NOISE IMPACT ASSESSMENT
FOR BRICKWORKS LTD
416 BERRIMA ROAD, NEW BERRIMA NSW 2577

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1. INTRODUCTION

Benbow Environmental has been engaged by Brickworks Ltd to prepare a noise impact assessment for a proposed brick factory located at 416 Berrima Road, New Berrima NSW 2577. The factory is proposed to operate 24/7 and have a capacity of 50 million bricks per annum.

The principal noise sources associated with the site include noise from plant equipment, external mobile vehicles and truck movements associated with material delivery and loading.

Benbow Environmental conducted a Noise Impact Assessment (181002_NIA_Rev3) on the subject site in May 2018. The previous assessment examined a proposed masonry manufacturing plant.

This assessment assesses the cumulative noise impacts of both the recently approved masonry manufacturing plant and the proposed brick manufacturing plant.

Construction noise from excavation, civil, concreting and building works are analysed. The noise road traffic impacts of the site on nearby receivers are also analysed.

The potential noise impacts of operational, construction and road traffic activities on the nearby receivers have been predicted utilising noise modelling software, SoundPlan (V7.3). This noise impact assessment has been prepared in accordance with the following guidelines and documents:

- NSW Noise Policy for Industry (EPA, 2017);
- NSW Road Noise Policy (RNP) (DECCW, 2011);
- NSW Interim Construction Noise Guideline (DECC, 2009); and
- Moss Vale Enterprise Corridor Development Control Plan (DCP) (Wingecarribee Council, 2012).

1.1 SCOPE OF WORKS

This noise impact assessment has been limited to the following scope of works:

a) Review of proposed plans and operations;
b) Long term and short term ambient and background noise monitoring in accordance with relevant guidelines;
c) Establish project specific noise levels;
d) Determine all potential noise sources associated with the proposed development;
e) Collect required noise source data;
f) Predict potential noise impacts at the nearest potentially affected receptors to the site;
g) Assess potential noise impacts against relevant legislation and guidelines;
h) Recommend control measures where required; and
i) Compile this report with concise statements of potential noise impact.

To aid in the review of this report, supporting documentation has been included within the Attachments. A glossary of terminology is included in Attachment 1.

2. PROPOSED DEVELOPMENT

2.1 SITE LOCATION

The subject site is located at 416 Berrima Road, New Berrima NSW 2577 described as Lot 1 in DP 785111. The site is located approximately 100 kilometres south-west of the Sydney central business district, within the local government area of Wingecarribee Shire Council. Figure 2-1 shows the location of the subject site.

2.2 HOURS OF OPERATIONS

The facility is seeking approval to operate 24 hours a day, seven days a week.

2.3 EXISTING DEVELOPMENT

A masonry manufacturing plant has been approved at the site. The masonry manufacturing plant involves material deliveries of aggregates and sands from driving trucks over underground storage bins near the north-eastern entry to the site. Cements and powders are delivered to the site in tanker trucks which pneumatically transfer the powdered material to the storage silos. An external crushing plant is used to crush masonry product for reuse in the plant. The crushed materials and aggregates get conveyed inside the building and the cement and powders get pneumatically transferred where the material is first mixed into various grades of concrete product.

The concrete sludge is transferred to the block machine which hydraulically presses the material into the desired blocks. The press is proposed to be located inside an acoustic enclosure. The product is transferred via fingerlifts to the curing chambers at the centre of the building. The chambers control the humidity and temperature to ensure the desired mechanical properties of the product are achieved. After the curing process the material are transferred via fingerlifts to the finishing lines located to the west of the curing chambers. Some products undergo additional processing such as polishing and splitting.

Once the finishing process is complete the batches are palletised and transferred outside for storage in the hardstand storage area, truck loading and final distribution.

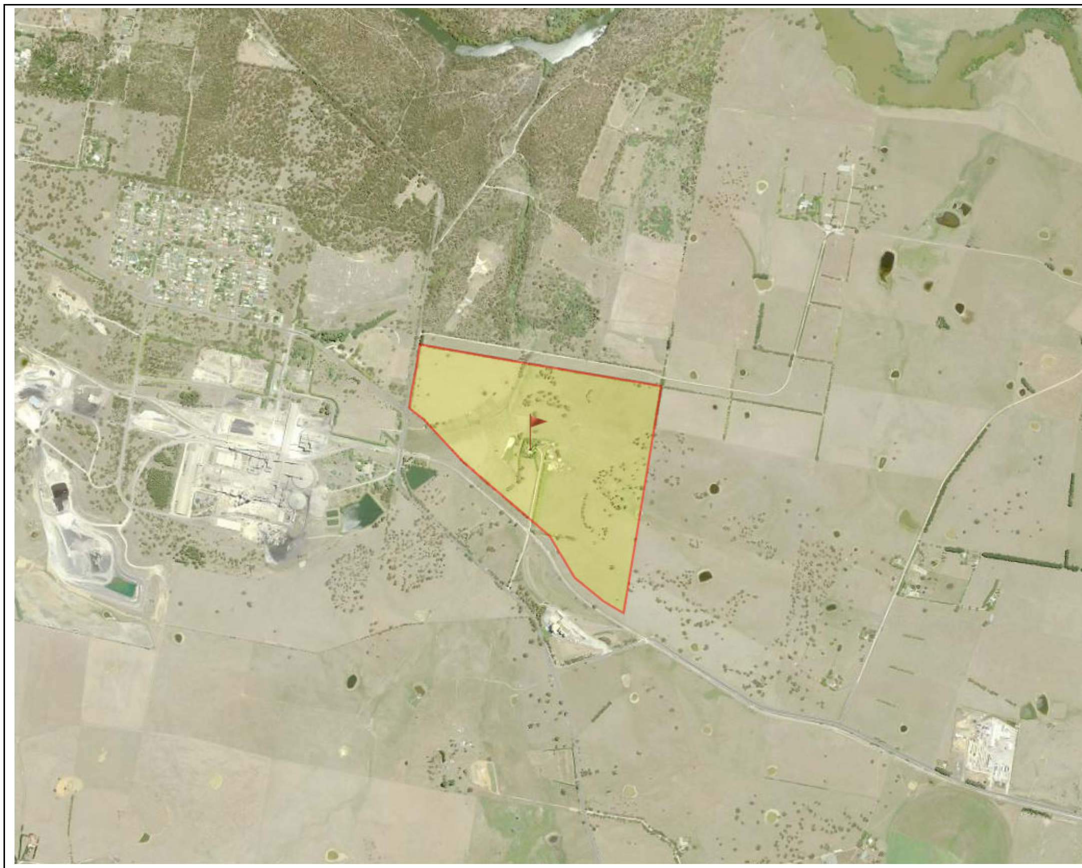
2.4 PROPOSAL DESCRIPTION

The proposal will consist of construction and operation of a large brick making plant in the north eastern area of the site. The site is proposed to have a capacity of 50 million bricks per annum.

Surface clays and shales are brought onto site and then dumped into drive over bins where the material is transferred via enclosed conveyors to a crusher and grinder and then conveyed to raw material bunkers in the shed. From here the material is conveyed to the hammer mill, panmill and screens before entering the premixer where water is added to the dry material. The material is then conveyed to the pugmill where water is mixed into the material until the desired consistency is achieved. The material is then extruded into one long slug and conveyed through numerous formation lines which alter the texture of the surface before being cut, separated and stacked. The stacked bricks are then transferred via fingerlifts into a dryer followed by the kiln. After being dried and baked, the bricks are transferred to storage areas before dispatch.

The site layout plan can be seen in Figure 2-2.

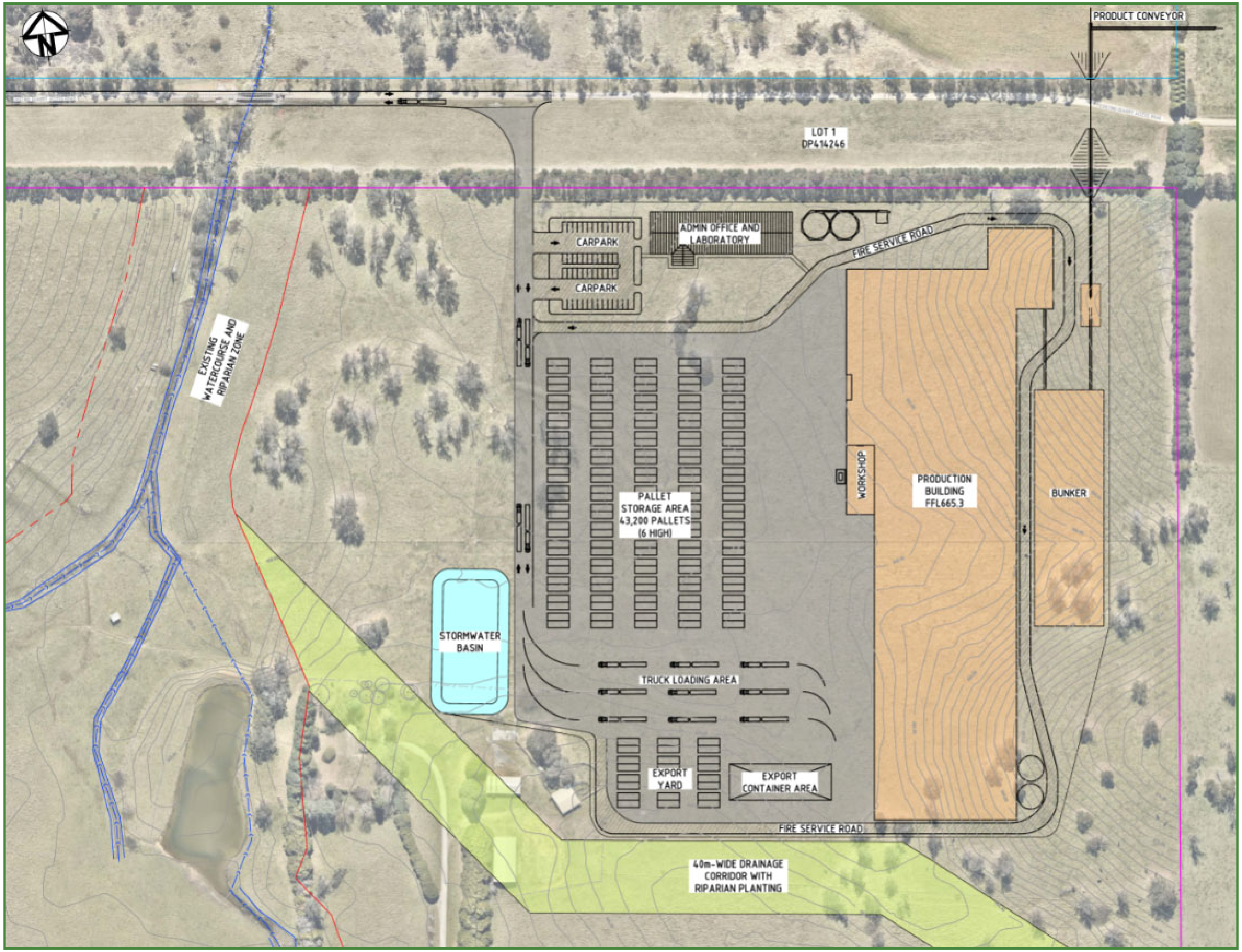
Figure 2-1: Site Location



Source: SIX Maps 2019

↑N Not to scale	**Legend**: Site Boundaries	Benbow Environmental 25-27 Sherwood Street, Northmead NSW 2152

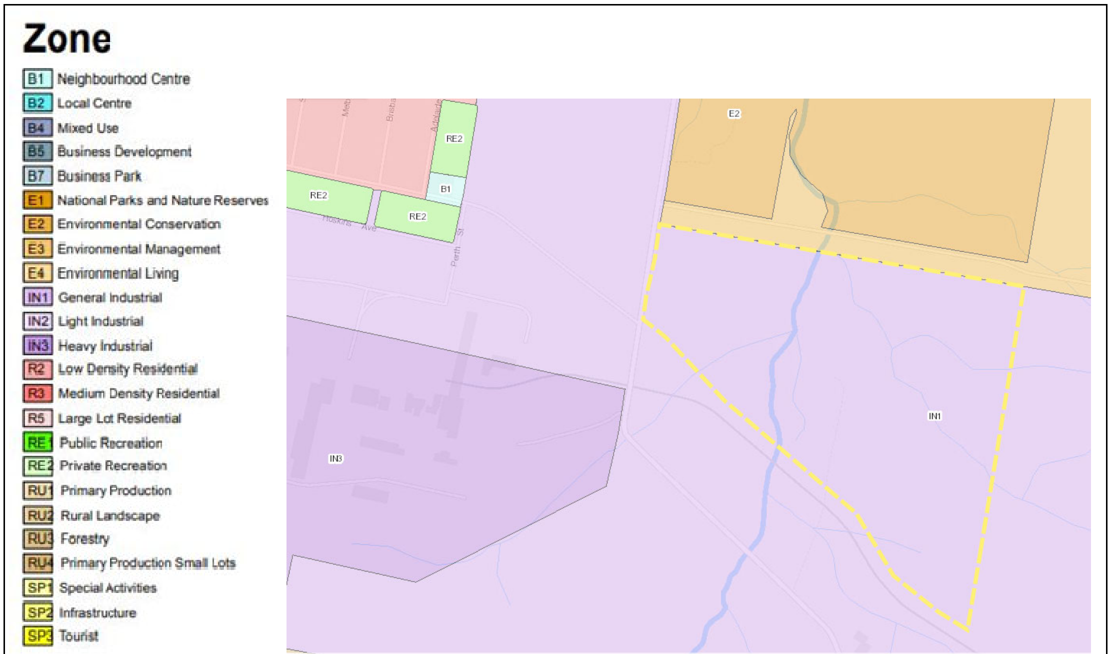
Figure 2-2: Site Plan



2.5 DESCRIPTION OF THE SURROUNDING AREA

The land is zoned as IN1 General Industrial under Wingecarribee Local Environmental Plan 2010, as per Figure 2-3. The property to the north is zoned E2 Environmental Conservation. A Boral Cement Works plant to the west is zoned as both IN3 Heavy industrial and IN1 General Industrial. The residential area to the north-west is zoned R2 Low Density Residential surrounded by zones of RE2 Private Recreation.

Figure 2-3: Land Zoning Map



Source: NSW Planning Portal 2019

↑N Not to scale	**Legend:** **Site** (yellow dashed box)	Benbow Environment 25-27 Sherwood Street NORTHMEAD NSW 2152

2.6 NEAREST SENSITIVE RECEPTORS

Table 2-1 lists the location of representative potentially affected receivers that are considered in this assessment. The locations are shown in Figure 2-4.

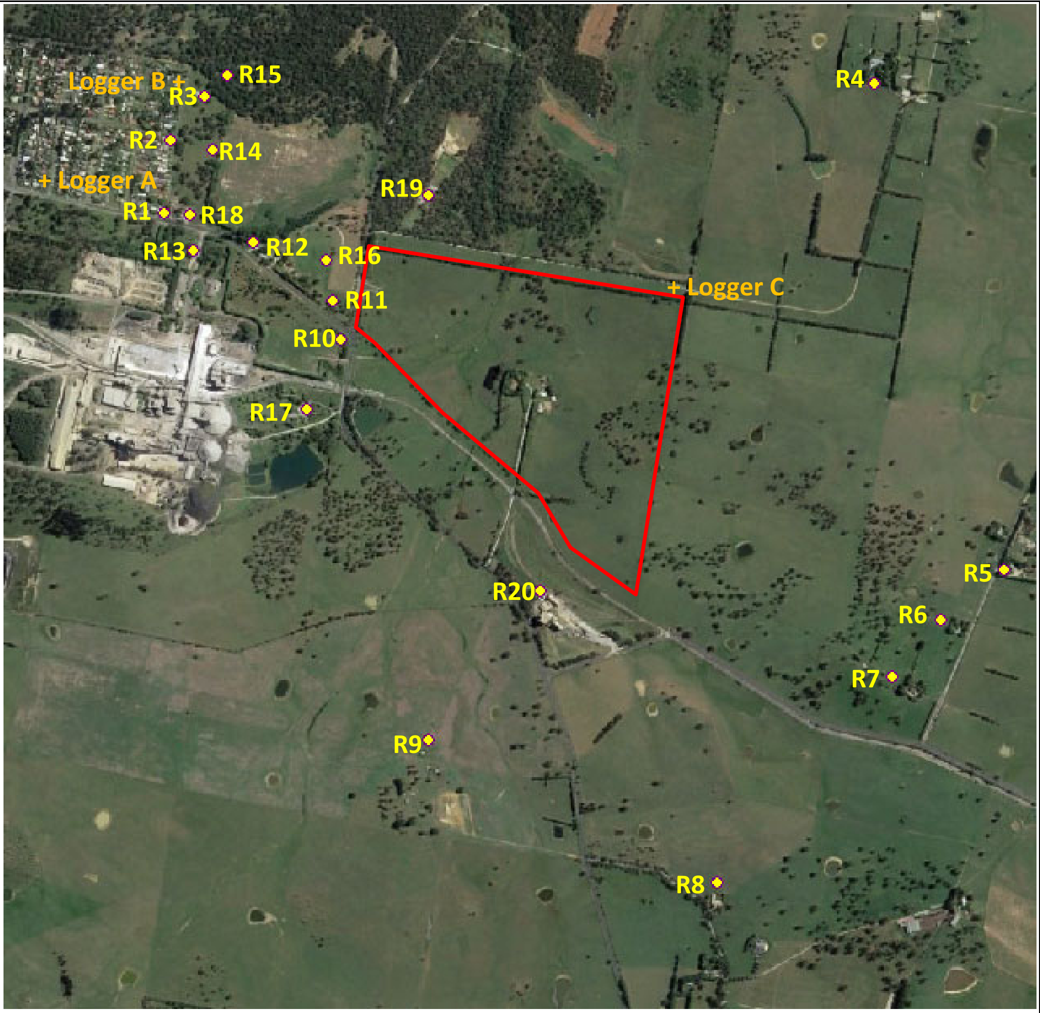
It is noted that receiver R4, the Mandurama property is owned by the proponent of this proposal and is to be used for staff accommodation associated with the quarry. For completeness and a conservative approach to this noise impact assessment, this residential receiver has been included in the report.

A number of receivers (R10-R15) are considered in this report as future commercial/industrial receivers. While no receiver is currently located in these positions, the land is zoned for these uses, and a receiver may potentially exist in the future.

Table 2-1: Nearest Potentially Affected Receptors

Receptor ID	Address	Lot	DP	Separation distance	Type of receiver
R1	70 Taylor Avenue, New Berrima	387	DP15995	680 m	Residential
R2	26 Adelaide Street, New Berrima	373	DP15995	700 m	Residential
R3	41 Adelaide Street, New Berrima	449	DP15995	680 m	Residential
R4	524 Berrima Road, Berrima	1	DP414246	840 m	Residential
R5	54 Carribee Road, Moss Vale	1	DP702629	1050 m	Residential
R6	33 Carribee Road, Moss Vale	4	DP623038	940 m	Residential
R7	15 Carribee Road, Moss Vale	12	DP527683	920 m	Residential
R8	86 Brookdale Road, Moss Vale	3	DP206160	1820 m	Residential
R9	Berrima Road, Moss Vale	2	DP1017008	910 m	Residential
R10	125 Taylor Avenue, New Berrima	1013	DP15995	80 m	Future Use – Commercial/Industrial
R11	125 Taylor Avenue, New Berrima	990	DP15995	120 m	Future Use – Commercial/Industrial
R12	125 Taylor Avenue, New Berrima	1010	DP15995	420 m	Future Use – Commercial/Industrial
R13	Hoskins Avenue, New Berrima	491	DP15995	560 m	Future Use – Commercial/Industrial
R14	5-25 Adelaide Street, New Berrima	427	DP15995	550 m	Future Use – Commercial/Industrial
R15	27-39 Adelaide Street, New Berrima	454	DP15995	660 m	Future Use – Commercial/Industrial
R16	New Berrima Sports Ground : 125 Taylor Avenue, New Berrima	2	DP774598	170 m	Active Recreation
R17	Boral Cement Works: 475 Berrima Road, New Berrima	1	DP1017008	260 m	Industrial
R18	62 Taylor Avenue, New Berrima	439	DP15995	600 m	Commercial
R19	Rifle Range: Berrima Road, Berrima	456	DP257032	175 m	Commercial
R20	372 Berrima Road, New Berrima	101	DP882139	320 m	Industrial

Figure 2-4: Location of Nearest Potentially Affected Receptors



Source: SIX Maps 2018

↑N Not to scale	**Legend**: Site Boundaries	Benbow Environment 25-27 Sherwood Street NORTHMEAD NSW 2152

3. EXISTING ACOUSTIC ENVIRONMENT

The level of background noise varies over the course of any 24 hour period, typically from a minimum at 3.00am to a maximum during morning and afternoon traffic peak hours. Therefore the NSW EPA Noise Policy for Industry (2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night time periods. The Noise Policy for Industry defines these periods as follows:

- **Day** – the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays;
- **Evening** – the period from 6pm to 10pm; and
- **Night** – the remaining periods.

3.1 NOISE MONITORING EQUIPMENT AND METHODOLOGY

Background noise level measurements were carried out using a Svantek SVAN 957 Precision Sound Level Meter (attended noise monitoring) and three (3) Acoustic Research Laboratories statistical Environmental Noise Logger, type EL-215 (unattended noise monitoring). The instrument sets were calibrated by a NATA accredited laboratory within two years of the measurement period. Calibration certificates have been included in Attachment 2.

To ensure accuracy and reliability in the results, field reference checks were applied both before and after the measurement period with an acoustic calibrator. There were no excessive variances observed in the reference signal between the pre-measurement and post-measurement calibration. The instruments were set on A-weighted Fast response and noise levels were measured over 15-minute statistical intervals. QA/QC procedures applied for the measurement and analysis of noise levels have been presented in Attachment 3. The microphones were fitted with windsocks and were positioned between 1.2 metres and 1.5 metres above ground level.

Weather data was sourced from the Bureau of Meteorology from the Automatic Weather Station (AWS) located at Moss Vale (ID 068239). In assessing the background noise levels, any data affected by adverse weather conditions has been broadly discarded according to the requirements of the NSW EPA Noise Policy for Industry. Section A4 of the Noise Policy for Industry states that *"data should be excluded when average wind speeds at microphone height are greater than 5 metres per second… exceptions to this rule are allowed provided the proponent is able to show that the wind-induced noise on the microphone… is at least 10 dB below the noise levels under investigation"*.

In this survey, a wind speed of 6.7 m/s instead of 5 m/s per second has been used in the discarding of data. The intent of the 5 m/s limit is to ensure that wind-induced noise is at least 10 dB below the noise levels under investigation. The gathered data showed higher than expected background noise levels from natural sources such as insects and cicadas, and from man-made sources such as residential noise and road traffic noise. The higher background noise levels raised the L_{Aeq} noise levels of the entire measurement above the range where the L_{Aeq} from wind speeds under 6.7 m/s alone would have impacted upon the measurements.

Furthermore, the Moss Vale AWS data in Figure 4-1-Figure 4-3 shows that higher wind speeds are characteristic of the area. The 6.7 m/s limit therefore gives a representative value that recognises the higher wind speeds in the area while not compromising the technical integrity of the data collection process as per the Noise Policy for Industry (EPA, 2017).

3.2 MEASUREMENT LOCATION

Unattended long-term noise monitoring was undertaken from 14th March 2018 to 1st April 2018 at three representative locations:

A – 90 Taylor Avenue, New Berrima
B – 44 Adelaide Street, New Berrima
C – 416 Berrima Road, Moss Vale (North East Corner)

Attended noise monitoring was undertaken at each location on 14th March 2018. The attended and noise logging locations are shown in Figure 2-4. Noise Logger Charts are presented in Attachment 3.

3.3 MEASURED NOISE LEVELS

3.3.1 Long-Term Unattended Noise Monitoring Results

The data was analysed to determine a single assessment background level (ABL) for each day, evening and night time period, in accordance with the NSW EPA Noise Policy for Industry. That is, the ABL is established by determining the lowest tenth-percentile level of the L_{A90} noise data over each period of interest. The background noise level or rating background level (RBL) representing the day, evening and night assessment periods is based on the median of individual ABL's determined over the entire monitoring period. The results of the long-term unattended noise monitoring are displayed in Table 3-1 - Table 3-3. Daily noise logger graphs have been included in Attachment 3.

Table 3-1: Unattended Noise Monitoring Results at Logger Location A, dB(A)

Date	Average L_1			Average L_{10}			ABL (L_{90})			L_{eq}		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
14/03/2018	-	72	70	-	57	52	-	42	42	-	58	57
15/03/2018	-	71	69	-	59	54	-	48	42	-	60	59
16/03/2018	76	71	68	68	57	54	45	43	41	64	58	59
17/03/2018	73	68	65	63	54	49	44	41	40	61	55	55
18/03/2018	-	-	-	-	-	-	-	-	-	-	-	-
19/03/2018	-	70	67	-	56	54	-	41	42	-	57	59
20/03/2018	-	-	69	-	-	55	-	-	43	-	-	60
21/03/2018	-	73	-	-	60	-	-	47	-	-	60	-
22/03/2018	-	73	-	-	60	-	-	49	-	-	60	-
23/03/2018	76	71	68	68	58	55	47	44	43	64	58	59
24/03/2018	-	-	-	-	-	-	-	-	-	-	-	-
25/03/2018	-	70	63	-	54	49	-	44	42	-	56	52
26/03/2018	-	71	67	-	57	53	-	46	42	-	58	58
27/03/2018	77	72	69	69	58	55	43	44	43	65	59	60
28/03/2018	-	71	-	-	57	-	-	45	-	-	59	-
29/03/2018	75	71	69	68	58	54	44	41	42	64	59	59
30/03/2018	69	67	64	58	54	50	44	47	44	57	55	54
Average	**74**	**71**	**67**	**66**	**57**	**53**	*	*	*	*	*	*
Median (RBL)	*	*	*	*	*	*	**44**	**44**	**42**	*	*	*
Logarithmic Average	*	*	*	*	*	*	*	*	*	**63**	**58**	**58**

Note: - indicates values that has not been considered due to adverse weather conditions.
* Indicates values that are not relevant to that noise descriptor.
Value in bold indicates relevant noise descriptor.

Table 3-2: Unattended Noise Monitoring Results at Logger Location B, dB(A)

Date	Average L_1			Average L_{10}			ABL (L_{90})			L_{eq}		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
14/03/2018	-	55	46	-	51	43	-	35	37	-	52	42
15/03/2018	-	63	52	-	59	51	-	42	36	-	57	54
16/03/2018	56	55	55	46	50	52	34	37	41	49	51	54
17/03/2018	58	61	58	47	57	57	36	38	40	49	57	55
18/03/2018	-	-	-	-	-	-	-	-	-	-	-	-
19/03/2018	-	54	51	-	51	48	-	38	38	-	49	47
20/03/2018	-	-	50	-	-	46	-	-	39	-	-	46
21/03/2018	-	56	-	-	51	-	-	44	-	-	49	-
22/03/2018	-	55	-	-	50	-	-	40	-	-	48	-
23/03/2018	56	52	46	47	45	43	36	36	35	48	46	42
24/03/2018	-	-	-	-	-	-	-	-	-	-	-	-
25/03/2018	-	51	47	-	46	44	-	40	35	-	45	47
26/03/2018	-	54	49	-	47	43	-	40	37	-	57	43
27/03/2018	57	53	47	46	45	45	34	37	35	49	51	45
28/03/2018	-	57	-	-	54	-	-	41	-	-	53	-
29/03/2018	56	59	52	45	56	50	33	38	41	58	54	50
30/03/2018	56	51	54	46	48	52	35	42	40	50	47	51
31/03/2018	54	48	46	43	42	45	33	35	34	45	43	44
1/04/2018	55	55	43	45	47	41	33	36	34	48	47	40
Average	**56**	**55**	**50**	**46**	**50**	**47**	*	*	*	*	*	*
Median (RBL)	*	*	*	*	*	*	**34**	**38**	**37**	*	*	*
Logarithmic Average	*	*	*	*	*	*	*	*	*	**51**	**52**	**50**

Table 3-3: Unattended Noise Monitoring Results at Logger Location C, dB(A)

Date	Average L_1			Average L_{10}			ABL (L_{90})			L_{eq}		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
14/03/2018	-	50	44	-	44	40	-	36	36	-	44	39
15/03/2018	-	57	45	-	48	41	-	35	36	-	48	41
16/03/2018	59	50	49	50	42	42	36	34	34	53	42	42
17/03/2018	60	46	53	52	42	45	39	35	36	54	41	58
18/03/2018	-	-	-	-	-	-	-	-	-	-	-	-
19/03/2018	-	47	45	-	42	42	-	38	36	-	41	42
20/03/2018	-	-	47	-	-	44	-	-	38	-	-	43
21/03/2018	-	49	-	-	45	-	-	36	-	-	45	-
22/03/2018	-	41	-	-	38	-	-	34	-	-	37	-
23/03/2018	50	43	40	42	40	37	34	34	34	45	39	54
24/03/2018	-	-	-	-	-	-	-	-	-	-	-	-
25/03/2018	-	49	46	-	46	44	-	41	38	-	57	43
26/03/2018	-	53	49	-	50	46	-	42	41	-	48	60
27/03/2018	52	46	48	45	42	45	34	35	36	45	40	45
28/03/2018	-	71	-	-	57	-	-	45	-	-	59	-
Average	**55**	**50**	**47**	**47**	**45**	**42**	*	*	*	*	*	*
Median (RBL)	*	*	*	*	*	*	**35**	**36**	**36**	*	*	*
Logarithmic Average	*	*	*	*	*	*	*	*	*	**51**	**51**	**53**

3.3.2 Short-Term Attended Noise Monitoring Results

Given that the results of the unattended noise monitoring are affected by all ambient noise sources such as local fauna, road traffic and industrial sources, it is not possible to determine with precision the exact existing industrial noise contribution based on unattended monitoring alone. Therefore, the attended noise monitoring allows for a more detailed understanding of the existing ambient noise characteristics and a more meaningful final analysis to be undertaken. The results of the short-term attended noise monitoring are displayed in Table 3-4.

Table 3-4: Attended Noise Monitoring Results, dB(A)

Location / Time	Noise Descriptor				Comments
	L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	
Location A 90 Taylor Ave 14/03/2018 12:17	64	43	65	78	*Trucks passing < 82 dB(A)* *Cars passing < 75 dB(A)* *Industrial hum from Boral plant 42-45 dB(A)* *Wind in trees < 44 dB(A)* *Birds < 55 dB(A)* *Residential gate < 46 dB(A)* *Concrete truck passing < 79 dB(A)* *Noise Dominated by Traffic*
Location B 44 Adelaide Street 14/03/2018 12:46	40	36	45	41	*Wind < 43 dB(A)* *Insects < 37 dB(A)* *Distant traffic < 41 dB(A)* *Bird < 63 dB(A)* *Industrial hum barely audible* *Residential impulse noise < 57 dB(A)* *Truck passing on Taylor Ave < 41 dB(A)*
Location C 416 Berrima Road 14/03/2018 11:25	40	36	40	48	*Distant industrial hum < 37 dB(A)* *Wind gust < 42 dB(A)* *Insects < 40 dB(A) typically 36-40 dB(A)* *Birds 60 dB(A) – intermittent* *Train horn audible (distant)* *Train passing < 39 dB(A)* *Road traffic barely audible << 37 dB(A)* *Boral plant increase in noise levels 41-43 dB(A) duration approx. 1 min* *Reverse beeper audible* *Distant trucks passing <46 dB(A)*

3.3.3 Existing Road Traffic Noise

Existing road traffic noise levels have been obtained from the unattended environmental noise logger at location A. Table 3-5 shows the results of the long term unattended road traffic noise monitoring. The noise traffic levels are adjusted for the predicted current impact at the façade of the resident closest to Taylor Ave, 76 Taylor Ave.

Table 3-5: Existing Road Traffic Noise Data – Logger A

Date	Existing Road Traffic Noise – dB(A)			
	Daytime (7am to 10pm)		Night-time (10pm to 7am)	
	$L_{eq\ (15\ hour)}$	$L_{eq\ (1\ hour)}$	$L_{eq\ (9\ hour)}$	$L_{eq\ (1\ hour)}$
14/03/2018	-	-	57	57
15/03/2018	-	-	57	60
16/03/2018	64	65	57	59
17/03/2018	61	62	53	55
18/03/2018	-	-	-	-
19/03/2018	-	-	56	59
20/03/2018	-	-	56	58
21/03/2018	-	-	-	-
22/03/2018	-	-	-	-
23/03/2018	64	65	57	60
24/03/2018	-	-	-	-
25/03/2018	-	-	52	52
26/03/2018	-	-	55	58
27/03/2018	65	66	58	60
28/03/2018	64	64	-	-
29/03/2018	64	65	57	60
30/03/2018	58	58	53	54
Overall	63	64	56	58
Road Traffic Noise Levels at the 76 Taylor Ave	**62**	**63**	**55**	**57**

– Data excluded because adverse weather conditions were present.

3.4 Photographs

Figure 3-1 to Figure 3-3 show the location of the noise monitoring instrumentation at locations A, B and C.

Figure 3-1: Monitoring Location – A – 90 Taylor Avenue, New Berrima

Figure 3-2: Monitoring Location – B – 44 Adelaide Street, New Berrima

Figure 3-3: Monitoring Location – C – 416 Berrima Road, Moss Vale (North East Corner)

4. CURRENT LEGISLATION AND GUIDELINES

4.1 NSW EPA Noise Policy for Industry

4.1.1 Introduction

The NSW Noise Policy for Industry was developed by the NSW EPA primarily for the assessment of noise emissions from industrial sites regulated by the NSW EPA.

The policy sets out two components that are used to assess potential site-related noise impacts. The intrusiveness noise level aims at controlling intrusive noise impacts in the short-term for residences. The amenity noise level aims at maintaining a suitable amenity for particular land uses including residences in the long-term. The more stringent of the intrusiveness or amenity level becomes the project noise trigger levels for the project.

4.1.2 Project Intrusiveness Noise Level

The project intrusiveness noise level is determined as follows:

$L_{Aeq,\ 15\ minute}$ = rating background noise level + 5 dB

Where the $L_{Aeq,(15minute)}$ is the predicted or measured L_{Aeq} from noise generated within the project site over a fifteen minute interval at the receptor.

This is to be assessed at the most affected point on or within the residential property boundary or if that is more than 30 m from the residence, at the most affected point within 30 m of the residential dwelling.

4.1.3 Amenity Noise Level

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW Noise Policy for Industry 2017. The relevant recommended noise levels applicable from the Noise Policy for Industry are reproduced in Table 4-1. The rural category has been selected for the residential noise amenity criteria to match the characteristics of the area.

Table 4-1: Amenity noise levels.

Receiver	Noise Amenity Area	Time of Day	L_{Aeq} dB(A)
			Recommended amenity noise level
Residential	Rural	Day	50
		Evening	45
		Night	40
Industrial premises	All	When in use	70
Commercial premises	All	When in use	65
Active recreation	All	When in use	55

> **The project amenity noise level for industrial developments = recommended amenity noise level minus 5 dB(A)**
>
> *The following exceptions to the above method to derive the project amenity noise levels apply:*
> 1. *In areas with high traffic noise levels*
> 2. *In proposed developments in major industrial clusters*
> 3. *Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.*
> 4. *Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for development.*

This development is not considered to be captured by the above exceptions.

4.1.4 Sleep Disturbance Criteria

In accordance with the NSW EPA Noise Policy for Industry, the potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

Where the subject development/premises night-time noise levels at a residential location exceed:

- **$L_{Aeq, 15\ minute}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or**
- **L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,**

a detailed maximum noise level assessment should be undertaken.

4.1.5 Project Noise Trigger Levels

The project noise trigger levels for the site have been established in accordance with the principles and methodologies of the NSW Noise Policy for Industry (EPA, 2017).

The table below presents the rating background level, project intrusive noise level, recommended amenity noise level, and project amenity noise level. The project noise trigger level is the lowest value of intrusiveness or project amenity noise level after conversion to $L_{Aeq\ 15\ minute}$, dB(A) equivalent level. Sleep disturbance trigger levels associated with operational activities are presented in Table 4-2.

Different time periods apply for the noise criteria as the intrusive criterion considers a 15 minute assessment period while the amenity criterion requires assessment over the total length of time that a site is operational within each day, evening or night period. In order to ensure compliance under all circumstances, a 15 minute period assessment has been considered for all receptors.

Table 4-2: Project Noise Trigger Levels (PNTL) for Operational Activities, dB(A)

Receiver	Type of Receptor	Time of day	Rating background noise level	Project intrusiveness noise level $L_{eq\ 15\ minute}$	Recommended amenity noise level $L_{Aeq\ period}$	Project amenity noise level $L_{Aeq\ 15\ minute}$[4]	PNTL $L_{Aeq\ 15\ minute}$	Sleep Disturbance L_{Amax}
R1-R3	Residential – Rural	Day	34[1]	**40**	50	48	**40**	-
		Evening	38	**40[2]**	45	43	**40**	-
		Night	37	40[3]	40	**38**	**38**	**52**
R4-R9	Residential – Rural	Day	35	**40**	50	48	**40**	-
		Evening	36	**40[2]**	45	43	**40**	-
		Night	36	40[3]	40	**38**	**38**	**52**
R10-R15	Future use – Commercial/Industrial	When in use	-	-	65	63	**63**	-
R16	Active Recreation	When in use	-	-	55	53	**53**	-
R17,R20	Industrial Premises	When in use	-	-	70	68	**68**	-
R18-R19	Commercial Premises	When in use	-	-	65	63	**63**	-

Notes:
1) A minimum rating background level of 35 dB(A) for daytime has been adopted as per the Noise Policy for Industry 2017
2) The project intrusiveness level for evening time should be no greater than the project intrusiveness level for day time as per the Noise Policy for Industry 2017
3) The project intrusiveness level for night time should be no greater than the project intrusiveness level for evening time as per the Noise Policy for Industry 2017
4) These levels have been converted to $L_{Aeq\ 15\ minute}$ using the following: $L_{Aeq\ 15\ minute} = L_{Aeq\ period} + 3$ dB (NSW Noise Policy for Industry Section 2.2).

4.2 Moss Vale Enterprise Corridor Development Control Plan – Wingecarribee Council

The proposed site sits within the applicable land for the Moss Vale Enterprise Corridor Development Control Plan (DCP) from Wingecarribee Council. Noise guidelines contained in section 3.14 of the DCP are therefore applicable to the site. Table 4-3 below reproduces section 3.14 of the DCP.

In November 2017, the Noise Policy for Industry (EPA, 2017) replaced the previous Industrial Noise Policy (EPA, 2000). For both documents, the amenity of the surrounding area and the existing industrial noise sources are taken into account. Criteria to meet the requirements of the Noise Policy for Industry (EPA, 2017) were outlined in section 4.1. Therefore, by meeting the requirements of the Noise Policy for Industry (EPA, 2017) in section 4.1, the Moss Vale Enterprise Corridor DCP will also be met.

Table 4-3: Section 3.14 of the Moss Vale Enterprise Corridor DCP

Objectives	Rules
Noise emissions from future development do not adversely impact on surrounding rural and residential uses.	1. Development must comply with the requirements of the NSW Industrial Noise Policy and Environmental Protection Authority (EPA) requirements. 2. A noise impact statement prepared by a suitably qualified person must be prepared for development proposals within 500 metres of a rural or residential zone boundary. The noise impact statement must demonstrate that noise from the proposed development will not result in a significant adverse impact on the amenity of surrounding rural or residential properties based on accepted noise criteria.
Externalities generated by existing heavy industrial uses are recognised as potential constraints to future development.	3. Proposed development within the vicinity of existing heavy industrial land uses must demonstrate an understanding of the noise impacts of existing development as part of their development proposal.

4.3 NSW Road Noise Policy

The NSW Road Noise Policy (RNP) has been adopted to establish the noise criteria for the potential noise impact associated with additional traffic generated by the proposed development. The RNP was developed by the NSW EPA primarily to identify the strategies that address the issue of road traffic noise from:

- Existing roads;
- New road projects;
- Road redevelopment projects; and
- New traffic-generating developments.

4.3.1 Road Category

The subject site is located on Berrima Road. A number of residential receivers are located on Taylor Avenue between the site, and the arterial roads, Old Hume Hwy and Hume Motorway.

Based on the RNP road classification description, Taylor Avenue would be classified as a 'sub-arterial road'.

4.3.2 Noise Assessment Criteria

Section 2.3 of the RNP outlines the criteria for assessing road traffic noise. The relevant sections of Table 3 of the RNP are shown in Table 4-4.

Table 4-4: Road Traffic Noise Assessment Criteria For Residential Land Uses, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria, dB(A)*	
		Day (7am-10pm)	Night (10pm-7am)
Sub-arterial Roads	3. Existing residences affected by additional traffic on existing sub-arterial roads generated by land use developments	$L_{Aeq\ (15\ hour)}$ 60 dB	$L_{Aeq\ (9\ hour)}$ 55 dB

* Measured at 1 m from a building façade.

4.3.3 Relative Increase Criteria

In addition to the assessment criteria outlined above, any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development, must be considered. Residences experiencing increases in total traffic noise levels above the relative criteria should also be considered for mitigation as described in Section 3.4 of the RNP. For road projects where the main subject road is a local road, the relative increase criterion does not apply.

Table 6 of the RNP outlines the relative increase criteria for residential land uses, with the details applicable to this project shown in Table 4-5.

Table 4-5: Relative Increase Criteria For Residential Land Uses, dB(A)

Road Category	Type of Project/Land Use	Total Traffic Noise Level Increase, dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Sub-arterial roads	Land use development with potential to generate additional traffic on existing road	Existing traffic $L_{Aeq\ (15\ hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq\ (9\ hour)}$ + 12 dB (external)

The assessment criteria provided in Table 4-4 and the relative increase criteria provided in Table 4-5 should both be considered when designing project specific noise levels. When existing traffic levels are below the criteria in Table 4-4, the lower of the relative increase criteria and the assessment criteria in Table 4-5 should be adopted. For example, if the assessment criteria is 60 dB(A) and the relative increase criteria is 42 dB(A), then a project specific noise level of 42 dB(A) should be adopted. Similarly, if the assessment criteria is 60 dB(A) and the relative increase criteria is 65 dB(A), a project specific noise level of 60 dB(A) should be adopted.

4.3.4 Exceedance of Criteria

If the criteria shown in both Table 4-4 and Table 4-5 cannot be achieved, justification should be provided that all feasible and reasonable mitigation measures have been applied.

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.

4.3.5 Assessment Locations for Existing Land Uses

Table 4-6: Assessment Locations for Existing Land Uses

Assessment Type	Assessment Location
External noise levels at residences	The noise level should be assessed at 1 metre from the façade and at a height of 1.5 metres from the floor. Separate noise criteria should be set and assessment carried out for each façade of a residence, except in straightforward situations where the residential façade most affected by road traffic noise can be readily identified. The residential noise level criterion includes an allowance for noise reflected from the façade ('façade correction'). Therefore, when taking a measurement in the free field where reflection during measurement is unlikely (as, for instance, when measuring open land before a residence is built), an appropriate correction – generally 2.5 dB – should be added to the measured value. The 'façade correction' should not be added to measurements taken 1 metre from the façade of an existing building. Free measurements should be taken at least 15 metres from any wall, building or other reflecting pavement surface on the opposite side of the roadway, and at least 3.5 metres from any wall, building or other pavement surface, behind or at the sides of the measurement point which would reflect the sound.
Noise levels at multi-level residential buildings	The external points of reference for measurement are the two floors of the building that are most exposed to traffic noise. On other floors, the internal noise level should be at least 10 dB less than the relevant external noise level on the basis of openable windows being opened sufficiently to provide adequate ventilation. (Refer to the Building Code of Australia (Australian Building Codes Board 2010) for additional information.)

Table 4-6: Assessment Locations for Existing Land Uses

Assessment Type	Assessment Location
Internal noise levels	Internal noise levels refer to the noise level at the centre of the habitable room that is most exposed to the traffic noise with openable windows being opened sufficiently to provide adequate ventilation. (Refer to the Building Code of Australia (Australian Building Codes Board 2010) for additional information.)
Open space – passive or active use	The noise level is to be assessed at the time(s) and location(s) regularly attended by people using the space. In this regard, 'regular' attendance at a location means at least once a week.

4.4 Construction Noise and Vibration Criteria

Criteria for construction and demolition noise has been obtained from the NSW Interim Construction Noise Guideline (DECC, 2009). Guidance for construction vibration has been taken from British Standard BS 7385-Part 2: 1993 '*Evaluation and measurement for vibration in buildings*' and other standards.

4.4.1 NSW Interim Construction Noise Guideline

Residential Criteria

Table 2 of the Interim Construction Noise Guideline (DECC, 2009), sets out construction noise management levels for noise at residences and how they are to be applied. The management noise levels are reproduced in Table 4-7 below. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected' noise management level.

Table 4-7: Management Levels at Residences Using Quantitative Assessment

Time of Day	Management Level $L_{Aeq(15\ minute)}$	How to Apply
Recommended standard hours: Monday to Friday 7am – 6pm Saturday 8am – 1pm 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 $L_{Aeq(15\ minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practises to meet the noise affected level. • The proponent should also inform all potentially affected 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: 1. times identified by the community when they are less sensitive to noise (such as before and after school, or mid-morning or mid-afternoon for works near residents. 2. 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 (RNP)

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 from the residence.

Other Land Uses

Table 4-8 sets out management levels for construction noise at other land uses applicable to the surrounding area.

Table 4-8: Management Levels at Other Land Uses

Land use	Management Level $L_{Aeq(15\ minute)}$ (applies when properties are being used)
Industrial Premises	External Noise Level 75 dB(A)
Commercial Premises, offices and retail outlets	External Noise Level 70 dB(A)
Active Recreation	External Noise Level 65 dB(A)

Note: [1] As per section 4.1.2 of the Interim Construction Noise Guideline, a conservative estimate of 10 dB difference between internal and external levels is applied.

There are no other sensitive land uses in the area surrounding the site.

The noise criterion for construction noise is presented in Table 4-9.

Table 4-9: Construction Noise Criterion dB(A)

Receiver	Land Use	Period	RBL L_{A90}	Management Level $L_{Aeq(15\ minute)}$
R1-R9	Residential	Standard Hours	35[1]	45
R10-R15	Future use – Commercial/Industrial	Standard Hours	-	70
R16	Active Recreation	Standard Hours	-	65
R17, R20	Industrial	Standard Hours	-	75
R18-R19	Commercial Premises	Standard Hours	-	70

1) A minimum rating background level of 35 dB(A) has been adopted as per the Noise Policy for Industry 2017

4.4.2 Vibration Criteria

Vibration criteria from construction works are outlined in this section, including guidelines to avoid cosmetic damage, structural damage or human discomfort. There is no specific vibration standard in NSW to assess cosmetic or structural damage to buildings. Usually the British Standard BS 7385–Part 2: 1993 '*Evaluation and measurement for vibration in buildings*' or the German standard DIN4150–Part 3: 1999 '*Structural Vibration Part 3 – effects of vibration on structures*' is referenced. The *Assessing Vibration – A Technical Guideline* (DEC, 2006) provides guidance on preferred levels for human exposure.

4.4.3 BS 7385–2:1993

The British Standard BS 7385–Part 2:1993 '*Evaluation and measurement for vibration in buildings*' provides vibration limits to avoid cosmetic damage on surrounding structures. Limits are set at the lowest limits where cosmetic damage has previously been shown.

Table 4-10: Vibration criteria for cosmetic damage (BS 7385:2 1993)

Type of building	Peak component particle velocity in frequency range of predominant pulse		
	4 to 15 Hz	15 Hz to 40 Hz	40 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above		
Unreinforced or light framed structures. Residential or light commercial type buildings	15 to 20 mm/s	20 to 50 mm/s	50 mm/s

4.4.4 DIN4150–3:1999

The German standard DIN4150-Part 3:1999 '*Structural Vibration* Part 3 – *Effects of vibration on structures*' has also been considered. The German standard is considered more onerous than the British standard, and specifically includes more stringent limits to avoid structural damage to surrounding heritage buildings.

Table 4-11: Structural damage criteria heritage structures (DIN4150-3 1999)

Type of building	Peak component particle velocity (PPV) mm/s			
	Vibration at the foundation at a frequency of:			Vibration of horizontal plane of highest floor at all frequencies
	1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	
Buildings used for commercial purposes, industrial buildings or buildings of similar design	20	20 to 40	40 to 50	40
Residential dwellings and similar	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, cannot be classified as the two categories above, and are of intrinsic value (for example heritage listed buildings).	3	3 to 8	8 to 10	8

4.4.5 Human Exposure

The guideline *Assessing Vibration – A Technical Guideline* (DEC, 2006) describes preferred criteria for human exposure. The limits describe values where occupants of buildings would be impacted by construction work.

Table 4-12: Preferred and maximum weighted rms z-axis values, 1-80 Hz

Location	Daytime		Night time	
	Preferred	Maximum	Preferred	Maximum
Continuous Vibration (weighted root mean square (rms) vibration levels for continuous acceleration (m/s^2) in the vertical direction)				
Residences	0.01	0.02	0.007	0.014
Offices, schools, educational institutions and places of worship	0.02	0.04	0.02	0.04
Workshops	0.04	0.08	0.04	0.08
Impulsive Vibration (weighted root mean square (rms) vibration levels for impulsive acceleration (m/s^2) in the vertical direction)				
Residences	0.3	0.6	0.1	0.2
Offices, schools, educational institutions and places of worship	0.64	1.28	0.64	1.28
Workshops	0.64	1.28	0.64	1.28
Intermittent Vibration (m/s)				
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

4.5 METEOROLOGICAL FACTORS

Wind and temperature inversions may affect the noise emissions from the site and are to be incorporated in the assessment when considered to be a feature of the area.

In this section, an analysis of the 2018 weather data has been conducted to establish whether significant winds are characteristic of the area.

4.5.1 Wind Effects

Wind is considered to be a feature where source-to-receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30% or more of the time in any assessment period in any season.

4.5.2 Wind Rose Plots

Wind rose plots show the direction that the wind is coming from, with triangles known as "petals". The petals of the plots in the figures summarise wind direction data into 8 compass directions i.e. north, north-east, east, south-east, etc. The length of the triangles, or "petals", indicates the frequency that the wind blows from that direction. Longer petals for a given direction indicate a higher frequency of wind from that direction. Each petal is divided into segments, with each segment representing one of the six wind speed classes.

Thus, the segments of a petal show what proportion of wind for a given direction falls into each class. The proportion of time for which wind speed is less than 0.5 m/s, when speed is negligible, is referred to as calm hours or “calms”. Calms are not shown on a wind rose as they have no direction, but the proportion of time consisting of the period under consideration is noted under each wind rose.

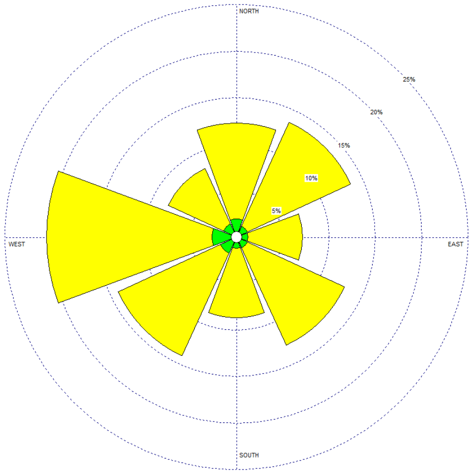
The concentric circles in each wind rose are the axis, which denote frequencies. In comparing the plots it should be noted that the axis varies between wind roses, although all wind roses are similar in size. The frequencies denoted on the axes are indicated beneath each wind rose.

4.5.3 Local Wind Trends

Seasonal wind rose plots for this site utilising Moss Vale AWS data have been included in Figure 4-1, Figure 4-2 and Figure 4-3 for day, evening and night periods respectively.

Figure 4-1: Wind Rose Plots – BOM Moss Vale AWS ID 068239 – 2018 – Day time

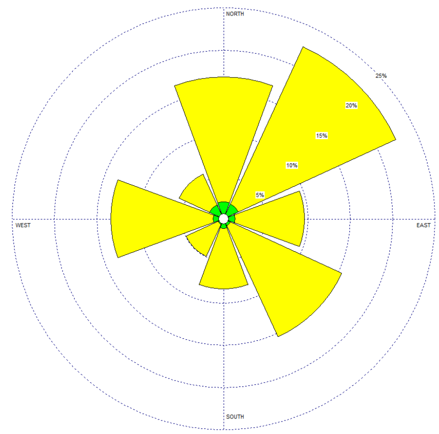
All Seasons



Average Wind Speed: 5.56 m/s

Axis Frequencies: 5%, 10%, 15%, 20%, 25%

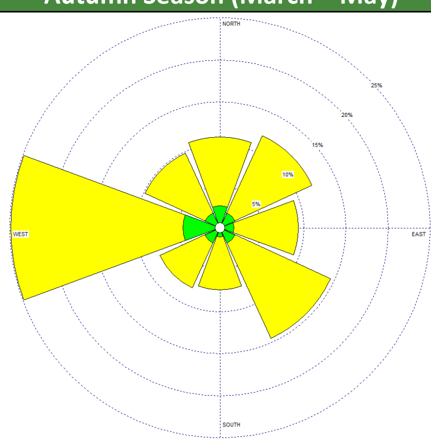
Summer Season (December – February)



Average Wind Speed: 5.421m/s

Axis Frequencies: 5%, 10%, 15%, 20%, 25%

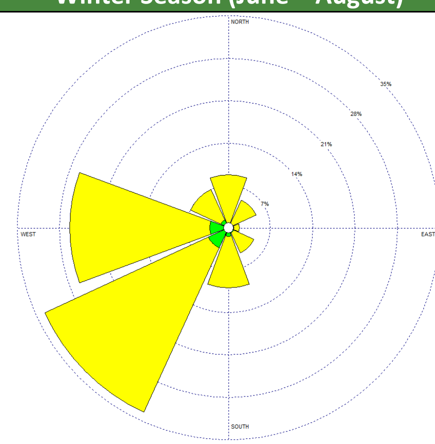
Autumn Season (March – May)



Average Wind Speed: 4.99 m/s

Axis Frequencies: 5%, 10%, 15%, 20%, 25%

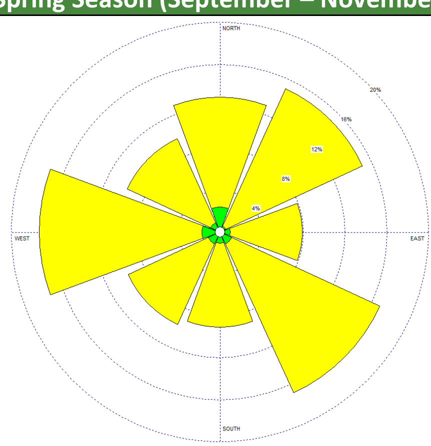
Winter Season (June – August)



Average Wind Speed: 6.03m/s

Axis Frequencies: 7%, 14%, 21%, 28%, 35%

Spring Season (September – November)



Average Wind Speed: 5.81 m/s

Axis Frequencies: 4%, 8%, 12%, 16%, 20%

Legend

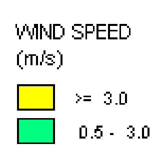
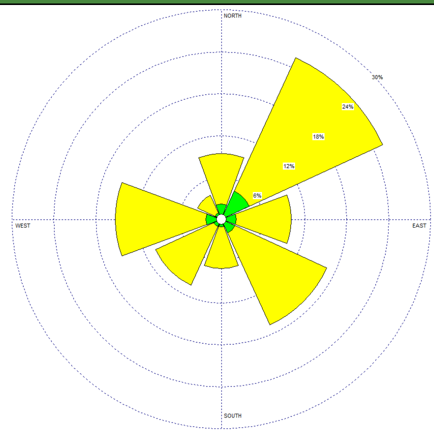


Figure 4-2: Wind Rose Plots – BOM Moss Vale AWS ID 068239 – 2018 – Evening time

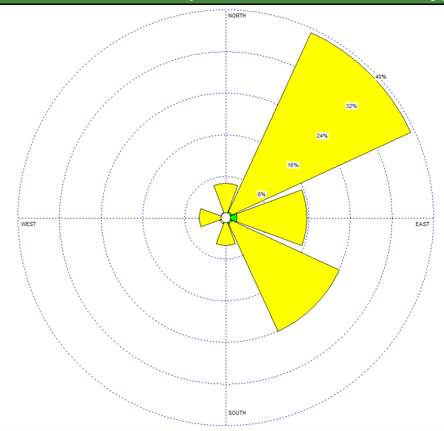
All Seasons



Average Wind Speed: 5.04 m/s

Axis Frequencies: 6%, 12%, 18%, 24%, 30%

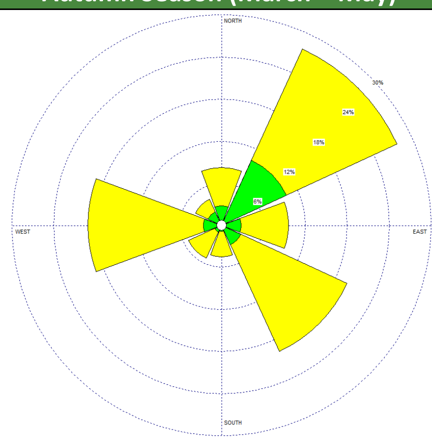
Summer Season (December – February)



Average Wind Speed: 5.49 m/s

Axis Frequencies: 8%, 16%, 24%, 32%, 40%

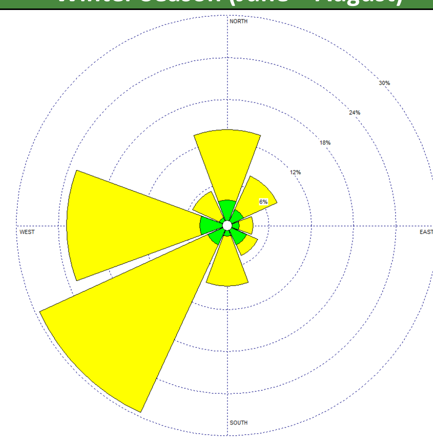
Autumn Season (March – May)



Average Wind Speed: 4.44 m/s

Axis Frequencies: 6%, 12%, 18%, 24%, 30%

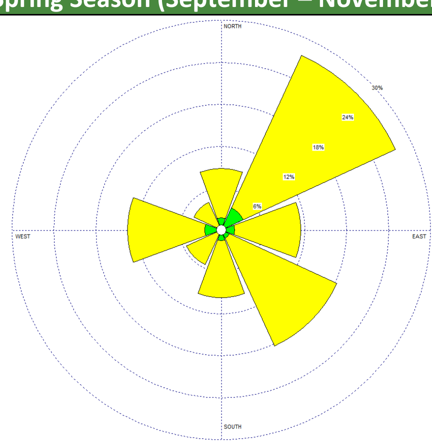
Winter Season (June – August)



Average Wind Speed: 5.11 m/s

Axis Frequencies: 6%, 12%, 18%, 24%, 30%

Spring Season (September – November)



Average Wind Speed: 5.16 m/s

Axis Frequencies: 6%, 12%, 18%, 24%, 30%

Legend

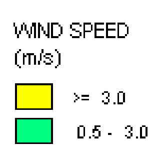
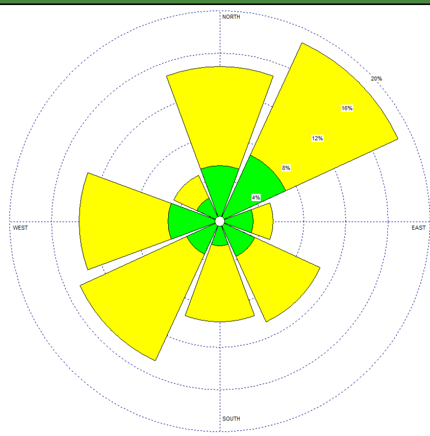


Figure 4-3: Wind Rose Plots – BOM Moss Vale AWS ID 068239 – 2018 – Night time

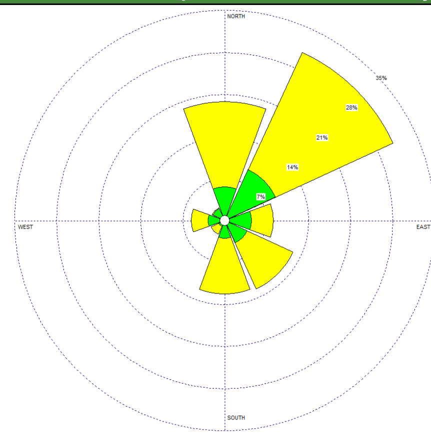
All Seasons



Average Wind Speed: 3.90 m/s

Axis Frequencies: 4%, 8%, 12%, 16%, 20%

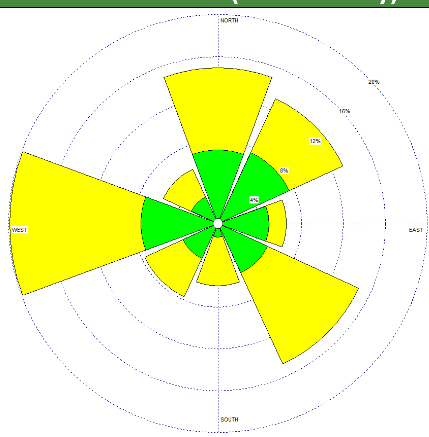
Summer Season (December – February)



Average Wind Speed: 3.65 m/s

Axis Frequencies: 7%, 14%, 21%, 28%, 35%

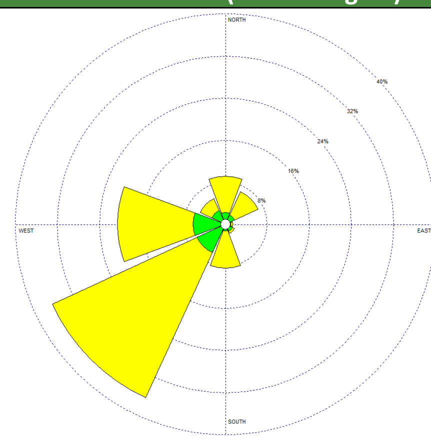
Autumn Season (March – May)



Average Wind Speed: 3.39 m/s

Axis Frequencies: 4%, 8%, 12%, 16%, 20%

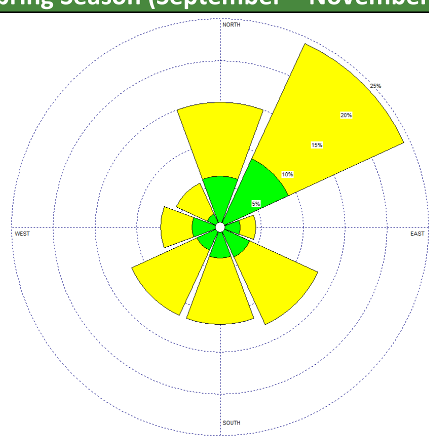
Winter Season (June – August)



Average Wind Speed: 4.77 m/s

Axis Frequencies: 8%, 16%, 24%, 32%, 40%

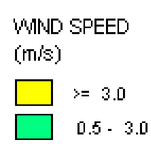
Spring Season (September – November)



Average Wind Speed: 3.78 m/s

Axis Frequencies: 5%, 10%, 15%, 20%, 25%

Legend



Appendix D2 of the Noise Policy for Industry (EPA, 2017), refers to utilising the Noise Enhancing Wind Analysis (NEWA) program on the NSW EPA website to determine the significance of source-to-receiver winds.

Table 4-13 below contains the noise wind component analysis from the NEWA software. Wind speeds are taken up to 3 m/s and wind direction is taken from source-to-receiver, plus and minus 45 degrees, as per appendix D2 of the Noise Policy for Industry.

It can be seen from Table 4-13 that there are no instances, where more than 30% of wind speeds are less than 3 m/s in the plus and minus 45 degree arc from source to receiver. Therefore, worst case 3 m/s source-to-receiver winds have not been included in the assessment.

Table 4-13: Noise Wind Component Analysis 2018 Moss Vale

Receiver	Day				Evening				Night			
	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
R1	2.9	5.5	2.5	3.6	7.2	8.2	6.3	5.8	11.2	11	2.2	7.8
R2	2.4	4.8	2.3	3.5	6.1	7.9	6.3	6.3	10.8	9.4	2.7	8.7
R3	2.6	5	1.8	3.2	4.7	8.4	6.8	6.6	10.1	8.7	2.9	8.4
R4	2.3	6.5	7.7	2.5	0.8	5.2	7.3	4.7	4.6	10.7	12.8	9.2
R5	3.3	7.2	5.3	3.2	0.3	6.5	7.6	4.7	5.3	13	10.9	6.2
R6	3.4	7.1	5.1	3.7	0.3	6.5	6	4.4	6.4	11.5	7.9	5.7
R7	3.6	7.4	4.4	3.4	0.6	7.3	7.3	4.1	7.2	10.3	7.1	5.6
R8	4.1	6.4	3.3	3	0.8	5.4	7.1	3.3	8.3	10.4	5.3	5.7
R9	3.4	5	2	2.3	3.6	17.4	7.9	8.2	18.2	15	4.5	17.5
R10	2.9	5.9	2.6	3.1	8.1	10.3	5.4	9.9	12	11.3	2.7	8.9
R11	2.9	5.5	2.5	3.6	7.2	8.2	6.3	5.8	11.2	11	2.2	7.8
R12	2.9	5.7	2.3	3.8	6.4	7.9	6.8	5.8	10.8	10.6	2.3	8.1
R13	3.1	5.9	2.6	3.1	8.9	9.5	4.9	7.7	12	11.1	2.4	8.3
R14	2.9	5.5	2.4	3.9	6.4	8.2	6.3	5.5	10.9	10.6	2.2	7.8
R15	2.7	5.1	2	3.3	4.4	7.6	6.8	5.5	9.8	8.3	3	8.2
R16	2.9	5	2.5	3.5	7.2	8.4	6.5	5.2	11.1	9.3	2.4	8.4
R17	3	6.1	1.7	2.7	8.6	17.4	5.2	11.8	14.7	11.8	2.4	13.8
R18	2.9	5.5	2.5	3.9	6.7	8.2	6.3	5.5	10.9	10.9	2.2	7.8
R19	1.7	4.1	1.7	2	3.9	6.5	5.2	4.9	8.3	7.1	1.9	7.3
R20	4.1	5.3	2.1	3.2	1.4	11.4	8.2	6.9	13.7	11.8	6	12.3

Noise enhancing meteorological conditions occur for 30% or more of the period and season

Based on the information presented from the weather data, source-to receiver wind speeds of 3 m/s or below are not present for more than 30% of the time during any season or time period. Therefore wind effects have not been included in the assessment.

4.6 TEMPERATURE INVERSIONS

Temperature inversion is considered a feature where this occurs more than 30% of the nights in winter.

Temperature inversion conditions would be best associated with F-class stability conditions – generally associated with still/light winds and clear skies during the night time or early morning period (these are referred to as stable atmospheric conditions).

The analysis conducted on the 2017 weather data highlighted that during winter 14.80% of the nights presented temperature inversion conditions, therefore these effects have not been included in the noise impact assessment.

4.6.1 Weather Conditions Considered in the Assessment

The following conditions will be considered in this noise impact assessment considered:

- Neutral Weather Conditions

Details of the considered meteorological conditions have been displayed in Table 4-14.

Table 4-14: Meteorological Conditions Assessed in Noise Propagation Modelling

Classification	Ambient Temp.	Ambient Humidity	Wind Speed	Wind Direction (blowing from)	Temperature Inversion	Affected Receiver	Applicability
Neutral	10°C	70%	0 m/s	–	No	All	All periods

5. OPERATIONAL NOISE IMPACT ASSESSMENT

An outline of the predictive noise modelling methodology and operational noise modelling scenarios has been provided in this section of the report.

5.1 MODELLING METHODOLOGY

Predictive Noise Modelling was carried out using the ISO9613 algorithm within SoundPLAN v7.3. This model has been extensively utilised by Benbow Environmental for assessing noise emissions for numerous sites, and is recognised by regulatory authorities throughout Australia.

Inputs into the noise model include topographical features of the area, ground absorption, on site structures and predicted noise sources. Receivers were included to predict the noise emissions of the proposed development at the nearest potentially affected residences.

The modelling scenario has been carried out using the L_{Aeq} and L_{Amax} descriptors. Using the model, noise levels were predicted at the potentially most affected receivers to determine the noise impact against the project specific noise levels and other relevant noise criteria in accordance with the NSW Noise Policy for Industry (EPA, 2017).

5.2 NOISE SOURCES

The sound power levels for the identified noise sources associated with the operational activities have been taken from equipment datasheets, on-site measurements of similar activities as well as from Benbow Environmental's database.

A-weighted third octave band centre frequency sound power levels have been used and are presented in Table 5-1 below. The noise sources utilised as part of this assessment comprise of the primary noise generating activities associated with the effective operation of the proposed development.

Table 5-1: A-weighted Sound Power Levels Associated with Operational Activities, dB(A)

Noise Source	L_{Amax}	Overall	Third Octave Band Centre Frequency (Hz)									
			25	31	40	50	63	80	100	125	160	200
			250	315	400	500	630	800	1000	1250	1600	2000
			2500	3150	4000	5000	6300	8000	10000	12500	16000	20000
Kiln	-	94	35	39	45	52	56	56	59	60	64	66
			67	70	71	76	76	77	79	81	82	83
			84	85	86	85	83	85	77	71	66	54
Vibratory Screen	-	106	84	82	91	92	99	96	91	94	92	92
			89	88	92	94	90	91	91	92	92	91
			90	89	88	86	84	81	78	75	71	66
Scrubber	102	96	37	34	34	57	53	58	52	63	64	64
			68	77	80	80	85	86	91	89	84	83
			82	82	82	82	77	77	75	74	68	58
Reactor	83	81	43	33	33	52	44	49	55	56	62	67
			65	71	70	72	71	72	71	70	68	67
			66	64	62	60	59	54	53	46	45	36
Hammermill	-	110	64	58	62	68	72	77	79	84	89	89
			91	90	97	101	97	102	99	100	100	99
			101	96	93	90	85	85	80	73	66	60
Pan Mill	-	104	82	80	89	90	97	94	89	92	90	90
			87	86	90	92	88	89	89	90	90	89
			88	87	86	84	82	79	76	73	69	64
Press	-	109	71	61	61	80	72	77	83	84	90	95
			93	99	98	100	99	100	99	98	96	95
			94	92	90	88	87	82	81	74	73	64
Premixer	-	104	37	48	49	56	72	62	71	75	74	82
			83	84	91	93	91	95	97	95	93	94
			91	89	89	86	84	81	78	74	73	64
Setting Machine	-	98	40	53	58	65	72	76	81	84	87	87
			81	80	84	89	91	88	86	87	86	84
			81	79	76	74	71	68	65	61	57	52
Extruder	-	93	33	42	40	62	75	63	72	81	80	75
			72	79	77	81	79	81	81	80	80	83
			81	82	83	78	75	75	77	70	68	52
Forklift	103	92	36	59	61	51	65	66	77	68	60	62
			66	69	74	81	78	78	81	85	84	84
			81	75	71	71	65	63	56	51	45	42
Aggregate & Waste Dumping	110	106	-	65	-	-	72	-	-	77	-	-
			84	-	-	91	-	-	95	-	-	98
			-	-	100	-	-	102	-	-	95	-
Front End Loader	109	102	44	51	59	85	84	77	77	78	80	85
			89	85	85	88	88	90	93	94	93	92
			91	90	88	87	84	81	77	73	66	60

Table 5-1: A-weighted Sound Power Levels Associated with Operational Activities, dB(A)

Noise Source	L_{Amax}	Overall	Third Octave Band Centre Frequency (Hz)									
			25	31	40	50	63	80	100	125	160	200
			250	315	400	500	630	800	1000	1250	1600	2000
			2500	3150	4000	5000	6300	8000	10000	12500	16000	20000
Crusher	114	108	50	63	68	75	82	86	91	94	97	97
			91	90	94	99	101	98	96	97	96	94
			92	89	86	84	81	78	75	71	67	62
CVR Crusher	120	112	54	67	72	79	86	90	95	98	101	101
			95	94	98	103	105	102	100	101	100	98
			95	93	90	88	85	82	79	75	71	66
Cement Blower	109	106	33	56	56	60	70	66	68	79	74	74
			77	78	84	86	98	104	90	94	93	95
			93	90	88	87	83	84	77	-	-	-
Conveyor	86	80	29	31	29	35	38	49	45	49	53	57
			57	65	68	70	68	71	70	72	71	70
			63	63	59	56	52	49	44	42	36	29
Finger Cart	-	92	36	59	61	51	65	66	77	68	60	62
			66	69	74	81	78	78	81	85	84	84
			81	75	71	71	65	63	56	51	45	42
Concrete Mixing	-	104	37	48	49	56	72	62	71	75	74	82
			83	84	91	93	91	95	97	95	93	94
			91	89	89	86	84	81	78	-	-	-
Boiler	-	96	50	45	48	60	59	72	77	74	79	79
			79	78	84	85	82	83	83	84	84	83
			84	86	85	80	81	78	82	81	82	73
Washing Device	-	81	43	33	33	52	44	49	55	56	62	67
			65	71	70	72	71	72	71	70	68	67
			66	64	62	60	59	54	53	46	45	36
Polisher	-	84	46	36	36	55	47	52	58	59	65	70
			68	74	73	75	74	75	74	73	71	70
			69	67	65	63	62	57	56	49	48	39
Chamfering	-	95	57	47	47	66	58	63	69	70	76	81
			79	85	84	86	85	86	85	84	82	81
			80	78	76	74	73	68	67	60	59	50
Shot Blasting	-	95	57	47	47	66	58	63	69	70	76	81
			79	85	84	86	85	86	85	84	82	81
			80	78	76	74	73	68	67	60	59	50
Curling	-	78	40	30	30	49	41	46	52	53	59	64
			62	68	67	69	68	69	68	67	65	64
			63	61	59	57	56	51	50	43	42	33
Drying Tunnel	-	91	53	43	43	62	54	59	65	66	72	77
			75	81	80	82	81	82	81	80	78	77
			76	74	72	70	69	64	63	56	55	46
Top Seal	-	79	41	31	31	50	42	47	53	54	60	65
			63	69	68	70	69	70	69	68	66	65
			64	62	60	58	57	52	51	44	43	34
Splitter	-	104	66	56	56	75	67	72	78	79	85	90
			88	94	93	95	94	95	94	93	91	90
			89	87	85	83	82	77	76	69	68	59

Table 5-1: A-weighted Sound Power Levels Associated with Operational Activities, dB(A)

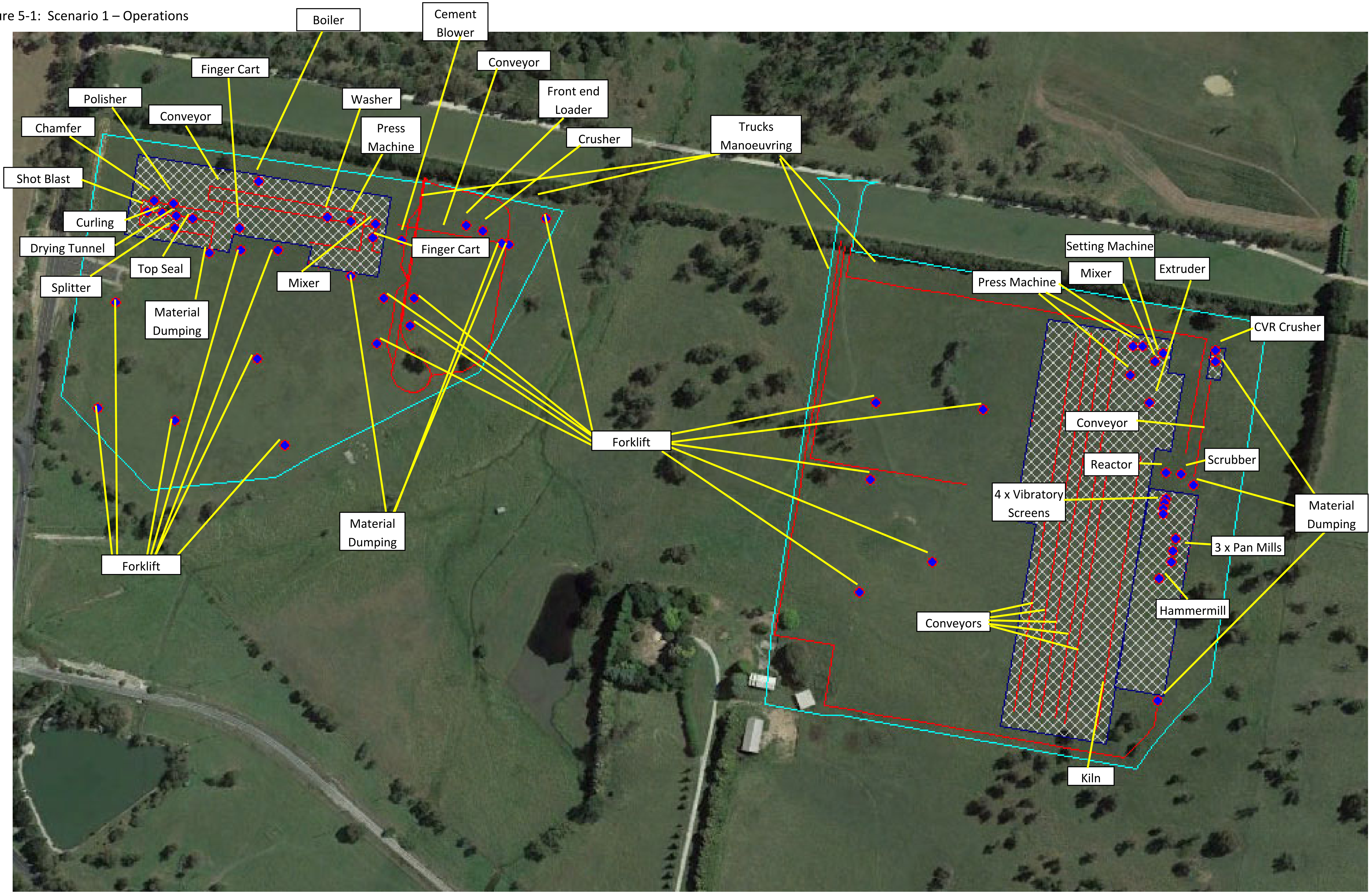
Noise Source	L_{Amax}	Overall	Third Octave Band Centre Frequency (Hz)									
			25	31	40	50	63	80	100	125	160	200
			250	315	400	500	630	800	1000	1250	1600	2000
			2500	3150	4000	5000	6300	8000	10000	12500	16000	20000
Press Machine (with enclosure)	-	109	71	61	61	80	72	77	83	84	90	95
			93	99	98	100	99	100	99	98	96	95
			94	92	90	88	87	82	81	74	73	64
Truck Engine Manoeuvring	109	103	44	48	57	65	70	73	78	78	80	82
			83	85	94	98	94	96	89	88	82	87
			85	84	82	83	83	82	78	-	-	-
Truck Exhaust Manoeuvring	103	101	42	46	55	63	68	71	76	76	78	80
			81	83	92	96	92	94	87	86	80	85
			83	82	80	81	81	80	76	-	-	-

5.2.1 Modelling Scenario

One scenario was modelled for operational noise emissions. The scenario proposed day evening and night operations, including proposed heavy vehicle movements, and plant operations of the approved masonry plant and the proposed brick manufacturing plant.

Figure 5-1 shows the locations of the noise sources for the operational scenario.

Figure 5-1: Scenario 1 – Operations



5.2.2 Modelling Assumptions

The relevant assessment period for operational noise emissions is 15 minutes when assessing noise levels against the Intrusive Criterion; therefore noise source durations detailed throughout the following assumptions section should be considered per 15 minute period in view of potential noise impacts under worst-case scenarios. Each assessment-specific assumption has been detailed below:

- Off-site topographical information has been obtained from Google Earth and implemented in SoundPLAN v.7.3.

- All ground areas surrounding the subject site and the nearest nominated occupancies have been modelled considering different ground factors ranging from 0 to 1. The site's hardstand area has been modelled with a ground absorption factor of 0 (hard). The New Berrima low density residential area has been modelled with a ground absorption factor of 0.5. The surrounding rural areas have been modelled with a ground absorption factor of 0.9 (soft).

- Five trucks, 2 × aggregate truck and dog, 1 × cement tanker, 2 × product trucks are assumed to enter and leave the already approved masonry manufacturing plant every 15 minutes (20 per hour). Trucks have been assumed to travel on the site at 20 km/h.

- Six trucks are assumed to enter and leave the proposed brick manufacturing plant every 15 minutes (24 per hour). Trucks have been assumed to travel on the site at 20 km/h.

- The aggregate & waste dumping is assumed to occur for 2 minutes every hour.

- All other sources are assumed to operate 100% of the time as a worst case scenario.

- The already approved masonry production building has been modelled with 1 mm corrugated steel sheeting (R_w 25 dB). All pedestrian doors, roller shutter doors and output doors have been modelled open (R_w 0 dB) 100% of the time.

- The proposed brick factory crusher building has been modelled with 1 mm corrugated steel sheeting (R_w 25 dB). Fast acting roller shutter doors on the brick factory crusher building are assumed to be open 50% of the time.

- The proposed material storage shed/building has been modelled with the first 2.4m as precast concrete walls (R_w 48 dB) with the rest of the building modelled with 1 mm corrugated steel sheeting (R_w 25 dB). 1x1m openings have been modelled for the conveyor access points (R_w 0 dB).

- The proposed brick factory main production building has been modelled with 1 mm corrugated steel sheeting (R_w 25 dB). 1x1m openings have been modelled for the conveyor access points (R_w 0 dB). Roller shutter doors have been modelled closed as they are primarily used for maintenance and materials are delivered into and out of the building via conveyor.

- All residential receivers were modelled at 1.5 m above ground level at the most noise-affected point within the property boundary.

5.3 Predicted Noise Levels – Operational

Noise levels at the nearest receptors have been calculated and results of the predictive noise modelling considering operational activities are shown in Table 5-2.

Table 5-2: Predicted Noise Levels – Operational Activities dB(A)

Receptor	Project Criteria $L_{eq(15\ minute)}$			Project Criteria L_{Amax}	Scenario 1	
	Day	Evening	Night		Predicted $L_{eq(15\ minute)}$	Predicted L_{Amax}
R1	40	40	38	52	35✓	40✓
R2	40	40	38	52	37✓	44✓
R3	40	40	38	52	37✓	44✓
R4	40	40	38	52	38✓	45✓
R5	40	40	38	52	36✓	42✓
R6	40	40	38	52	37✓	43✓
R7	40	40	38	52	37✓	42✓
R8	40	40	38	52	36✓	41✓
R9	40	40	38	52	37✓	43✓
R10	63			NA	47✓	N/A
R11	63			NA	46✓	N/A
R12	63			NA	37✓	N/A
R13	63			NA	35✓	N/A
R14	63			NA	38✓	N/A
R15	63			NA	37✓	N/A
R16	53			NA	39✓	N/A
R17	68			NA	43✓	N/A
R18	63			NA	35✓	N/A
R19	63			NA	48✓	N/A
R20	68			NA	41✓	N/A

✓Complies ✗ Non-compliance

The modelled scenario is predicted to comply with the project specific criteria under neutral weather conditions at all sensitive receptors. Furthermore, sleep disturbance is not predicted at any residential receptors.

Further mitigation measures beyond the assumptions listed throughout this chapter are therefore not required to meet the project criteria. However, proactive recommended mitigation measures are listed in Section 6 in order to further reduce noise levels at surrounding receivers.

6. RECOMMENDED MITIGATION MEASURES

The noise assessment in Section 5 predicted that noise levels would be met at all surrounding receivers during all periods. While further noise mitigation measures are not required to meet the project criteria, the following noise mitigation measures are recommended in order to proactively further reduce noise levels at surrounding receivers:

- Prohibition of extended periods of on-site revving/idling;
- Minimisation of the use of truck exhaust brakes on site;
- Enforcement of low on-site speed limits;
- Signs to encourage quiet operations during the night period;
- On-site mobile equipment to be maintained in accordance with a preventative maintenance program to ensure optimum performance and early detection of wearing or noisy components; and
- Replacement of beeping reversing alarms on all vehicles which are regularly used on site (the forklift and front end loader) with reversing lights or a white noise reversing alarm (squawker).

7. ROAD TRAFFIC NOISE IMPACT ASSESSMENT

A description of the calculation methodology and the noise predictions associated with road traffic has been provided below.

Approved Masonry Plant
115 trucks, 230 movements would occur in a 24 hour period. Therefore 150 movements have been considered during the day time (7am-10pm) and 80 movements have been considered during the night (10pm-7am).

Proposed Brick Plant
85 trucks, 170 movements would occur in a 24 hour period. Therefore 110 movements have been considered during the day time (7am-10pm) and 60 movements have been considered during the night (10pm-7am).

Total Traffic
Based on the traffic numbers above, 260 movements have been considered during the day time (7am-10pm) and 140 movements have been considered during the night (10pm-7am).

As mentioned in section 3.3.3, the closest residential receptors along the proposed truck routes to and from site are along Taylor Avenue. Road traffic noise impacts have been analysed at the potentially most impacted road traffic receiver at 76 Taylor Avenue, New Berrima.

Vehicles are assumed to travel at the posted speed of 60 km/h.

The $L_{Aeq,\ 15\ hour}$ and $L_{Aeq,\ 9\ hour}$ noise descriptors have been calculated at the most affected residential receptor, 76 Taylor Avenue, New Berrima. The predicted noise levels are displayed in Table 7-1. The highest contribution from the route to/from the site is predicted at this location; therefore it is the only results displayed.

Table 7-1: Predicted Levels for Road Traffic Noise, dB(A)

Receptor	Noise Criteria		Existing Traffic		Site Contribution		Cumulative Road Traffic Noise	
	Day $L_{Aeq,\ 15\ hour}$	Night $L_{Aeq,\ 9\ hour}$	Day $L_{Aeq,\ 15\ hour}$	Night $L_{Aeq,\ 9\ hour}$	Day $L_{Aeq,\ 15\ hour}$	Night $L_{Aeq,\ 9\ hour}$	Day $L_{Aeq,\ 15\ hour}$	Night $L_{Aeq,\ 9\ hour}$
76 Taylor Avenue, New Berrima	60	55	62	55	53 ✓	52 ✓	63 ✓	57 ✓

For residential dwellings that front onto Taylor Avenue, the predicted noise levels associated with the vehicle movements from the site would be below the daytime criteria of $L_{Aeq\ (15\ hour)}$ 60 dB(A) and $L_{Aeq\ (9\ hour)}$ 55 dB(A) for sub-arterial roads. Furthermore, given the current volumes along Taylor Avenue, the proposal will not increase the cumulative road traffic noise levels during the day or night periods by more than 2 dB.

Step 3 of Section 3.4.1 of the RNP identifies possible reasonable and feasible control measures when exceedances of either of the outlined criteria. As no exceedances are predicted, the proposed vehicle movements comply with the RNP, and no additional mitigation strategies are recommended.

8. CONSTRUCTION NOISE IMPACT ASSESSMENT

8.1 Construction Activities

Construction activities are proposed to include the following:

- Excavation/cut and fill levelling of land;
- Concreting site works; and
- Construction of industrial building.

8.2 Modelled Noise Generating Scenarios

Considering the construction activities outlined in section 8.1, the three construction scenarios listed in Table 8-1 are modelled for:

- Excavation/levelling works (scenario 1);
- Concreting works for the new masonry manufacturing plant (scenario 2); and
- Structure works for the new masonry manufacturing plant (scenario 3).

The noise generating scenarios consider a situation in which all equipment was running for 100% of the time over the 15 minute assessment period. The equipment list for the scenario is detailed in Table 8-1, with an equipment location diagrams in Figure 8-1 to Figure 8-3.

All works are proposed to be undertaken during standard construction hours, that is:

- Monday to Friday, 7am to 6pm;
- Saturday 8am to 1pm ; and
- No work on Sundays or public holidays.

Table 8-1: Modelled Noise Scenarios for Proposed Construction Works

Scenario	Time of the day	Noise Sources for Worst 15-minute Period
1. Excavation works	Standard hours	• 20T Excavator • Backhoe • Truck • Hand tools
2. Concreting construction works	Standard hours	• Concrete mixer truck • Concrete pump • Hand tools
3. Structure construction works	Standard hours	• Truck • Crane • Welder • Hand Tools

Note 1: As per section 4.5 of the Interim Construction Noise Guideline (DECC, 2009), a number of activities have proven to be particularly annoying to residents and have therefore had 5 dB added to their predicted levels.

Figure 8-1: Construction Scenario 1 – Excavation Construction Works

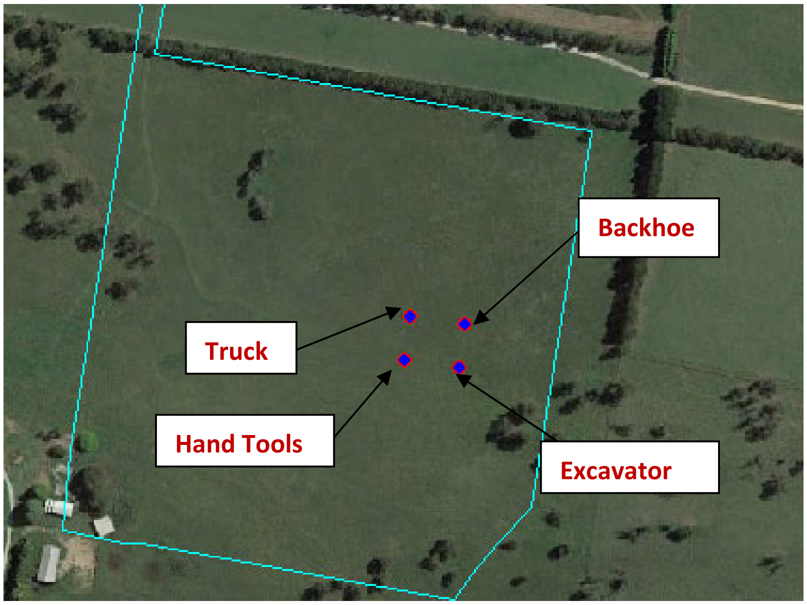


Figure 8-2: Construction Scenario 2 – Concreting Construction Works

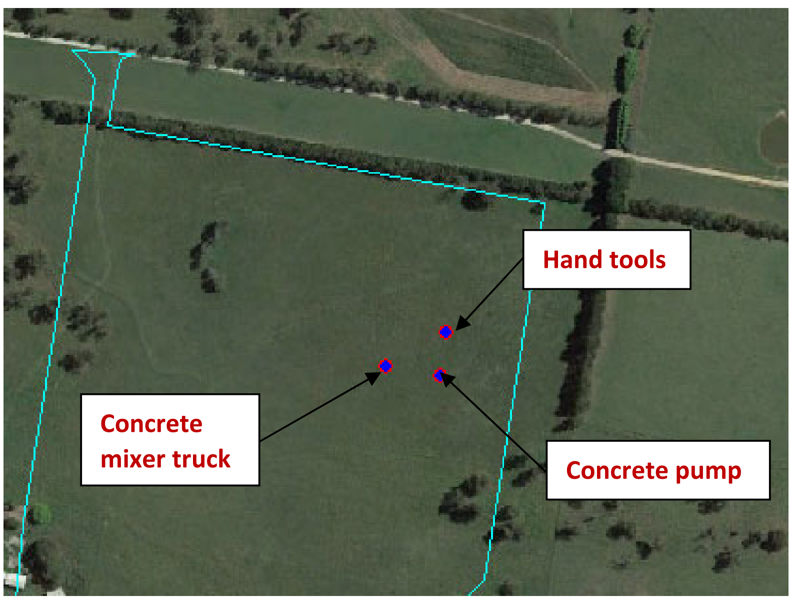
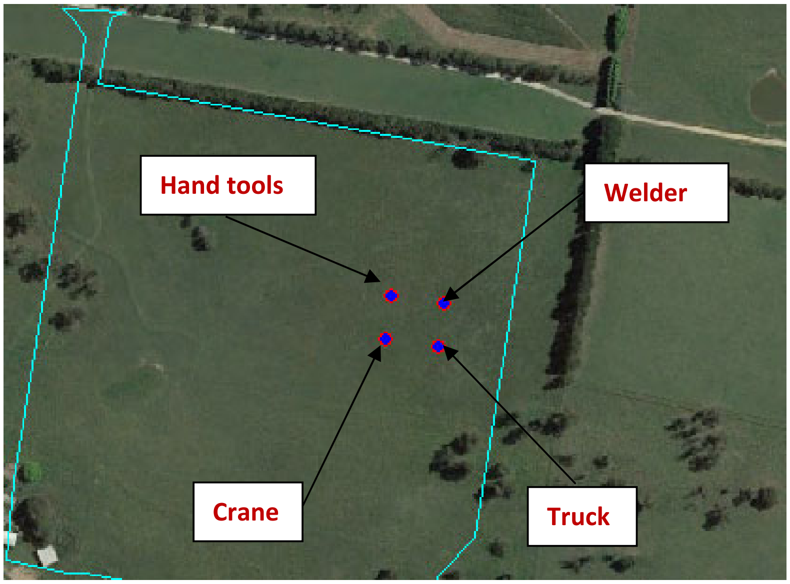


Figure 8-3: Construction Scenario 3 – Structure Construction Works



8.3 MODELLING METHODOLOGY

8.3.1 Noise Model

Noise propagation modelling for the construction activities was carried out using the ISO 9613 algorithm within SoundPLAN v7.3. The construction scenarios were modelled using the $L_{Aeq,\ 15\ minutes}$ descriptor.

Assumptions made in the noise modelling of the construction noise scenarios are as follows:

- The relevant assessment period for operational noise emissions has been considered to be 15 minutes. Construction scenarios assume all equipment is running 100% of the time during the 15 minute assessment period, to provide a worst case scenario;
- Topographical information was obtained from Google Earth;
- All receptors were modelled at 1.5 m above ground level;
- All ground areas surrounding the subject site and the nearest nominated occupancies have been modelled considering different ground factors ranging from 0 to 1. The site's hardstand area has been modelled with a ground absorption factor of 0 (hard). The New Berrima low density residential area has been modelled with a ground absorption factor of 0.5. The surrounding rural areas have been modelled with a ground absorption factor of 0.9 (soft).
- All noise sources associated with the construction works have been modelled as point sources.

8.3.2 Noise Sources

A-weighted octave band centre frequency sound power levels are presented shown in Table 8-2 below. The sound power levels for the relevant noise sources have been calculated from measurements of sound pressure levels undertaken by an acoustic engineer from Benbow Environmental at similar sites and sourced from Benbow Environmental's noise source database, as well as taken from AS 2436–2010 and the UK Department for Environmental Food and Rural Affairs (DEFRA) database, *Update of noise database for prediction of noise on construction and open sites*.

Table 8-2: A-weighted Sound Power Levels Associated with Construction Activities, dB(A)

Noise Source	Overall	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Excavator 20T	**110**	103	101	100	101	102	102	97	90
Truck	**106**	76	84	89	104	95	93	88	88
Hand tools	**100**	71	81	91	96	94	90	87	81
Backhoe	**104**	102	94	92	92	91	88	87	78
Concrete truck	**108**	85	86	85	94	98	107	89	82
Concrete pump truck	**105**	77	92	97	99	100	95	95	89
Crane	**110**	94	99	103	104	104	102	94	84
Welders	**108**	83	90	93	99	105	102	98	93

8.4 Construction Predicted Noise Levels

Results of the predictive noise modelling of the construction activities are shown in Table 8-3. It can be seen that the predicted noise levels comply with the construction noise criteria at all residential receivers during standard construction hours.

Construction activities are therefore proposed to take place during standard **construction** hours as follows:

Monday to Friday:	7am to 5pm (with no hammering or saw-cutting to occur before 7.30am)
Saturday:	8am to 1pm (with no hammering or saw-cutting to occur before 8.30am)
Sunday and Public Holidays:	No works permitted

Should construction works take place during standard construction hours, no additional noise mitigation measures are recommended.

Table 8-3: Noise Modelling Results Associated with Construction Activities for L_{eq}, dB(A)

Receiver	PSNL ($L_{eq,15 minute}$ dB(A))	Scenario (Standard Hours) (L_{eq}, dB(A))		
	Standard Hours	1	2	3
R1	45	27✓	26✓	32✓
R2	45	26✓	25✓	31✓
R3	45	26✓	26✓	31✓
R4	45	29✓	30✓	35✓
R5	45	27✓	27✓	33✓
R6	45	28✓	28✓	33✓
R7	45	28✓	28✓	33✓
R8	45	25✓	24✓	30✓
R9	45	27✓	27✓	33✓
R10	70	35✓	36✓	41✓
R11	70	36✓	36✓	41✓
R12	70	29✓	29✓	34✓
R13	70	27✓	27✓	33✓
R14	70	27✓	27✓	32✓
R15	70	26✓	26✓	31✓
R16	65	31✓	32✓	37✓
R17	75	34✓	35✓	40✓
R18	70	27✓	27✓	32✓
R19	70	35✓	38✓	42✓
R20	75	34✓	34✓	39✓

✓Complies ✗ Non-compliance

The modelled scenario is predicted to comply with the project specific criteria under neutral weather conditions at all sensitive receptors.

9. VIBRATION IMPACT ASSESSMENT

In the NSW TfNSW Construction Noise Strategy document and Assessing Vibration – a Technical Guideline, construction equipment that may cause vibration impacts includes hydraulic hammers, vibratory pile drivers, pile boring, jackhammers, wacker packers, concrete vibrators and pavement breakers, amongst other equipment. The construction work and operations proposed would not use this type of equipment and is not expected to cause vibration impacts. A detailed Vibration Impact Assessment is therefore not considered warranted.

10. CONCLUDING REMARKS

Benbow Environmental has been engaged by Brickworks Ltd to prepare a noise impact assessment for a proposed masonry manufacturing plant to be located at 416 Berrima Road, New Berrima NSW 2577.

The principal noise sources associated with the site include noise from plant equipment, external mobile vehicles, truck movements associated with material delivery and loading and the external crushing operations.

The noise impact assessment was undertaken in accordance with the following guidelines:

- NSW Noise Policy for Industry (EPA, 2017);
- NSW Road Noise Policy (RNP) (DECCW, 2011);
- NSW Interim Construction Noise Guideline (DECC, 2009); and
- Moss Vale Enterprise Corridor Development Control Plan (DCP) (Wingecarribee Council, 2012).

Assessment criteria for noise emissions from the subject site were used to determine whether the potential noise impacts from the site were within the derived limits or in exceedance of the guidelines.

This assessment assessed the cumulative noise impacts of both the recently approved masonry manufacturing plant and the proposed brick manufacturing plant.

The site operations, construction scenarios and road traffic impacts were modelled using the predictive noise software, Sound Plan V7.3. Operational noise modelling utilised a worst case scenario in which all activities were conducted simultaneously. The noise generating scenarios are predicted to comply with the project specific noise levels at all receivers during all time periods and considered weather conditions.

Compliance with the guidelines set out in the Interim Construction Noise Guideline and NSW Road Noise Policy was predicted at all considered receptors.

This concludes the report.

Emma Hansma	R T Benbow
<u>Senior Environmental Engineer</u>	<u>Principal Consultant</u>

11. LIMITATIONS

Our services for this project are carried out in accordance with our current professional standards for site assessment investigations. No guarantees are either expressed or implied.

This report has been prepared solely for the use of Brickworks Ltd, as per our agreement for providing environmental services. Only Brickworks Ltd is entitled to rely upon the findings in the report within the scope of work described in this report. Otherwise, no responsibility is accepted for the use of any part of the report by another in any other context or for any other purpose.

Although all due care has been taken in the preparation of this study, no warranty is given, nor liability accepted (except that otherwise required by law) in relation to any of the information contained within this document. We accept no responsibility for the accuracy of any data or information provided to us by Brickworks Ltd for the purposes of preparing this report.

Any opinions and judgements expressed herein, which are based on our understanding and interpretation of current regulatory standards, should not be construed as legal advice.

ATTACHMENTS

Attachment 1: Noise Terminology

'A' FREQUENCY WEIGHTING

The 'A' frequency weighting roughly approximates to the Fletcher-Munson 40 phon equal loudness contour. The human loudness perception at various frequencies and sound pressure levels is equated to the level of 40 dB at 1 kHz. The human ear is less sensitive to low frequency sound and very high frequency sound than midrange frequency sound (i.e. 500 Hz to 6 kHz). Humans are most sensitive to midrange frequency sounds, such as a child's scream. Sound level meters have inbuilt frequency weighting networks that very roughly approximates the human loudness response at low sound levels. It should be noted that the human loudness response is not the same as the human annoyance response to sound. Here low frequency sounds can be more annoying than midrange frequency sounds even at very low loudness levels. The 'A' weighting is the most commonly used frequency weighting for occupational and environmental noise assessments. However, for environmental noise assessments, adjustments for the character of the sound will often be required.

AMBIENT NOISE

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. Usually assessed as an energy average over a set time period 'T' (L_{Aeq},T).

AUDIBLE

Audible refers to a sound that can be heard. There are a range of audibility grades, varying from "barely audible", "just audible" to "clearly audible" and "prominent".

BACKGROUND NOISE LEVEL

Total silence does not exist in the natural or built-environments, only varying degrees of noise. The Background Noise Level is the minimum repeatable level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc.. It is quantified by the noise level that is exceeded for 90 % of the measurement period 'T' (L_{A90}, T). Background Noise Levels are often determined for the day, evening and night time periods where relevant. This is done by statistically analysing the range of time period (typically 15 minute) measurements over multiple days (often 7 days). For a 15 minute measurement period the Background Noise Level is set at the quietest level that occurs at 1.5 minutes.

'C' FREQUENCY WEIGHTING

The 'C' frequency weighting approximates the 100 phon equal loudness contour. The human ear frequency response is more linear at high sound levels and the 100 phon equal loudness contour attempts to represent this at various frequencies at sound levels of approximately 100 dB.

DECIBEL

The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0 dB to 120 dB. The decibel is ten times the logarithm of the ratio of any two quantities that relate to the flow of energy (i.e. power). When used in acoustics it is the ratio of square of the sound pressure level to a reference sound pressure level, the ratio of the sound power level to a reference sound power level, or the ratio of the sound intensity level to a reference sound intensity level. See also Sound Pressure Level and Sound Power Level. Noise levels in decibels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dB, and another similar machine is placed beside it, the level will increase to 53 dB (from $10 \log_{10} (10^{(50/10)} + 10^{(50/10)})$ and not 100 dB. In theory, ten similar machines placed side by side will increase the sound level by 10 dB, and one hundred machines increase the sound level by 20 dB. The human ear has a vast sound-sensitivity range of over a thousand billion to one so the logarithmic decibel scale is useful for acoustical assessments.

dBA – See 'A' frequency weighting

dBC – See 'C' frequency weighting

EQUIVALENT CONTINUOUS SOUND LEVEL, LAeq

Many sounds, such as road traffic noise or construction noise, vary repeatedly in level over a period of time. More sophisticated sound level meters have an integrating/averaging electronic device inbuilt, which will display the energy time-average (equivalent continuous sound level - L_{Aeq}) of the 'A' frequency weighted sound pressure level. Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the LAeq level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.

'F'(FAST) TIME WEIGHTING

Sound level meter design-goal time constant which is 0.125 seconds.

FLETCHER–MUNSON EQUAL LOUDNESS CONTOUR CURVES

The Fletcher–Munson curves are one of many sets of equal loudness contours for the human ear, determined experimentally by Harvey Fletcher and Wilden A. Munson, and reported in a 1933 paper entitled "Loudness, its definition, measurement and calculation" in the Journal of the Acoustic Society of America.

FREE FIELD

In acoustics a free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall or inside an anechoic chamber.

FREQUENCY

The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.

IMPACT ISOLATION CLASS (IIC)

The American Society for Testing and Materials (ASTM) has specified that the IIC of a floor/ceiling system shall be determined by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The IIC is a number found by fitting a reference curve to the measured octave band levels and then deducting the sound pressure level at 500 Hz from 110 decibels. Thus the higher the IIC, the better the impact sound isolation. Not commonly used in Australia.

'I' (IMPULSE) TIME WEIGHTING

Sound level meter time constant now not in general use. The 'I' (impulse) time weighting is not suitable for rating impulsive sounds with respect to their loudness. It is also not suitable for assessing the risk of hearing impairment or for determining the 'impulsiveness' of a sound.

IMPACT SOUND INSULATION ($L_{nT,w}$)

Australian Standard AS ISO 717.2 – 2004 has specified that the Impact Sound Insulation of a floor/ceiling system be quantified by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The Weighted Standardised Impact Sound Pressure Level ($L_{nT,w}$) is the sound pressure level at 500 Hz for a reference curve fitted to the measured 1/3 octave band levels. Thus the lower $L_{nT,w}$ the better the impact sound insulation.

IMPULSE NOISE

An impulse noise is typified by a sudden rise time and a rapid sound decay, such as a hammer blow, rifle shot or balloon burst.

LOUDNESS

The volume to which a sound is audible to a listener is a subjective term referred to as loudness. Humans generally perceive an approximate doubling of loudness when the sound level increases by about 10 dB and an approximate halving of loudness when the sound level decreases by about 10 dB.

MAXIMUM NOISE LEVEL, LAFmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'F' (Fast) time weighting. Often used for noise assessments other than aircraft.

MAXIMUM NOISE LEVEL, LASmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'S' (Slow) time weighting. Often used for aircraft noise assessments.

NOISE RATING NUMBERS

A set of empirically developed equal loudness curves has been adopted as Australian Standard AS1469-1983. These curves allow the loudness of a noise to be described with a single NR number. The Noise Rating number is that curve which touches the highest level on the measured spectrum of the subject noise. For broadband noise such as fans and engines, the NR number often equals the 'A' frequency weighted dB level minus five.

NOISE

Noise is unwanted, harmful or inharmonious (discordant) sound. Sound is wave motion within matter, be it gaseous, liquid or solid. Noise usually includes vibration as well as sound.

NOISE REDUCTION COEFFICIENT – See: "Sound Absorption Coefficient"

OFFENSIVE NOISE

Reference: Dictionary of the NSW Protection of the Environment Operations Act (1997). "Offensive Noise means noise:
(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:
(i) is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or
(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or
(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."

PINK NOISE

Pink noise is a broadband noise with an equal amount of energy in each octave or third octave band width. Because of this, Pink Noise has more energy at the lower frequencies than White Noise and is used widely for Sound Transmission Loss testing.

REVERBERATION TIME, T60

The time in seconds, after a sound signal has ceased, for the sound level inside a room to decay by 60 dB. The first 5 dB decay is often ignored, because of fluctuations that occur while reverberant sound conditions are being established in the room. The decay time for the next 30 dB is measured and the result doubled to determine the T_{60}. The Early Decay Time (EDT) is the slope of the decay curve in the first 10 dB normalised to 60 dB.

SOUND ABSORPTION COEFFICIENT, α

Sound is absorbed in porous materials by the viscous conversion of sound energy to a small amount of heat energy as the sound waves pass through it. Sound is similarly absorbed by the flexural bending of internally damped panels. The fraction of incident energy that is absorbed is termed the Sound Absorption Coefficient, α. An absorption coefficient of 0.9 indicates that 90 % of the incident sound energy is absorbed. The average α from 250 to 2 kHz is termed the Noise Reduction Coefficient (NRC).

‘S’ (SLOW) TIME WEIGHTING

Sound level meter design-goal time constant which is 1 second.

SOUND ATTENUATION

A reduction of sound due to distance, enclosure or some other devise. If an enclosure is placed around a machine, or an attenuator (muffler or silencer) is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 20 dB reduces the sound energy by one hundred times.

SOUND EXPOSURE LEVEL (LAE)

Integration (summation) rather than an average of the sound energy over a set time period. Use to assess single noise events such as truck or train pass by or aircraft flyovers. The sound exposure level is related to the energy average (L_{Aeq}, T) by the formula L_{Aeq}, T = L_{AE} – 10 $\log_{10}$ T. The abbreviation (SEL) is sometimes inconsistently used in place of the symbol (L_{AE}).

SOUND PRESSURE

The rms sound pressure measured in pascals (Pa). A pascal is a unit equivalent to a newton per square metre (N/m^2).

SOUND PRESSURE LEVEL, Lp

The level of sound measured on a sound level meter and expressed in decibels (dB). Where L_P = 10 $\log_{10}$ $(Pa/Po)^2$ dB (or 20 log10 (Pa/ Po) dB) where Pa is the rms sound pressure in Pascal and Po is a reference sound pressure conventionally chosen is 20 µPa (20 x 10^{-6} Pa) for airborne sound. L_p varies with distance from a noise source.

SOUND POWER

The rms sound power measured in watts (W). The watt is a unit defined as one joule per second. A measures the rate of energy flow, conversion or transfer.

SOUND POWER LEVEL, Lw

The sound power level of a noise source is the inherent noise of the device. Therefore sound power level does not vary with distance from the noise source or with a different acoustic environment. Lw = Lp + 10 $\log_{10}$ ‘a’ dB, re: 1pW, (10^{-12} watts) where ‘a’ is the measurement noise-emission area (m^2) in a free field.

SOUND TRANSMISSION CLASS (STC)

An internationally standardised method of rating the sound transmission loss of partition walls to indicate the sound reduction from one side of a partition to the other in the frequency range of 125 Hz to 4000 kHz. (Refer: Australian Standard AS 1276 – 1979). Now not in general use in Australia see: weighted sound reduction index.

SOUND TRANSMISSION LOSS

The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS 1191 - 2002.

STATISTICAL NOISE LEVELS, Ln.

Noise which varies in level over a specific period of time 'T' (standard measurement times are 15 minute periods) may be quantified in terms of various statistical descriptors for example:-

- The noise level, in decibels, exceeded for 1 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as L_{AF1}, T. This may be used for describing short-term noise levels such as could cause sleep arousal during the night.
- The noise level, in decibels, exceeded for 10 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as L_{AF10}, T. In most countries the LAF10, T is measured over periods of 15 minutes, and is used to describe the average maximum noise level.
- The noise level, in decibels, exceeded for 90 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as L_{AF90}, T. In most countries the LAF90, T is measured over periods of 15 minutes, and is used to describe the average minimum or background noise level.

STEADY NOISE

Noise, which varies in level by 6 dB or less, over the period of interest with the time-weighting set to "Fast", is considered to be "steady". (Refer AS 1055.1 1997).

WEIGHTED SOUND REDUCTION INDEX, Rw

This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 Hz to 3.150 kHz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999). Internal partition wall Rw + C ratings are frequency weighted to simulate insulation from human voice noise. The R_w + C is similar in value to the STC rating value. External walls, doors and windows may be R_w + C_{tr} rated to simulate insulation from road traffic noise. The spectrum adaptation term Ctr adjustment factor takes account of low frequency noise. The weighted sound reduction index is normally similar or slightly lower number than the STC rating value.

WHITE NOISE

White noise is broadband random noise whose spectral density is constant across its entire frequency range. The sound power is the same for equal bandwidths from low to high frequencies. Because the higher frequency octave bands cover a wider spectrum, white noise has more energy at the higher frequencies and sounds like a hiss.

'Z' FREQUENCY WEIGHTING

The 'Z' (Zero) frequency weighting is 0 dB within the nominal 1/3 octave band frequency range centred on 10 Hz to 20 kHz. This is within the tolerance limits given in AS IEC 61672.1–2004: 'Electroacoustics - Sound level meters – Specifications'.

Attachment 2: Calibration Certificates

Certificate Of Calibration

Certificate No.: **SLM 20815 & FILT 4015**

Equipment Description: Sound & Vibration Analyser

Manufacturer: Svantek

Model No: Svan-957 **Serial No:** 15335

Microphone Type: 7052E **Serial No:** 40814

Filter Type: 1/3 Octave **Serial No:** 15335

Comments: All tests passed for class 1.
(See over for details)

Owner: Benbow Environmental
13 Daking Street
North Parramatta NSW 2151

Ambient Pressure: 1014 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 53% ±5%

Date of Calibration: 14/06/2017 **Issue Date:** 16/06/2017

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

Checked by: .... **Authorised Signature:** ....
Jack Kielt

Accredited for compliance with ISO/IEC 17025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

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Mobile: 0413 809806
web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 20949

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Rion
Type No: NC-73 **Serial No:** 10186522
Owner: Benbow Environmental
13 Daking Street
North Parramatta NSW 2151

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	94.03	991.4	2.00
Level 2:	NA	N	NA	NA	NA
Uncertainty:			±0.11 dB	±0.05 Hz	±0.2 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 996 hPa ±1.5 hPa **Relative Humidity:** 42% ±5%
Temperature: 22 °C ±2° C
Date of Calibration: 05/07/2017 **Issue Date:** 06/07/2017
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2004

CHECKED BY: .... **AUTHORISED SIGNATURE:** ....
Jack Kielt

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Acoustic and Vibration Measurements

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Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C16331

Client Details Benbow Environmental
13 Daking Street
North Paramatta NSW 2151

Equipment Tested/ Model Number : ARL EL-215
Instrument Serial Number : 194438
Microphone Serial Number : N/A
Pre-amplifier Serial Number : N/A

Atmospheric Conditions
Ambient Temperature : 22°C
Relative Humidity : 50.1%
Barometric Pressure : 99.02kPa

Calibration Technician : Dennis Kim
Calibration Date : 11/07/2016
Secondary Check: Riley Cooper
Report Issue Date : 12/07/2016

Approved Signatory : Juan Aguero

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	*Pass*	10.3.4: Inherent system noise level	*Pass*
10.2.3: Frequency weighting	*Pass*	10.4.2: Time weighting characteristic F and S	*Pass*
10.3.2: Overload indications	*Pass*	10.4.3: Time weighting characteristic I	*Pass*
10.3.3: Accuracy of level range control	*Pass*	10.4.5: R.M.S performance	*Pass*
8.9: Detector-indicator linearity	*Pass*	9.3.2: Time averaging	*Pass*
8.10: Differential level linearity	*Pass*	9.3.5: Overload indication	*Pass*

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.120dB*	*Temperature*	*±0.3°C*
12.5kHz	*±0.165dB*	*Relative Humidity*	*±4.1%*
16kHz	*±0.245dB*	*Barometric Pressure*	*±0.1kPa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.098dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 2 requirements for periodic testing as described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

NATA
WORLD RECOGNISED ACCREDITATION

This calibration certificate is to be read in conjunction with the calibration test report.

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Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C18128

Client Details Benbow Environmental
13 Daking Street
North Paramatta NSW 2151

Equipment Tested/ Model Number : ARL EL-215
Instrument Serial Number : 194441
Microphone Serial Number : N/A
Pre-amplifier Serial Number : N/A

Atmospheric Conditions
Ambient Temperature : 23.4°C
Relative Humidity : 52.3%
Barometric Pressure : 100.4kPa

Calibration Technician : Lucky Jaiswal
Calibration Date : 9 Mar 2018
Secondary Check: Riley Cooper
Report Issue Date : 12 Mar 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	*Pass*	10.3.4: Inherent system noise level	*Pass*
10.2.3: Frequency weighting	*Pass*	10.4.2: Time weighting characteristic F and S	*Pass*
10.3.2: Overload indications	*Pass*	10.4.3: Time weighting characteristic I	*Pass*
10.3.3: Accuracy of level range control	*Pass*	10.4.5: R.M.S performance	*Pass*
8.9: Detector-indicator linearity	*Pass*	9.3.2: Time averaging	*Pass*
8.10: Differential level linearity	*Pass*	9.3.5: Overload indication	*Pass*

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.15dB*	*Temperature*	*±0.07°C*
12.5kHz	*±0.21dB*	*Relative Humidity*	*±0.58%*
16kHz	*±0.29dB*	*Barometric Pressure*	*±0.017Pa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.12dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 2 requirements for periodic testing as described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - calibration.

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

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

NATA WORLD RECOGNISED ACCREDITATION

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Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
AS 1259.1:1990 - AS 1259.2:1990
Calibration Certificate

Calibration Number C18127

Client Details Benbow Environmental
13 Daking Street
North Parramatta NSW 2151

Equipment Tested/ Model Number : ARL EL-215
Instrument Serial Number : 194702
Microphone Serial Number : N/A
Pre-amplifier Serial Number : N/A

Atmospheric Conditions
Ambient Temperature : 22.3°C
Relative Humidity : 53.1%
Barometric Pressure : 100.61kPa

Calibration Technician : Lucky Jaiswal
Calibration Date : 9 Mar 2018
Secondary Check: Riley Cooper
Report Issue Date : 12 Mar 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	*Pass*	10.3.4: Inherent system noise level	*Pass*
10.2.3: Frequency weighting	*Pass*	10.4.2: Time weighting characteristic F and S	*Pass*
10.3.2: Overload indications	*Pass*	10.4.3: Time weighting characteristic I	*Pass*
10.3.3: Accuracy of level range control	*Pass*	10.4.5: R.M.S performance	*Pass*
8.9: Detector-indicator linearity	*Pass*	9.3.2: Time averaging	*Pass*
8.10: Differential level linearity	*Pass*	9.3.5: Overload indication	*Pass*

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.15dB*	*Temperature*	*±0.07°C*
12.5kHz	*±0.21dB*	*Relative Humidity*	*±0.58%*
16kHz	*±0.29dB*	*Barometric Pressure*	*±0.017Pa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.12dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 2 requirements for periodic testing as described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

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WORLD RECOGNISED ACCREDITATION

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Accredited for compliance with ISO/IEC 17025 - calibration.

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

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

Attachment 3: QA/QC Procedures

Calibration of Sound Level Meters

A sound level meter requires regular calibration to ensure its measurement performance remains within specification. Benbow Environmental sound level meters are calibrated by a National Association of Testing Authority (NATA) registered laboratory or a laboratory approved by the NSW Environment Protection Authority (EPA) every two years and after each major repair, in accordance with AS 1259–1990.

The calibration of the sound level meter was checked immediately before and after each series of measurements using an acoustic calibrator. The acoustic calibrator provides a known sound pressure level, which the meter indicates when the calibrator is activated while positioned on the meter microphone.

The sound level meters also incorporate an internal calibrator for use in setting up. This provides a check of the electrical calibration of the meter, but does not check the performance of the microphone. Acoustical calibration checks the entire instrument including the microphone. Calibration certificates for the instrument sets used have been included as Attachment 1.

Care and Maintenance of Sound Level Meters

Noise measuring equipment contains delicate components and therefore must be handled accordingly. The equipment is manufactured to comply with international and national standards and is checked periodically for compliance. The technical specifications for sound level meters used in Australia are defined in Australian Standard AS 1259–1990 "*Sound Level Meters*".

The sound level meters and associated accessories are protected during storage, measurement and transportation against dirt, corrosion, rapid changes of temperature, humidity, rain, wind, vibration, electric and magnetic fields. Microphone cables and adaptors are always connected and disconnected with the power turned off. Batteries are removed (with the instrument turned off) if the instrument is not to be used for some time.

Investigation Procedures

All investigative procedures were conducted in accordance with AS 1055.1–1997 *Acoustics – Description and Measurement of Environmental Noise* Part 1: *General Procedures*.

The following information was recorded and kept for reference purposes:

- type of instrumentation used and measurement procedure conducted;
- description of the time aspect of the measurements, ie. measurement time intervals; and
- positions of measurements and the time and date were noted.

As per AS 1055.1–1997, all measurements were carried out at least 3.5 m from any reflecting structure other than the ground. The preferred measurement height of 1.2 m above the ground was utilised. A sketch of the area was made identifying positions of measurement and the approximate location of the noise source and distances in meters (approx.).

Unattended Noise Monitoring

NOISE MONITORING EQUIPMENT

ARL noise loggers type Ngara and EL-215 were used to conduct the long-term unattended noise monitoring. This equipment complies with Australian Standard 1259.2–1990 *Acoustics – Sound Level Meters* and is designated as a Type 1 and Type 2 instrument suitable for field use.

The measured data is processed statistically and stored in memory every 15 minutes. The equipment was calibrated prior and subsequent to the measurement period using a Rion NC-73 sound level calibrator. There were no significant variances observed in the reference signal between the pre-measurement and post-measurement calibrations. Instrument calibration certificates have also been included in Attachment 1.

METEOROLOGICAL CONSIDERATION DURING MONITORING

For the long-term attended monitoring, meteorological data for the relevant period were provided by the Bureau of Meteorology, which was considered representative of the site for throughout the monitoring period.

DESCRIPTORS & FILTERS USED FOR MONITORING

Noise levels are commonly measured using A-weighted filters and are usually described as dB(A). The "A-weighting" refers to standardised amplitude versus frequency curve used to "weight" sound measurements to represent the response of the human ear. The human ear is less sensitive to low frequency sound than it is to high frequency sound. Overall A-weighted measurements quantify sound with a single number to represent how people subjectively hear different frequencies at different levels.

Noise environments can be described using various descriptors depending on characteristics of noise or purpose of assessments. For this survey the L_{A90} was used to analyse the monitoring results. The statistical descriptors L_{A90} measures the noise level exceeded for 90% of the sample measurement time, and is used to describe the “Background noise”. Background noise is the underlying level of noise present in the ambient noise, excluding extraneous noise or the noise source under investigation.

Measurement sample periods were fifteen minutes. The Noise -vs- Time graphs representing measured noise levels at the noise monitoring location are presented in Attachment 3.

ATTENDED NOISE MONITORING

NOISE MONITORING EQUIPMENT

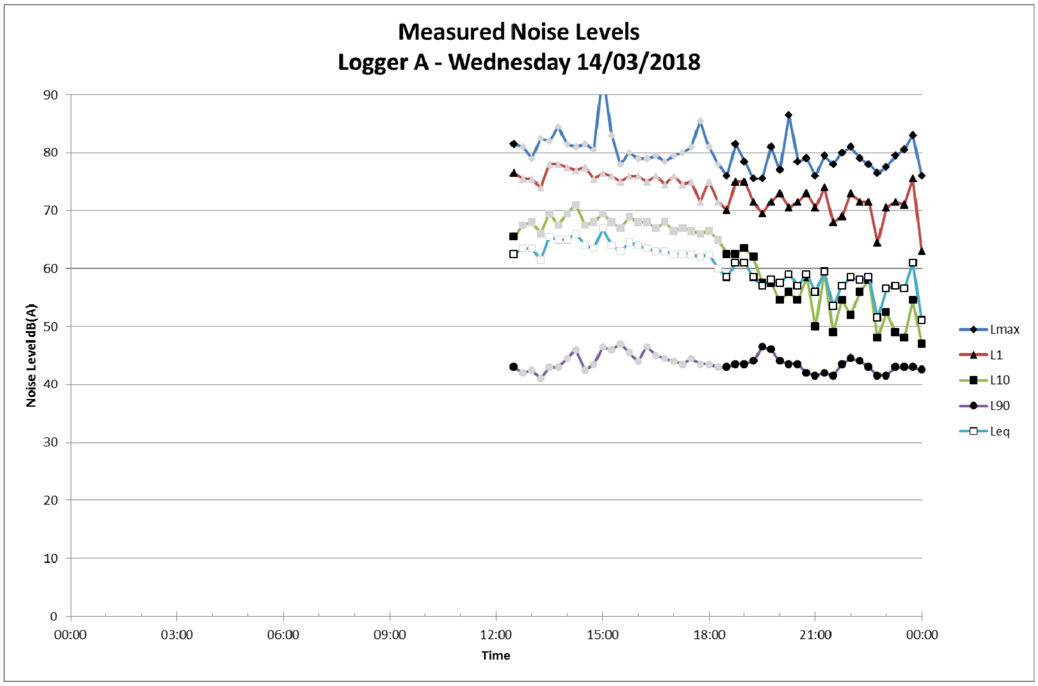
The attended short-term noise monitoring was carried out using a SVANTEK SVAN957 Class 1 Precision Sound Level Meter. The instrument was calibrated by a NATA accredited laboratory within two years of the measurement period. The instrument sets comply with AS 1259 and was set on A-weighted, fast response.

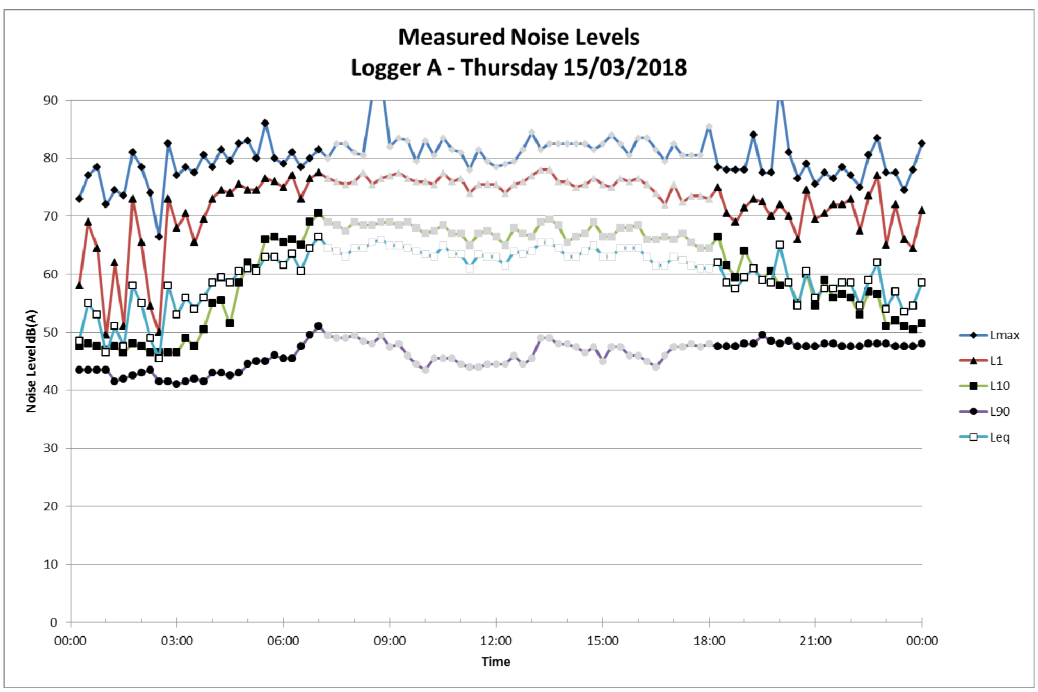
The microphone was positioned at 1.5 metres above ground level and was fitted with a windsock. The instrument was calibrated using a Rion NC-73 sound level calibrator prior and subsequent to the measurement period to ensure the reliability and accuracy of the instrument sets. There were no significant variances observed in the reference signal between the pre-measurement and post-measurement calibrations. Instrument calibration certificates have also been included in Attachment 1.

WEATHER CONDITIONS
It was partially cloudy, fine without significant breeze.

METHODOLOGY
The attended noise measurements were carried out generally in accordance with Australian Standard AS 1055-1997 "Acoustics – Description and Measurement of Environmental Noise".

Attachment 4: Daily Noise Logger Charts


Measured Noise Levels
Logger A - Wednesday 14/03/2018
90
80
70
60
50
40
30
20
10
0
Noise Level dB(A)
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Thursday 15/03/2018
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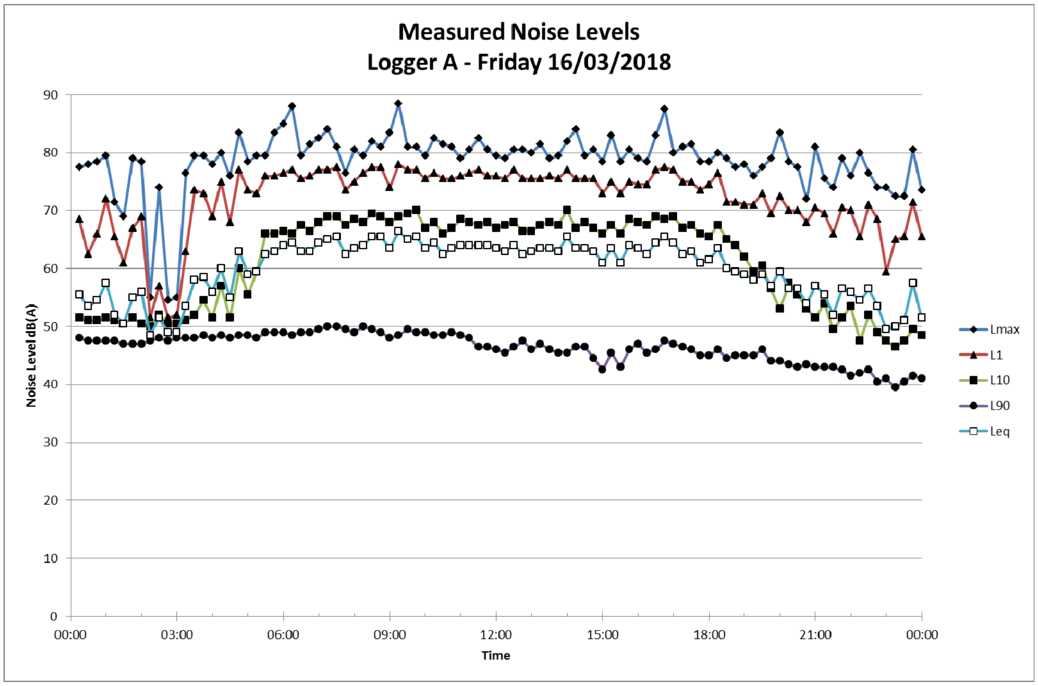
80
70
60
50
40
30
20
10
0
Noise Level dB(A)
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Friday 16/03/2018
Noise Level dB(A)
Time
0
10
20
30
40
50
60
70
80
90
00:00
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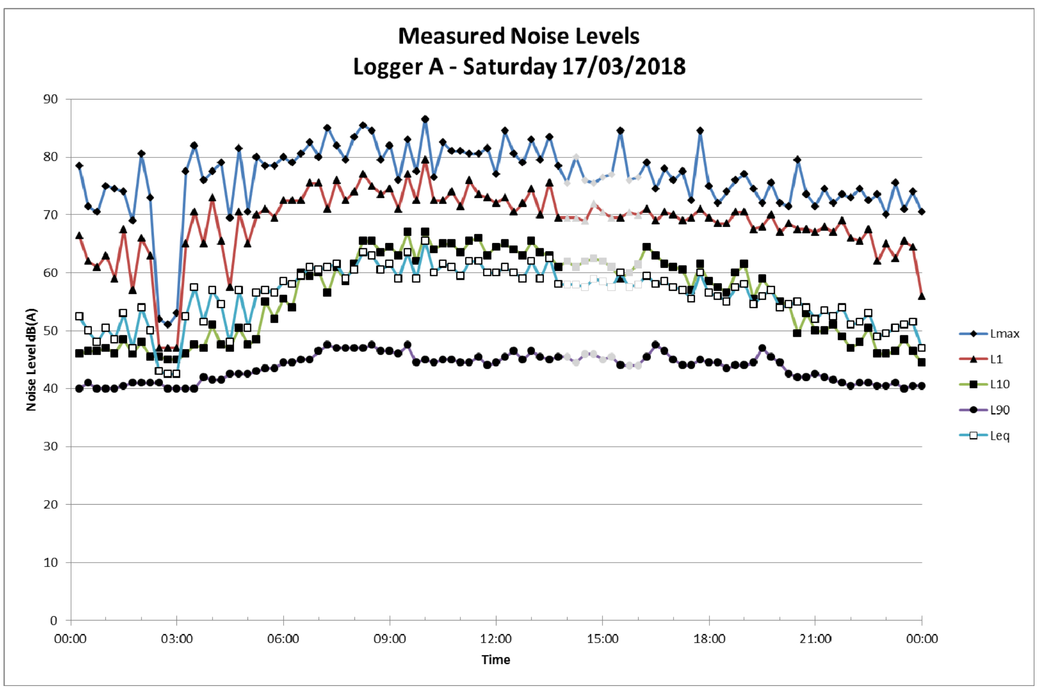
12:00
15:00
18:00
21:00
00:00
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Saturday 17/03/2018
Noise Level dB(A)
Time
0
10
20
30
40
50
60
70
80
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00:00
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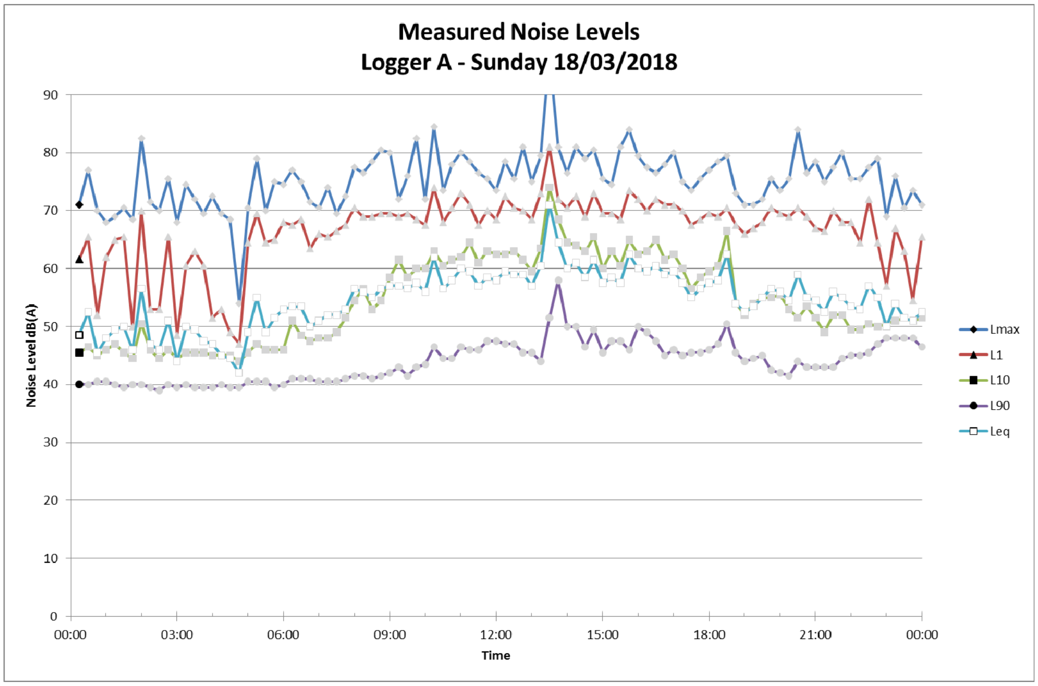
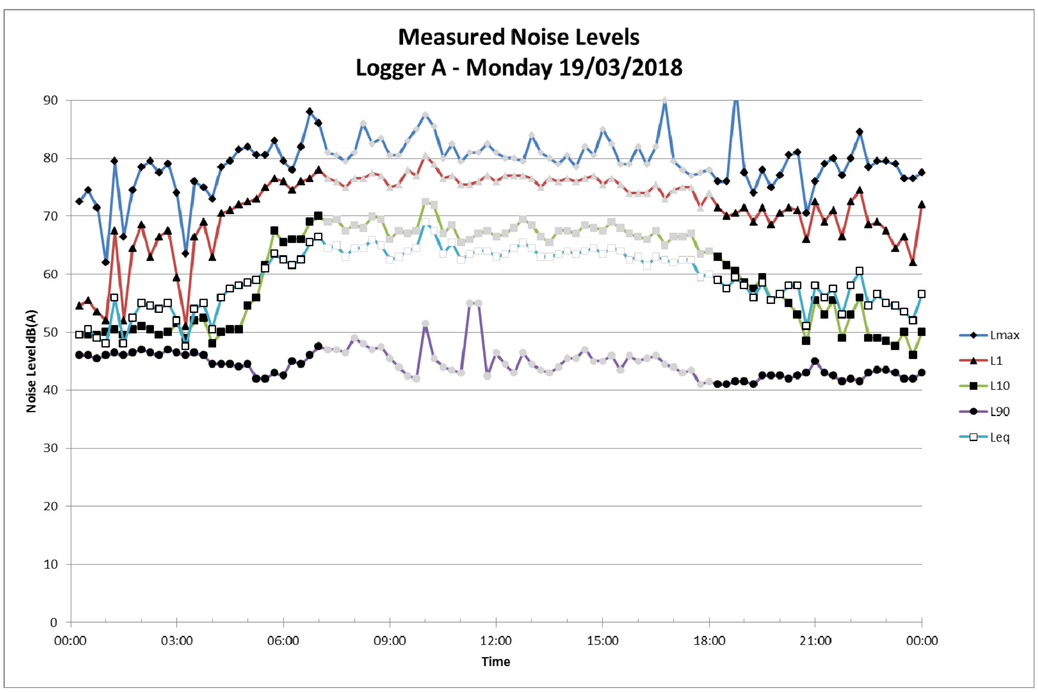
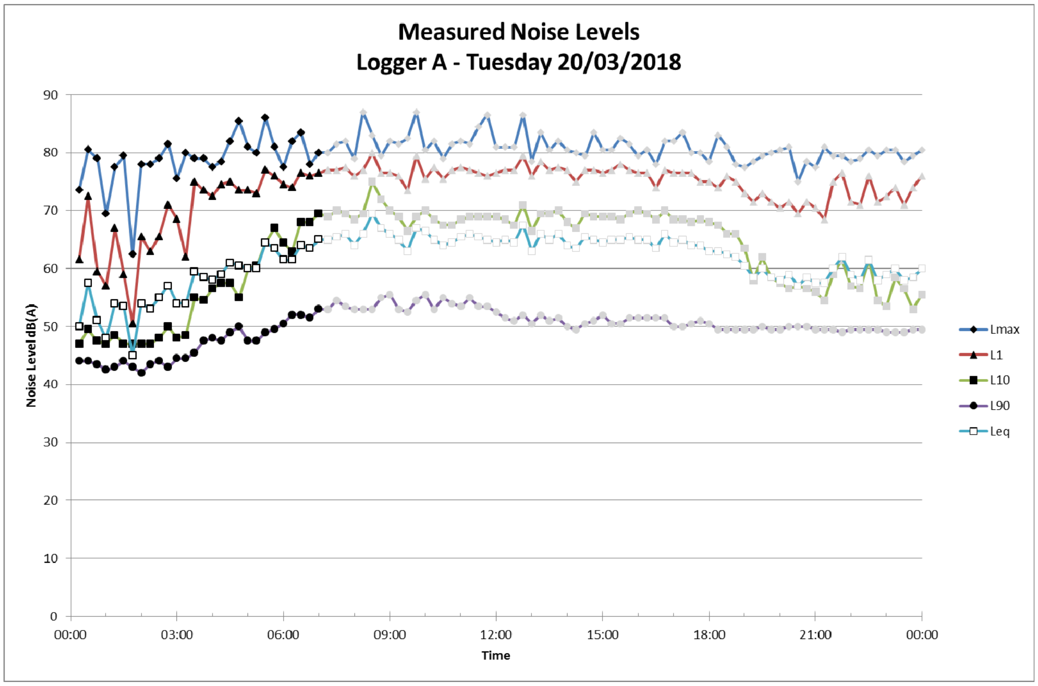
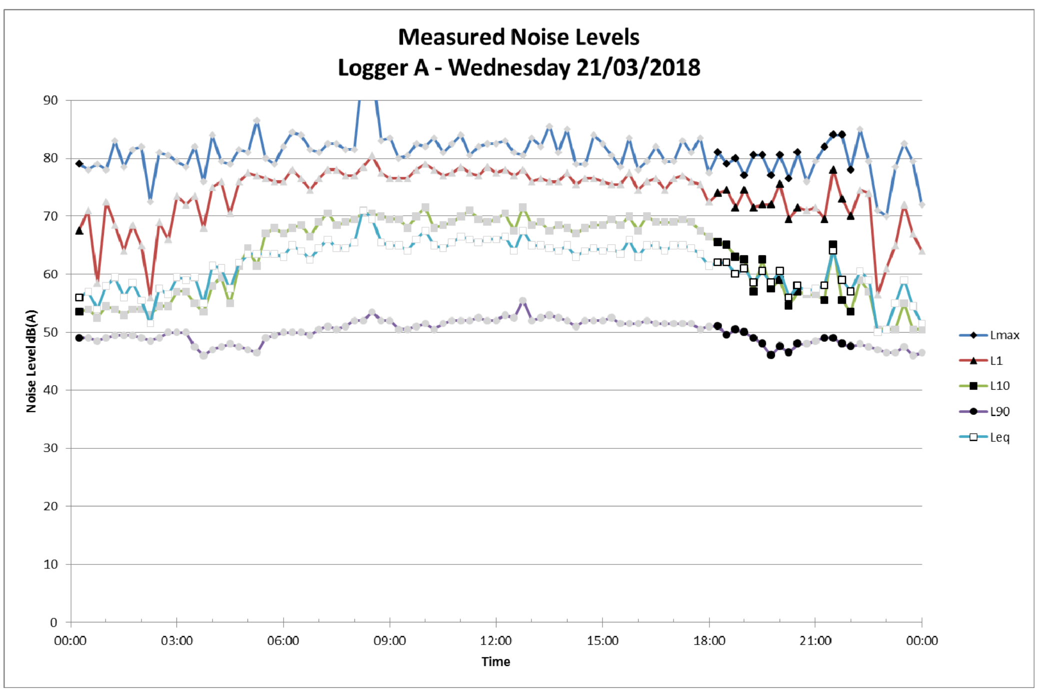
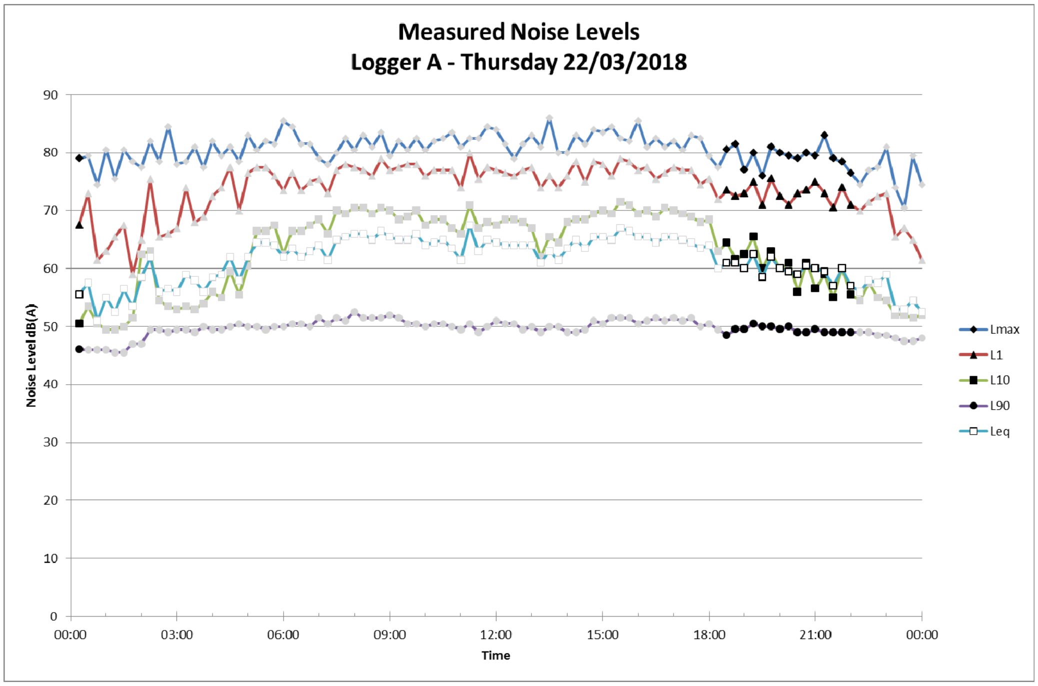
12:00
15:00
18:00
21:00
00:00
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Sunday 18/03/2018
90
80
70
60
50
40
30
20
10
0
Noise Level dB(A)
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Monday 19/03/2018
90
80
70
60
50
40
30
20
10
0
Noise Level dB(A)
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Tuesday 20/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Wednesday 21/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Thursday 22/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
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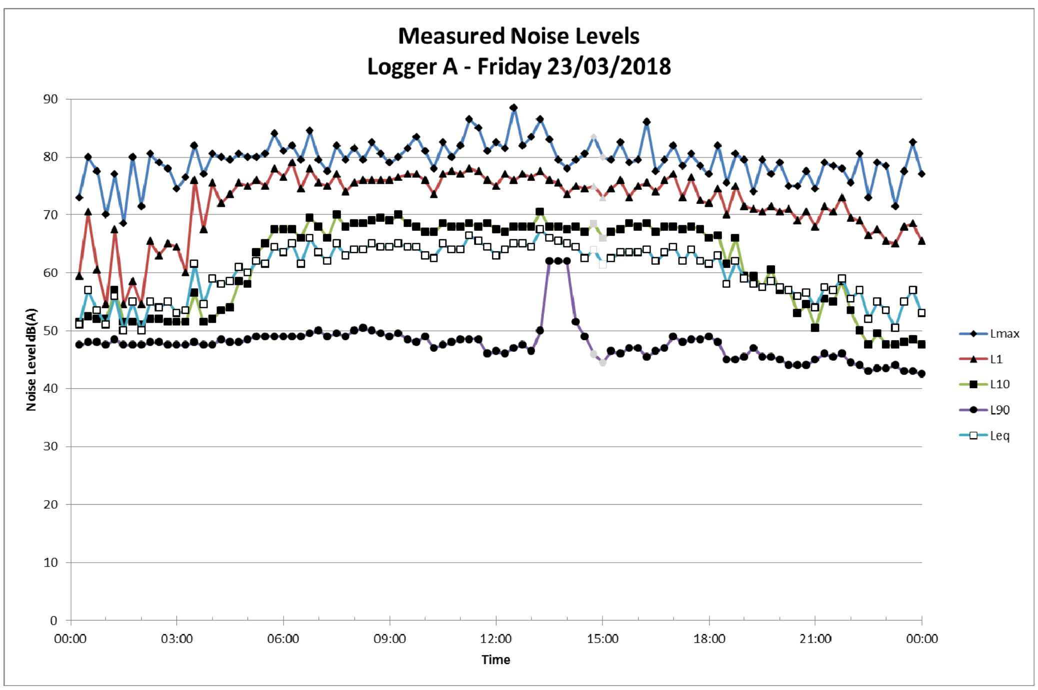
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Friday 23/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
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21:00
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Time
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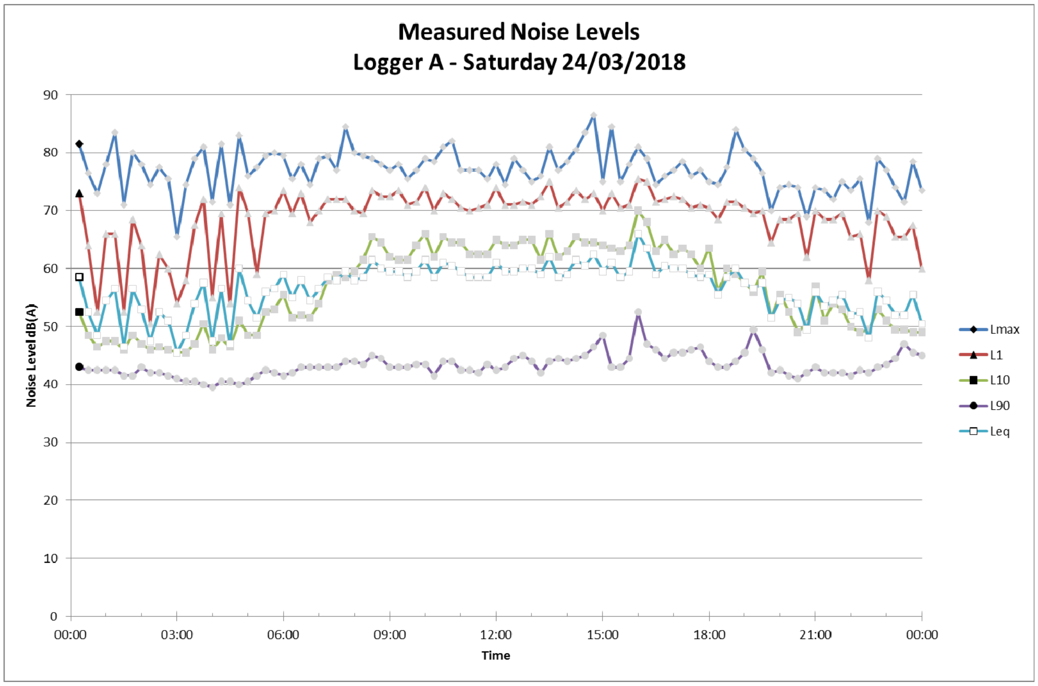
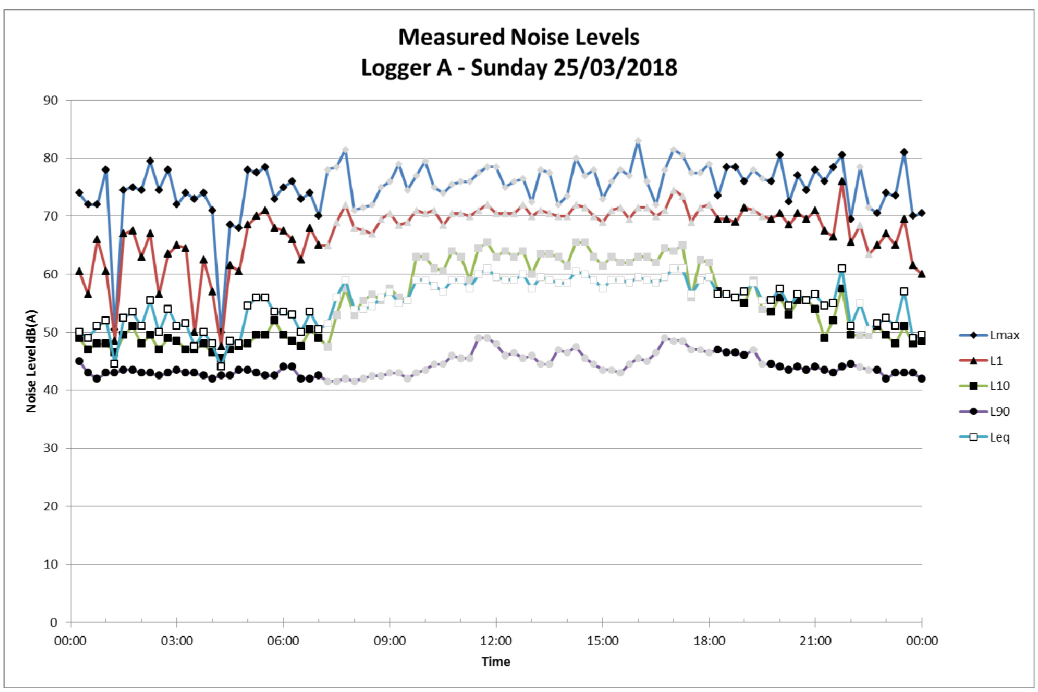
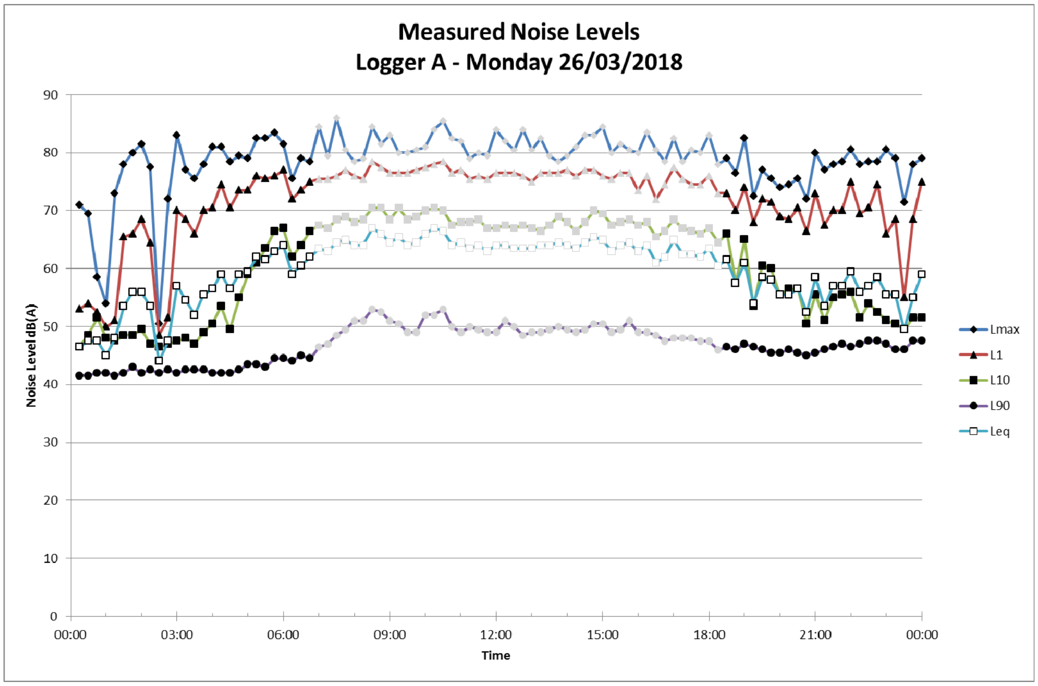
L1
L10
L90
Leq



Measured Noise Levels
Logger A - Saturday 24/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



Measured Noise Levels
Logger A - Sunday 25/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger A - Monday 26/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
90
80
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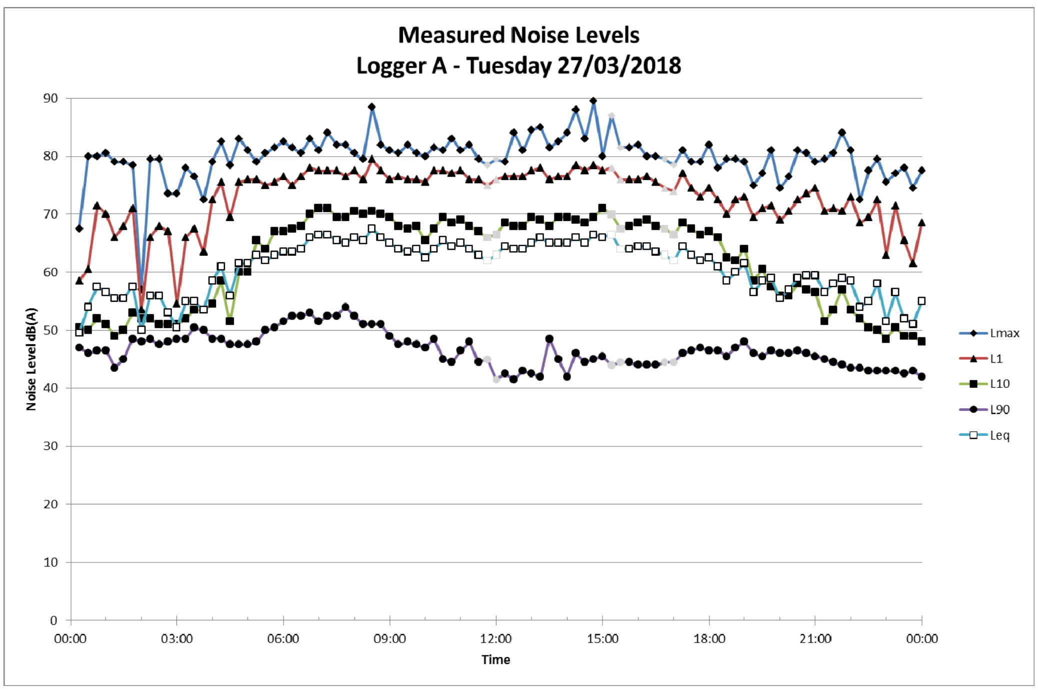
18:00
21:00
00:00


Measured Noise Levels
Logger A - Tuesday 27/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
90
80
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18:00
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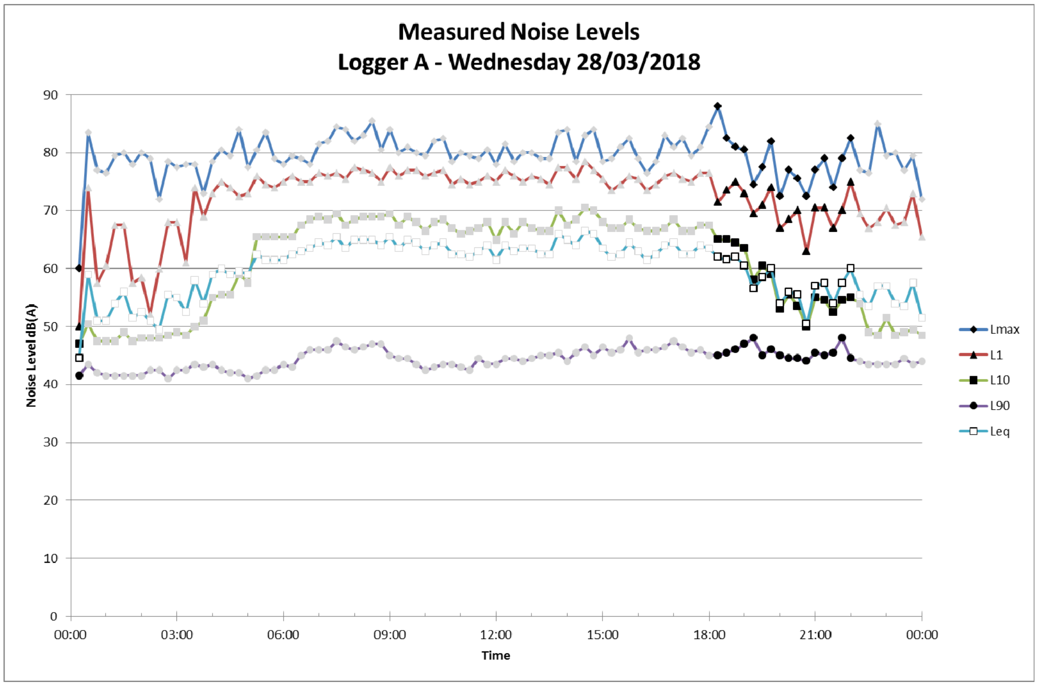
Measured Noise Levels
Logger A - Wednesday 28/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
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30
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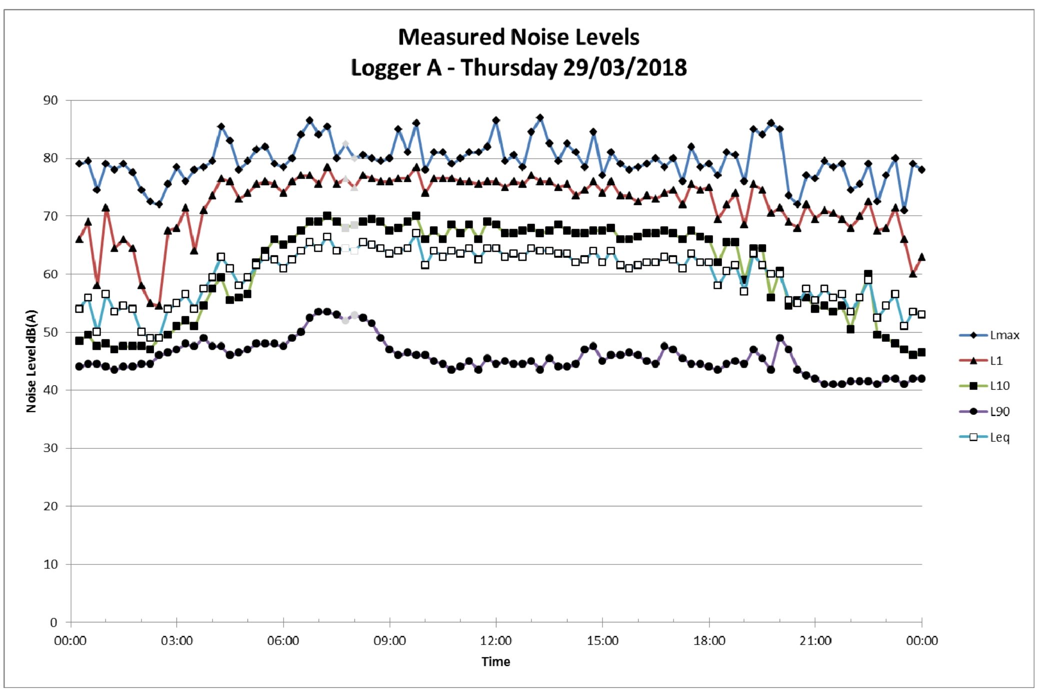
Measured Noise Levels
Logger A - Thursday 29/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
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30
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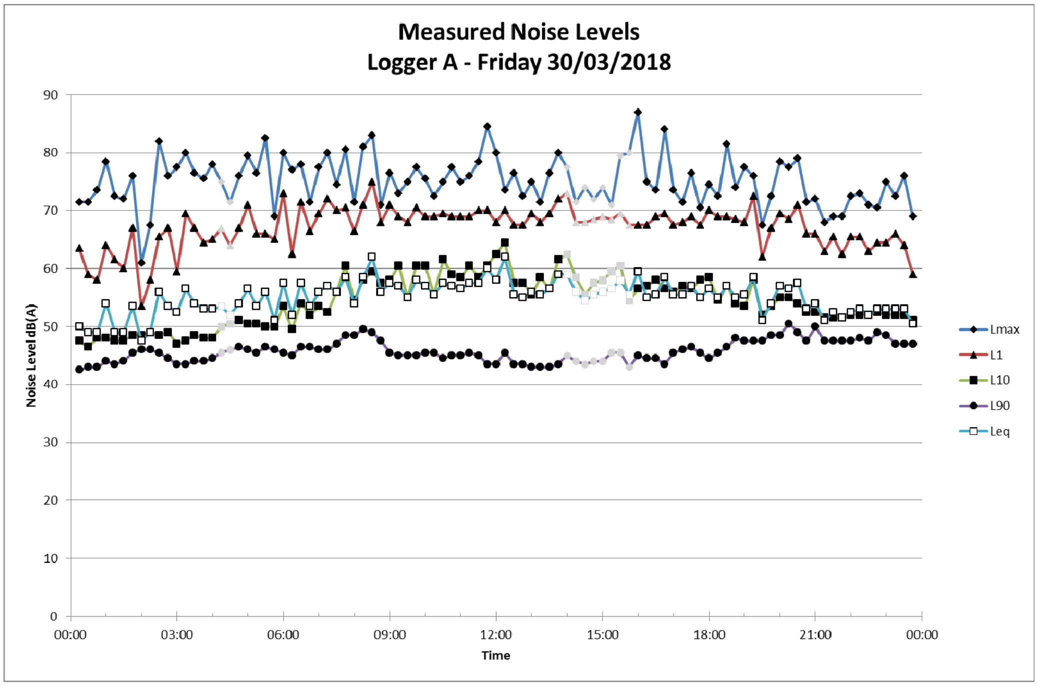
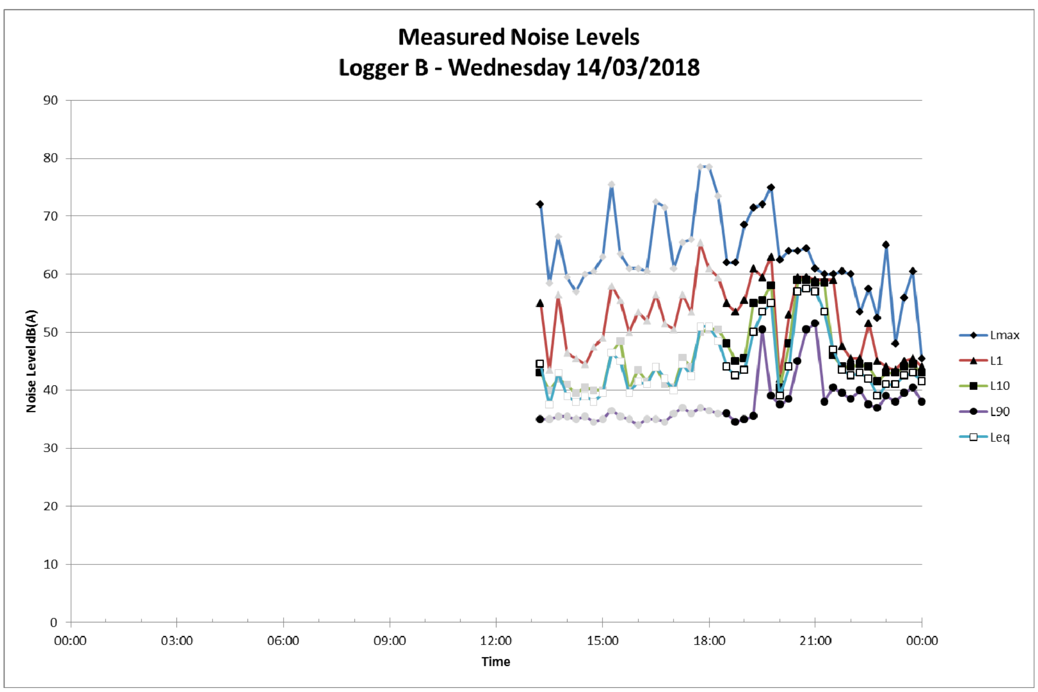
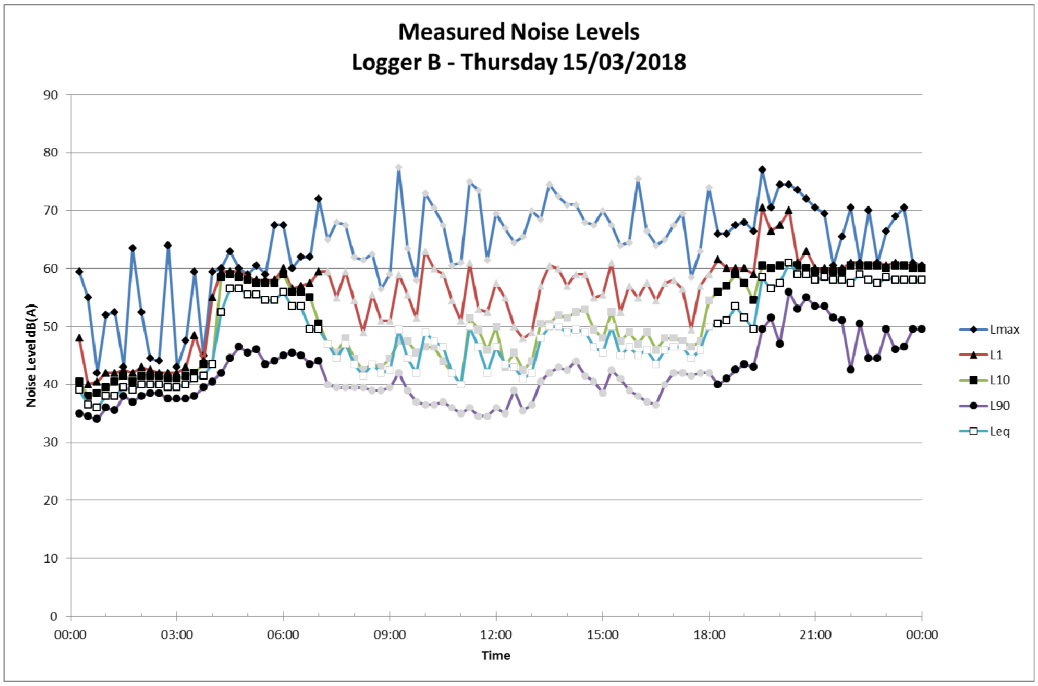


Measured Noise Levels
Logger A - Friday 30/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



Measured Noise Levels
Logger B - Wednesday 14/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Thursday 15/03/2018
Noise Level dB(A)
Time
90
80
70
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40
30
20
10
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00:00
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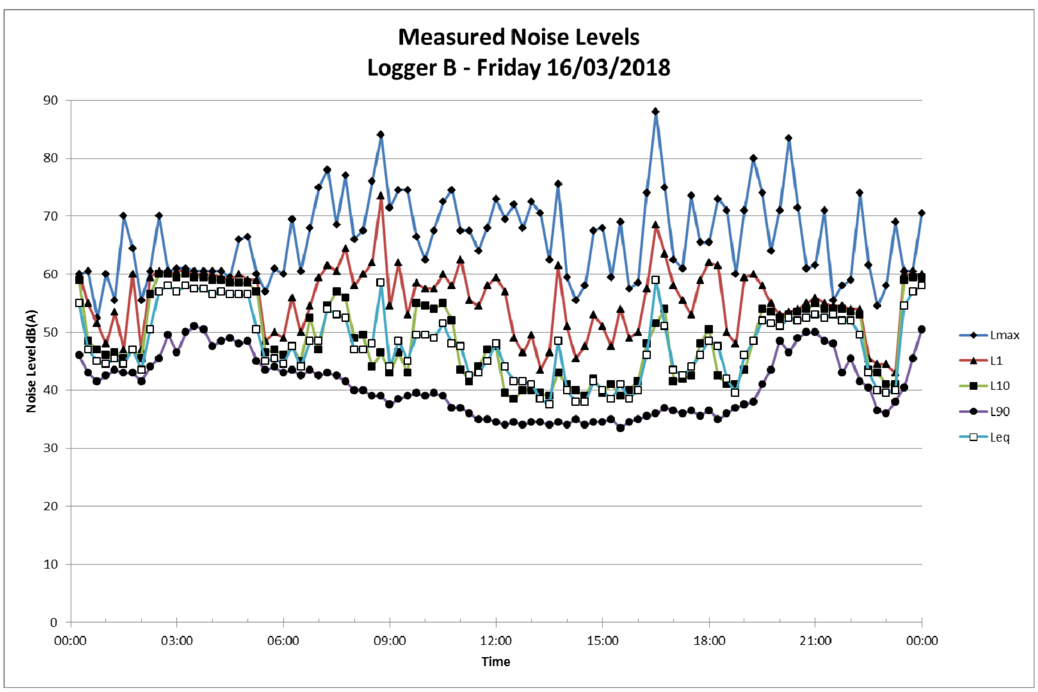
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Friday 16/03/2018
Noise Level dB(A)
Time
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80
70
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30
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10
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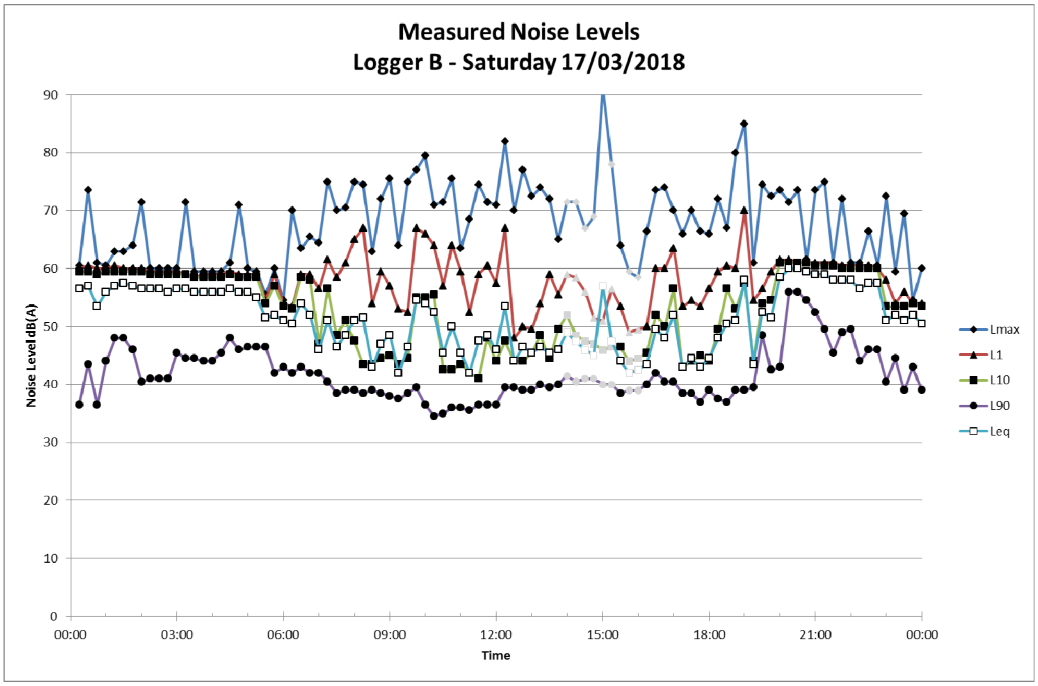
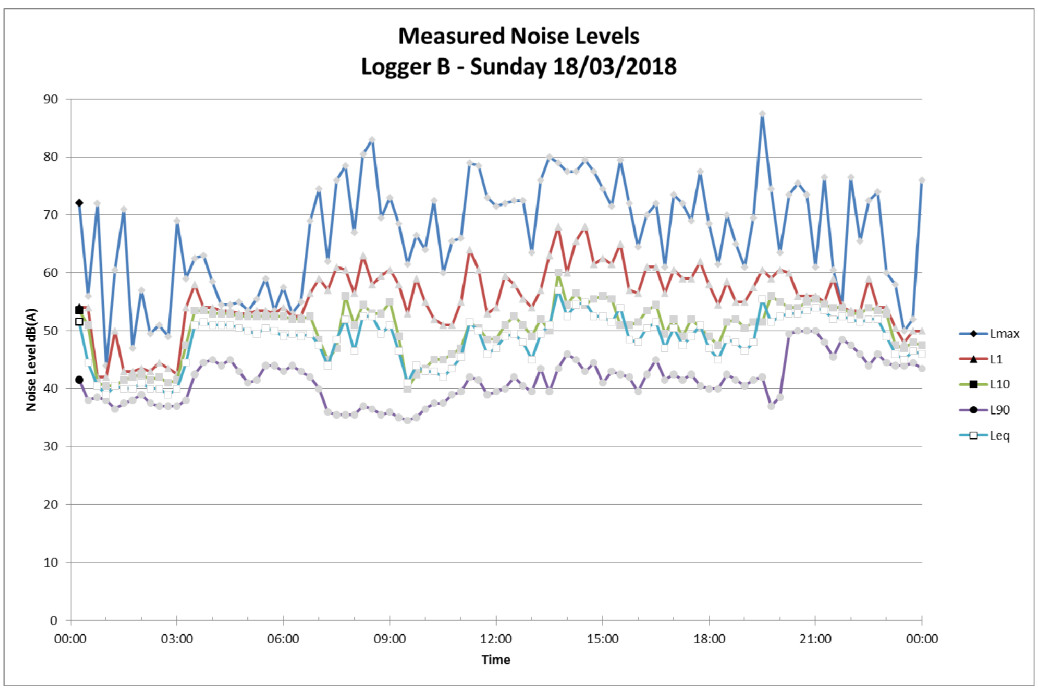
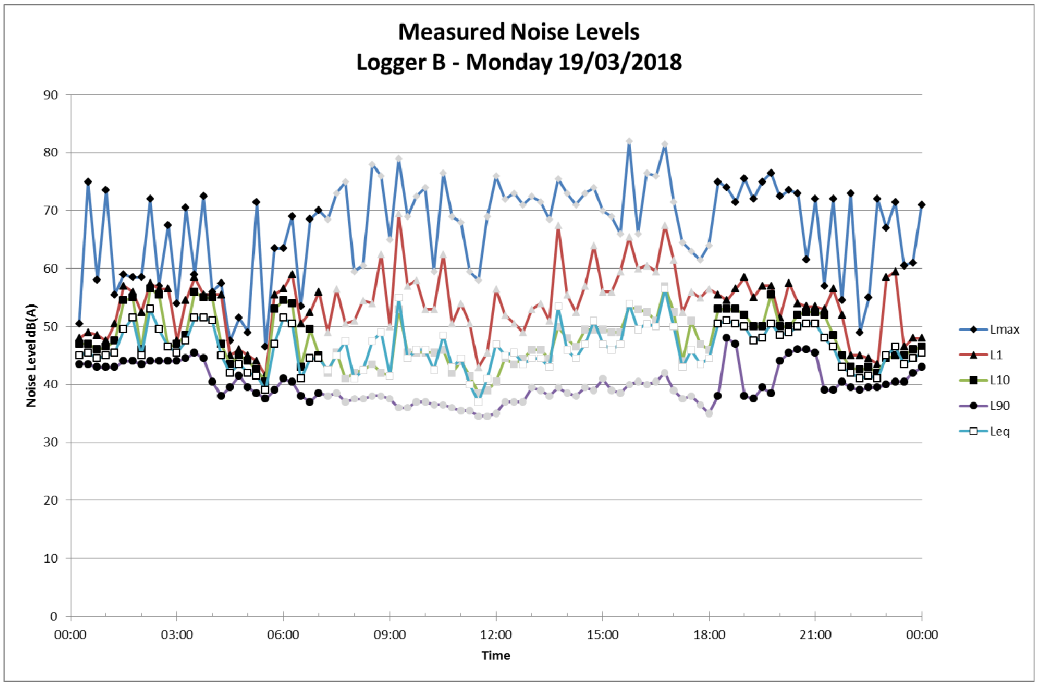
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Saturday 17/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Sunday 18/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Monday 19/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
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30
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18:00
21:00
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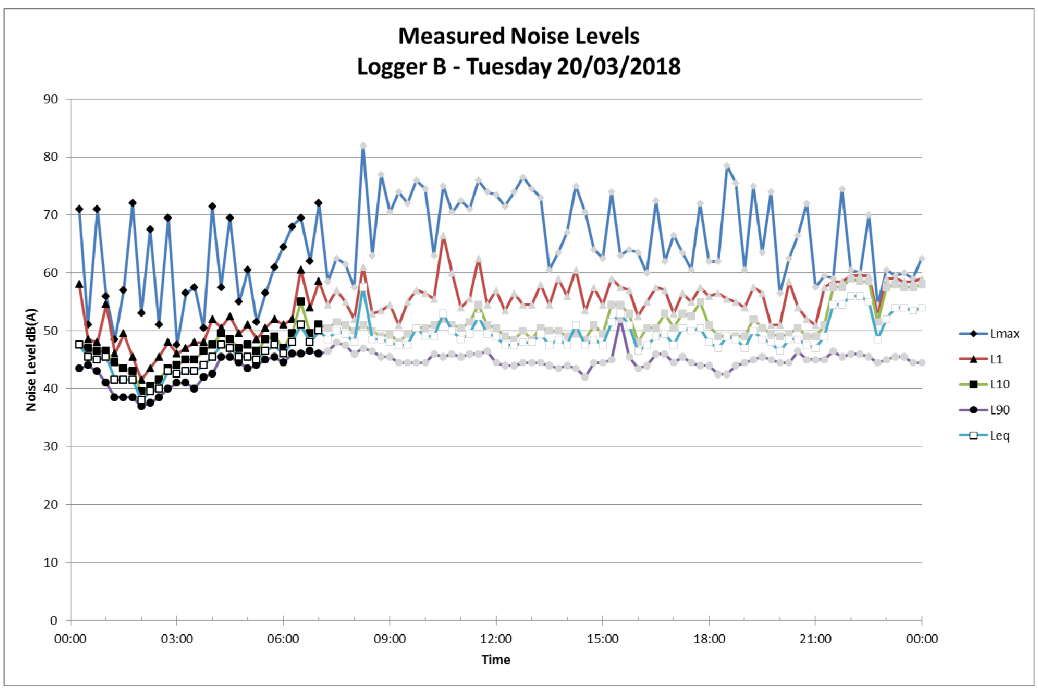
Measured Noise Levels
Logger B - Tuesday 20/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
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30
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18:00
21:00
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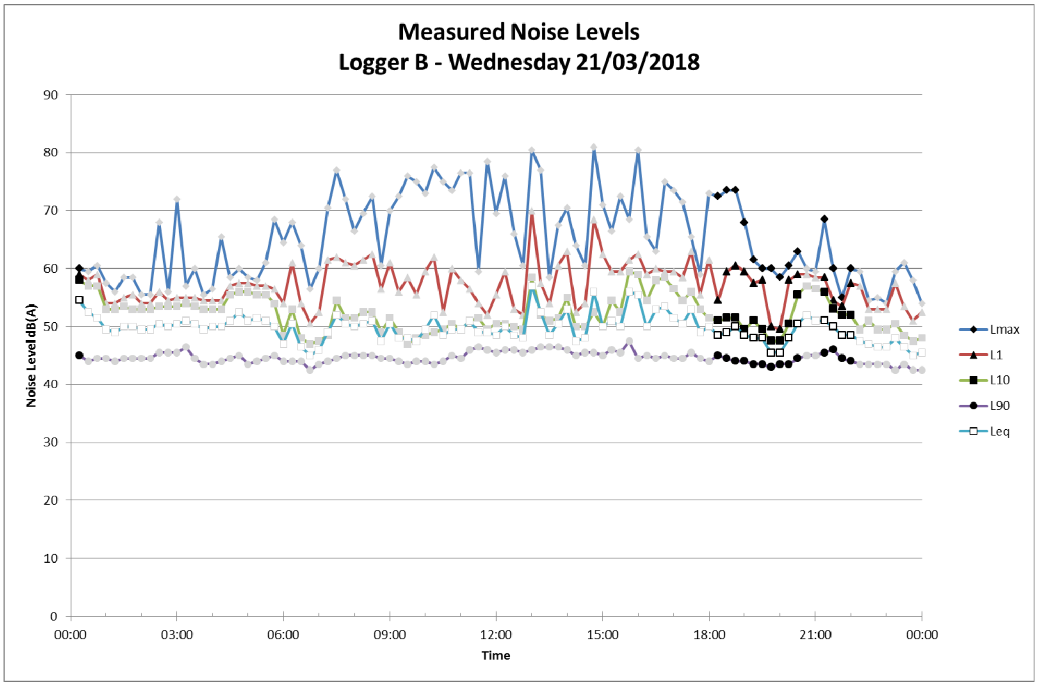
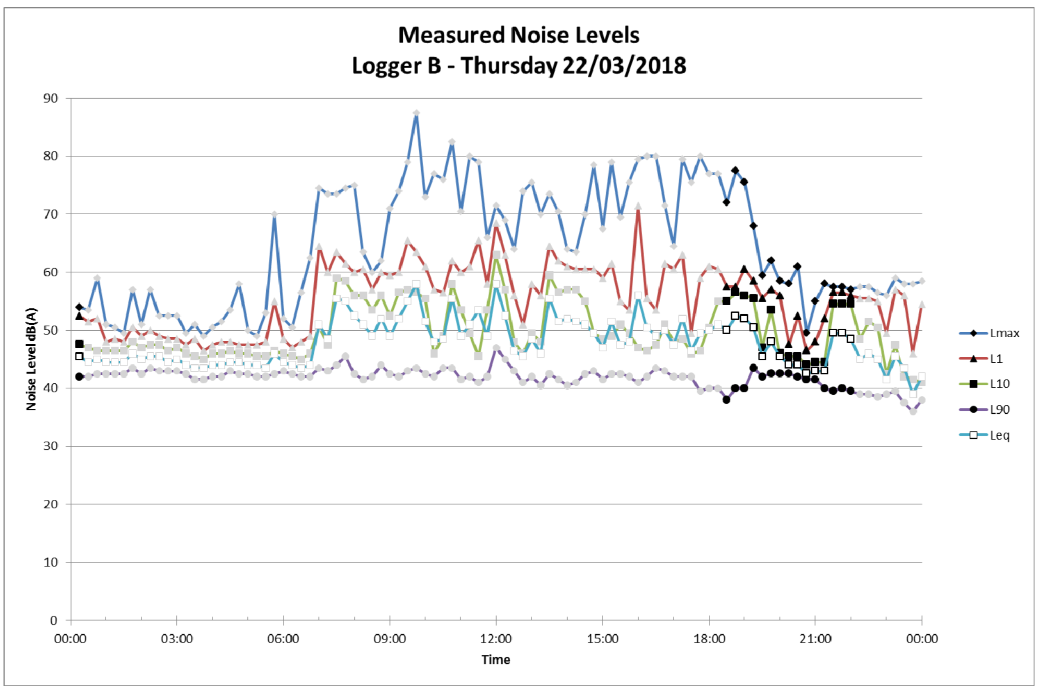
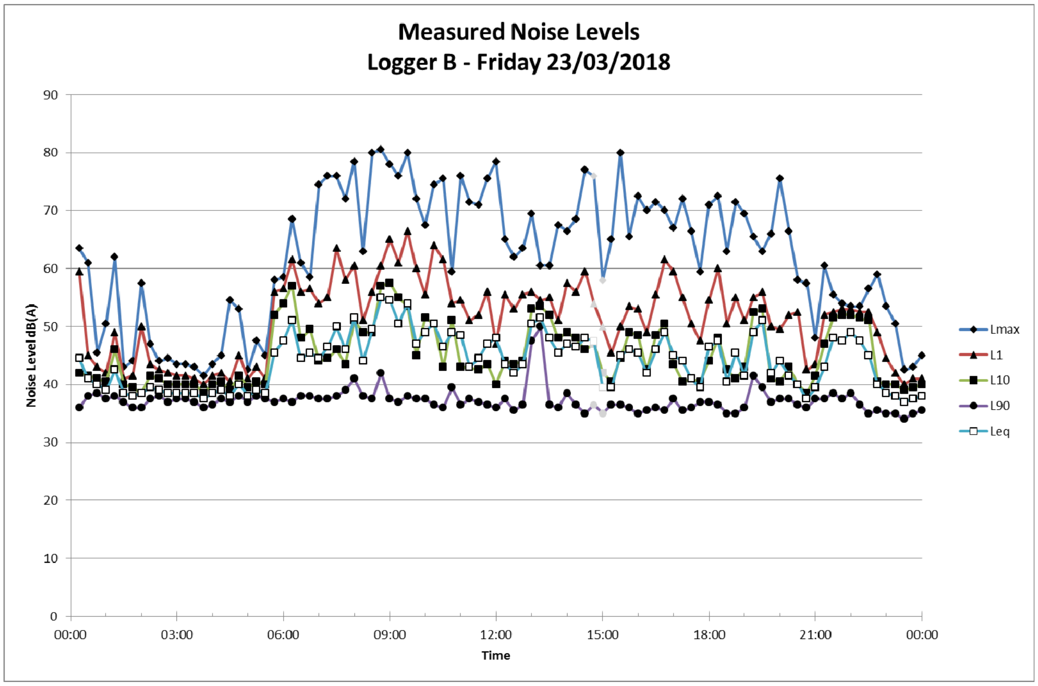

Measured Noise Levels
Logger B - Wednesday 21/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Thursday 22/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



Measured Noise Levels
Logger B - Friday 23/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
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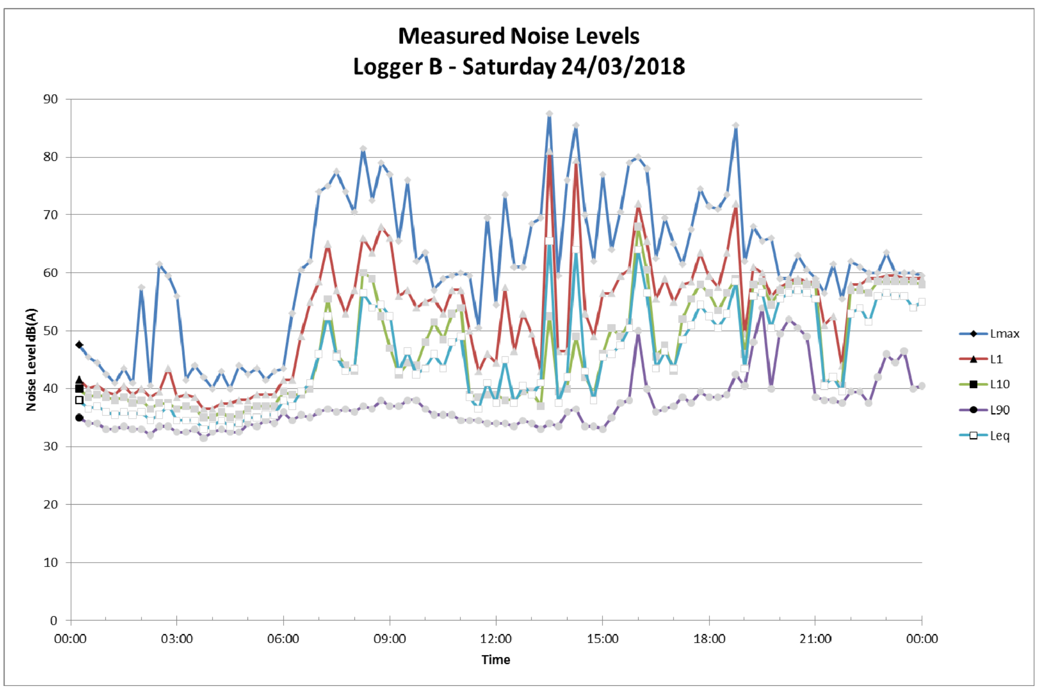
L1
L10
L90
Leq



Measured Noise Levels
Logger B - Saturday 24/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
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Time
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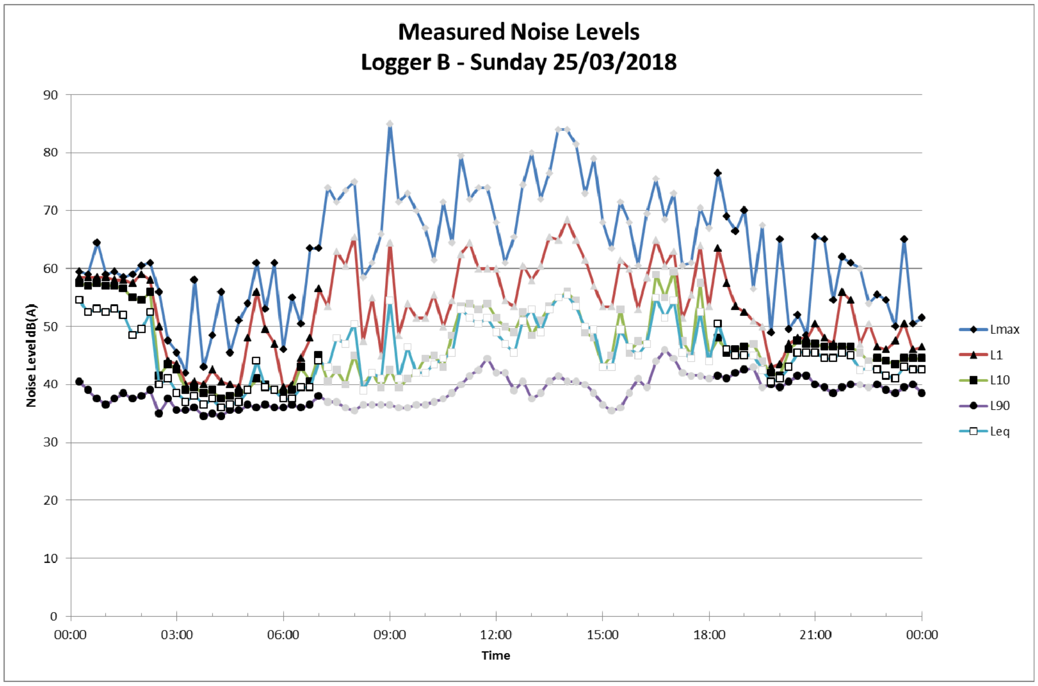
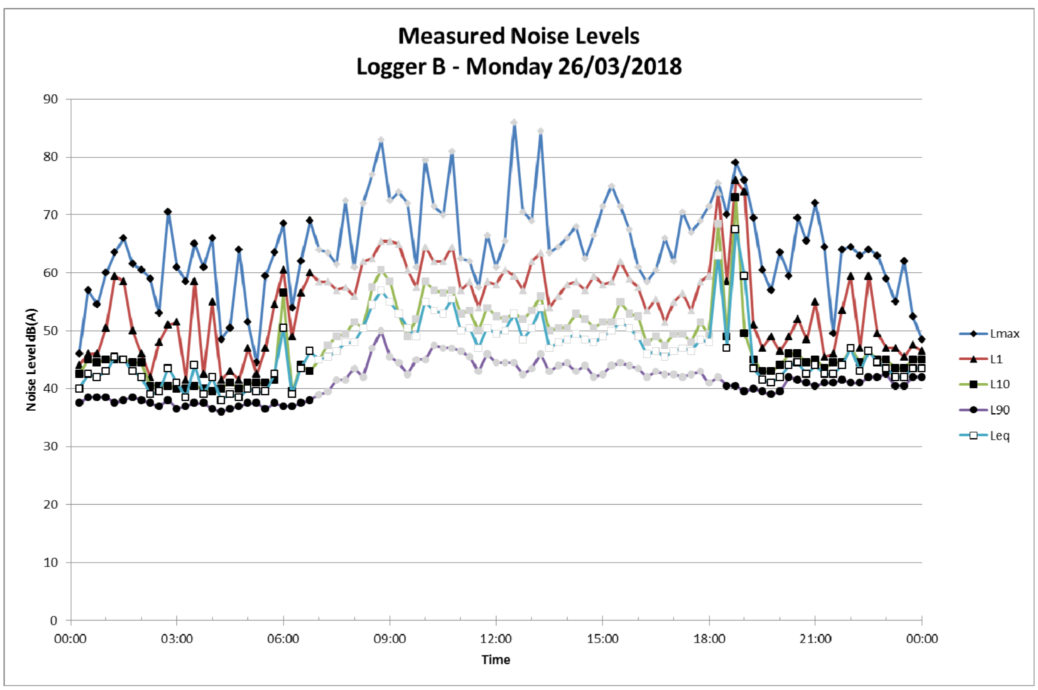
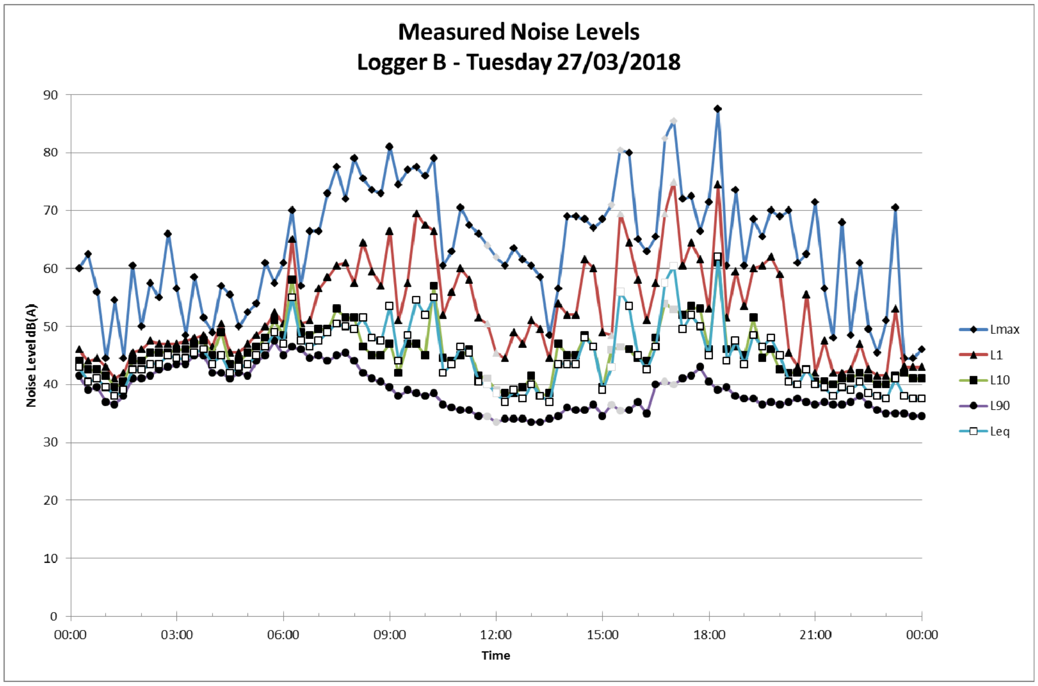
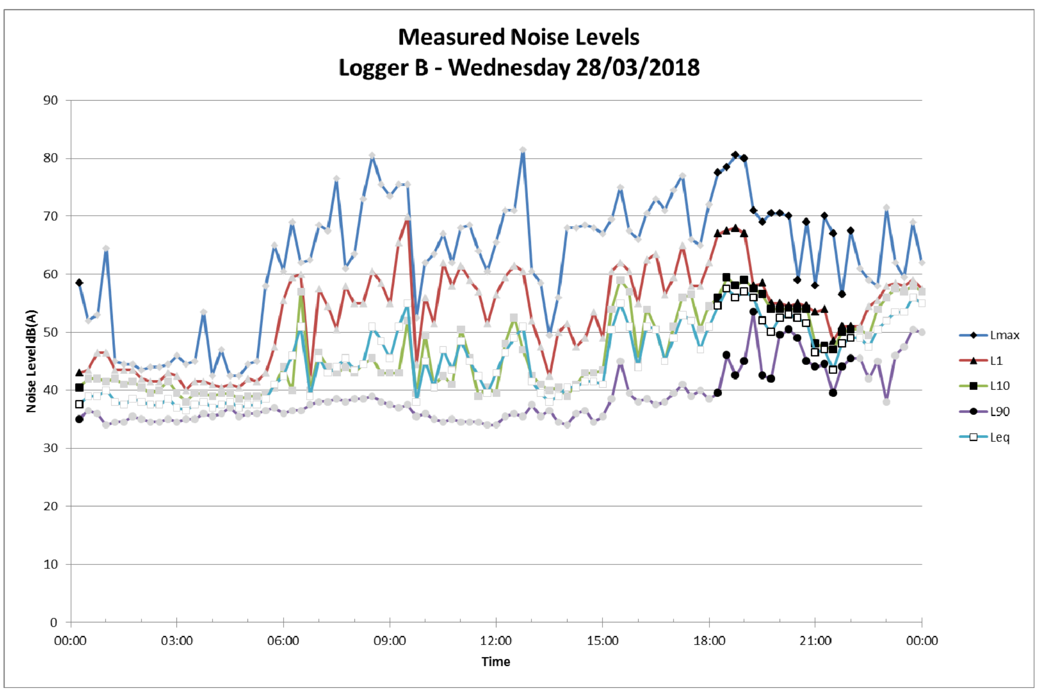
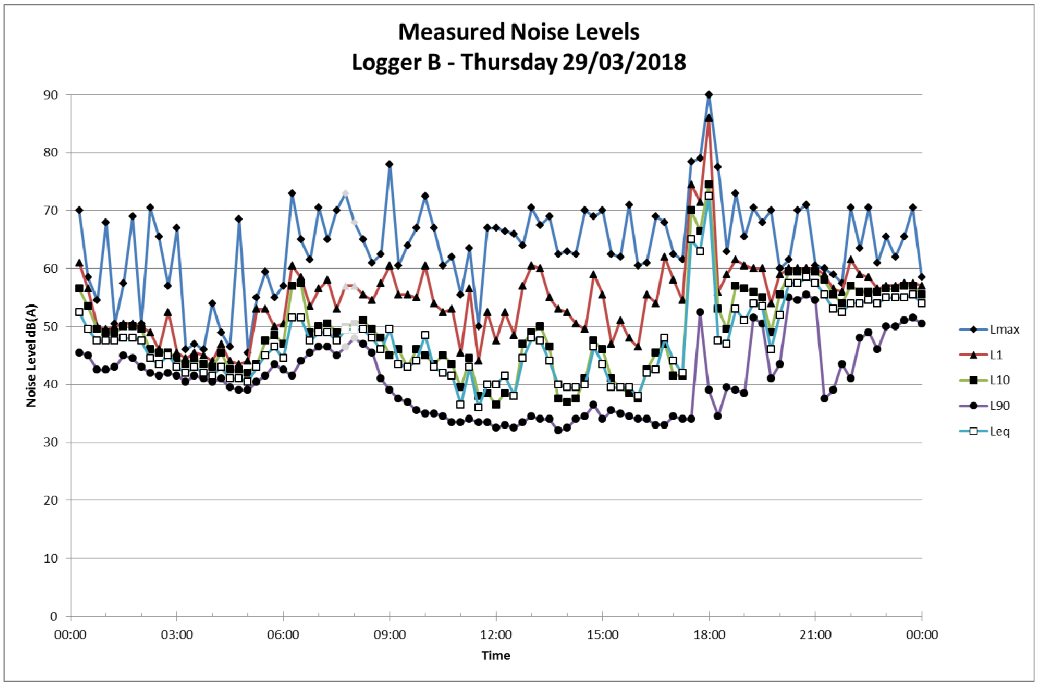
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Sunday 25/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

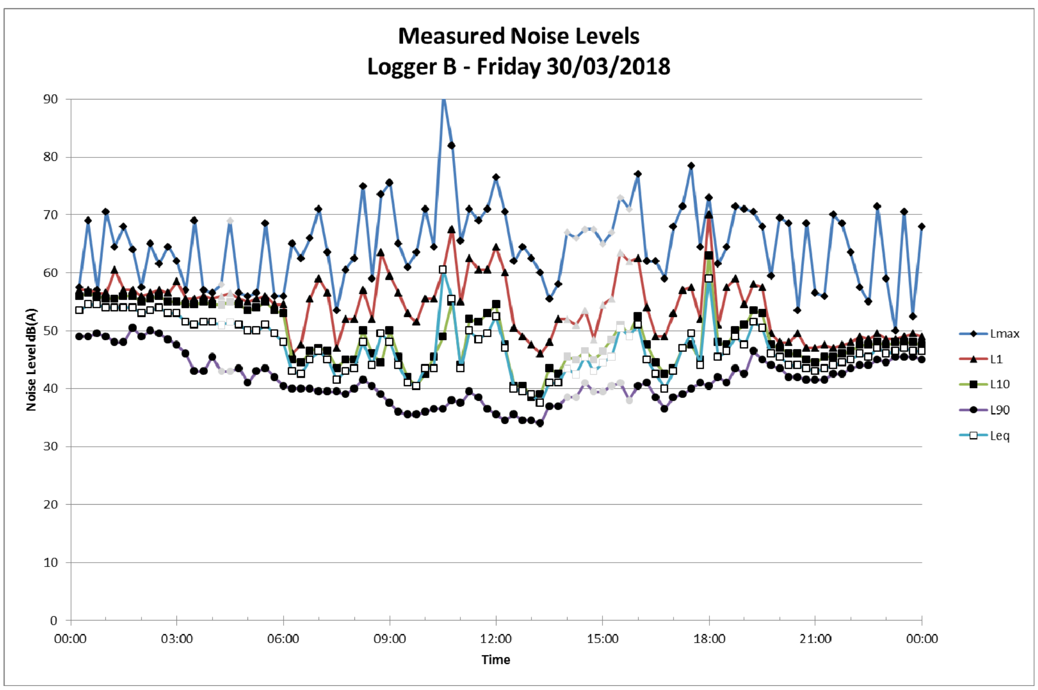

Measured Noise Levels
Logger B - Monday 26/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger B - Tuesday 27/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

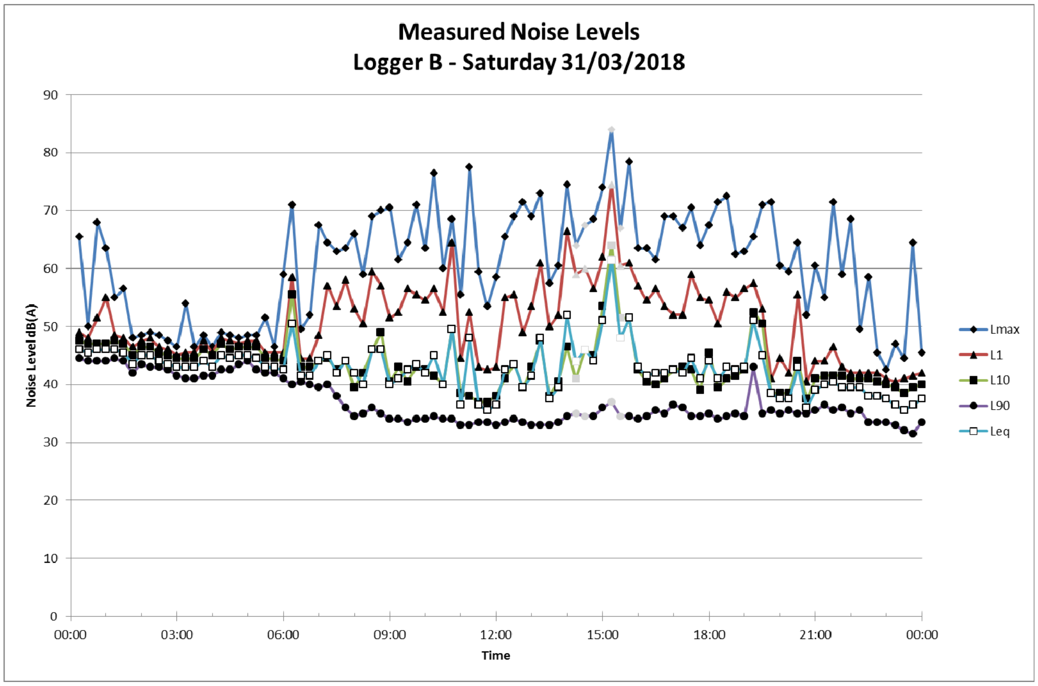

Measured Noise Levels
Logger B - Wednesday 28/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



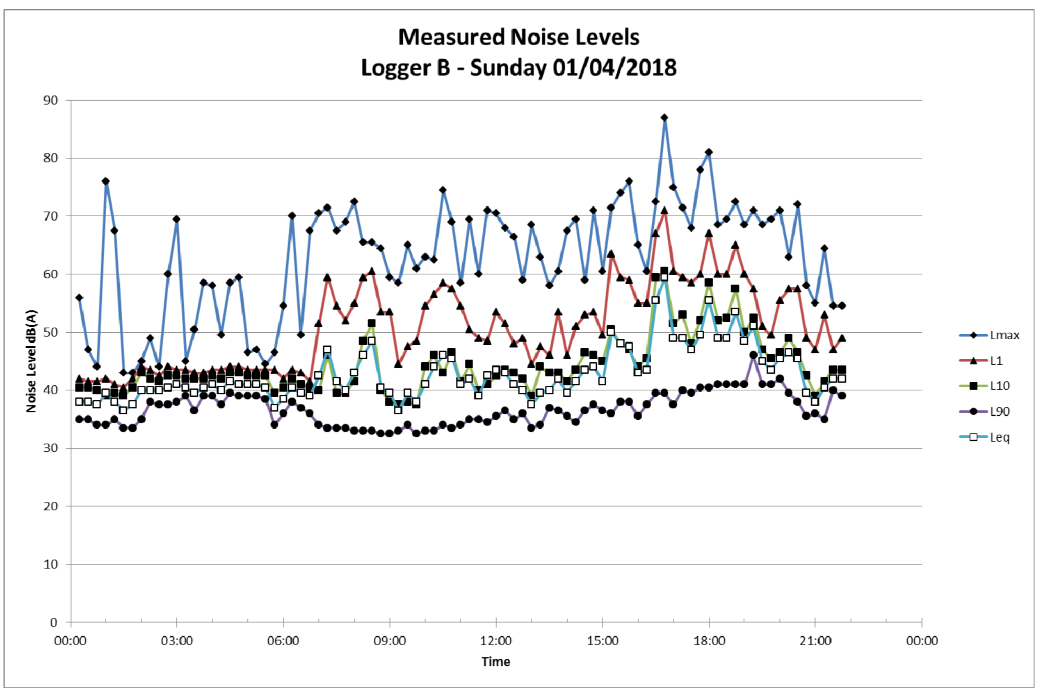
Measured Noise Levels
Logger B - Thursday 29/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



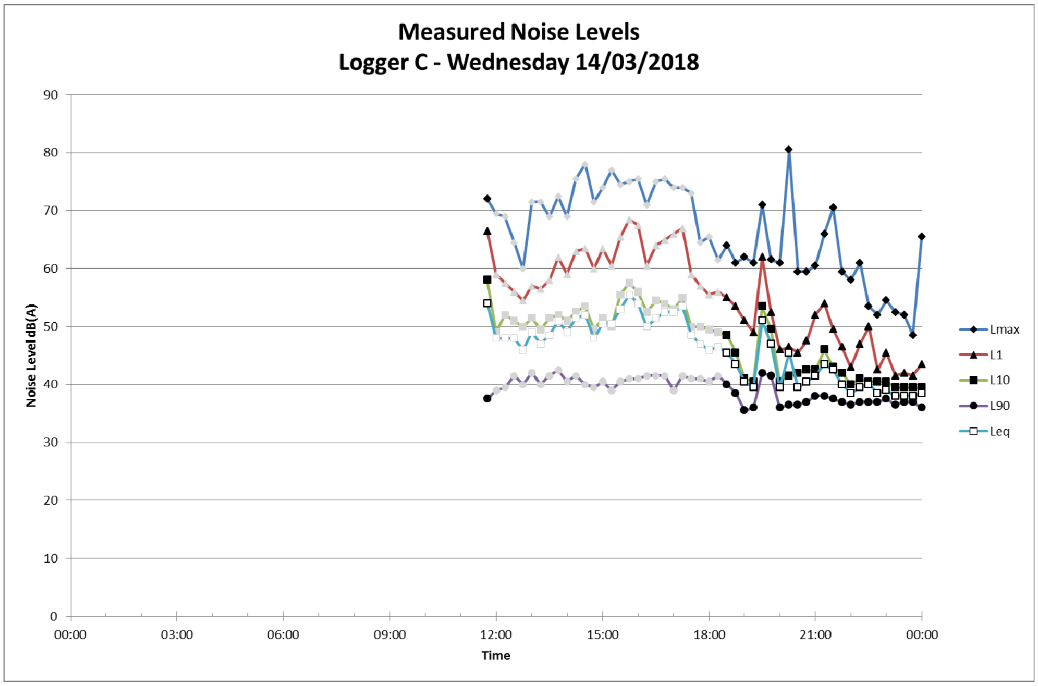
Measured Noise Levels
Logger B - Friday 30/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



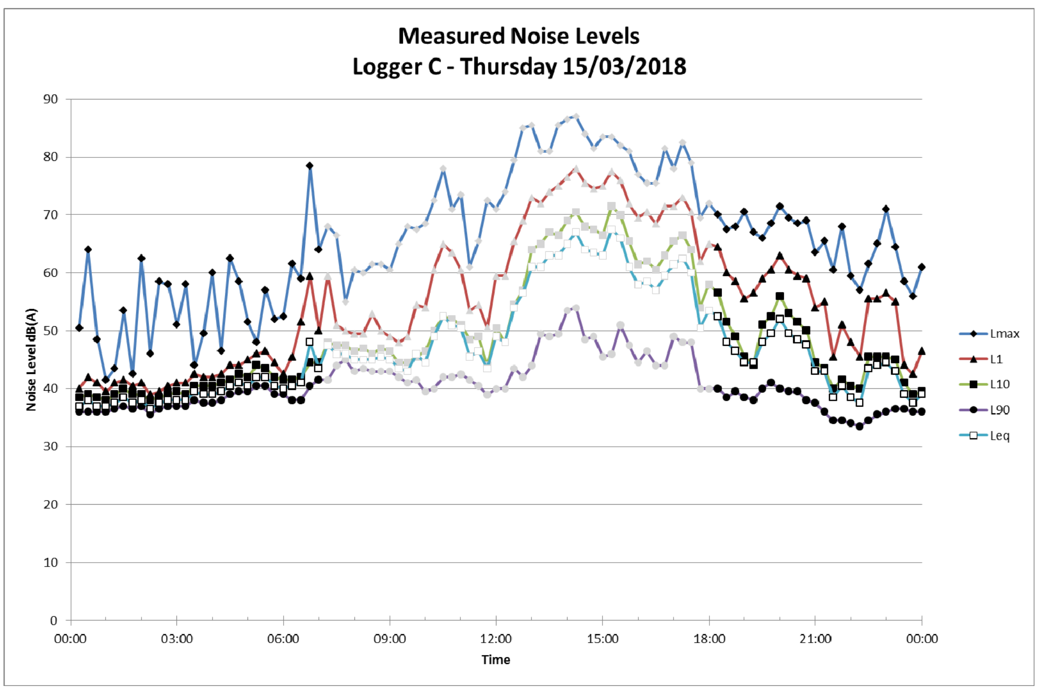
Measured Noise Levels
Logger B - Saturday 31/03/2018
Noise Level dB(A)
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq



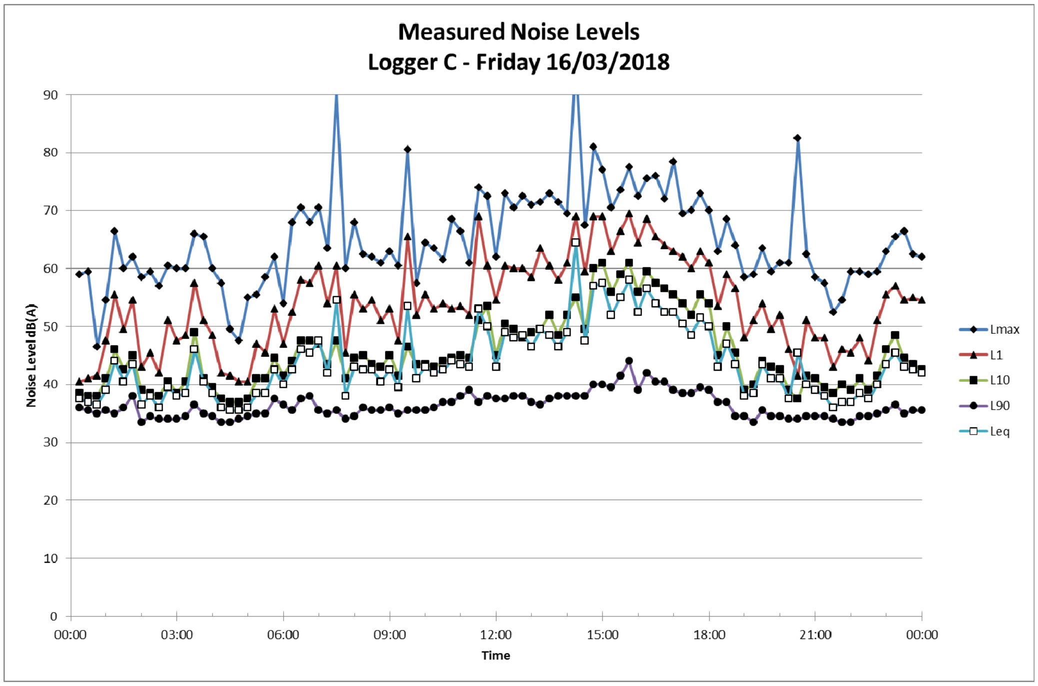
Measured Noise Levels
Logger B - Sunday 01/04/2018
Noise Level dB(A)
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq



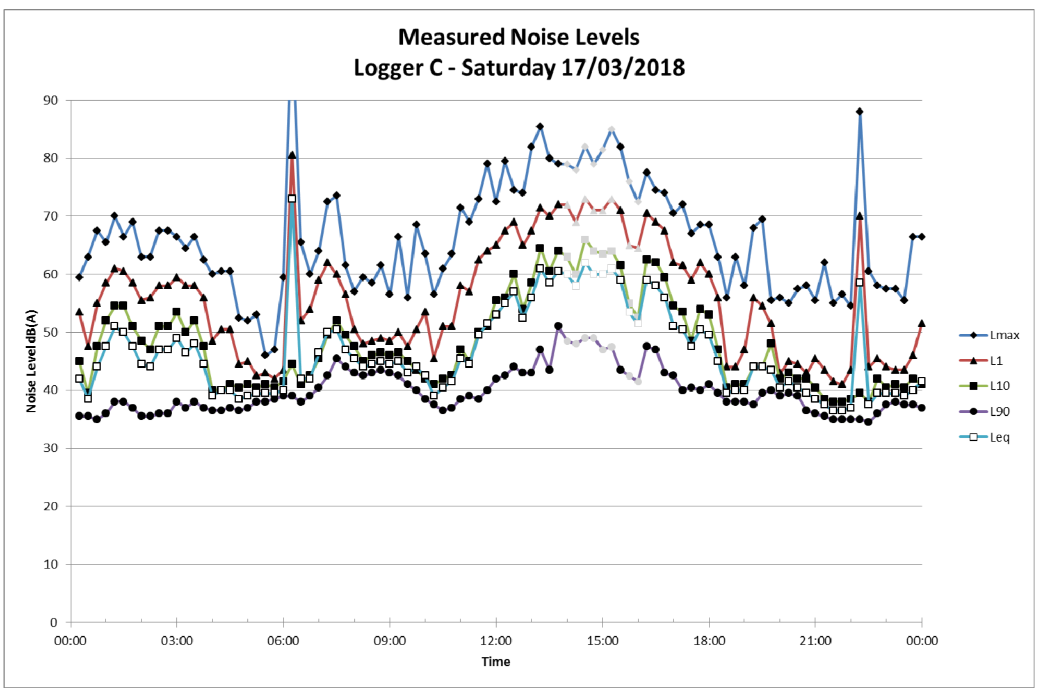
Measured Noise Levels
Logger C - Wednesday 14/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



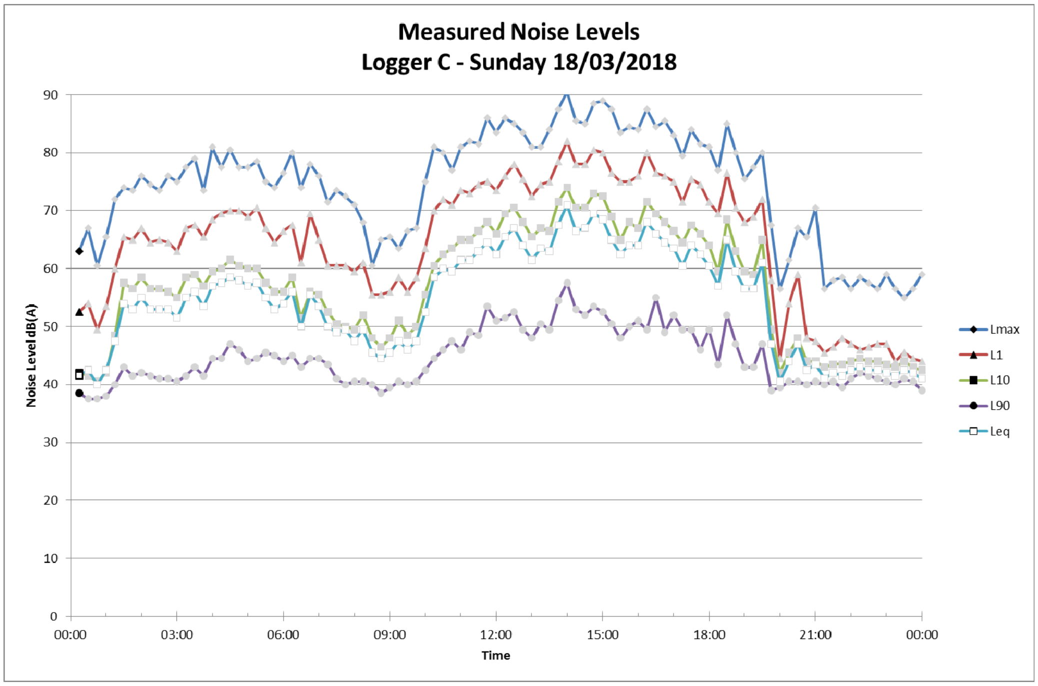
Measured Noise Levels
Logger C - Thursday 15/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



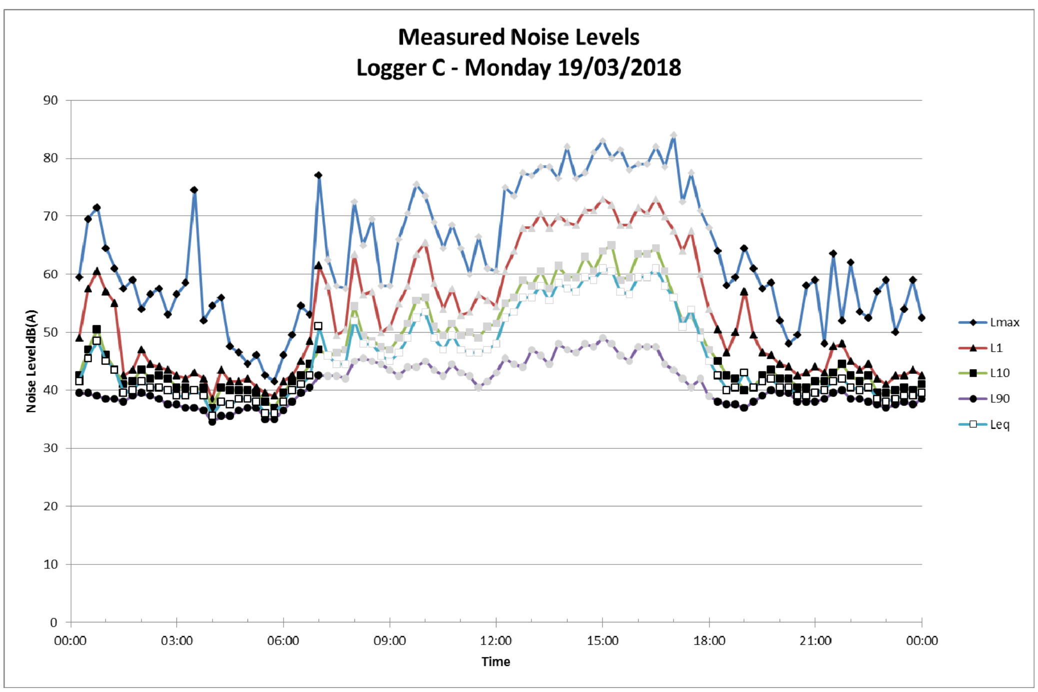
Measured Noise Levels
Logger C - Friday 16/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



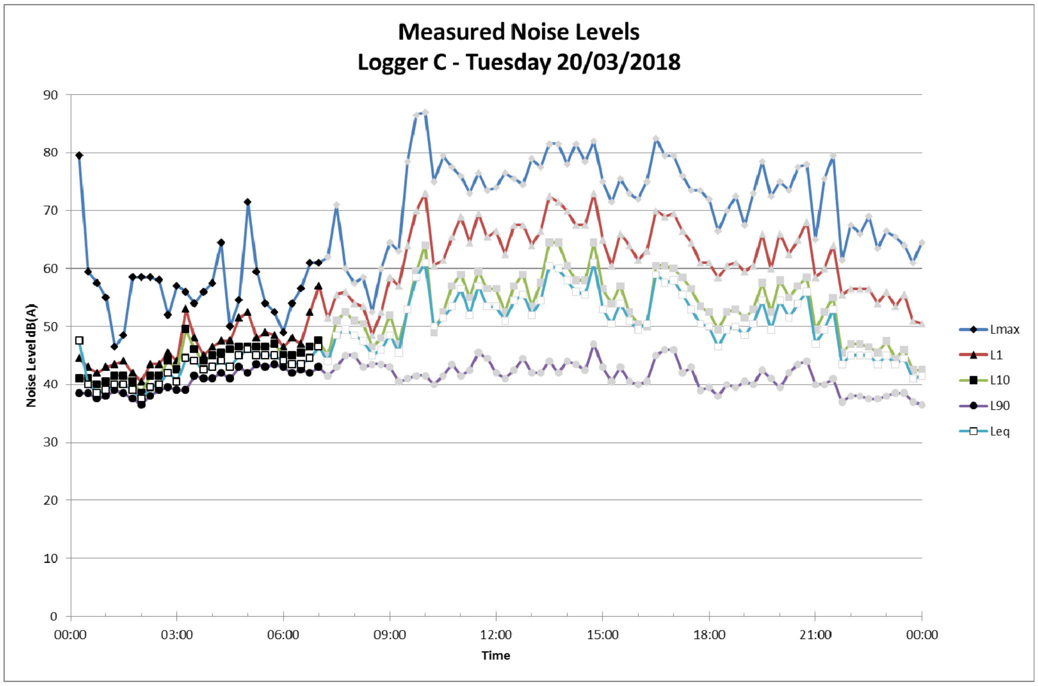
Measured Noise Levels
Logger C - Saturday 17/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



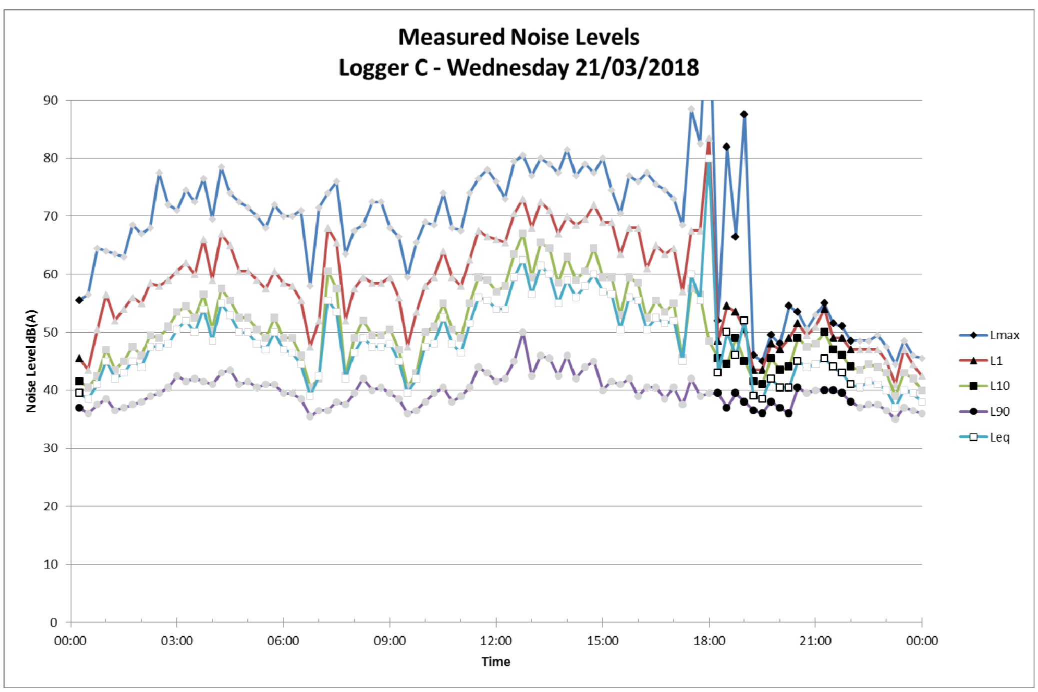
Measured Noise Levels
Logger C - Sunday 18/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq



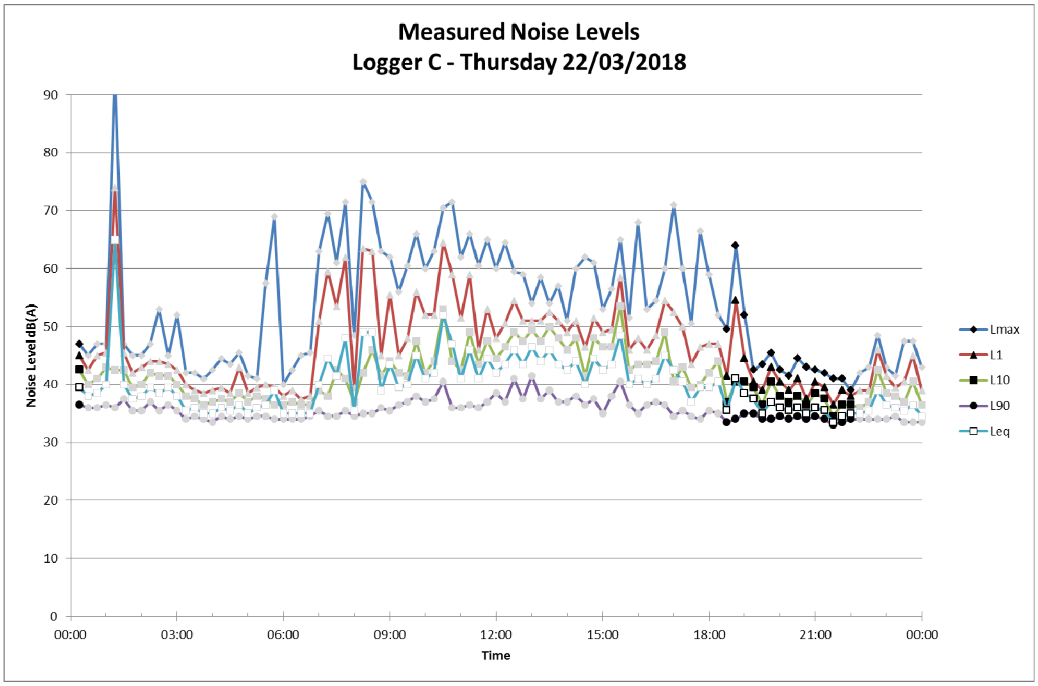
Measured Noise Levels
Logger C - Monday 19/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq



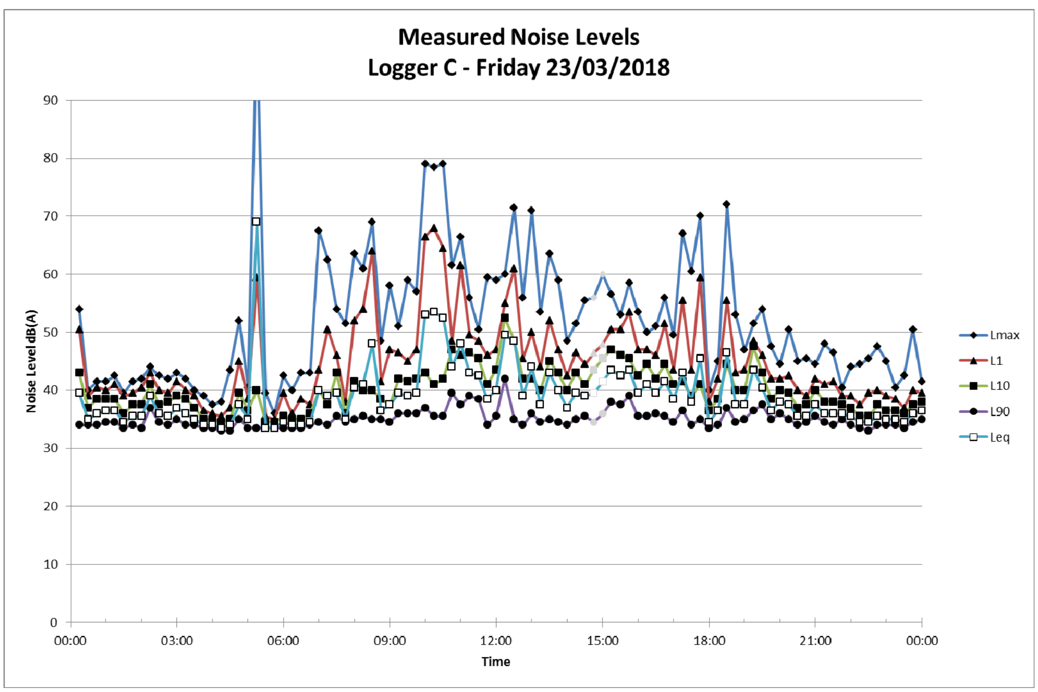
Measured Noise Levels
Logger C - Tuesday 20/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq



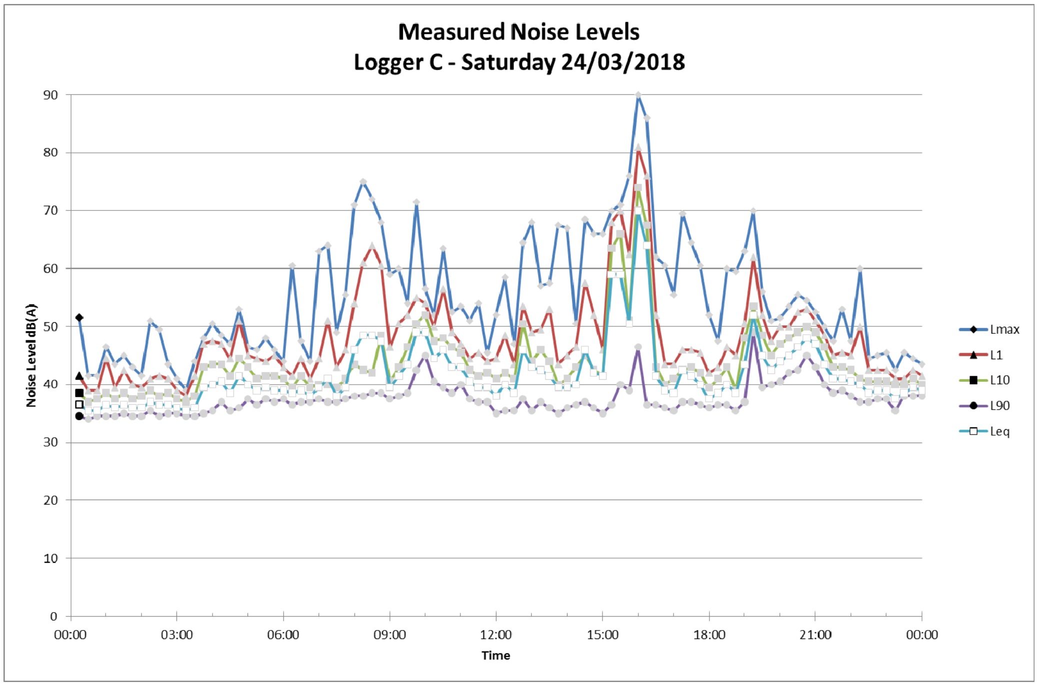
Measured Noise Levels
Logger C - Wednesday 21/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

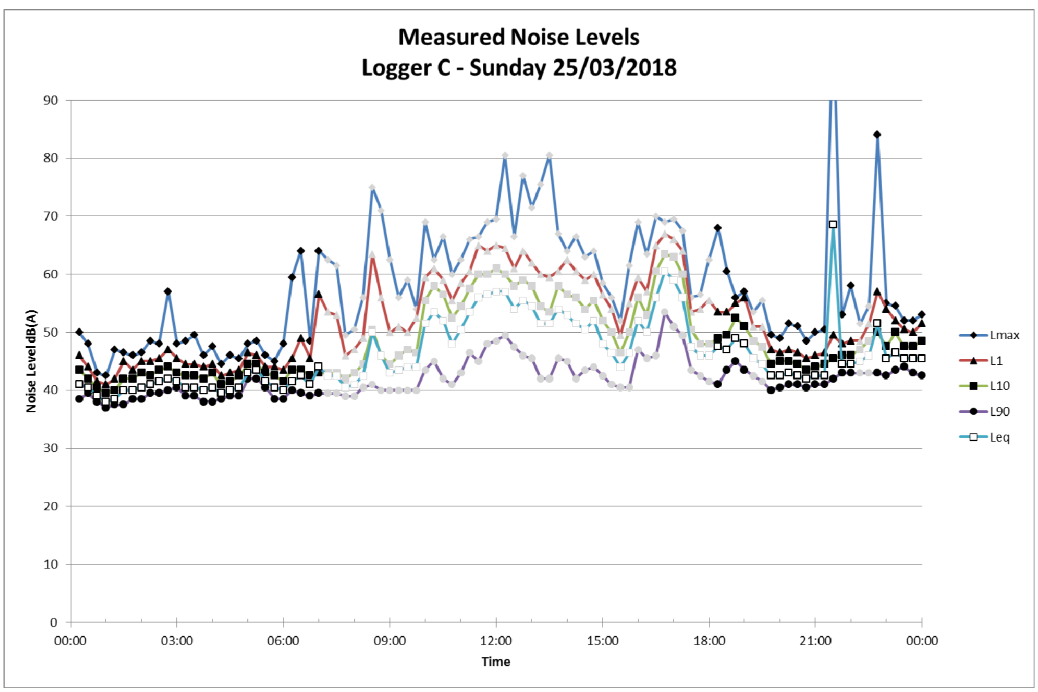


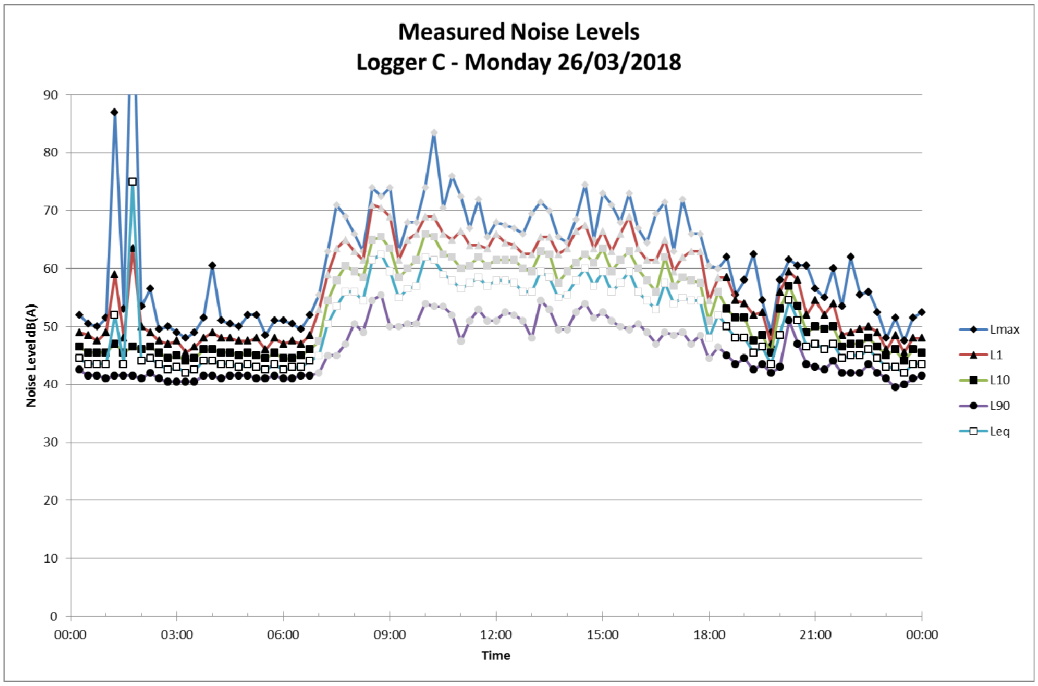
Measured Noise Levels
Logger C - Thursday 22/03/2018
Noise Level dB(A)
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq

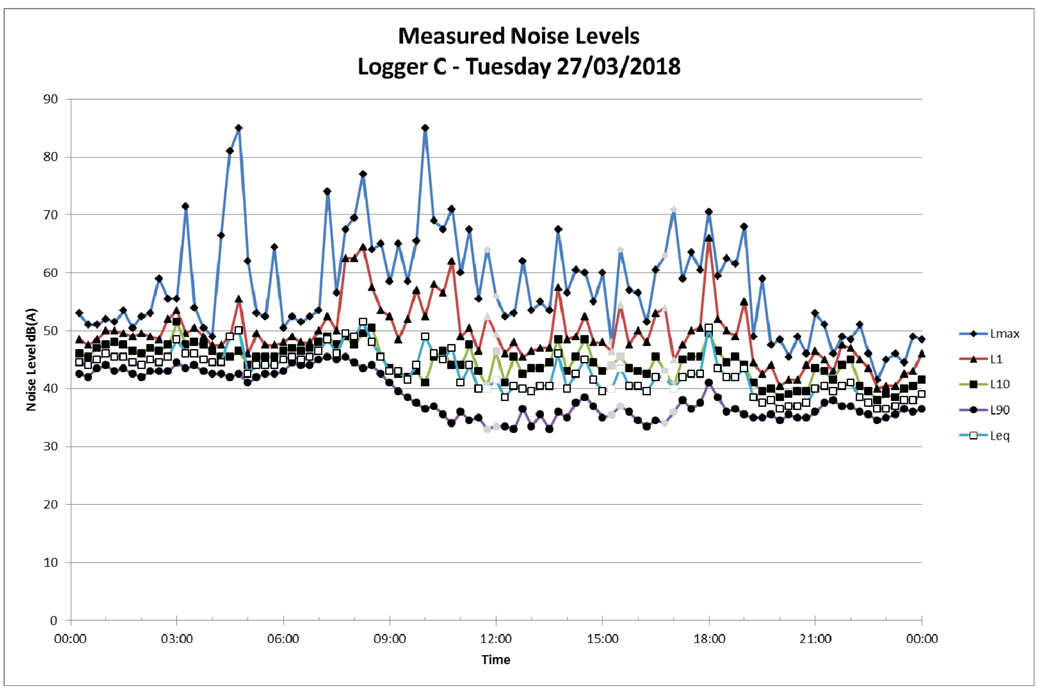


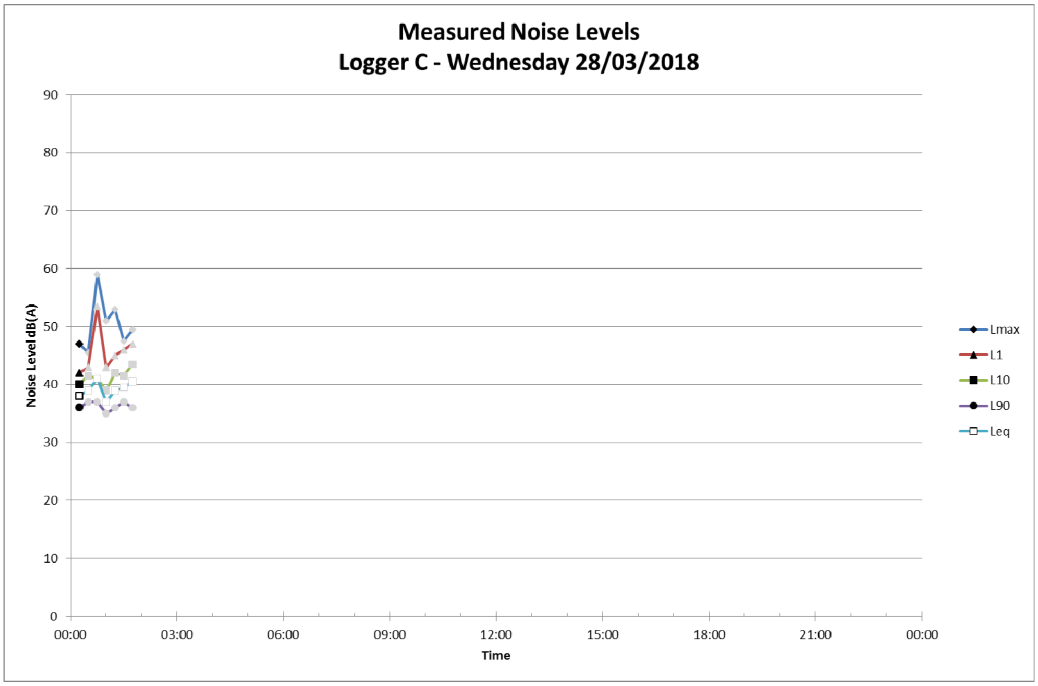
Measured Noise Levels
Logger C - Friday 23/03/2018
Noise Level dB(A)
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger C - Saturday 24/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger C - Sunday 25/03/2018
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger C - Monday 26/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger C - Tuesday 27/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
Logger C - Wednesday 28/03/2018
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq