrol powered equipment.
- Examine, and implement where feasible and reasonable, the option of using silenced equipment.
- Ensure plant is regularly maintained.
- Locate noisy plant away from potentially noise-affected neighbours or behind barriers, such as sheds or walls.
- Where reasonable, provide respite periods for very noisy activities.

Involve workers in minimising noise:

- Avoid dropping materials from a height.
- Talk to workers about noise from the works and how it can be reduced.
- Use radios and stereos indoors rather than outdoors.

Handle complaints:

- Review, and implement where feasible and reasonable, work practices to minimise noise from construction that are the subject of noise complaints.

5.0 Operational noise assessment

The operation of the proposed transformer substation has been modelled in SoundPLAN Version 7.0.

Industrial noise emission from the site has been modelled using an implementation of the CONCAWE noise propagation algorithm, which is considered appropriate for the source to receiver distances in this study (ranging from 475 m to 1250 m).

5.1 TransGrid modelling inputs

Modelling inputs have been provided by TransGrid. AECOM has interpreted this information in order to input it into a SoundPLAN computer noise model of the proposed operational scenario. The information provided and the resultant modelled outcomes are presented as shown in Table 7

Table 7 – Transgrid modelling inputs

TransGrid Input Information	Modelling Input
The existence of a 9m fire wall separating the two transformers…	A noise wall with a height of 9.0 m above the natural ground level has been input into the model mid way between the two transformers.
Worst case meteorological conditions to apply	A 3.0 m/s source to receiver wind condition has been modelled.
The RL of the slab/transformer runway is halfway between the highest and lowest point of the natural ground topography.	The site slopes down from north west to south east by approximately 8 m from RL 38.0 m to 30.0 m. As such, a flat, level surface has been modelled at RL 34.0 m. All source heights are referenced to this level.
Transformer assumed to be 5.5 m height, Point source assumed to be at half of this height	The transformers have been modelled as a point source 2.75 m above the natural ground height.
Reactors…Point source assumed at centre of each reactor enclosure	The reactors have been modelled as a point source 3.75 m above the natural ground height. See Section 5.2 for sound power information.
GIS building with dimensions and height of 11.5 m, height of other structures assumed insignificant	GIS building has been modelled as 11.5 m high, no other buildings modelled on site.

5.2 Transformer and reactor one-third octave band sound power levels

The noise emission of transformers and reactors often has a characteristic ‘tone’ at 100 Hz. TransGrid has directed AECOM to use one third octave band sound power data for the transformers and reactors in order to examine the potential for tonal noise emission form the site. The sound power data has been based on two sources as follows:

- Transformers – based upon measurements undertaken by Bassett Consulting Engineers (AECOM) as part of the Sydney North Substation project for Transgrid (Refer BCE report 60023379.SK01.00 dated July 2007); and
- Reactors – based upon measurements undertaken by Day Design (acoustic engineers) as part of the Sydney East Substation project. Refer to Day Design report 3700-r1 dated 27 February 2008 (relevant excerpt provided to AECOM by Transgrid for the current study).

  The linear one-third octave band sound power levels for the transformers (T) and reactors (R) used as the basis for this assessment are presented in Table 8:

Table 8 - Linear one-third octave band sound power levels for the transformers and reactors

Equipment	Sound Power Level (dB) at one-third octave band centre frequency (Hz)																											Lw Overall, dBA
	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	
T	77	76	70	74	58	80	102	83	79	94	88	96	95	89	82	74	71	69	64	60	54	50	47	42	35	34	33	**96**
R	-	-	-	96	79	82	112	94	91	112	96	101	94	96	85	81	76	73	70	68	67	57	53	48	-	-	-	**103**

5.3 Other modelling inputs

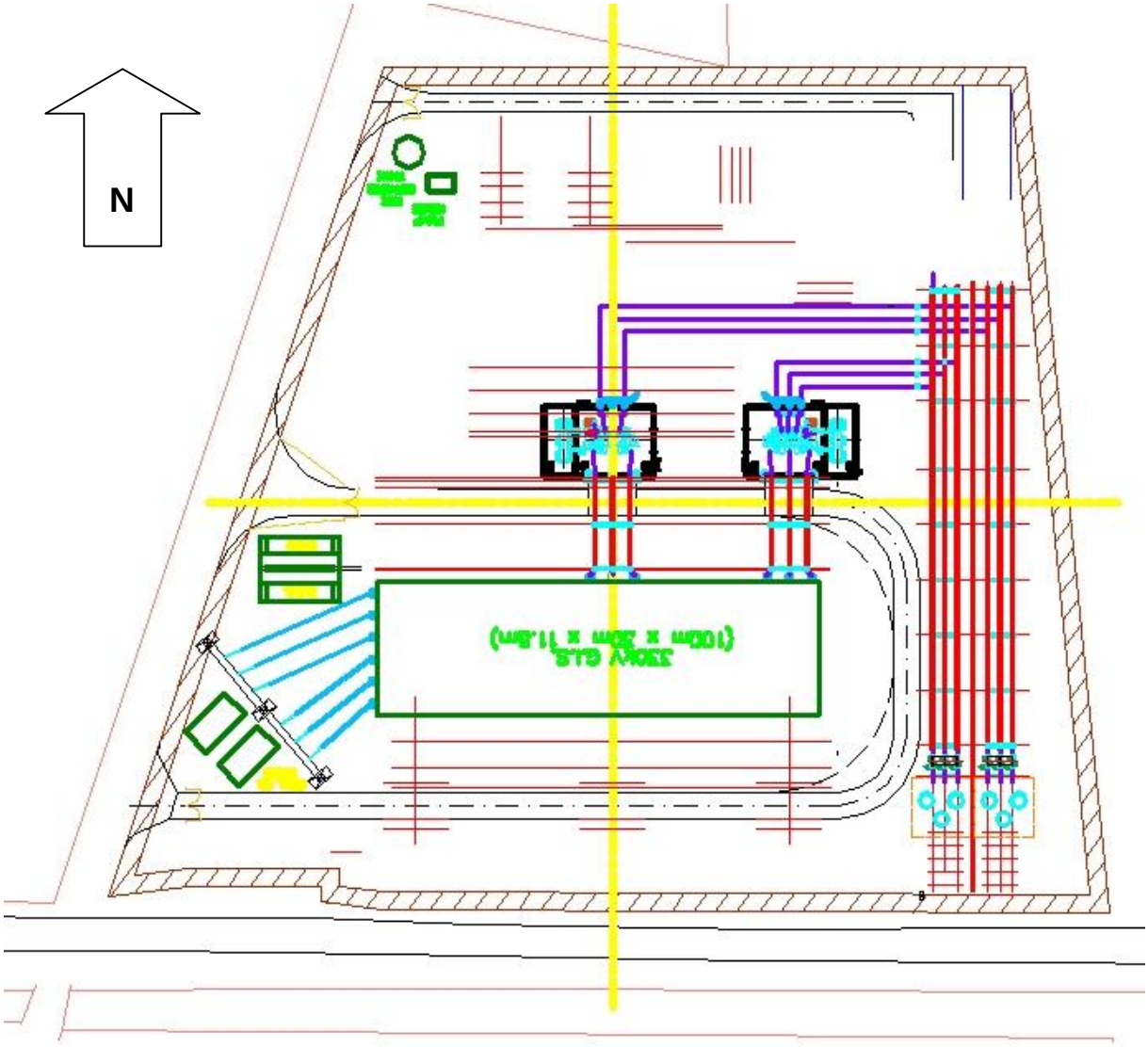
2 m interval ground contours have been sourced from the Department of Lands. For reference, the north-east corner of the site is the highest point at approximately RL 38.0m. The south-east corner of the site is the lowest point, at approximately RL 30.0m.

The basis for the layout of the proposed substation is TransGrid drawing M3c.dxf, which shows the two transformers located on an east-west axis in the centre of the site, the GIS building on an east-west axis near to the southern boundary of the site and the two reactors are located near to the south-eastern extremity. Refer to Figure 2.

All receivers have been modelled at 1.5 m above the natural ground height at the locations identified in Figure 1.

The ground surface of the entire substation site has been modelled as acoustically 'hard', i.e.: it is reflective, with an absorption coefficient of 0.1.

Figure 2 – TransGrid drawing M3c.dxf



5.4 Tonality screening test

As noted in Section 5.2 and evidenced in the one-third octave band sound power spectrum presented in Table 8, the equipment used in substations often has a characteristic 'tone' or 'hum' at 100 Hz and first order harmonic frequency at 200 Hz.

In order to assess the need to apply a 'tonality penalty' to account for the potential greater annoyance caused by tonal noise sources, a screening test has been conducted by examining the one-third octave band results at each receiver location under a 'no treatment' scenario.

The methodology of this screening test is as follows:

- Run a calculation in SoundPLAN under a 'no treatment' scenario to generate one-third octave band predicted noise levels at all single point receiver locations;
- Logarithmically add the predicted noise levels at frequencies of interest (being 80 Hz, 100 Hz and 125 Hz for this assessment) to the measured ambient noise spectra at each receiver at the same frequencies; and
- Examine the logarithmically summed noise level and apply the INP tonality rules (Refer to Section 2.2) and determine whether a tonality penalty is appropriate to apply.

The 'ambient' L_{Aeq} noise levels used for this process have been determined based upon attended noise measurements taken at various receiver locations (described in BCE report 60050599.RPT01.02). The measured noise levels, which were obtained during the daytime period, have been scaled (reduced) to account for the lower noise levels during the night-time period. The scaling factor used has been applied equally to all one-third octave bands of interest, and is calculated based upon the difference between the background noise level during the 15 minute attended measurement period and the night-time RBL. In accordance with the INP, tonality is assessed based on the Linear, (not A-weighted spectrum) at the receiver location.

The results of this process are presented in Table 9:

Table 9 – Tonality screening test results

Receiver Location	L_{Aeq} Predicted/Measured Ambient/Summed Noise Level	L_{eq} noise level, dB, at one-third octave band centre frequency, Hz		
		80	100	125
Hyland Road	Predicted	26.4	49.6	31.5
	Measured Ambient	49.3	44.1	41.3
	Summed	**49.3**	**50.7**	**41.7**
Kurrajong Road	Predicted	24.8	47.9	29.7
	Measured Ambient	46.4	41.1	39.3
	Summed	**46.4**	**48.7**	**39.7**
Munro Street	Predicted	24.6	47.6	29.4
	Measured Ambient	43.9	41.7	36.7
	Summed	**44.0**	**48.6**	**37.4**
Driftway Drive	Predicted	14.8	37.9	19.6
	Measured Ambient	48.5	42.8	41.9
	Summed	**48.5**	**44.0**	**41.9**
Residentially-zoned land	Predicted	30.7	55.5	37.3
	Measured Ambient	48.5	42.8	41.9
	Summed	**48.5**	**55.7**	**43.3**
Rosford Street	Predicted	15.0	38.8	20.7
	Measured Ambient	50.7	44.2	40.4
	Summed	**50.7**	**45.3**	**40.5**

The results of this screening test show that whilst the noise emission of the summed sources is theoretically-tonal, when considered in the context of the ambient noise environmental each receiver location, the noise emission from the operation of the proposed Substation will not be perceived as tonal, according to the definitions of tonality provided by the INP. Therefore no tonality penalty has been applied to the noise emission from the proposed Substation for any one source (or collectively) and the intent of the treatments presented hereafter is to control the broadband noise emission from the site to the established dBA criteria presented in Table 1.

5.5 Modelling results

Results are presented to the nearest 0.1 dB(A) only to identify any marginal differences between treatment scenarios. The determination of a compliant or non-compliant outcome is based on each value rounded to the nearest 1 dB(A).

Compliant outcomes are identified by green text. Non-compliant outcomes are identified by red text.

Table 10 – Modelling results

Receiver Location	Night-time criterion, dB(A)	No treatment	5 m barriers around north, and east of reactors	5 m barriers around reactors and reduce Lw of reactors by 4 dBA
3.0 m/s source to receiver wind conditions				
Driftway Drive	40	28.2	25.1	23.7
Hyland Road	37	38.3	34.4	32.4
Kurrajong Road	40	36.8	33.0	31.0
Munro Street	40	36.5	33.8	31.5
Residentially-zoned land	40	45.4	42.6	40.5
Rosford Street	40	28.4	28.4	25.0

5.6 Analysis of results

- Under a 'no treatment', 3.0 m/s source to receiver wind condition scenario, two of the six receiver locations do not comply with the project criteria. The Hyland Road receiver experiences an exceedance of 1.3 dB(A), whilst the residentially-zoned land to the north west experiences an exceedance of 5.4 dB(A).
- Under a 3.0 m/s source to receiver wind scenario with a 5.0 m high barrier to the north, west and east of the reactors, one of the six receiver locations does not comply with the project criterion. The residentially-zoned land to the north west experiences an exceedance of 2.6 dB(A).
- Under a 3.0 m/s source to receiver wind scenario with a 5.0 m high barrier to the north, west and east of the reactors and a reduction of the sound power of each reactor by 4 dBA (with an assumed corresponding reduction in each one-third octave band), a negligible exceedance is predicted to occur at the residentially-zoned land to the north west. This magnitude of exceedance is considered acoustically-insignificant.

5.7 Assessment

The results of modelling largely show a trend of compliance under worst-case adverse meteorological conditions. The exceptions to this trend are the receivers at Hyland Road (the closest receivers to the north-east of the site) and the residentially-zoned land to the north-west of the site.

Note that the nearest boundary of the residentially zoned land has been assessed. Other receiver locations within this land (further to the north-west) whilst being elevated, are not as potentially affected by noise emission from the substation, as confirmed by modelling. (This is due to the increased source to receiver distances).

Results of modelling show that with the implementation of a 5 m barrier around the reactors (at the locations identified in Figure 3) will result in compliance with the established project criteria at all receiver locations considered in this assessment.

Figure 3 – Location of 5 m barrier around reactors

6.0 Conclusion

A construction stage and operational stage noise assessment has been conducted for the proposed Substation at Hyland Road, Holroyd on behalf of TransGrid.

Noise criteria have been prescribed based upon the results of a previous noise survey conducted at potentially-affected residential received near the proposed Substation site, and upon the requirements of the DECC Interim Construction Noise Guidelines (ICNG) and Industrial Noise Policy (INP) for construction and operation respectively.

The results of a construction noise assessment show compliance with the requirements of the ICNG. Notwithstanding the compliant outcomes, methods to mitigate construction noise emission have been presented in order to minimise potential of annoyance to the residential community.

The results of an operational noise assessment show that under a 'no treatment scenario' modest exceedances of the established INP criteria are predicted to occur under a worst-case 3.0 m/s source to receiver wind condition. In order to mitigate the predicted exceedances, various barrier configurations have been tested along with mitigation measures which involve sourcing equipment with a lower sound power level. A compliant outcome has been predicted (notwithstanding a negligible and inconsequential exceedance at one receiver location) under a scenario where a 5.0 m high barrier is constructed to the north and east of the reactors at the south-east of the proposed development site (where shown in Figure 3), in combination with a reduced sound power level for the reactors for those initially tested. This compliant outcome requires that the reactors used for the project have a similar spectrum to that presented in Table 8 and an overall sound power level of 99 dBA.

Based on the results of this study, the proposed Substation is considered an acoustically-feasible proposition.