NARRABRI MINE NOISE MONITORING

Quarter Ending September 2019
Summary Noise Report

Prepared for:

Whitehaven Coal Mining Limited
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Whitehaven Coal Mining Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.18063-R06-v1.0	3 October 2019	Adam Sirianni	Mark Russell	Mark Russell

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1 Introduction

Narrabri Coal Operations Pty Ltd has commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct operational noise monitoring for the Narrabri Mine located near Narrabri, New South Wales (NSW) in accordance with the approved Noise Management Plan (NMP) dated June 2018, the Narrabri Mine Project Approval (PA) 08_0144 and the Environment Protection Licence 12789 dated 19 January 2017 (EPL 12789).

The objectives of the noise monitoring programme for this operating period were as follows:

- Conduct operator attended noise surveys at 6 locations (as listed in **Section 3.3**) surrounding the mine during the day, evening and night-time periods.
- Quantify all sources of noise within each of the attended noise surveys, including their measured and/or estimated contribution and maximum level of individual noise sources.
- Assess the noise emissions of Narrabri Mine and determine compliance with respect to the limits contained in Section 2 of the NMP.

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

2 PERFORMANCE ASSESSMENT AND DISCUSSION

The following provides a summary of the attended noise measurements undertaken at each monitoring location. Further details are provided for each location in **Section 5** of this report.

Table 1 Performance Assessment – Operations

EPL ID	Location	Date	Narrabri Mine Contribution dBA				Noise Criteria[2]	Measurement Periods	Weather Compliant			Compliant
			LAeq 15 min Day	LAeq 15 min Evening	LAeq 15 min Night	LA1 (1 min) Night			Day	Evening	Night	
N5	Oakleigh	03/09/2019	I/A	34	33	39	Day, Evening and Night – LAeq(15minute) 35 dBA Night LA1(1minute) – 45 dBA	Day - 1.5 hrs Evening - 0.5 hrs Night – 1hrs	Y	Y	Y	Y
		04/09/2019	29	28	28	34			Y	Y	Y	Y
		05/09/2019	33	26	30	36			Y	Y	Y	Y
N6	Newhaven	03/09/2019	31	34	35	41			Y	Y	N	Y
		04/09/2019	<30	30	32	34			Y	Y	Y	Y
		05/09/2019	I/A	26	23	24			N	Y	Y	Y
N8	Haylin View	03/09/2019	I/A	24	30	31			Y	Y	Y	Y
		04/09/2019	<25	I/A	25	27			Y	Y	Y	Y
		05/09/2019	I/A	28	30	31			Y	N	Y	Y
N9	High Range	03/09/2019	35	I/A	32	38			Y	N	N	Y
		04/09/2019	39[1]	25	28	32			Y	Y	Y	N
		05/09/2019	N/M	I/A	I/A	I/A			Y	N	Y	Y
N1	Bow Hills[2]	04/06/2019	I/A	35	38	49		Day 15 min Evening 15 min Night 15 min	Y	Y	Y	Y
N3	Ardmona	03/06/2019	I/A	33	34	38			Y	Y	N	Y
N7	Merriman	05/06/2019	<25	30	26	27			N	Y	N	Y
N8	Matilda	04/06/2019	I/A	I/A	29	33			Y	Y	Y	Y

I/A = Inaudible, N/M = Not Measurable

Note 1: 2dB modifying factor correction for low frequency noise has been applied in accordance with the NPfI.

Note 2: A private agreement between NCOPL and the residents of N1 Bow Hills of 50 dBA LAeq(15minute) is in place. This new level of 50 dBA LAeq(15minute) replaces the levels identified in Conditions 1-3, Schedule 4 of PA 08_0144 Mod 2 and the identical limits contained in condition L3 of Environment Protection Licence No 12789

3 Noise Criteria

3.1 Project Approval, EPL and NMP

Noise monitoring at the Narrabri Mine was conducted in accordance with EPL 12789, the PA requirements and the NMP. The site specific EPL and PA noise limits are summarised in Section 2 of the NMP and are reproduced in **Table 2**.

Table 2 Project Approval and EPL Noise Criteria

Location	Day	Emergency Day	Night	
	$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{A1(1minute)}$
All Privately owned Residences	35	35	35	45

3.2 Non-compliances & Exemptions

In accordance with Section 11.1.3 of the NSW Industrial Noise Policy (INP) a development is deemed to be in non-compliance with a noise consent or licence condition if the monitored noise level is more than 2 dB above the statutory noise limit specified in the consent or licence. This may occur for two reasons:

- The noise from the Narrabri Mine is excessive, in which case Narrabri Mine will be not complying with its consent or licence condition.
- The noise was increased by extreme, non-standard weather effects—in which case the Narrabri Mine is not considered to be in noncompliance with its consent or licence condition.

In this latter case, further monitoring at a later date is required to determine compliance under "normal" meteorological conditions.

The INP states in Section 9.2 that *"it is not practicable to meet the noise limit under all inversion events; hence exceedances under extreme temperature inversions are not considered to be a non-compliance with consent or licence conditions."*

Non-standard weather effects include:

- Wind speeds greater than 3 m/s at 10m above ground level; or
- Stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level; or
- Stability category G temperature inversion conditions

As stated in EPL 12789 *"Data recorded by the meteorological station identified as EPA Identification Point(s) W1 must be used to determine meteorological conditions and temperature inversion conditions (stability category) are to be determined by direct measurement over a minimum 50m height interval as referred to in Part E2 of Appendix E of the "New South Wales Industrial Noise Policy" dated January 2000 ISBN 0 7313 2715 2."*

Weather and Temperature inversion monitoring is undertaken continuously in accordance with EPL 12789 with monitoring locations displayed in **Figure 1**. Monitoring Location W1 records wind speed and direction at 10m above ground level. Temperature inversion monitoring is undertaken continuously by directly measuring temperature at two elevations 50m apart (10m & 60m from ground level) at monitoring location W2. All weather data reported in **Table 6** to **Table 21** have been recorded at these monitoring locations.

EPL 12789 states that, *For the purposes of determining the noise generated at the premises the modification factors in Section 4 of the NSW Industrial Noise Policy must be applied, as appropriate, to the noise levels measured by the noise monitoring equipment.*

3.3 Attended Monitoring

Attended Noise monitoring is to be undertaken on a quarterly basis at residential areas. The attended monitoring will take place at the following locations:

EPL Monitoring Locations

- N5 Oakleigh – 16293 Kamilaroi Highway Baan Baa
- N6 Newhaven – 184 Greylands Road Turrawan
- N8 Haylin View – 791 Mayfield Road Baan Baa
- N9 High Range – 92 Davis Road Turrawan

EPL also requires monitoring at N8 Haylin View to be conducted quarterly when surface activities approach the eastern end of the southern longwall panels. Works have commenced within the eastern end of the southern longwall, and as such monitoring at N8 Haylin View has been undertaken.

NMP Monitoring Locations

- N1 Bow Hills – 16652 Kamilaroi Highway Baan Baa
- N3 Ardmona – 16462 Kamilaroi Highway Baan Baa
- N7 Merriman – 16896 Kamilaroi Highway Baan Baa
- N8 Matilda – 773 Mayfield Road Baan Baa

The following details the requirements of the monitoring:

EPL Monitoring Requirements

- At each one of the monitoring locations N5 and N6
- Occur quarterly in a reporting period;
- Occur during each day, evening and night period as defined in the NSW Industrial Noise Policy for a minimum of:

  i) 1.5 hours during the day;

  ii) 30 minutes during the evening; and

  iii) 1 hour during the night.
- Occur for three consecutive operating days.

NMP Monitoring Requirements

- At each one of the monitoring locations N1, N3, N7 and N8
- Occur quarterly in a reporting period; and
- Occur during each day, evening and night period as defined in the NSW Industrial Noise Policy for a minimum 15 minutes for one operating day.

4 Operational Noise Monitoring Methodology

4.1 General Requirements

All acoustic instrumentation employed throughout the monitoring programme has been designed to comply with the requirements of AS IEC 61672.1 – 2004 *Electroacoustics—Sound level meters – Specifications*, AS IEC 61672.2-2004, AS IEC 61672.3-2004 and carried current NATA or manufacturer calibration certificates. Instrument calibration was checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA. Calibration certificates for all instruments employed during the monitoring campaign are presented in **Appendix B.**

4.2 Methodology - Operator Attended Noise Monitoring

Operator attended noise measurements were conducted during the day, evening and night-time periods for a minimum of 1.5 hours during the day; 30 minutes during the evening and 1 hour during the night at the two EPL nominated noise monitoring locations and for 15 minutes during the day, evening and night at each of the NMP nominated noise monitoring location representing the most affected receiver locations, listed in **Table 3** and shown in **Figure 1**. During the operator attended noise measurements, the character and relative contribution of ambient noise sources and mine contributions were determined.

Table 3 Noise Monitoring Locations

Monitoring Location	Monitoring Requirements	Receiver Type	Address	Monitoring Location - MGA Zone 55	
				Easting (m)	Northing (m)
N5	EPL	Residence	Oakleigh – 16293 Kamilaroi Highway Baan Baa	779526	6617751
N6	EPL	Residence	Newhaven – 184 Greylands Road Turrawan	776564	6624643
N8[1]	EPL	Residence	Haylin View - 791 Mayfield Road Baan Baa	777428	6617316
N9	EPL	Residence	High Range – 92 Davis Road Turrawan	775879	6625895
N1[2]	NMP	Residence	Bow Hills – 16652 Kamilaroi Highway Baan Baa	780114	6620641
N3	NMP	Residence	Ardmona – 16462 Kamilaroi Highway Baan Baa	780233	6618836
N7	NMP	Residence	Merriman – 16896 Kamilaroi Highway Baan Baa	779290	6623143

Monitoring Location	Monitoring Requirements	Receiver Type	Address	Monitoring Location - MGA Zone 55	
				Easting (m)	Northing (m)
N8	NMP	Residence	Matilda – 773 Mayfield Road Baan Baa	777815	6617045

Note: 1. EPL monitoring locations
2. NMP monitoring locations

The objective of the operator attended noise monitoring was to measure the ($L_{A1(1minute)}$) and the $L_{Aeq(15minute)}$ noise level contribution from the Narrabri Mine at the nearest potentially affected receptors in order to determine the noise contribution of operational activities associated with Narrabri Mine over each 15 minute measurement period. In addition, the operator quantifies and characterises the overall levels of ambient noise in the area (i.e. L_{Amax}, L_{A1}, L_{A10}, L_{A90}, and L_{Aeq}) over the 15 minute measurement interval.

Operator attended noise measurements were conducted using one-third octave integrating Brüel & Kjær Type 2250 sound level meters (s/n 3011919 and s/n 3011830).

Figure 1 Attended Noise Monitoring Locations

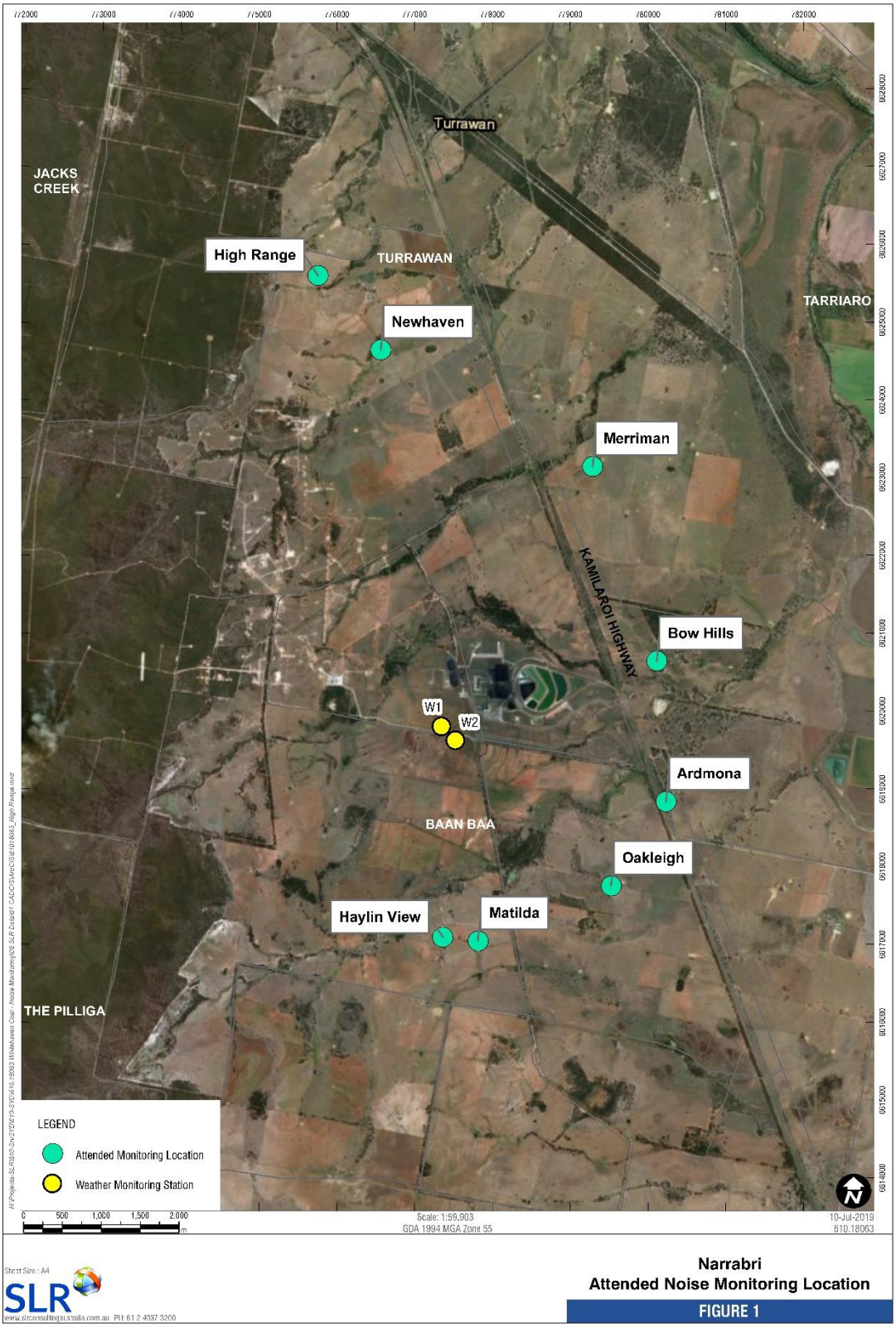


Table 4 and **Table 5** present summaries of which days of the week the quarterly monitoring was conducted, in accordance with condition M7.4 of EPL 12789 and Section 5 of the NMP.

Table 4 Days of the Week Quarterly EPL Monitoring was Conducted, Year 2019

Period	Day of the Week (Excluding Weekends and Public Holidays)				
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Day		3rd September 2019	4th September 2019	5th September 2019	
Evening		3rd September 2019	4th September 2019	5th September 2019	
Night[1]		3rd September 2019	4th September 2019	5th September 2019	

Note 1: Taken to mean the night time period from 10:00 pm on the stated day to 7:00 am the following day.

Table 5 Days of the Week Quarterly NMP Monitoring was Conducted, Year 2019

Period	Day of the Week (Excluding Weekends and Public Holidays)				
	Monday	**Tuesday[1]**	**Wednesday[2]**	**Thursday[3]**	**Friday**
Day		3rd September 2019	4th September 2019	5th September 2019	
Evening		3rd September 2019	4th September 2019	5th September 2019	
Night[4]		3rd September 2019	4th September 2019	5th September 2019	

Note 1: Monitoring for N3 Ardmona was conducted on 3 September 2019.

Note 2: Monitoring for N1 Bow Hills and N8 Matilda was conducted on 4 September 2019.

Note 3: Monitoring for N7 Merriman was conducted on 5 September 2019

Note 4: Taken to mean the night time period from 10:00 pm on the stated day to 7:00 am the following day.

5 Results and Discussion

5.1 Results of Operator Attended Monitoring

Results of the operator attended noise surveys at N5, N6, $N8_{(EPL)}$, N9, N1, N3, N7 and $N8_{(NML)}$ are provided **Table 6** to **Table 21**.

Ambient noise levels presented include all noise sources such as transport (roads, rail and aircraft), fauna (insects, frogs, birds and bats), the natural environment (wind in trees), domestic noises, other industrial operations as well as Narrabri Mine noise emissions.

Weather data during the monitoring period has been obtained from the weather station located on the Narrabri Mine site and observed conditions.

The tables also provide the following information:

- Date and start time, operator and equipment details.
- Monitoring location.
- Wind velocity (m/s) and temperature (°C) at weather station W1, as detailed in **Section 3.2**.
- Typical maximum (L_{Amax}) and contributed $L_{Aeq(15minute)}$ noise levels.

5.1.1 Operator Attended Noise Survey Results – EPL Monitoring Location N5

Results of the operator attended noise surveys at N5 are provided in **Table 6**, **Table 7** and **Table 8**. Monitoring location N5 represents residential receptors located to the southeast of the site in Oakleigh.

Table 6 Operator Attended EPL Noise Survey Results – N5 – Oakleigh (Day 1)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Day 1 03/09/2019 09:41 1.2-2 m/s E/ENE 21-24 °C 3011919	35 dBA LAeq(15minute)	1	A	51	43	35	25	33	22	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Birds 35-56 Traffic 30-45 Aircraft 31-41
		2	A	56	47	38	26	36	23	I/A	
		3	A	53	43	35	26	33	23	I/A	
		4	A	47	40	36	26	32	23	I/A	
		5	A	44	35	31	25	29	23	I/A	
		6	A	43	35	32	27	30	24	I/A	
Evening 1 03/09/2019 20:47 2.6-2.7 m/s W 15 °C 3011919	35 dBA LAeq(15minute)	1	E	55	51	44	33	41	30	33 LAeq	**Site Related Noise Events:** Dozer operations 31-43 General mine activity 29-34 **Other Noise Events:** Traffic 35-57 Birds 35-40
		2	E	57	49	39	32	38	28	34 LAeq	

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Night 1 04/09/2019 22:02 2.6-2.8 m/s W 14-15 °C 3011919	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	F	58	54	44	27	41	25	29 LAeq 33 LA1	**Site Related Noise Events:** Dozer operations 26-36 General mine activity 26-39 **Other Noise Events:** Traffic 35-58 Train 40-65
		2	F	64	56	44	28	43	25	30 LAeq 34 LA1	
		3	F	54	50	40	30	38	27	31LAeq 35 LA1	
		4	E	50	47	38	29	35	26	33 LAeq 39 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

Table 7 Operator Attended EPL Noise Survey Results – N5 – Oakleigh (Day 2)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 1 04/09/2019 10:16 1-3.7 m/s NE/SW 27-29 °C 3011919	35 dBA LAeq(15minute)	1	A	55	43	36	26	33	24	I/A	**Site Related Noise Events:** Dozer operations 24-32 **Other Noise Events:** Birds 40-56 Traffic 30-39
		2	B	56	48	40	25	37	22	I/A	
		3	A	53	45	36	26	34	23	<25 LAeq	
		4	A	56	50	40	27	38	24	27 LAeq	
		5	B	50	42	36	28	33	24	26 LAeq	
		6	C	56	46	38	29	36	25	29 LAeq	
Evening 1 04/09/2019 20:52 1.2-1.3 m/s SE/ESE 18 °C 3011919	35 dBA LAeq(15minute)	1	E	50	45	41	29	37	25	28 LAeq	**Site Related Noise Events:** Dozer operations 25-32 General mine activity 24-30 **Other Noise Events:** Traffic 35-50 Aircraft 45-53
		2	F	53	48	43	20	38	19	<25 LAeq	
Night 1 04/09/2019 22:01 1.1-1.4 m/s E/SE 17-18 °C 3011919	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	F	58	49	41	28	38	24	<25 LAeq 34 LA1	**Site Related Noise Events:** Dozer operations 25-35 **Other Noise Events:** Traffic 30-52 Bats 50-58 Aircraft 37-44 Birds 42-62
		2	F	47	45	41	25	37	22	28 LAeq 31 LA1	
		3	F	52	48	39	20	36	19	N/M	
		4	E	62	47	41	21	37	20	I/A	

Note: N/M = Not Measurable, I/A = Inaudible

Table 8 Operator Attended EPL Noise Survey Results – N5 – Oakleigh (Day 3)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 3 05/09/2019 09:41 0.8-4.7 m/s ESE/WSW 23-28 °C 3011919	35 dBA LAeq(15minute)	1	A	61	47	40	32	37	29	32 LAeq	**Site Related Noise Events:** General mine activity 30-36 Dozer operations 30-36 **Other Noise Events:** Birds 40-61 Traffic 33-49 Aircraft 35-52 Wind 45-53
		2	A	47	42	37	30	35	28	33 LAeq	
		3	A	53	46	39	31	36	28	30 LAeq	
		4	B	51	41	37	31	35	29	33 LAeq	
		5	C	49	41	37	31	35	28	29 LAeq	
		6	C	53	46	40	33	38	30	N/M	
Evening 3 05/09/2019 20:19 2.1-2.5 m/s WNW 19 °C 3011919	35 dBA LAeq(15minute)	1	E	47	35	30	26	28	24	26 LAeq	**Site Related Noise Events:** Dozer operations 23-29 General mine activity 20-28 **Other Noise Events:** Traffic 30-38 Birds 35-60
		2	E	60	35	29	25	30	23	25 LAeq	
Night 3 05/09/2019 22:01 2.6-2.8 m/s W/WNW 16 °C 3011919	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	E	56	49	45	28	40	24	27 LAeq 33 LA1	**Site Related Noise Events:** Dozer operations 24-36 General mine activity 30-32 **Other Noise Events:** Traffic 33-52 Bats 40-56 Train 40-54
		2	E	52	47	40	26	37	24	28 LAeq 34 LA1	
		3	F	50	38	32	27	30	25	29 LAeq 36 LA1	
		4	F	49	47	37	27	35	25	30 LAeq 34 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

5.1.2 Operator Attended Noise Survey Results – EPL Monitoring Location N6

Results of the operator attended noise surveys at N6 are provided in **Table 9**, **Table 10** and **Table 11**. Monitoring location N6 represents residential receptors located to the northwest of the site in Newhaven.

Table 9 Operator Attended EPL Noise Survey Results – N6 – Newhaven (Day 1)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Day 1 03/09/2019 07:39 0.9-1.7 m/s E/ESE 13-19 °C 3008204	35 dBA LAeq(15minute)	1	D	61	52	47	32	46	27	I/A	**Site Related Noise Events:** Main Exhaust Vent Fan briefly audible 38-41 **Other Noise Events:**
		2	C	58	50	43	34	40	30	31 LAeq	
		3	B	61	52	41	31	40	28	I/A	
		4	B	66	48	37	30	38	27	I/A	
		5	A	62	57	47	29	44	26	I/A	
		6	B	62	49	38	26	38	24	I/A	
Evening 1 03/09/2019 21:04 2.7 m/s W 15 °C 3008204	35 dBA LAeq(15minute)	1	E	49	45	40	28	36	26	34 LAeq	**Site Related Noise Events:** Main Exhaust Vent Fan 26-35 **Other Noise Events:** Traffic 36-50
		2	F	54	45	40	25	36	23	27 LAeq	

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Night 1 03/09/2019 23:35 3.2-3.5 m/s W/WSW 16-17 °C 3008204	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	E	48	42	37	28	34	18	32 LAeq 34 LA1	**Site Related Noise Events:** Main Exhaust Vent Fan 26-41 **Other Noise Events:** Traffic 37-42 Domestic noise 40 Owl 38 Dog barking 51
		2	E	48	40	35	27	42	18	31 LAeq 33 LA1	
		3	E	51	44	40	32	40	29	35 LAeq 37 LA1	
		4	D	52	43	38	31	36	28	34 LAeq 36 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

Table 10 Operator Attended EPL Noise Survey Results – N6 – Newhaven (Day 2)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 2 04/09/2019 11:09 1.9-3.7 m/s SW 29-30 °C 3008204	35 dBA LAeq(15minute)	1	B	48	42	32	29	32	26	<30 LAeq	**Site Related Noise Events:** Main Exhaust Vent Fan drone <30 **Other Noise Events:** Birds 43-69 Wind 29-68
		2	C	55	46	41	29	38	27	<30 LAeq	
		3	C	56	49	45	34	48	31	N/M	
		4	C	52	45	4	30	39	27	<30 LAeq	
		5	C	69	54	47	31	45	27	<30 LAeq	
		6	C	68	60	46	29	46	26	N/M	
Evening 2 04/09/2019 21:02 1.2-1.3 m/s E/NE 18°C 3008204	35 dBA LAeq(15minute)	1	E	54	49	39	27	37	23	29 LAeq	**Site Related Noise Events:** Dozer briefly audible 28 Main Exhaust Vent Fan 29-31 **Other Noise Events:** Traffic 22-37 Plane 47-54
		2	E	52	43	38	27	35	24	30 LAeq	
Night 2 04/09/2019 23:52 1.6-1.9 m/s SE 16-17 °C 3008204	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	E	55	41	39	30	35	26	32 LAeq 34 LA1	**Site Related Noise Events:** General drone 28-36 **Other Noise Events:** Traffic 35-55 Cow 38
		2	G	45	37	36	30	34	27	32 LAeq 34 LA1	
		3	E	58	38	34	24	31	22	29 LAeq 31 LA1	
		4	E	47	43	37	25	33	23	26 LAeq 28 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

Table 11 Operator Attended EPL Noise Survey Results – N6 – Newhaven (Day 3)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 3 05/09/2019 11:06 5.5-6 m/s W/WSW 16-19 °C 3008204	35 dBA LAeq(15minute)	1	D	65	46	39	31	39	29	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Wind 30-46 Bird 48-65 Aircraft 39
		2	D	68	59	45	34	46	29	I/A	
		3	C	59	49	44	35	41	36	I/A	
		4	D	77	57	45	32	45	29	I/A	
		5	C	60	52	47	34	43	27	I/A	
		6	D	61	51	45	32	42	27	I/A	
Evening 3 05/09/2019 20:59 2.4-2.5 m/s WNW 17-18 °C 3008204	35 dBA LAeq(15minute)	1	E	59	39	33	23	31	27	26 LAeq	**Site Related Noise Events:** Main Exhaust Vent Fan 24-30 **Other Noise Events:** Animal 39-47 Traffic 26-31 Insects 25-27
		2	E	58	42	36	22	33	22	24 LAeq	
Night 3 04/09/2019 00:04 2.1-2.6 m/s W/WNW 14-16 °C 3008204	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	E	37	32	25	22	24	21	22 LAeq 24 LA1	**Site Related Noise Events:** Main Exhaust Vent Fan 22-25 **Other Noise Events:** Traffic 40-46 Dogs 29-31 Bird 57
		2	E	57	43	32	22	31	21	23 LAeq 25 LA1	
		3	F	45	40	32	22	29	21	22 LAeq 24 LA1	
		4	E	46	33	28	22	25	21	22 LAeq 24 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

5.1.3 Operator Attended Noise Survey Results – EPL Monitoring Location N8

Results of the operator attended noise surveys at N8 are provided in **Table 12**, **Table 13** and **Table 14**. Monitoring location N8 represents residential receptors located to the southwest of the site in Haylin View.

Table 12 Operator Attended EPL Noise Survey Results – N8 – Haylin View (Day 1)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Day 1 03/09/2019 10:04 1.4-2 m/s E/NE 22-25 °C 3008204	35 dBA LAeq(15minute)	1	A	74	47	35	24	39	23	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Farm Animal 50-74 Faint road traffic noise 22-25 Birds 51-59
		2	A	51	37	27	23	27	22	I/A	
		3	A	54	41	29	23	29	23	I/A	
		4	A	62	34	26	23	28	23	I/A	
		5	A	48	36	60	25	28	23	I/A	
		6	A	47	41	32	25	30	23	I/A	
Evening 1 03/09/2019 20:06 2.2 m/s W/WSW 14-15 °C 3008204	35 dBA LAeq(15minute)	1	E	44	30	26	23	25	22	24 LAeq	**Site Related Noise Events:** General drone 23-25 **Other Noise Events:** Train 35 Animals 40-45
		2	D	40	28	26	24	25	23	24 LAeq	

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Night 1 03/09/2019 22:01 2.6-3 m/s W 14-15 °C 3008204	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	F	44	33	28	24	27	23	25 LAeq 27 LA1	**Site Related Noise Events:** General drone 24-29 Dozer 29-32 **Other Noise Events:** Traffic 32-44 Animals 53-55
		2	F	53	38	33	27	31	25	27 LAeq 29 LA1	
		3	F	55	38	31	27	30	25	26 LAeq 28 LA1	
		4	E	47	32	29	26	27	24	30 LAeq 32 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

Table 13 Operator Attended EPL Noise Survey Results – N8 – Haylin View (Day 2)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 2 04/09/2019 08:44 0.9-1.4 m/s E/SE 24-26 °C 3008204	35 dBA LAeq(15minute)	1	A	52	38	29	25	38	23	N/M	**Site Related Noise Events:** General drone <25 **Other Noise Events:** Birds 28-64 Wind 27 Faint traffic 28
		2	A	64	47	36	23	35	22	I/A	
		3	A	55	42	31	24	30	23	N/M	
		4	A	51	41	34	24	31	23	<25 LAeq	
		5	A	51	40	35	25	31	23	N/M	
		6	A	49	41	34	24	31	22	I/A	
Evening 2 04/09/2019 19:48 2.7-2.8 m/s S 20-21 °C 3008204	35 dBA LAeq(15minute)	1	D	48	31	26	22	25	22	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Insects 22-24 Traffic 22-26 Birds 46-48
		2	D	46	28	26	22	24	21	I/A	
Night 2 04/09/2019 22:01 0.7-1.3 m/s E/NE 18 °C 3008204	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	F	49	33	29	26	28	21	24 LAeq 26 LA1	**Site Related Noise Events:** General drone 23-27 **Other Noise Events:** Traffic 41 Train 40-48
		2	E	41	30	26	23	25	22	23 LAeq 25 LA1	
		3	E	47	34	28	25	27	22	25 LAeq 27 LA1	
		4	E	48	39	35	21	30	21	I/A	

Note: N/M = Not Measurable, I/A = Inaudible

Table 14 Operator Attended EPL Noise Survey Results – N8 – Haylin View (Day 3)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 3 05/09/2019 08:31 0.8-2.9 m/s SE/ESE 19-24 °C 3008204	35 dBA LAeq(15minute)	1	C	47	40	34	29	32	23	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Traffic 28-36 Birds 24-47 Aircraft 36-45 Resident vehicle 60-66
		2	C	64	44	37	29	34	27	I/A	
		3	D	59	47	39	28	36	25	I/A	
		4	C	63	52	40	27	39	25	I/A	
		5	B	53	42	36	28	33	27	I/A	
		6	A	66	45	35	28	27	26	I/A	
Evening 3 05/09/2019 19:35 2.8 m/s W 21 °C 3008204	35 dBA LAeq(15minute)	1	F	47	30	28	26	27	24	28 LAeq	**Site Related Noise Events:** General drone 26-28 **Other Noise Events:** Animal 39-47 Traffic 26-31 Insects 25-27
		2	F	40	28	27	25	26	23	26 LAeq	
Night 3 05/09/2019 22:00 2.6-2.8 m/s W/WNW 16 °C 3008204	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	E	41	38	35	24	31	23	24 LAeq 26 LA1	**Site Related Noise Events**: General drone 24-28 Dozer 31-32 **Other Noise Events:** Traffic 29-38 Owl 31 Plane 36-41 Train 36-40 Animal 49-53
		2	E	49	43	32	24	21	23	24 LAeq 26 LA1	
		3	F	49	37	28	25	28	23	25 LAeq 28 LA1	
		4	F	53	35	29	26	28	24	30 LAeq 32 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

5.1.4 Operator Attended Noise Survey Results – EPL Monitoring Location N9

Results of the operator attended noise surveys at N9 are provided in **Table 15**, **Table 16** and **Table 17**. Monitoring location N9 represents residential receptors located to the northwest of the site in High Range.

Table 15 Operator Attended EPL Noise Survey Results – N9 – High Range (Day 1)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Day 1 03/09/2019 07:16 0.9-1.7 m/s E/ESE 11-17 °C 3011919	35 dBA LAeq(15minute)	1	B	53	48	43	33	40	29	N/M	**Site Related Noise Events:** Main Exhaust Vent Fan 25-39 **Other Noise Events:** Traffic 30-52 Birds 40-68 Animals 45-55 Farm operations 35-58
		2	D	57	48	44	35	41	31	29 LAeq	
		3	D	68	48	45	39	43	35	30 LAeq	
		4	C	55	51	46	37	43	32	32 LAeq	
		5	B	59	50	42	36	40	33	33 LAeq	
		6	B	58	43	39	33	37	30	35 LAeq	
Evening 1 03/09/2019 19:31 2.2 m/s W/NW 17 °C 3011919	35 dBA LAeq(15minute)	1	F	49	36	30	22	28	20	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Traffic 30-40 Animals 35-49
		2	F	48	38	34	23	30	21	I/A	

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	**LA1 (dB)**	**LA10 (dB)**	**LA90 (dB)**	**LAeq (dB)**	**LAmin (dB)**		
Night 1 04/09/2019 00:10 3.4-3.7 m/s W/WSW 17 °C 3011919	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	E	47	42	37	31	35	28	32 LAeq 36 LA1	**Site Related Noise Events:** Main Exhaust Vent Fan 28-38 **Other Noise Events:** Traffic 30-42 Animals 35-47 Birds 40-56
		2	E	45	39	35	30	33	27	30 LAeq 32 LA1	
		3	D	46	42	38	31	35	28	32 LAeq 38 LA1	
		4	E	56	39	35	30	33	27	30 LAeq 32 LA1	

Note: N/M = Not Measurable, I/A = Inaudible

Table 16 Operator Attended EPL Noise Survey Results – N9 – High Range (Day 2)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 2 04/09/2019 07:52 0.9-2.6 m/s E/WNW 20-24 °C 3011919	35 dBA LAeq(15minute)	1	D	66	58	47	37	46	34	39 LAeq[1]	**Site Related Noise Events:** Main Exhaust Vent Fan 27-40 **Other Noise Events:** Aircraft 40-54 Animals 38-66 Farm operations 43-56 Traffic 39-50 Birds 40-65
		2	D	64	58	50	37	47	34	39 LAeq[1]	
		3	A	64	60	53	34	48	31	31 LAeq	
		4	C	61	55	47	35	44	31	37 LAeq[1]	
		5	A	64	54	47	29	44	25	35 LAeq	
		6	A	62	55	42	25	42	23	<25 LAeq	
Evening 2 04/09/2019 19:32 2.7 m/s S/SSW 19-20 °C 3011919	35 dBA LAeq(15minute)	1	E	50	36	30	24	28	22	25 LAeq	**Site Related Noise Events:** Main Exhaust Vent Fan 21-29 **Other Noise Events:** Animals 35-50 Traffic 30-40 Insects 25-30
		2	D	40	35	29	23	27	21	<25 LAeq	
Night 2 05/09/2019 00:02 1.6-1.9 m/s W/NW 15-17 °C 3011919	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	E	60	51	36	25	38	23	28 LAeq 32 LA1	**Site Related Noise Events:** Main Exhaust Vent Fan 22-30 Dozer operations 24-32 **Other Noise Events:** Animals 35-58 Traffic 30-43
		2	G	58	49	34	24	36	22	25 LAeq 26 LA1	
		3	E	49	34	31	22	27	20	N/M	
		4	E	48	40	35	24	31	23	N/M	

Note: N/M = Not Measurable, I/A = Inaudible

Note 1: 2dB modifying factor correction for low frequency noise has been applied in accordance with the NPfI.

Table 17 Operator Attended EPL Noise Survey Results – N9 – High Range (Day 3)

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 3 05/09/2019 07:27 2.9-4.8 m/s SE 16-19 °C 3011919	35 dBA LAeq(15minute)	1	D	65	53	42	35	41	32	I/A	**Site Related Noise Events:** Main Exhaust Vent Fan barely audible **Other Noise Events:** Traffic 35-44 Animals 39-65 Farm activity 45-50 Birds 38-65 Wind 40-50
		2	D	60	51	42	36	41	31	N/M	
		3	D	60	54	45	36	43	31	I/A	
		4	D	65	57	46	36	45	32	I/A	
		5	D	55	50	41	34	39	31	I/A	
		6	C	59	52	41	32	40	29	I/A	
Evening 3 05/09/2019 19:25 2.8 m/s W 21-22 °C 3011919	35 dBA LAeq(15minute)	1	F	51	34	29	22	27	20	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Traffic 36-51 Animals 35-42
		2	F	42	31	27	20	24	20	I/A	
Night 3 05/09/2019 23:24 2.1-2.4 m/s W/WNW 16 °C 3011919	35 dBA LAeq(15minute) 45 dBA LA1(1minute)	1	F	45	32	27	20	25	20	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Traffic 25-40 Insects 30-38 Bats 40-48
		2	F	48	27	24	20	22	19	I/A	
		3	E	46	34	30	20	26	19	I/A	
		4	E	32	27	25	20	22	20	I/A	

Note: N/M = Not Measurable, I/A = Inaudible

5.1.5 Operator Attended Noise Survey Results – NMP Monitoring Location N1

Results of the operator attended noise surveys at N1 are provided in **Table 18.** Monitoring location N1 represents residential receptors located to the east of the site in Bow Hills.

Table 18 Operator Attended NMP Noise Survey Results – N1 – Bow Hills

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 04/09/2019 09:45 1.2 m/s E 26 °C 3011919	35 dBA[1] LAeq(15minute)	1	A	55	47	41	31	38	28	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Birds 40-55 Traffic 37-45
Evening 04/09/2019 20:21 2.4 m/s S 20 °C 3011919	35 dBA[1] LAeq(15minute)	1	E	73	63	54	37	51	33	35 LAeq	**Site Related Noise Events:** Dozer operations 34-41 **Other Noise Events**: Train 42-51 Birds 35-44 Traffic 45-73
Night 04/09/2019 23:23 1.7 m/s W 17 °C 3011919	35 dBA[1] LAeq(15minute)	1	E	55	51	46	33	42	29	38 LAeq 49 LA1	**Site Related Noise Events:** Dozer operations 31-49 General mine activity 30-35 **Other Noise Events:** Traffic 35-55 Animals 35-44

Note: N/M = Not Measurable, I/A = Inaudible

Note 1: A private agreement between NCOPL and the residents of N1 Bow Hills of 50 dBA LAeq(15minute) is in place. This new level of 50 dBA LAeq(15minute) replaces the levels identified in Conditions 1-3, Schedule 4 of PA 08_0144 Mod 2 and the identical limits contained in condition L3 of Environment Protection Licence No 1278

5.1.6 Operator Attended Noise Survey Results – NMP Monitoring Location N3

Results of the operator attended noise surveys at N3 are provided in **Table 19.** Monitoring location N3 represents residential receptors located to the southeast of the site in Ardmona.

Table 19 Operator Attended NMP Noise Survey Results – N3 – Ardmona

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 03/09/2019 11:29 1.4 m/s NE 25 °C 3011919	35 dBA LAeq(15minute)	1	A	92	84	68	36	70	28	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Light Vehicle Traffic 50-85 Heavy Vehicle Traffic 60-92 Birds 40-47
Evening 03/09/2019 20:16 2.1 m/s W 15 °C 3011919	35 dBA LAeq(15minute)	1	D	92	76	57	34	66	30	33 LAeq	**Site Related Noise Events:** Dozer operations 32-43 General mine activity 31-35 **Other Noise Events**: Light Vehicle Traffic 60-82 Heavy Vehicle Traffic 70-92
Night 03/09/2019 23:24 3.3 m/s W 16 °C 3011919	35 dBA LAeq(15minute)	1	E	89	76	57	33	64	29	34 LAeq 38 LA1	**Site Related Noise Events:** General mine activity 30-35 Dozer operations 30-38 **Other Noise Events:** Light Vehicle Traffic 50-82 Heavy Vehicle Traffic 60-89

Note: N/M = Not Measurable, I/A = Inaudible

5.1.7 Operator Attended Noise Survey Results – NMP Monitoring Location N7

Results of the operator attended noise surveys at N7 are provided in **Table 20.** Monitoring location N7 represents residential receptors located to the northeast of the site in Merriman.

Table 20 Operator Attended NMP Noise Survey Results – N7 – Merriman

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 05/09/2019 10:32 3.3 m/s NW 27 °C 3011919	35 dBA LAeq(15minute)	1	C	55	43	37	29	35	27	<25 LAeq	**Site Related Noise Events:** Drone briefly audible <25 **Other Noise Events:** Traffic 34-40 Dog 55 Birds 28-41 Plane 36-43
Evening 05/09/2019 20:22 2.1 m/s WNW 19 °C 3011919	35 dBA LAeq(15minute)	1	E	59	45	36	30	37	28	30 LAeq	**Site Related Noise Events:** General drone 28-32 **Other Noise Events:** Residential noise 33-59 Insects 27 Traffic 38-45
Night 05/09/2019 23:27 2.4 m/s WNW 16 °C 3011919	35 dBA LAeq(15minute)	1	F	75	64	46	23	51	21	26 LAeq 27 LA1	Site Related Noise Events: Faint drone 24-27 **Other Noise Events:** Traffic 42-75

Note: N/M = Not Measurable, I/A = Inaudible

5.1.8 Operator Attended Noise Survey Results – NMP Monitoring Location N8

Results of the operator attended noise surveys at N8 are provided in **Table 21**. Monitoring location N8 represents residential receptors located to the south of the site in Matilda.

Table 21 Operator Attended NMP Noise Survey Results – N8 – Matilda

Period Date/Start Time Weather SLM Details	Criteria	Measurement Number	Stability Category	Primary Noise Descriptor						Narrabri Mine Contribution, (dB)	Description
				LAmax (dB)	LA1 (dB)	LA10 (dB)	LA90 (dB)	LAeq (dB)	LAmin (dB)		
Day 04/09/2019 10:24 1.8 m/s NNE 27 °C 3011919	35 dBA LAeq(15minute)	1	A	57	51	42	26	39	24	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events:** Plane 37-42 Birds 28-57
Evening 04/09/2019 20:22 2.4 m/s ESE 20 °C 3011919	35 dBA LAeq(15minute)	1	E	42	28	24	22	23	21	I/A	**Site Related Noise Events:** Inaudible **Other Noise Events**: Faint traffic 21-25 Birds 38-42 Insects/frogs
Night 04/09/2019 23:10 1.3 m/s SE 18 °C 3011919	35 dBA LAeq(15minute)	1	F	75	34	30	22	27	21	29 LAeq 33 LA1	**Site Related Noise Events:** Dozer 24-33 General drone 24-29 **Other Noise Events:** Traffic 25-32 Hprse 45

Note: N/M = Not Measurable, I/A = Inaudible

6 Conclusion

SLR was engaged by Narrabri Coal Operations Pty Ltd to conduct attended noise monitoring for the Narrabri Mine in accordance with the Narrabri Mines' Noise Management Plan, Environment Protection Licence and Project Approval.

Operator attended noise monitoring was conducted at 6 locations in order to determine the noise performance of the Narrabri Mine, with noise levels above the 35 dBA L_{Aeq} noise measured at N9 'High Range' during the daytime monitoring period on Day 2. During this period mine contribution levels of 39 dBA, including a +2 dB correction for low frequency noise, were observed. Compliance was achieved at all other time periods at N9 'High Range as well as all other locations during all time periods.

APPENDIX A

Acoustic Terminology

Sound Level or Noise Level

The terms “sound” and “noise” are almost interchangeable, except that in common usage “noise” is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 “A” Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an “A-weighting” filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People’s hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as “linear”, and the units are expressed as dB(lin) or dB.

3 Sound Power Level

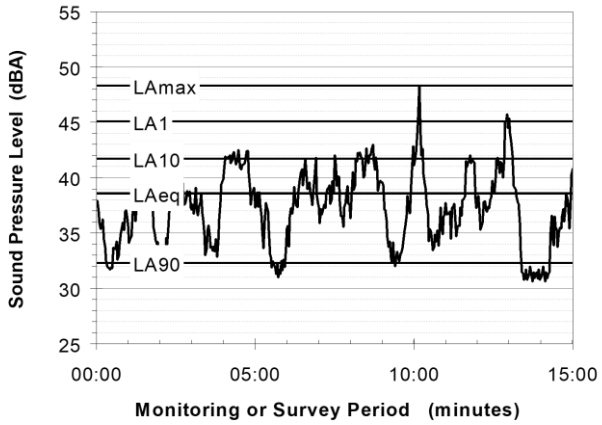
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the “repeatable minimum” LA90 noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or “average” levels representative of the other descriptors (LAeq, LA10, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than “broad band” noise. 7. Impulsiveness

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

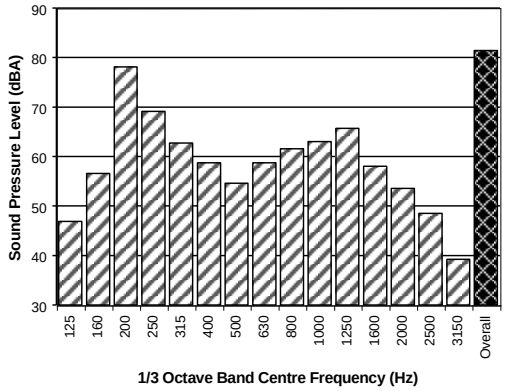
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of "peak" velocity or "rms" velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as "peak particle velocity", or PPV. The latter incorporates "root mean squared" averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

9 Human Perception of Vibration

People are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

10 Over-pressure

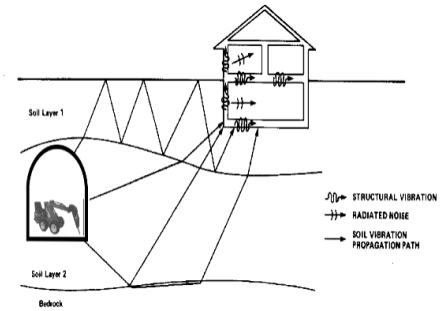
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed "structure-borne noise", "ground-borne noise" or "regenerated noise". This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term "regenerated noise" is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise

APPENDIX B

Calibration Certificates

Brüel & Kjær

Australian Calibration Laboratory
Suite 2, 6-10 Talavera Road, North Ryde NSW 2113, Australia

NATA
WORLD RECOGNISED ACCREDITATION
Laboratory No. 1301

CERTIFICATE OF CALIBRATION

Certificate No: CAU1700873 Page 1 of 9

CALIBRATION OF:

Sound Level Meter:	Bruel & Kjaer	2250	No: 3011830
Microphone:	Bruel & Kjaer	4952	No: 3122120
Preamplifier:	Bruel & Kjaer	N/A	No: N/A
Supplied Calibrator:	N/A	N/A	No: N/A
Software version:	BZ7225 Version 4.6.3	Pattern Approval:	PTB
Instruction manual:	BE1746-18	Identification:	N/A

CUSTOMER:

SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove NSW 2066

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 °C
Environment conditions: *see actual values in **Environmental conditions** sections*

SPECIFICATIONS:

The Sound Level Meter has been calibrated in accordance with the requirements as specified in IEC61672-3:2006 class 1. Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

PROCEDURE:

The measurements have been performed with the assistance of Brüel & Kjær Sound Level Meter Calibration System B&K 3630 with application software type 7763 (version 6.0 - DB: 6.00) and test procedure 2250-N-4952.

RESULTS:

X	Initial calibration		Calibration prior to repair/adjustment
	Calibration without repair/adjustment		Calibration after repair/adjustment

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the device under calibration.

Date of Calibration: 11/09/2017

Sajeeb Tharayil
Calibration Technician

Certificate issued: 11/09/2017

Jan Rasmussen
Approved signatory

Summary

Preliminary inspection	**Passed**
Environmental conditions, Prior to calibration	**Passed**
Reference information	**Passed**
Indication at the calibration check frequency	**Passed**
Self-generated noise, Microphone installed	**Passed**
Acoustical signal tests of a frequency weighting, C weighting	**Passed**
Self-generated noise, Electrical	**Passed**
Electrical signal tests of frequency weightings, A weighting	**Passed**
Electrical signal tests of frequency weightings, C weighting	**Passed**
Electrical signal tests of frequency weightings, Z weighting	**Passed**
Frequency and time weightings at 1 kHz	**Passed**
Level linearity on the reference level range, Upper	**Passed**
Level linearity on the reference level range, Lower	**Passed**
Toneburst response, Leq	**Passed**
Overload indication	**Passed**
Environmental conditions, Following calibration	**Passed**

Bruel & Kjaer Australia is a NATA Accredited facility, Accreditation number 1301.

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/National Standards

NATA is a signatory of the APLAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

The sound level meter submitted for periodic testing successfully completed the class 1 tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed.
As public evidence was available, from an independant testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Conformance to the requirements of IEC 61672-3:2006, is demonstrated when the measured deviations extended by the actual expanded uncertainties of measurement, do not exceed the applicable tolerance limits given in IEC 61672-1:2002. (as specified in IEC 61672-3:2006 § 4.1)

Brüel & Kjær

Australian Calibration Laboratory
Suite 2, 6-10 Talavera Road, North Ryde NSW 2113, Australia

NATA
WORLD RECOGNISED ACCREDITATION
Laboratory No. 1301

CERTIFICATE OF CALIBRATION

Certificate No: CAU1700872 Page 1 of 9

CALIBRATION OF:

Sound Level Meter:	Bruel & Kjaer	2250	No: 3011919
Microphone:	Bruel & Kjaer	4952	No: 3094024
Preamplifier:	Bruel & Kjaer	N/A	No: N/A
Supplied Calibrator:	N/A	N/A	No: N/A
Software version:	BZ7225 Version 4.6.3	Pattern Approval:	PTB
Instruction manual:	BE1746-18	Identification:	N/A

CUSTOMER:

SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove NSW 2066

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 °C
Environment conditions: *see actual values in **Environmental conditions** sections*

SPECIFICATIONS:

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The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the device under calibration.

Date of Calibration: 11/09/2017

Sajeb Tharayil
Calibration Technician

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