

MEMO

Project:	Valhalla Gas Exploration and Appraisal Program – Baseline Noise Monitoring Survey	Document No.:	Mm 001 r01		
To:	Bennett Resources Pty Ltd	Date:	29 September 2021		
Attention:	Bennett Resources representatives	Cross Reference:	-		
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From:	Ben Wilson	No. Pages:	17	Attachments:	Yes
Subject:	Baseline noise monitoring data				

The memo outlines the results of a baseline noise monitoring survey carried out for the proposed Valhalla Gas Exploration and Appraisal Program in the Kimberley region of Western Australia.

SURVEY DETAILS

Three noise loggers were deployed by Bennett Resources representatives from 16 – 23 August 2021. The loggers were deployed at sites being used concurrently for air quality monitoring.

The purpose of the survey was to establish existing background noise levels at representative locations around the project site.

Noise environment

Each logger was deployed at a remote rural/outback location. The noise environment was typically characterised by sounds from natural sources (bird song, insects, wind generated noise). It is understood vehicle use on nearby access roads is infrequent and not a dominant contributor to average noise levels.

A constant low-level noise was generated by the co-located air quality monitoring equipment which was only apparent at the quietest periods. The noise monitors were relocated midway through the survey to eliminate any influence of this noise (typically within 20-30 m of the original location).

Equipment details

Table 1 presents the detail of the noise logging equipment used for the survey. The location of each noise logger is also provided. Photos showing the loggers are presented in Appendix D. A map showing the location is provided in Appendix E.

A field calibration check was carried out. No significant change in level was noted for the survey period.

The loggers were configured to continuously measure noise levels at 125 ms intervals (post processed to generate 15-minute logging periods). Measurements were obtained using the slow ('S') response time and A-weighting frequency network for consistency with the *Western Australia Environmental Protection (Noise) Regulations 1997 (the Noise Regulations)* .

The logger microphones were mounted on tripods at a height of approximately 1.2m above ground level in free field conditions.

Weather conditions during the survey period were fine (no rain) and typical for the northern dry season, based on review of the BoM data from the Fitzroy Crossing weather station. Wind speeds during the survey were typically lowest during night-time periods with higher wind speeds during the middle of the day. Site specific conditions can be confirmed by AES.



Table 1: Noise monitoring equipment details

Logger/equipment	Device Type	Serial Number	Coordinates
Logger 1	01dB Cube (FW 2.50)	10423	17° 53' 55.05 S 124° 40' 08.52 E
Logger 2	01dB Cube (FW 2.50)	10418	18° 15' 44.57 S 124° 51' 46.22 E
Logger 3	01dB DUO (FW 2.50)	10447	18° 27' 48.49 S 124° 51' 27.67 E
Calibrator	Cal 21	34134143	n/a

RESULTS

Table 2 - Table 4 present the average levels for the day, evening and night periods for each logger. A range of typical measurement parameters have been presented.

A daily breakdown of the results is presented in Appendix B. Time history plots are provided in Appendix C

Table 2: Average noise level – Day time period (Day 0700-1900)

Logger	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Logger 1	44	42	34	56	48
Logger 2	46	52	43	44	42
Logger 3	46	44	32	55	51

Table 3: Average noise level – Evening period (1900-2200)

Logger	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Logger 1	40	42	31	50	45
Logger 2	52	51	46	57	53
Logger 3	48	48	43	52	50

Table 4: Average noise level – Night period (2200-0700)

Logger	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Logger 1	57	36	25	63	45
Logger 2	46	39	34	51	42
Logger 3	36	28	26	43	34

DISCUSSION

The results show levels that are consistent with remote locations not heavily influenced by human activity. Diurnal patterns typical of urban areas (higher average levels during the day and quieter at night) were not observed. Instead, noise levels were influenced by bird song and insects which are active during the early morning (dawn) and evening/early night periods. Detailed review of the L_{eq} levels for Logger 1 shows that they were likely to be heavily influenced by early morning bird song between 4-6am which may explain why the average night L_{eq} level is higher than the day and evening periods.

Brief periods of elevated levels (spikes in L_{Amax} levels) are likely due to vehicles passing or when birds and insects were located near the microphone (this was confirmed through sampling of audio from logger 3).

Of particular note is the very low levels of background noise at some periods during the night-time, particularly at logger location 3. Background levels (typically quantified using the L_{A90} parameter) fall below 20 dB for some periods at each location (see plots in Appendix C). This is at the quieter end of the range that might typically be expected in a remote location. Background noise at this level will not provide any masking so noise from any industrial or commercial sources could be more noticeable than might be the case in less remote areas with high background noise environments. This may be a relevant consideration during the assessment phase of the project, noting that the lower night-time assigned noise level is L_{A10} 35 dB.

APPENDIX A GLOSSARY OF TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
dB	<u>Decibel</u> The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of $P_r=20 \mu\text{Pa}$ i.e. $\text{dB} = 20 \times \log(P/P_r)$
dB(A)	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
Frequency	The number of pressure fluctuation cycles per second of a sound wave. Measured in units of Hertz (Hz).
L_{A01}	The noise level exceeded for only 1% of the measurement period, measured in dB(A). This is sometimes referred to as the typical maximum noise level.
L_{A10}	The noise level exceeded for 10% of the measurement period, measured in dB(A). This is commonly referred to as the average maximum noise level.
L_{A90} (t)	The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{Aeq} (t)	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
Masking Noise	Background noise that is not disturbing, but due to its presence causes other unwanted noises to be less intelligible, noticeable and distracting.
Octave Band	A range of frequencies where the highest frequency included is twice the lowest frequency. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.
SPL or L_p	<u>Sound Pressure Level</u> A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 μPa RMS) and expressed in decibels.

APPENDIX B DETAILED RESULTS

Table 5 to Table 13 present the breakdown of average levels for each day. It should be noted that the results for the first day period (Monday 16 August) and last night period (Sunday 22 August) are based on partial periods since data was not collected for the entire period due to deployment and retrieval times.

Logger 1 results

Table 5: Logger 1 – Day time period (Day 0700-1900)

Day of week		Noise level (dB)			
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	44	46	40	61	50
Tuesday	47	45	36	59	52
Wednesday	46	42	29	55	49
Thursday	41	37	25	51	45
Friday	41	34	23	52	44
Saturday	39	35	24	50	44
Sunday	40	37	24	51	44
Average	44	42	34	56	48

Table 6: Logger 1 – Evening period (1900-2200)

Day of week		Noise level (dB)			
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	46	49	29	58	51
Tuesday	39	34	29	44	41
Wednesday	31	29	21	41	38
Thursday	35	36	30	45	42
Friday	34	35	29	41	39
Saturday	42	41	37	45	44
Sunday	39	35	31	39	37
Average	40	42	31	50	45

Table 7: Logger 1 – Night period (2200-0700)

Day of week		Noise level (dB)			
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	39	36	25	71	50
Tuesday	38	28	25	37	32
Wednesday	55	33	24	44	40
Thursday	58	39	23	53	48

Day of week	Noise level (dB)					
	160821-220821	L_{Aeq}	L_{AS10}	L_{A90}	L_{ASmax}	L_{AS1}
Friday		62	39	27	48	45
Saturday		54	32	23	42	38
Sunday		58	36	26	45	41
Average		57	36	25	63	45

Logger 2 results

Table 8: Logger 2 – Day time period (Day 0700-1900)

Day of week		Noise level (dB)			
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	44	61	50	46	40
Tuesday	29	28	28	35	30
Wednesday	44	36	29	43	40
Thursday	45	35	30	40	38
Friday	49	43	36	48	46
Saturday	47	42	38	44	43
Sunday	48	41	36	45	43
Average	46	52	43	44	42

Table 9: Logger 2 – Evening period (1900-2200)

Day of week		Noise level (dB)			
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	40	44	28	59	46
Tuesday	42	38	32	49	44
Wednesday	51	49	44	57	52
Thursday	54	52	48	57	54
Friday	55	53	49	58	55
Saturday	54	53	48	57	55
Sunday	54	52	48	56	54
Average	52	51	46	57	53

Table 10: Logger 2 – Night period (2200-0700)

Day of week		Noise level (dB)			
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	35	37	30	59	43
Tuesday	29	28	28	35	30
Wednesday	44	36	29	43	40
Thursday	45	35	30	40	38

Day of week	Noise level (dB)					
	160821-220821	L_{Aeq}	L_{AS10}	L_{A90}	L_{ASmax}	L_{AS1}
Friday		49	43	36	48	46
Saturday		47	42	38	44	43
Sunday		48	41	36	45	43
Average		46	39	34	51	42

Logger 3 results

Table 11: Logger 3 – Day time period (Day 0700-1900)

Day of week	Noise level (dB)				
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday *	-	-	-	-	-
Tuesday	52	51	38	61	57
Wednesday	49	45	33	56	51
Thursday	38	37	24	49	44
Friday	33	33	21	48	42
Saturday	30	30	20	44	38
Sunday	29	28	20	45	38
Average	46	44	32	55	51

* Insufficient data collected for analysis purposes as logger deployed late in day period.

Table 12: Logger 3 – Evening period (1900-2200)

Day of week	Noise level (dB)				
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	37	40	30	55	44
Tuesday	40	38	32	48	44
Wednesday	42	39	30	45	43
Thursday	48	49	44	53	51
Friday	50	50	46	52	51
Saturday	52	51	46	54	53
Sunday	50	49	44	53	52
Average	48	48	43	52	50

Table 13: Logger 3 – Night period (2200-0700)

Day of week	Noise level (dB)				
160821-220821	L _{Aeq}	L _{AS10}	L _{A90}	L _{ASmax}	L _{AS1}
Monday	32	32	30	51	40
Tuesday	39	30	30	37	32
Wednesday	21	20	18	30	24

Day of week	Noise level (dB)				
	160821-220821	L_{Aeq}	L_{AS10}	L_{A90}	L_{ASmax}
Thursday	36	26	22	35	30
Friday	35	27	22	35	31
Saturday	37	29	23	36	33
Sunday	35	27	23	34	30
Average	36	28	26	43	34

APPENDIX C TIME HISTORY PLOTS

Figure 1: Logger 1 time history plot

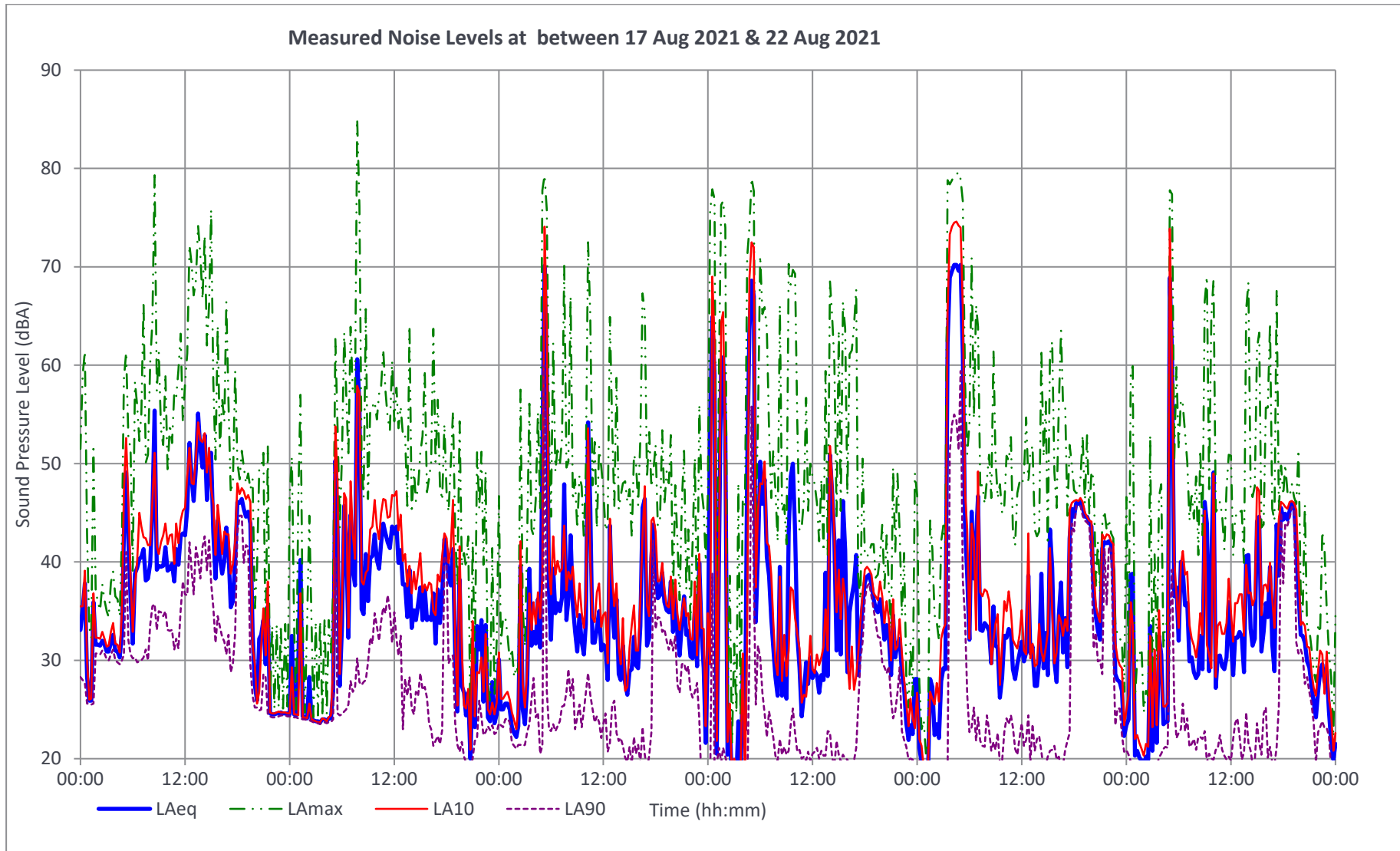


Figure 2: Logger 2 time history plot

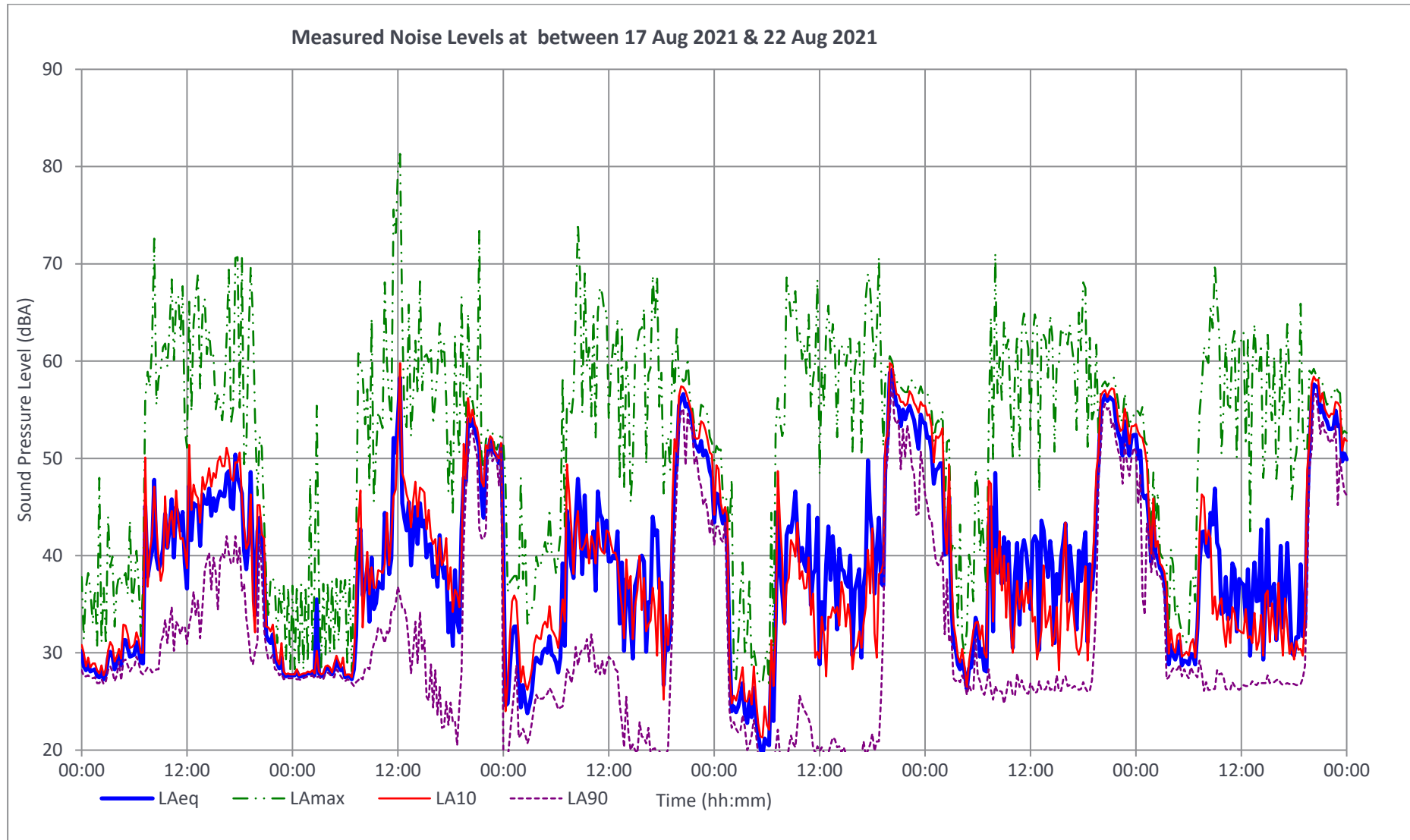
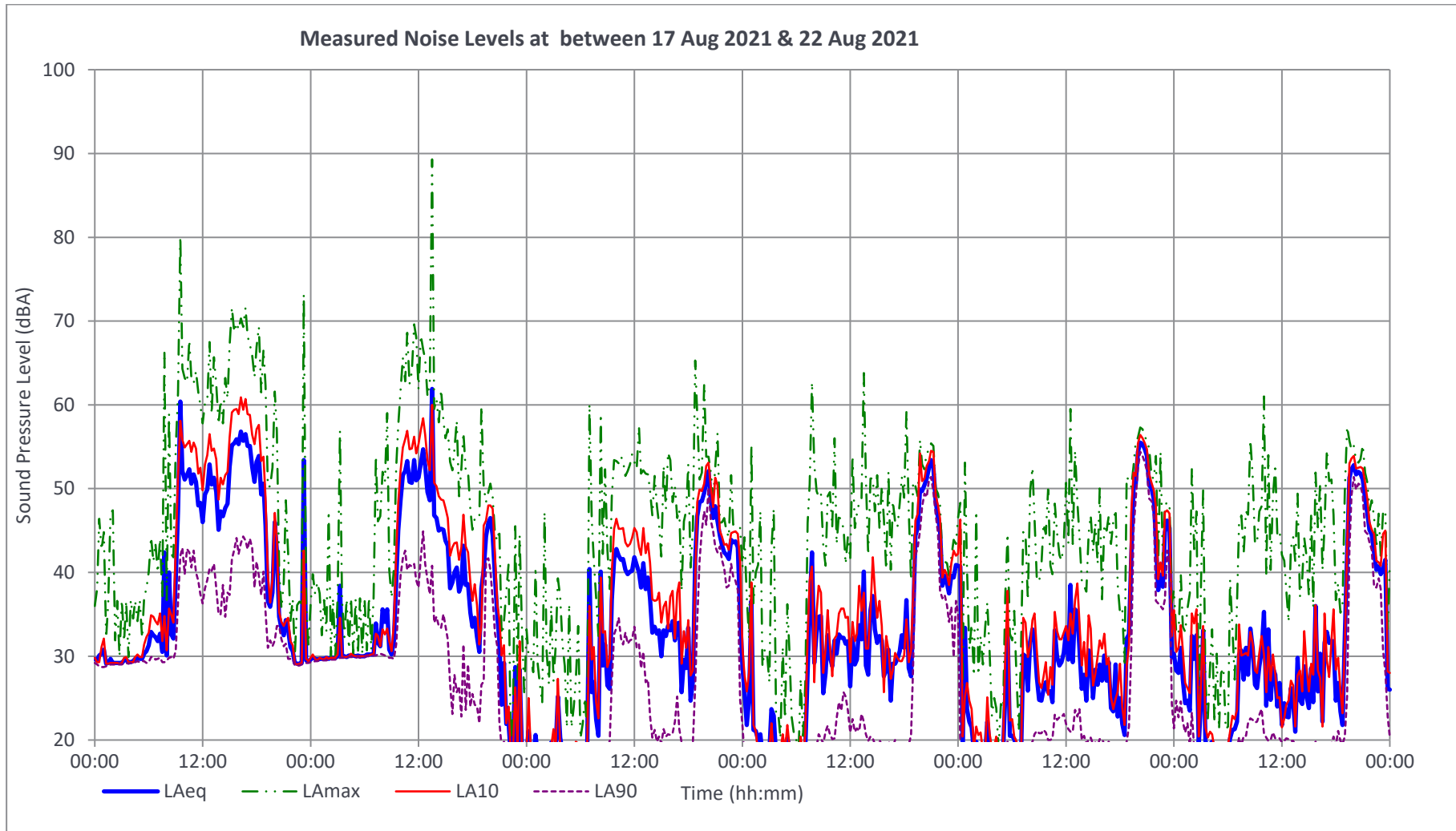


Figure 3: Logger 3 time history plot



APPENDIX D LOGGER PHOTOS

Figure 4: : Logger 1 - Cube 10423



Figure 5: : Logger 2 - Cube 10418



Figure 6: : Logger 3 - Duo 10447



APPENDIX E AERIAL MAP SHOWING LOGGER LOCATIONS

