Perilya Broken Hill Limited
ABN: 46 099 761 289

Broken Hill North Mine

Noise Impact Assessment

Prepared by

Muller Acoustic Consulting Pty Ltd

January 2017

Specialist Consultant Studies Compendium
Part 3

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Perilya Broken Hill Limited
ABN: 46 099 761 289

Broken Hill North Mine

Noise Impact Assessment

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Noise Impact Assessment

Proposed Broken Hill North Mine

Environmental Impact Statement

Prepared for : R.W. Corkery & Co Pty Ltd

January 2017

MAC
Muller Acoustic Consulting

Document Information

Noise Impact Assessment

Proposed Broken Hill North Mine

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by R.W. Corkery & Co. Pty. Limited (RWC) on behalf of Perilya Broken Hill Limited (the "Applicant") to prepare a Noise Impact Assessment (NIA) for the recommencement of mining operations at the Broken Hill North Mine (the "Mine"), located on the Line of Lode, Broken Hill, NSW.

The NIA was completed to quantify potential acoustic impacts associated with operation of the mine on the surrounding community and will accompany the Environmental Impact Statement (EIS) that is being prepared to assess the proposed development. The NIA has been prepared taking into consideration requirements outlined in the Secretary's Environmental Noise Assessment Requirements (SEARs) (ref:SSD7538) issued by the NSW Department of Planning and Environment (2016) and in accordance with the following policies and guidelines:

- Environment Protection Authority (EPA) 2000, NSW Industrial Noise Policy (INP);
- Department of Environment and Climate Change (DECC) 2009, Interim Construction Noise Guideline (ICNG); and
- Department of Environment, Climate Change and Water NSW (DECCW), Road Noise Policy (RNP), 2011.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Policy and Guidelines

The following section summarises relevant policy and guidelines pertinent to undertaking an industrial noise assessment. Key policies relevant to the mining include the INP, ICNG and RNP.

2.1 Industrial Noise Policy

The EPA released the NSW INP in January 2000. The INP provides a process for establishing noise criteria for consents and licences enabling the EPA to regulate noise emissions from scheduled premises under the Protection of the Environment Operations Act 1997.

The specific policy objectives of the INP are:

- to establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses;
- to use the criteria as the basis for deriving project specific noise levels;
- to promote uniform methods to predict, quantify and assess noise impacts, including a procedure for evaluating meteorological effects;
- to outline a range of mitigation measures that could be used to minimise noise impacts;
- to provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and
- to carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the Act.

2.1.1 Assessing Intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level (LA_{eq}) from the proposed mine should not be more than 5dB above the existing rating background level (RBL) in any assessment period. Therefore, when assessing intrusiveness, the background noise needs to be measured. Where the RBL is less than 30dBA, a value of 30dBA is used.

2.1.2 Assessing Amenity

The amenity assessment is based on noise criteria relevant to a specific land use or locality. The criteria relate only to limiting cumulative or combined levels of industrial noise in a locality. Where existing industrial noise approaches the criterion value, then noise levels from proposed industries need meet the amenity criteria so that cumulative noise or 'industrial-creep' is minimised. The amenity assessment methodology takes into consideration areas of high traffic noise when assessing ambient industrial noise.

Private residences and other sensitive receivers potentially affected by the mine are safeguarded by the EPA's amenity categories as presented in Table 2.1 of the INP. Table 2.1 of the INP for residential receivers is reproduced in **Table 1**.

Table 1 Receiver Locations – Assessing Amenity

Type of Receiver	Indicative Noise Amenity Area	Period	Recommended LAeq(Period) Noise Level, dBA	
			Acceptable	Recommended Max
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45

Note: Monday – Saturday Daytime 7am to 6pm; Evening 6pm to 10pm; Night-time 10pm to 7am. On Sundays and Public Holidays, Daytime 8am to 6pm; Evening 6pm to 10pm; Night-time 10pm-8am.

2.2 Sleep Disturbance Criteria

The EPA via the INP and associated application notes, provides guidance on assessing sleep disturbance for industrial and commercial sites. As the mine propose to operate between 10pm to 7am, sleep disturbance will be assessed in this report. Detailed criteria for sleep disturbance are presented in detail in Section 4.

2.3 Interim Construction Noise Guideline

The assessment and management of noise from construction works is completed using the ICNG. The ICNG is specifically aimed at managing noise from construction works and is used to assist in setting statutory conditions in licences or other regulatory instruments.

The ICNG sets out procedures to identify and address the impacts of construction noise on residences and other sensitive land uses.

2.3.1 Standard Hours for Construction

Table 2 summarises the ICNG recommended standard hours for construction activities where the noise from construction is audible at residential premises.

Table 2 Recommended Standard Hours for Construction

Daytime	Preferred Construction Hours
Monday to Friday	7am to 6pm
Saturdays	8am to 1pm
Sundays or Public Holidays	No construction

These recommended hours do not apply in the event of direction from police, or other relevant authorities, for safety reasons or where required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

2.3.2 Construction Noise Management Levels

Table 3 reproduces the ICNG management levels for residential receivers. The construction noise management levels are the sum of the management level and relevant rating background level (RBL) for each specific assessment period.

Table 3 ICNG Residential Management Levels

Time of day	Management level LAeq (15-minute)	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB.[1]	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA.	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: -times identified by the community when they are less sensitive to noise (such as before and after school for works near schools), or mid-morning or mid-afternoon for works near residences.

Table 3 ICNG Residential Management Levels		
Time of day	Management level LAeq (15-minute)	How to apply
Outside recommended standard hours.	Noise affected RBL + 5dB.	-if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times. 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 dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period.

2.4 Road Noise Policy

The road traffic noise criteria are provided in the Road Noise Policy (RNP) (DECCW, 2011). The policy sets out noise criteria applicable to different road classifications for the purpose of quantifying traffic noise impacts. Road noise criteria relevant to this assessment are presented in detail in Section 4.

2.5 Blasting Guideline

The limits adopted by EPA for blasting are provided in the Australian and New Zealand Environment Conservation Council (ANZECC) - Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration. Blasting criteria relevant to this assessment are presented in detail in Section 4.

3 Existing Environment

3.1 Receiver Review

The mine is located on the suburban fringe of Broken Hill, NSW, south of Argent Street. Receivers in the locality surrounding the mine are primarily residential and have been divided into representative noise catchments (NCs) for assessment purposes. **Figure 1** provides a locality plan identifying the position of NCs in relation to the mine. Each NCs approximate single point MGA(54) coordinate to the project are summarised in **Table 4**. Each single point location is generally the nearest or most exposed point within each catchment to the project site.

Table 4 Receivers and MGA Coordinates

Ref	Easting	Northing
NC1	545752	6465303
NC2	545714	6465323
NC3	545388	6465087
NC4	545157	6464923
NC5	545125	6464637
NC6[1]	548728	6465779
NC7	544775	6464141
NC8	544712	6463026
NC9	545114	6461982

Note 1: As per Table A2-2 of the Secretary's Environmental Assessment Requirements (SEAR's)

3.2 Background Noise Environment

3.2.1 Unattended Noise Monitoring

To quantify the existing background noise environment of the area, unattended noise logging was conducted at three locations in surrounding noise catchments. The selected monitoring locations are shown in **Figure 1**. The unattended noise survey was conducted in general accordance with the procedures described in Australian Standard AS 1055-1997, "Acoustics - Description and Measurement of Environmental Noise".

The measurements were carried out using Svantek Type 1, 977 noise analysers from Friday 29 April 2016 to Monday 9 May 2015. The monitoring locations are considered representative of the acoustic environment of noise catchments surrounding the project. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Data affected by adverse meteorological conditions have been excluded from the results in accordance with methodologies provided in the INP. A summary of measured background noise levels and measured ambient LAeq levels are summarised in Table 5 and plotted in graph format in Appendix B.

Table 5 Background Noise Monitoring Summary

Location	Measured background noise level, RBL, dBA			Measured LAeq, dBA		
	Day	Evening	Night	Day	Evening	Night
L1	30 (29)[1]	31	30 (22)[1]	43	43	38
L2	33	35	30 (26)[1]	50	50	46
L3	31	31	30 (25)[1]	48	47	45

Note: excludes periods of wind or rain affected data, meteorological data obtained from the Bureau of Meteorology Broken Hill Airport.

Note: Day period is 7am to 6pm, evening is 6pm to 10pm, night period is 10pm to 7am.

Note 1: Where the RBL is lower than 30dBA, a RBL of 30dBA is applied, the measured RBL is shown in brackets.


NC6*
PROJECT SITE
ACCENT STREET
NC2
L2
NC1
L3
NC3
L1
NC4
NC5
MORILLON STREET
NC7
NC8
NC9
KEY
NC4
NOISE CATCHMENTS
APPROXIMATE PROJECT SITE BOUNDARY
L2
NOISE LOGGER LOCATION
N
0
1km
FIGURE 1 - LOCALITY PLAN
MAC160242 - BROKEN HILL NORTH MINE
*Required to be assessed as part of the SEARs

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4 Project Specific Noise Criteria

4.1 Operational Noise Criteria

The operational noise emission criteria for the proposed mine have been set in accordance with Section 4.0 of the INP. The Project Specific Noise Levels (PSNLs) (project criteria) is the lower of the intrusive or amenity criteria. The PSNLs for the mine are presented in **Table 6**.

Table 6 Project Specific Noise Criteria, dBA $LA_{eq(15min)}$

Receiver	Measured RBL LA90, dBA	Intrusiveness Criteria LAeq(15minute), dBA	Amenity Criterion LAeq(period), dBA	PSNL
		Day		
NC 1 and NC2 (L2)	33	38	55	38
NC3, NC4 and NC5 (L3)	31	36	55	36
NC6 (L1) (and all other receivers)	30	35	55	35
		Evening		
NC 1 and NC2 (L2)	33[1]	38	45	38
NC3, NC4 and NC5 (L3)	31	36	45	36
NC6 to NC9 (L1) (and all other receivers)	30[1]	35	45	35
		Night		
All Residential	30	35	40	35

Note: Day period is 7am to 6pm, evening is 6pm to 10pm, night period is 10pm to 7am.

Note 1: As per the INP, evening cannot be set higher than the day.

4.2 Sleep Disturbance Criterion

An important aspect of intermittent noise, is the potential to disturb the sleep of nearby residents. The EPA provides guidance on assessing sleep disturbance for industrial and commercial sites.

The EPA nominates that a screening criterion of background noise level (LA90) plus 15dB shall apply to maximum noise level events from the site which are to be calculated at one metre from the bedroom facade at the nearest residential properties.

If noise levels over the screening criterion are identified, then additional analysis should consider factors such as:

- how often the events would occur;
- the time the events would occur (between 10pm and 7am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

Based on the night RBL, an LAmax sleep disturbance criterion of 45dBA is applicable to this project.

4.3 Construction Noise Management Levels (NMLs)

Construction activities within the project site include the establishment of an internal haul road, and refurbishment of the infrastructure office, store, workshop, change house and magazine.

Noise associated with construction activities for extractive industries are often assessed as operational noise, as the emissions from plant and associated construction equipment are similar. Notwithstanding, it is evident that construction tasks on the project site are unique and clearly related to construction of buildings and infrastructure. Therefore, this assessment has adopted a worst case construction noise management level (NML) of 30dBA RBL + 10dB = 40dBA, $LA_{eq(15min)}$.

4.4 Road Traffic Noise Criteria

The road traffic noise criteria are provided in the NSW EPA's Road Noise Policy (RNP) (2011).

The 'Freeway/arterial/sub-arterial road' categories as specified in the RNP are adopted for Argent Street for this assessment which is the primary transportation route of ore to the South Mine for processing. **Table 7** presents the road traffic noise assessment criteria reproduced from the RNP relevant for this road type.

Table 7 Road Traffic Noise Assessment Criteria for Residential Land Uses

Road category	Type of project/development	Assessment Criteria - dBA	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub-arterial road	Existing residences affected by additional traffic on existing freeways/sub-arterial/roads generated by land use developments	60dBA, $LA_{eq(15hr)}$	55dBA, $LA_{eq(9hr)}$

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dB, which is generally accepted as the threshold of perceptibility to a change in noise level. In addition to meeting the assessment criteria, any significant increase in total traffic noise at receivers must be considered. Receivers experiencing increases in total traffic noise levels above those presented in **Table 8** due to the addition of mine vehicles on the roads surrounding the project should be considered for mitigation.

Table 8 Relative Increase Criteria for Residential Land Uses

Road Category	Type of Project/Development	Total Traffic Noise Level Increase, dBA	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub-arterial roads and transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic LAeq(15hr) +12dB (external)	Existing traffic LAeq(9hr) + 12dB (external)

4.5 Blasting Criteria

The limits adopted by EPA for blasting are provided in the Australian and New Zealand Environment Conservation Council (ANZECC) - Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration.

The limits address two main effects of blasting:

- airblast noise overpressure; and
- ground vibration.

4.5.1 Airblast

The recommended maximum level for airblast is 115dB linear peak. The level of 115dB may be exceeded on up to 5 percent of the total number of blasts over 12 months. However, the level should not exceed 120dB linear peak at any time.

4.5.2 Ground Vibration

Peak particle velocity (PPV) from ground vibration should not exceed 5mm/s for more than 5 percent of the total number of blasts over 12 months. However, the maximum level should not exceed 10mm/s at any time. The ANZECC blast limits are reproduced in **Table 9**.

Table 9 Airblast Overpressure and Ground Vibration Limits

Airblast	
Overpressure level dB(Zpeak)	Allowable exceedance
115	5% of the total number of blasts over 12 months
120	0%
Ground vibration	
Peak particle velocity (mm/s)	Allowable exceedance
5	5% of the total number of blasts over 12 months
10	0%

5 Noise Assessment Methodology

5.1 Operational Noise Modelling Methodology

Brüel and Kjær Predictor Type 7810 (Version 11.10) noise modelling software was used to assess potential noise impacts associated with the mine. The model uses relevant noise source data, ground type, shielding such as barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected NCs. Plant and equipment were modelled at various locations within representative positions of future mining operations (see **Appendix C**).

The model incorporated three-dimensional digitised ground contours of the surrounding land base topography. The noise model predicts LAeq noise levels, although it should be noted that this assessment has assumed that all plant and equipment operate simultaneously. In practice, such an operating scenario would be unlikely to occur and the results should therefore be considered conservatively high. Where relevant, modifying factors in accordance with Section 4 of the INP have been applied to calculations.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation'.

The model incorporates the internal haul road cutting which is a noise control initiative implemented by the mine to eliminate line of site from haul trucks to surrounding receivers.

5.1.1 Meteorological Analysis

Noise emissions from industry can be significantly influenced by prevailing weather conditions. Wind has the potential to increase noise at a receiver when it is at low speeds and is from the direction of the noise source. As the strength of the wind increases the noise produced by the wind masks the audibility of most industrial sources.

Meteorological conditions that enhance received noise levels include source to receiver winds and the presence of temperature inversions. To account for the potential for enhancements, the INP specifies that the source to the receiver wind component for speeds up to 3m/s for 30% or more of the time in any seasonal period (ie day, evening or night), are feature winds and must be assessed.

The NSW INP Section 5.3 Wind Effects states:

> *'Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source to receiver wind speeds (at 10m height) of 3m/s or below occur for 30 percent of the time or more in any assessment period in any season.'*

To determine the prevailing conditions for the mine, weather data during the period May 2014 to May 2016 was obtained from the Bureau of Meteorology's (BOM) Broken Hill Airport weather station. The data was analysed using the EPA's Noise Enhancement Wind Analysis (NEWA) program in order to determine the frequency of occurrence of winds of speeds up to 3m/s in each season.

Table 10 summarises the results of the wind analysis and includes the dominant wind directions and percentage occurrence for each season for the daytime, evening and night assessment periods (ie 'prevailing winds'). The prevailing winds will be adopted as part of the noise modelling scenarios for the project. **Appendix D** presents a summary of the analysed NEWA data.

Table 10 Modelled Prevailing Meteorological Parameters

Assessment Condition	Wind Speed / Direction	Stability Class
Calm	n/a	n/a
Prevailing wind - Morning Shoulder/Night	n/a	F

5.1.2 Modelling Scenarios

A worst case modelling scenario was adopted in this assessment to represent noise emissions during maximum production at the mine with plant operating at representative positions within the project boundary.

5.1.3 Sound Power Levels - Operation

Emission modelling data for relevant mine sources were obtained from the MAC noise database. The noise emission levels used in modelling are summarised in **Table 11**. **Appendix E** provides the octave sound power data of modelled plant.

Table 11 Equipment Sound Power Levels

Item	LAeq(15min) Sound Power Level (SWL),	Period of Operation		
Operational Noise Sources		Day	Evening	Night
Mobile crusher (x1)	114	✓	✓	x
Haul truck (x2)	108	✓	✓	✓
Loader (x2)	106	✓	✓	✓
Paste fill plant(x1)	108	✓	✓	✓
Road Truck (x1)	102	✓	✓	x
Construction Noise Sources				
Backhoe (small) (x 1)	103		Day Only	
Road Truck (x1)	102		Day Only	
Grader (x1)	108		Day Only	
Hand tools (x3)	97		Day Only	

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6 Noise Modelling Results and Discussion

6.1 Operational Noise Results

The predicted noise levels at each receiver during calm and noise enhancing meteorological conditions for mine operations are provided in **Table 12**. The results of the model show that noise emissions from the mine will satisfy the PSNL at all assessed receivers for worst case operations.

Appendix F provides noise contours for calm and inversion meteorological conditions.

Table 12 Predicted Operational Noise Levels, dBA $LA_{eq(15min)}$

Noise Catchment	Period[1]	Prediction for Calm	Predictions for Worst Case Meteorology[2]	PSNL
NC1	Day	37	N/A	38
	Evening	38	N/A	38
	Night	<30	35	35
NC2	Day	36	N/A	38
	Evening	36	N/A	38
	Night	<30	35	35
NC3	Day	31	N/A	36
	Evening	31	N/A	36
	Night	<30	32	35
NC4	Day	33	N/A	36
	Evening	33	N/A	36
	Night	<30	33	35
NC5	Day	<30	N/A	36
	Evening	<30	N/A	36
	Night	<30	31	35
NC6	Day	<30	N/A	35
	Evening	<30	N/A	35
	Night	<30	<30	35
NC7	Day	<30	N/A	35
	Evening	<30	N/A	35
	Night	<30	<30	35
NC8	Day	<30	N/A	35
	Evening	<30	N/A	35
	Night	<30	<30	35
NC9	Day	<30	N/A	35
	Evening	<30	N/A	35
	Night	<30	<30	35

Note 1: Day period is 7am to 6pm, evening is 6pm to 10pm, night period is 10pm to 7am.

Note 2: Based on inversion meteorological conditions.

6.2 Sleep Disturbance Results

In assessing sleep disturbance, typical L_{Amax} noise levels from transient noise events such as metallic impact noise from the mine were assessed to the nearest residential receivers. The use of the L_{Amax} noise level provides a worst-case prediction since the $L_{A1(1minute)}$ noise level of a noise event is likely to be less than the L_{Amax}. For the sleep disturbance assessment, a sound power level of 120dBA has been adopted and is representative of the maximum emission associated with plant impact noise sources.

Predicted noise levels from L_{Amax} events for assessed receivers are presented in **Table 13**. Results identify that sleep the disturbance criterion will be satisfied for all assessed receivers.

Table 13 Predicted Sleep Disturbance Noise Levels, dBA LAmax

Noise Catchment	Predicted LAmax noise level events, dBA[1]	Sleep Disturbance Noise Criterion LAmax, dBA
NC1	45	45
NC2	45	45
NC3	42	45
NC4	41	45
NC5	39	45
NC6	32	45
NC7	36	45
NC8	31	45
NC9	<30	45

Note1: includes assessment of noise emissions during inversion meteorological conditions.

6.3 Construction Noise Results

This assessment has quantified potential noise emissions from the proposed construction of the internal infrastructure office, store, workshop, change house, magazine and internal haul road cutting. **Table 14** provides a summary of the project noise model results for simultaneous construction fleets operating within the vicinity of the future infrastructure/buildings, the internal haul road cutting and magazine.

Table 14 Predicted Noise Levels from Construction, dBA $L_{Aeq(15min)}$

Noise Catchment	Worst Case Construction Predictions	NML
NC1	38	40
NC2	37	40
NC3	37	40
NC4	34	40
NC5	33	40
NC6	<30	40
NC7	<30	40
NC8	<30	40
NC9	<30	40

6.4 Traffic Noise Results

The United States (US) Environment Protection Agency's road traffic calculation method was used to predict the LAeq noise levels from site trucks travelling past receivers along public roads. This method is an internationally accepted theoretical traffic noise prediction model and is ideal for calculating road traffic noise where relatively small traffic flows are encountered.

The majority of truck movements from the project would be to and from the south west, via Argent Street, towards the South Mine where ore will use their existing processing facilities. For this assessment, the maximum proposed daily truck movements associated with ore dispatch from the mine of 48 movements per day was adopted. The road noise calculations assume that all trucks travel along Argent Street to and from the south west. The results of the traffic noise calculations are presented in **Table 15** and demonstrate the noise levels from mine road trucks would remain below the relevant day criteria for receivers at a distance of 15m from the roadway and also satisfy the relevant increase criteria.

Table 15 Operational Road Traffic Noise Levels

Distance to Nearest Receiver(m)	Measured existing road traffic noise	Predicted Site Noise Contribution	Existing + Future Quarry Combined Total	Assessment Criteria
		Day $LA_{eq(15hr)}$, dBA		
15	49.5	45.2[1]	50.9	60

Note 1: Calculated value assuming 48 truck movements per day.

6.5 Blasting Results

Blast overpressure and vibration results have been calculated using the method given in the AS2187-2: Explosives – Storage and use Part 2: Use of explosives, 2006 and ICI Explosives Blasting Guide, as applicable to blasting in hard rock. This formula has been shown to be conservative in calculating overpressure and vibration.

The relevant formulae are as follows:

$PVS = 5000 (R/Q^{0.5})^{-1.6}$

$dB = 164.2 - 24(\log_{10} R - 0.33 \log_{10} Q)$

Where,

PVS = peak vector sum ground vibration level (mm/s)

dB = peak airblast level (dB Linear)

R = distance between charge and receptor (m)

Q = charge mass per delay (kg) or maximum instantaneous charge (MIC)

Future blasting is proposed to occur from Level 12 to Level 26 when the project recommences at a minimum depth of 404m below shaft Number 1. The diagonal distance from Level 12 to the nearest Catchment (NC1) is 890 metres. **Table 16** provides the calculated blast MICs for the minimum offset distances where blasting may occur within Level 12 of the No 1 Shaft.

Table 16 Blast Overpressure and Vibration Results

Approximate minimum distance from future blast areas to receivers (m)	Derived overpressure (dB(L)peak)	Derived vibration PPV (mm/s)	MIC (kg)
890	N/A	4.5	120

The conservatively predicted blast overpressure and vibration levels identify that a maximum MIC of up to 120kg would comply with relevant ANZECC criteria at overall distances of greater than 890m. Notwithstanding, the proposed MIC blast patterns should be designed specifically to meet the relevant ANZECC guidelines at receivers and be completed in conjunction with an appropriate blast monitoring program. These programs are already in place at the neighbouring Southern Operations that has shown a historic demonstrated track record of compliance with respect to ground vibration.

7 Conclusion

MAC has conducted a NIA of potential impacts from the recommencement of mining operations at the Broken Hill North Mine, located on the Line of Lode, Broken Hill, NSW.

The assessment has quantified potential operational noise emissions pertaining to extraction, crushing, and transportation. The results of the NIA demonstrate that worst case operational noise levels comply with the relevant INP criteria for all assessment periods during calm and prevailing meteorological conditions.

Furthermore, sleep disturbance is not anticipated, as emissions from impact noise are predicted to remain below the EPA screening criterion for sleep disturbance.

Results identify that noise levels from the proposed construction works at the mine are demonstrated to satisfy the standard hours construction NML at all assessed receivers.

Off-site road noise emissions from product transport are predicted to satisfy relevant day road noise criteria and relative increase criteria specified in the RNP.

Underground blasting is anticipated to be managed in a manner that is consistent with existing Southern Operations strategies that are designed to minimise blast vibration impacts on the surrounding community.

Appendix A – Glossary of Terms

A number of technical terms have been used in this report and are explained in Table A1.

Table A1 Glossary of Terms

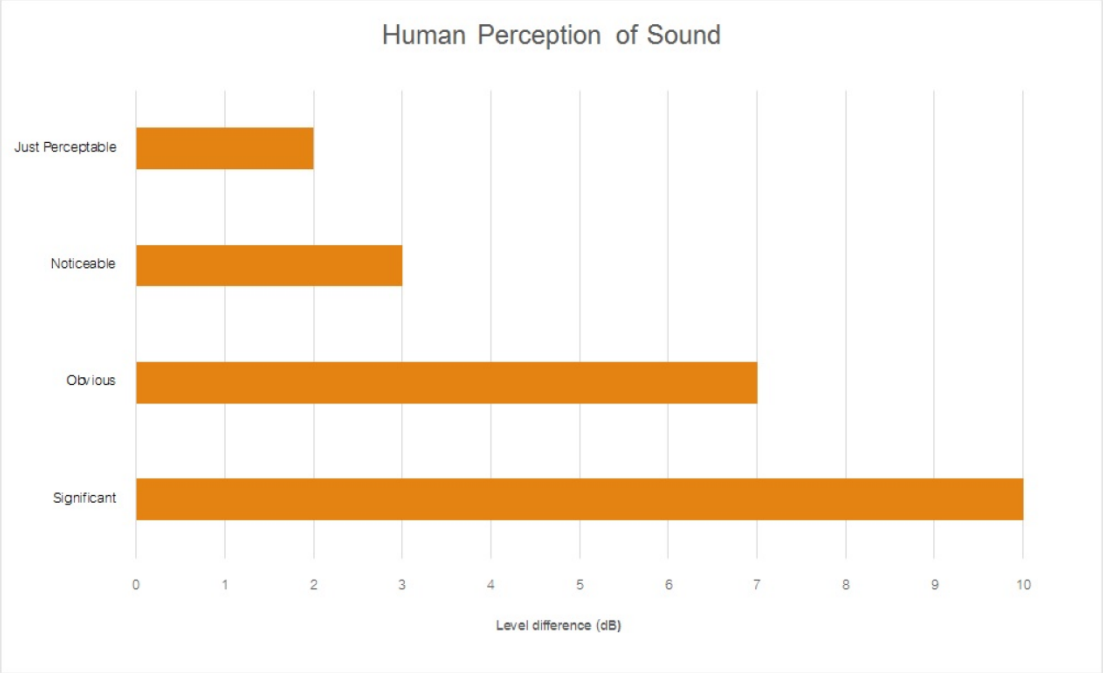
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by : = 10.log10 (W/Wo) Where : W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

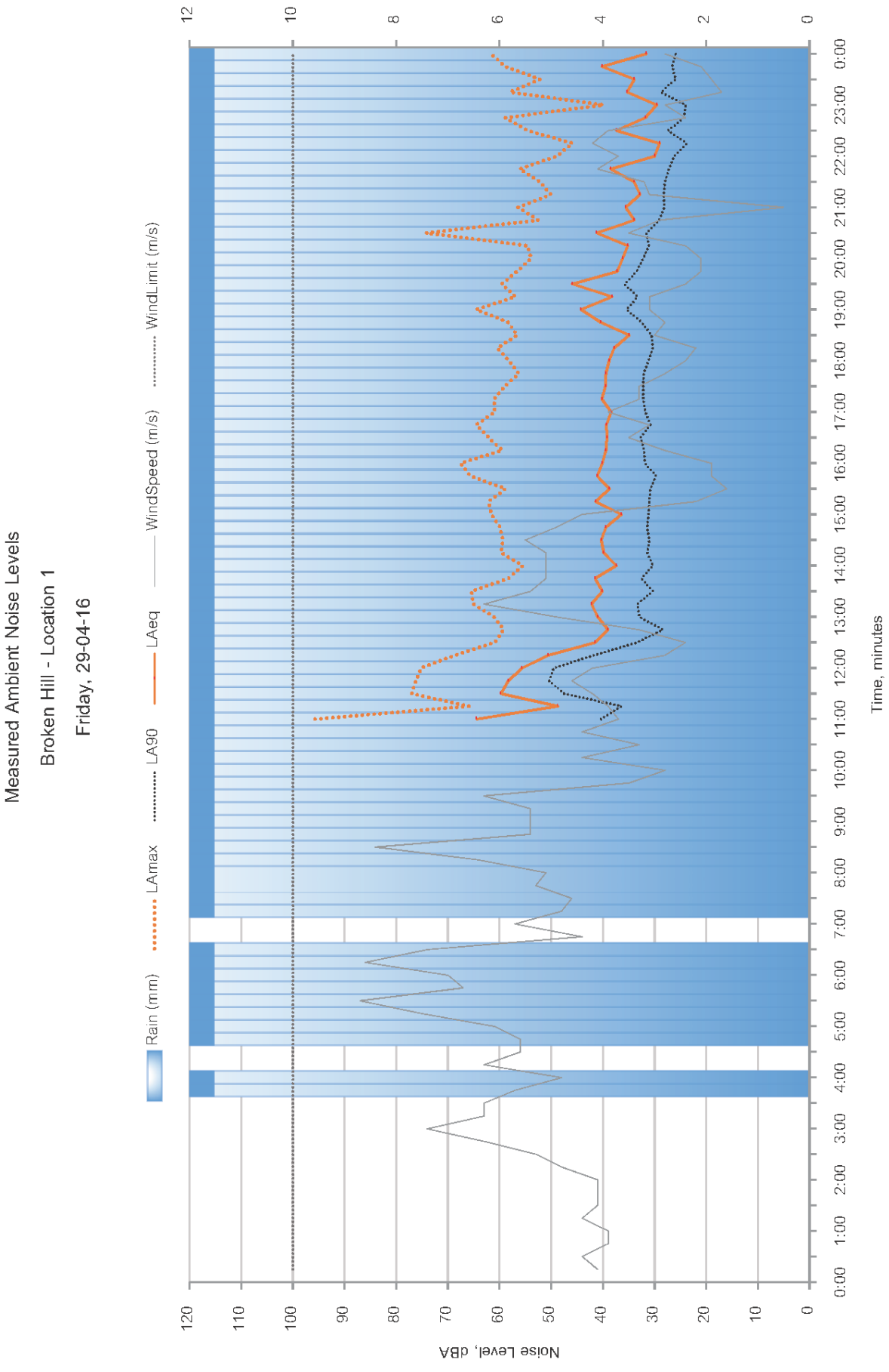
Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

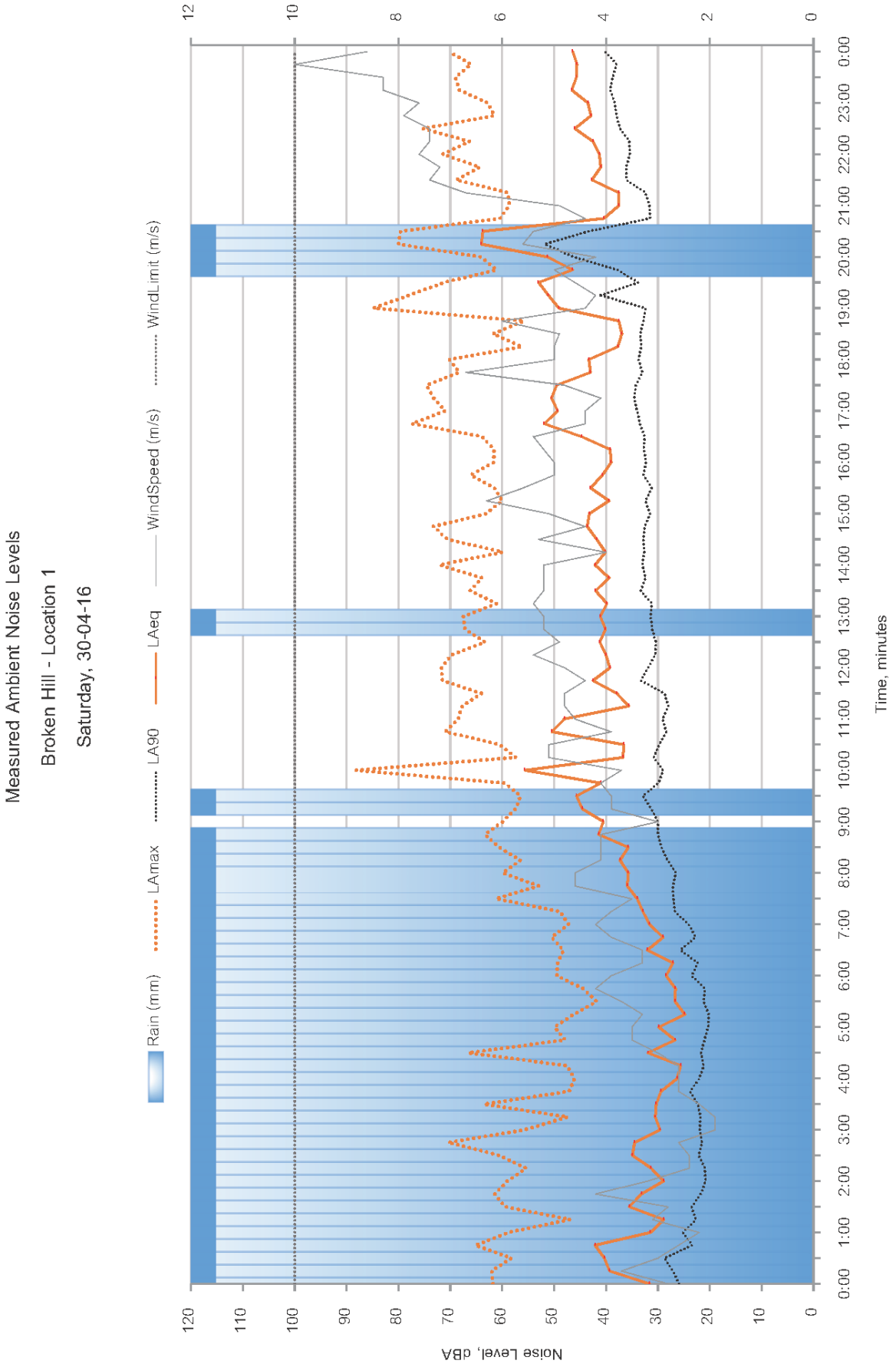
Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

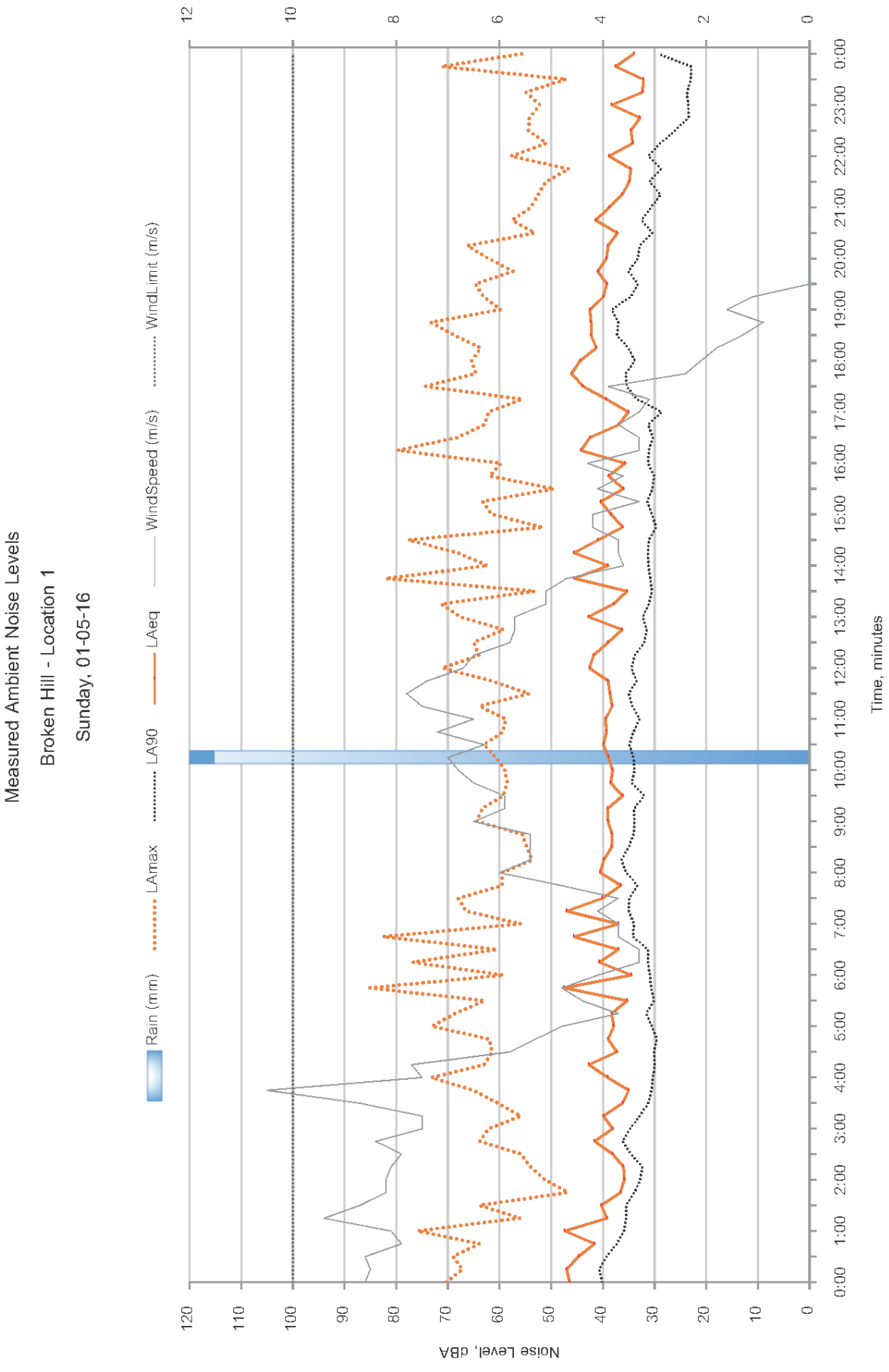
Figure A1 – Human Perception of Sound



Appendix B – Unattended Noise Logging Charts


Measured Ambient Noise Levels
Broken Hill - Location 1
Friday, 29-04-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 1
Saturday, 30-04-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 1
Sunday, 01-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
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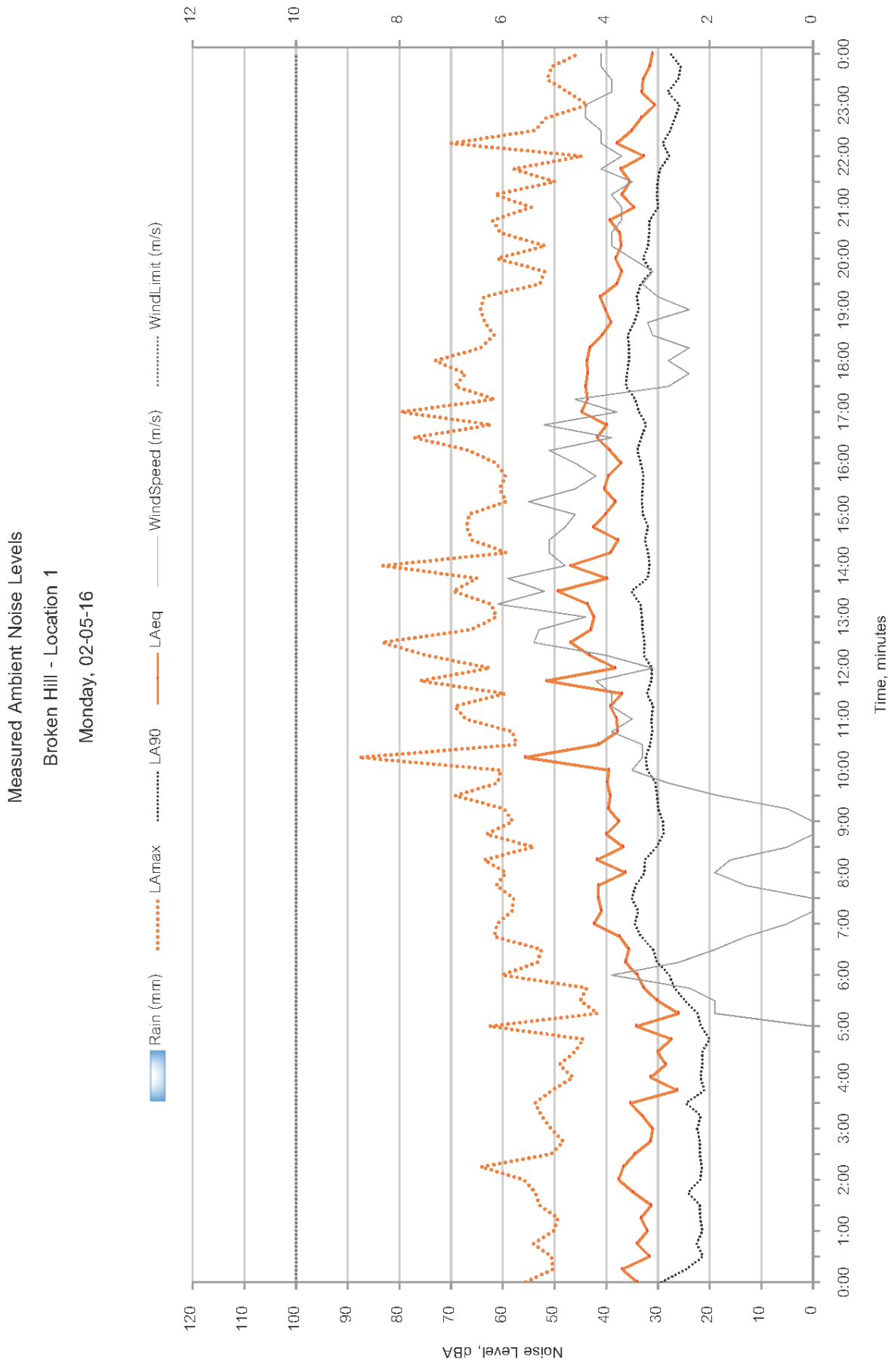
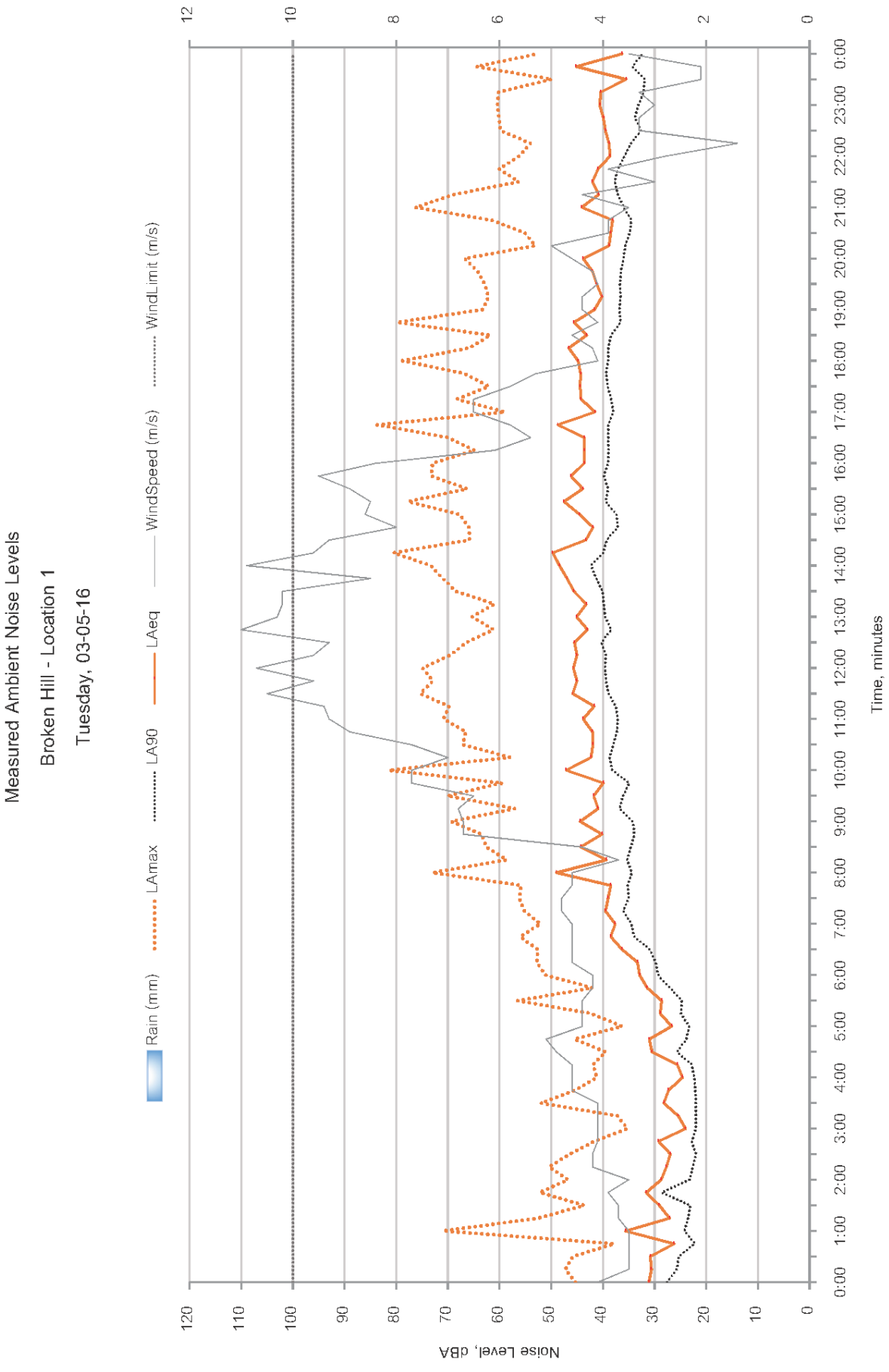
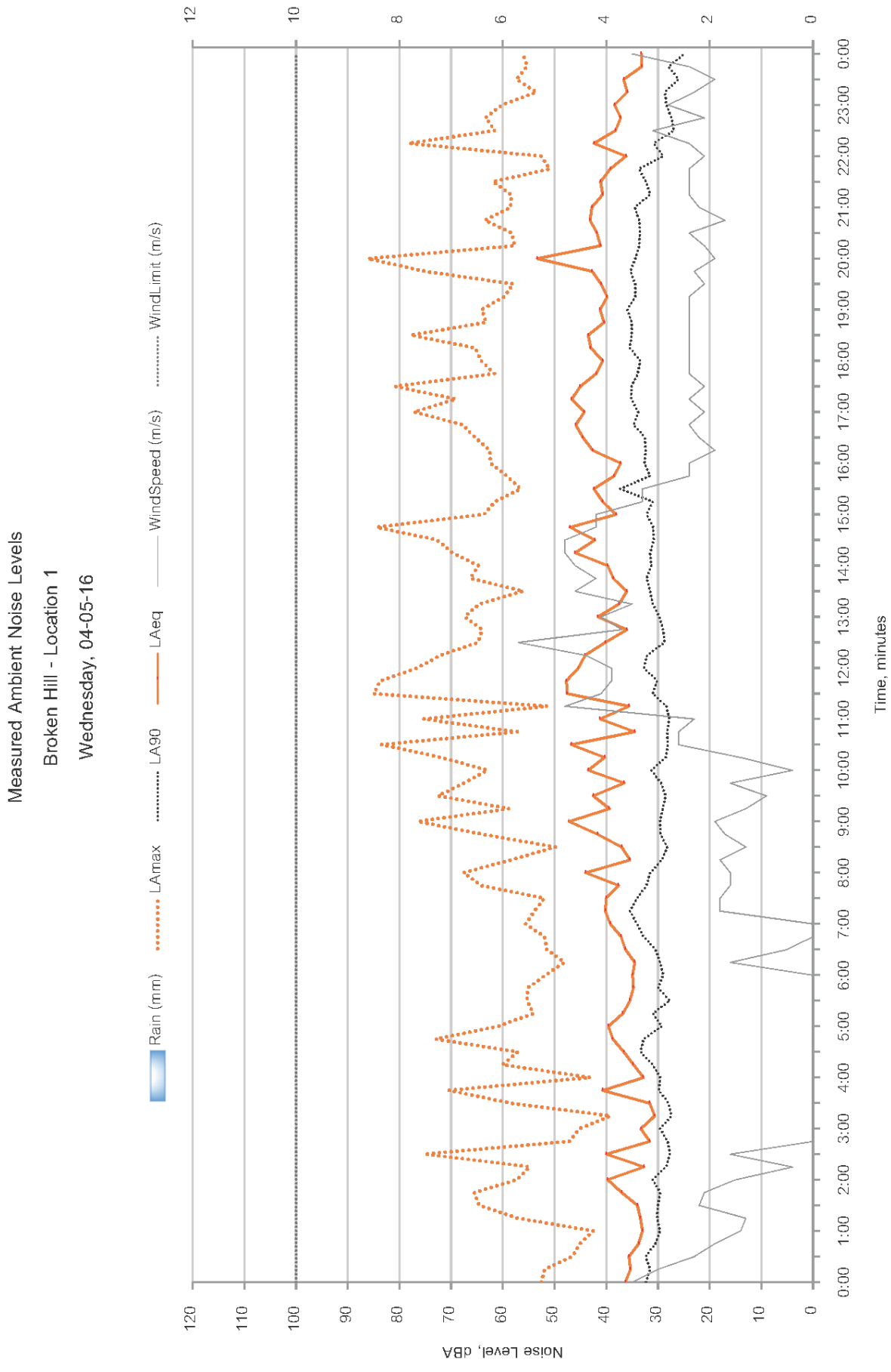
19:00
20:00
21:00
22:00
23:00
0:00


Measured Ambient Noise Levels
Broken Hill - Location 1
Monday, 02-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 1
Tuesday, 03-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
6
4
2
0


Measured Ambient Noise Levels
Broken Hill - Location 1
Wednesday, 04-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
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23:00
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120
110
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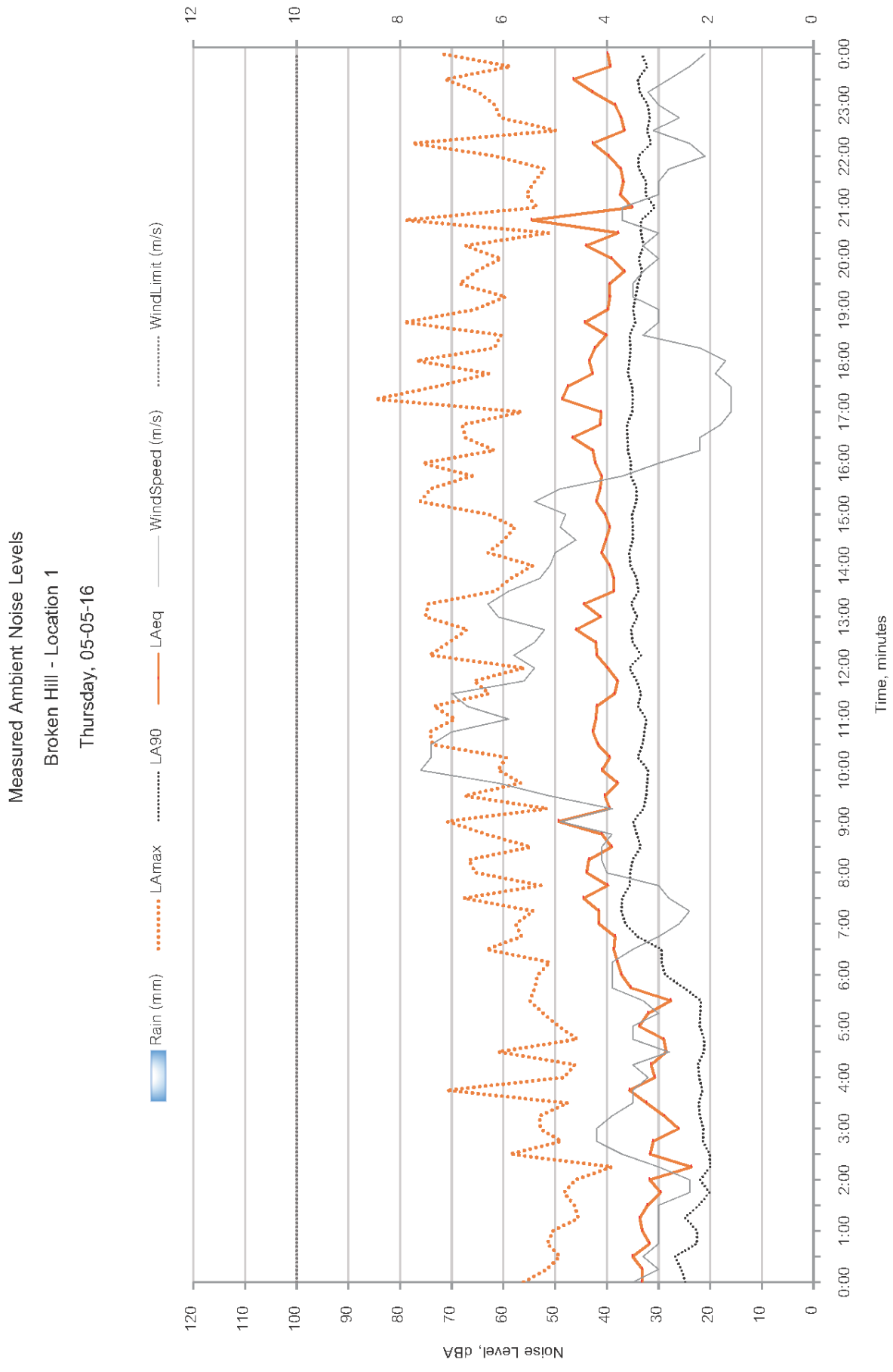
Measured Ambient Noise Levels
Broken Hill - Location 1
Thursday, 05-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
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20:00
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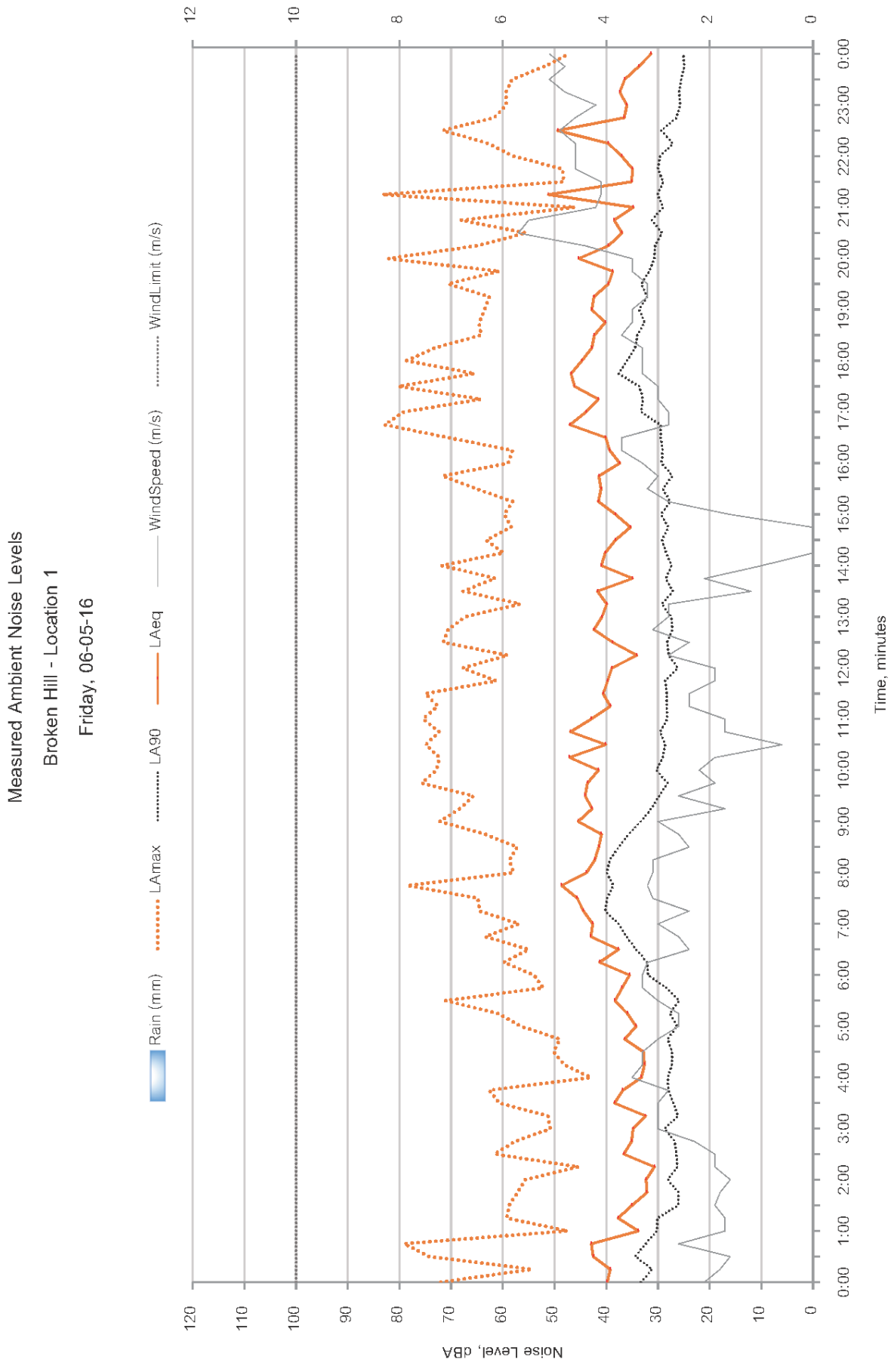
Measured Ambient Noise Levels
Broken Hill - Location 1
Friday, 06-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
6
4
2
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0:00
1:00
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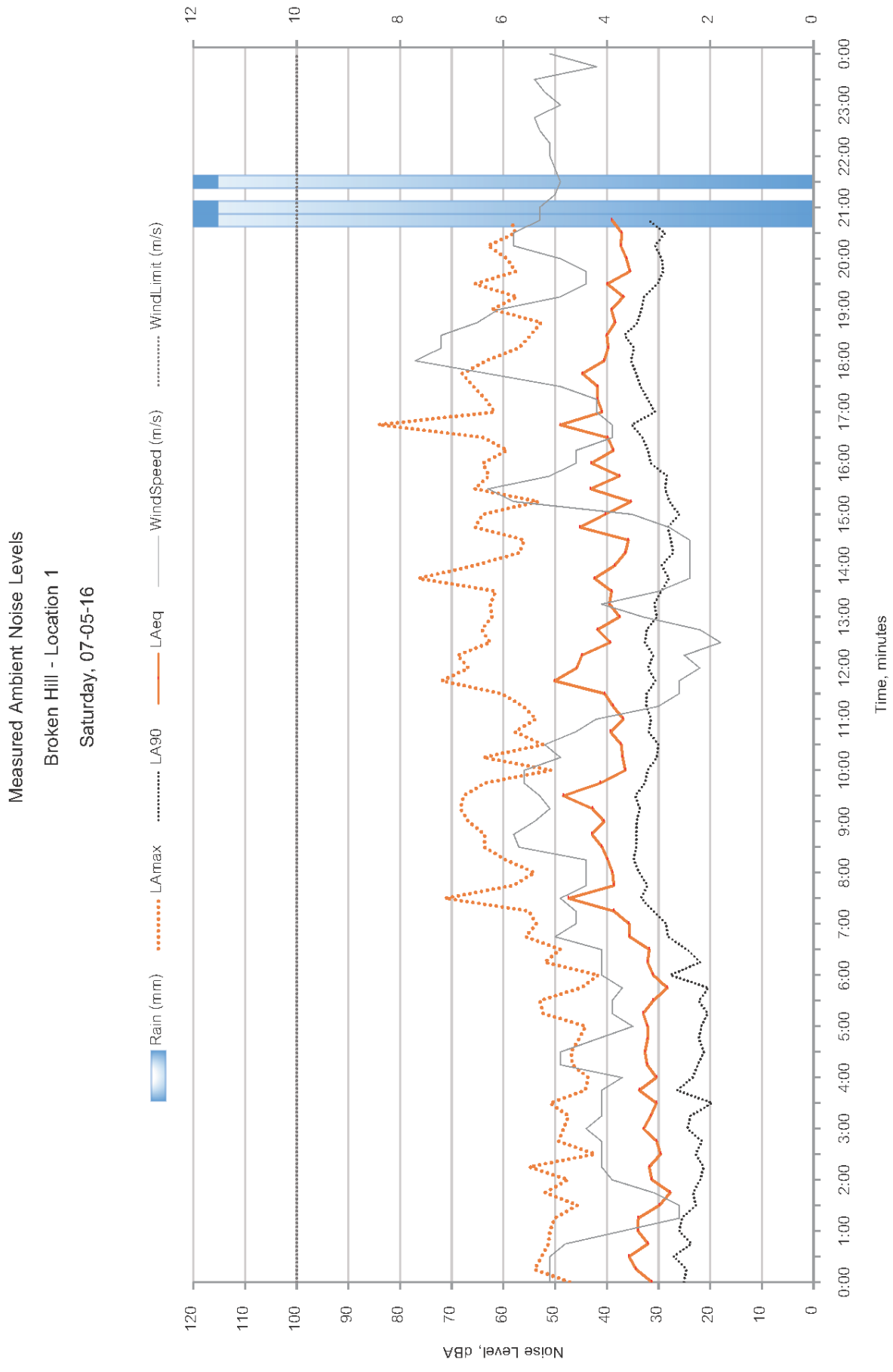
20:00
21:00
22:00
23:00
0:00


Measured Ambient Noise Levels
Broken Hill - Location 1
Saturday, 07-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
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20:00
21:00
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23:00
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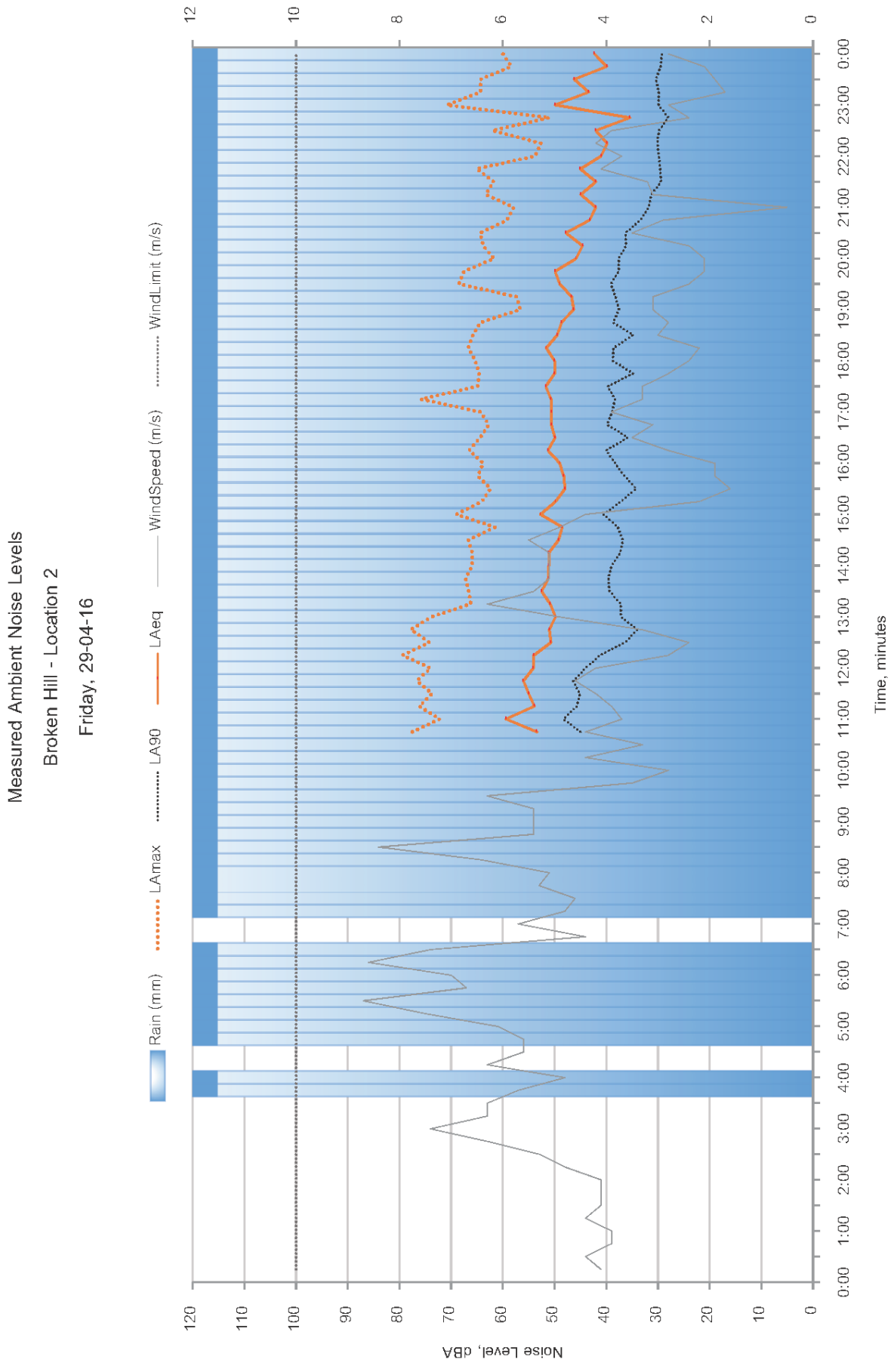
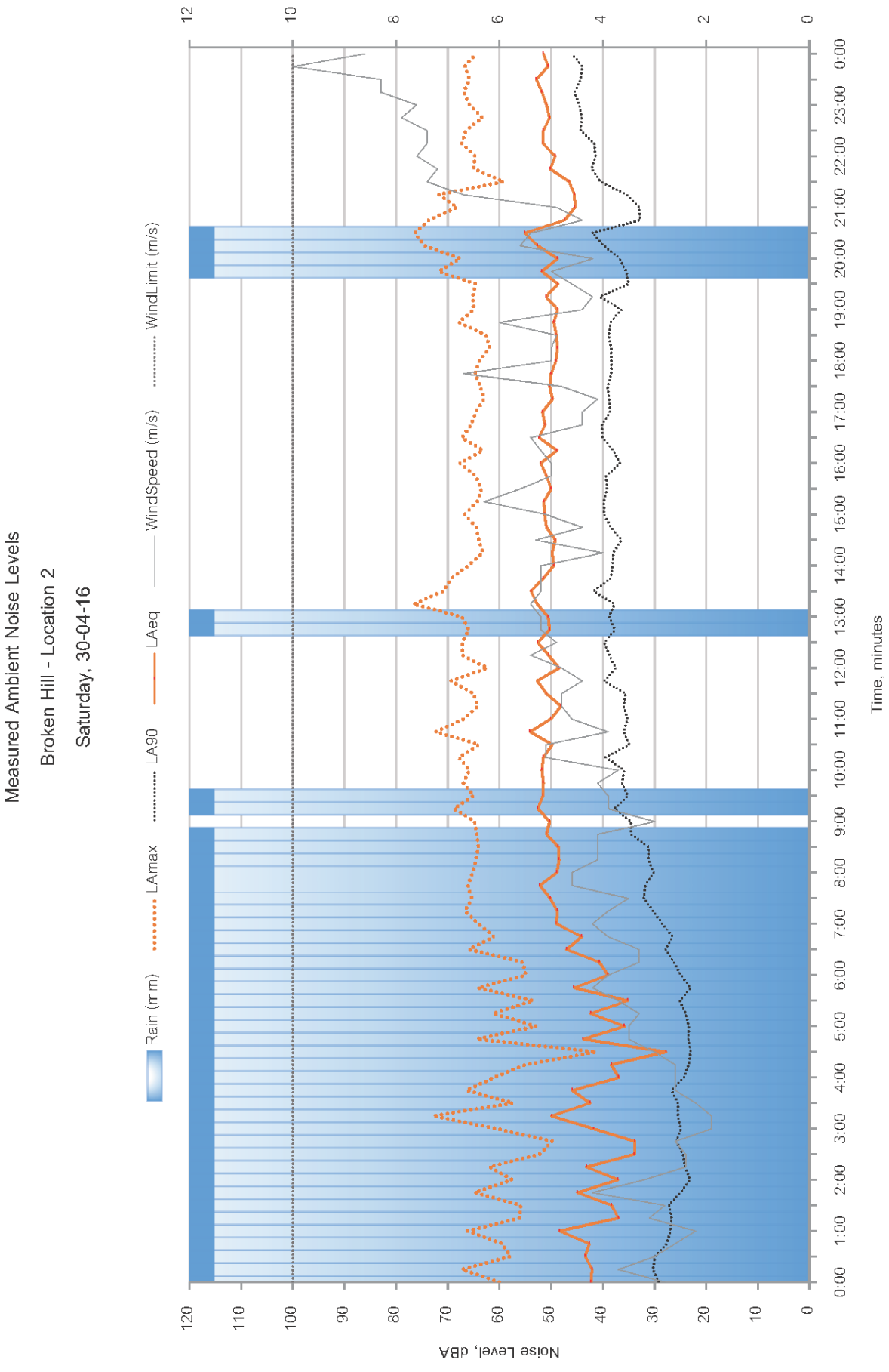
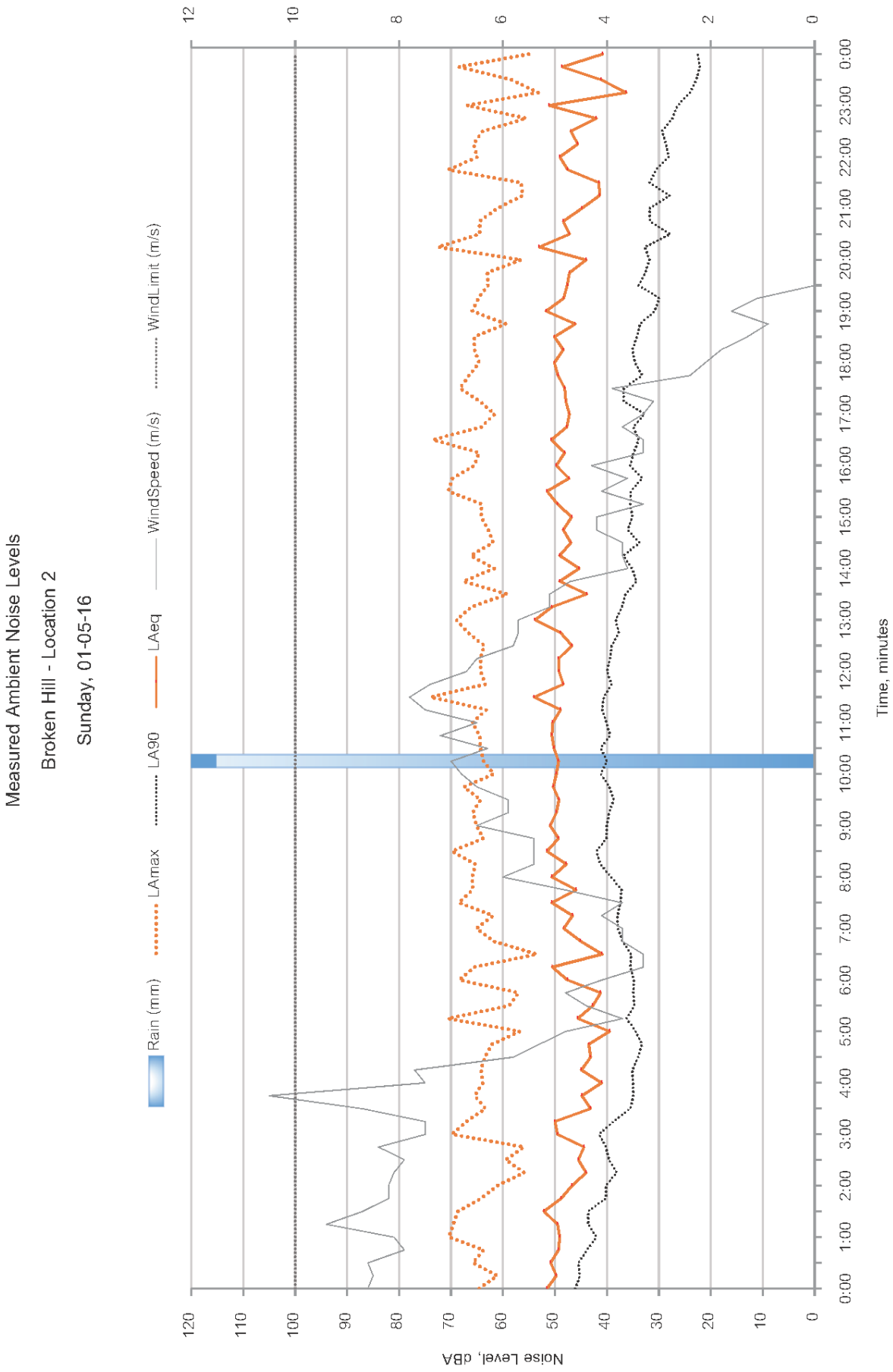
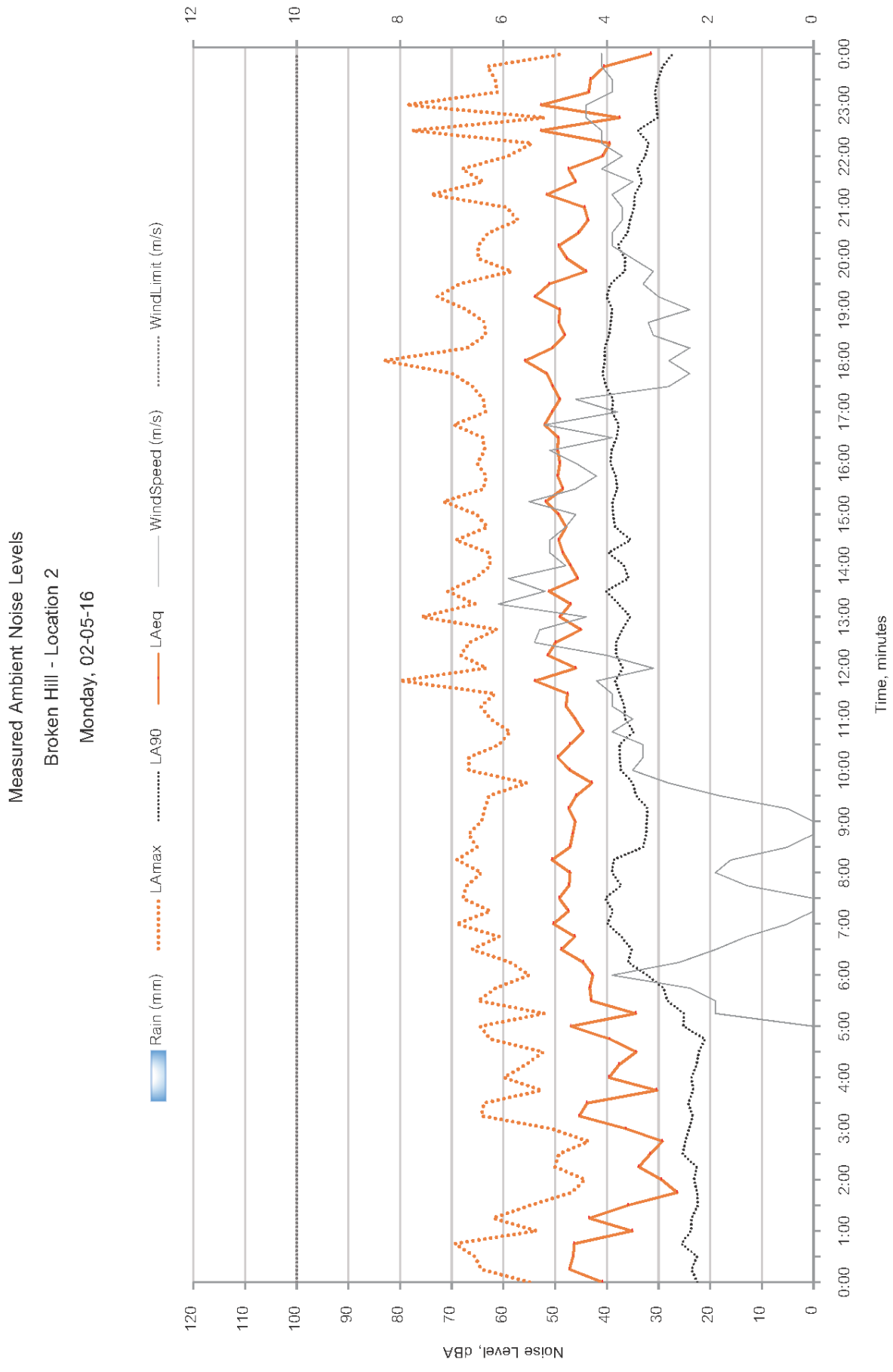

Measured Ambient Noise Levels
Broken Hill - Location 2
Friday, 29-04-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 2
Saturday, 30-04-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 2
Sunday, 01-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 2
Monday, 02-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
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7:00
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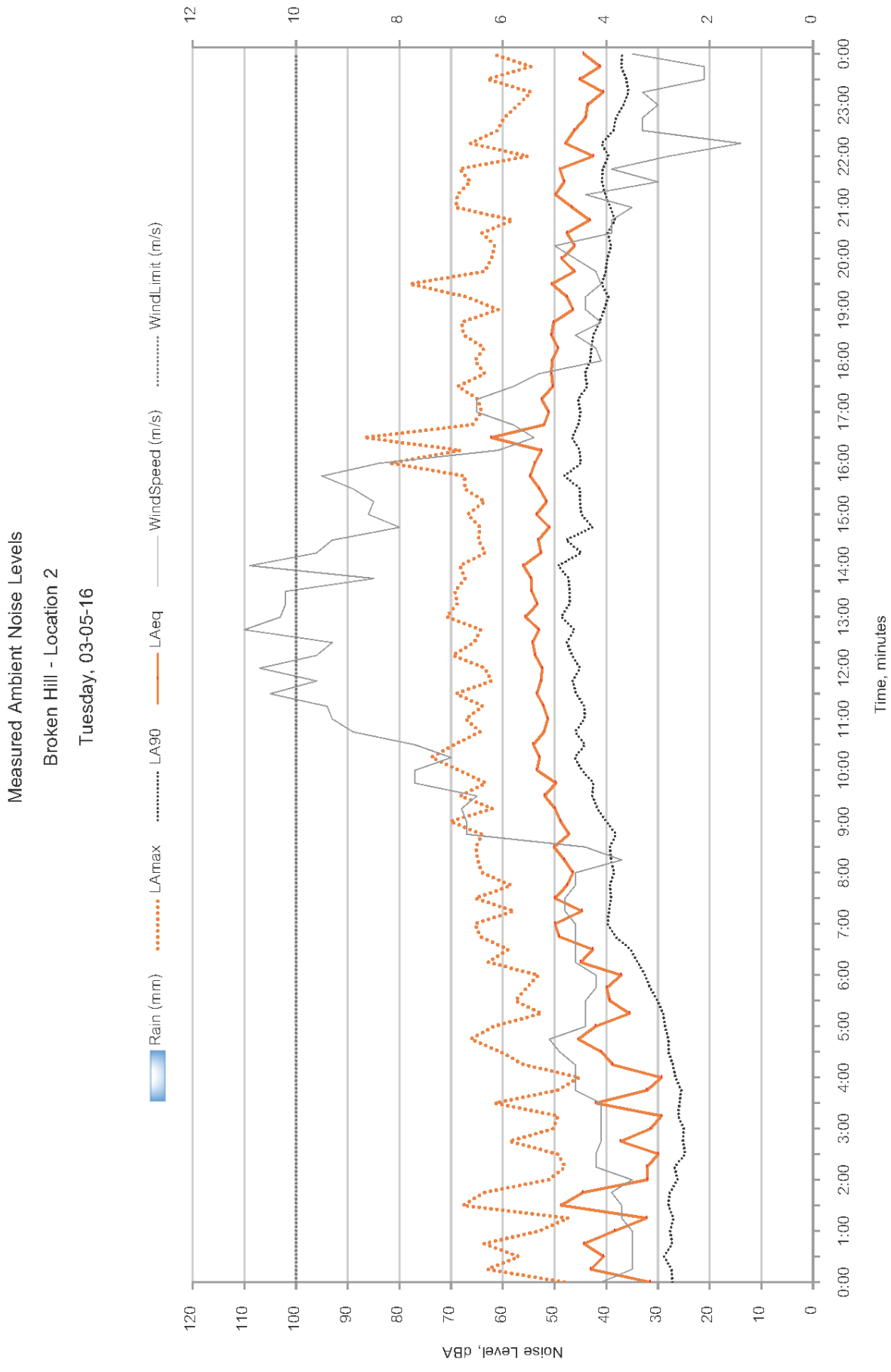
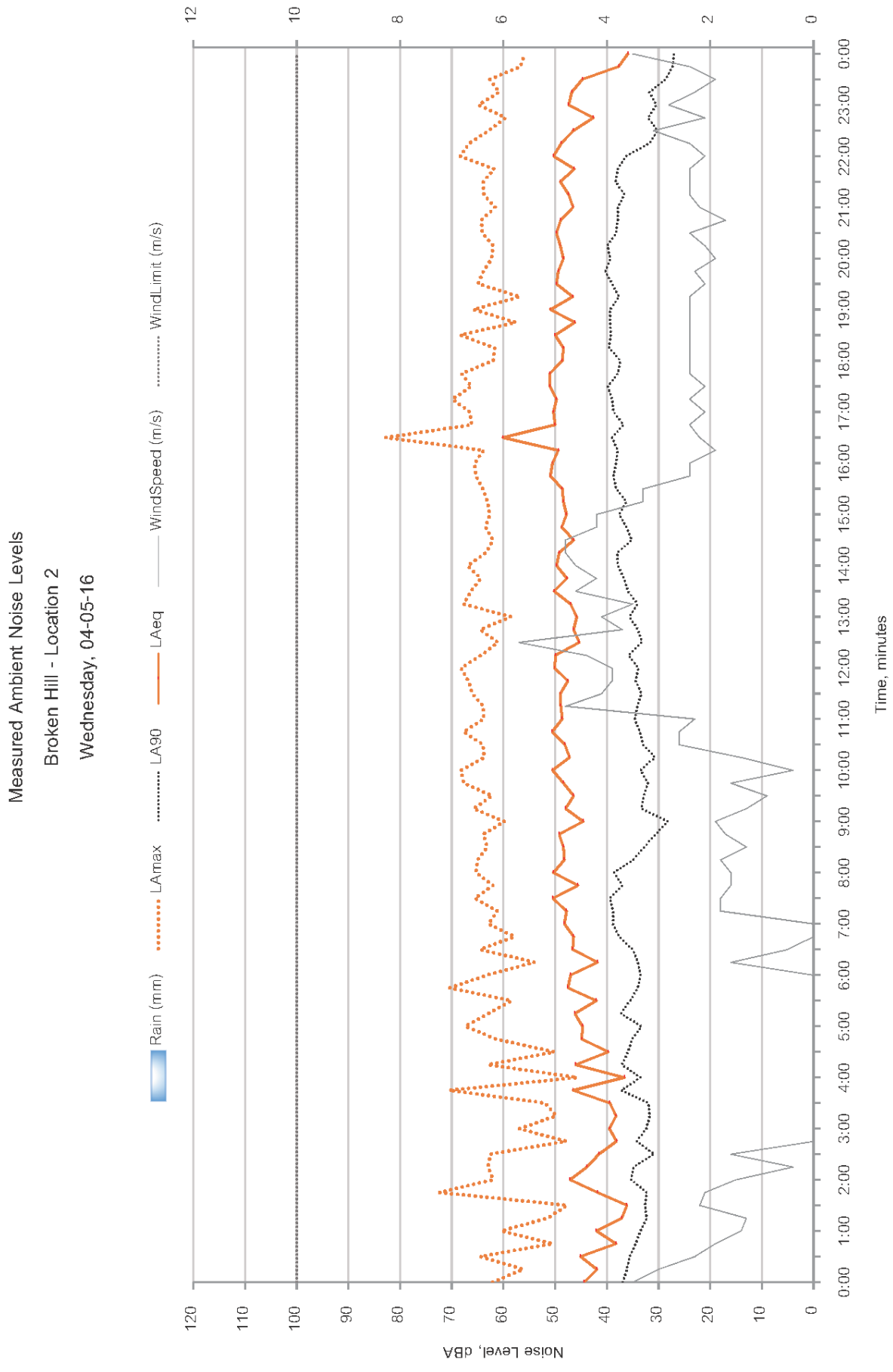

Measured Ambient Noise Levels
Broken Hill - Location 2
Tuesday, 03-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 2
Wednesday, 04-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
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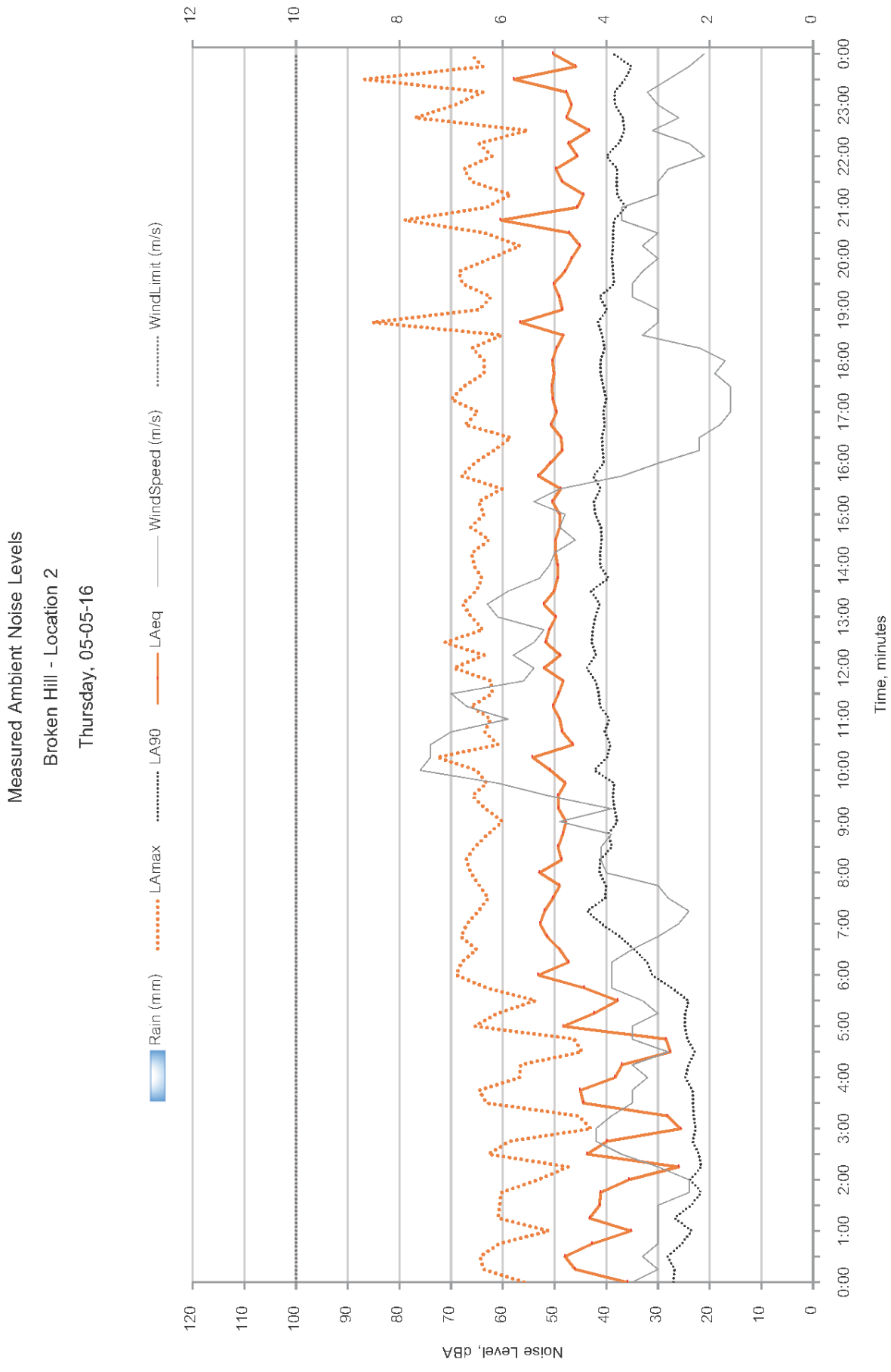
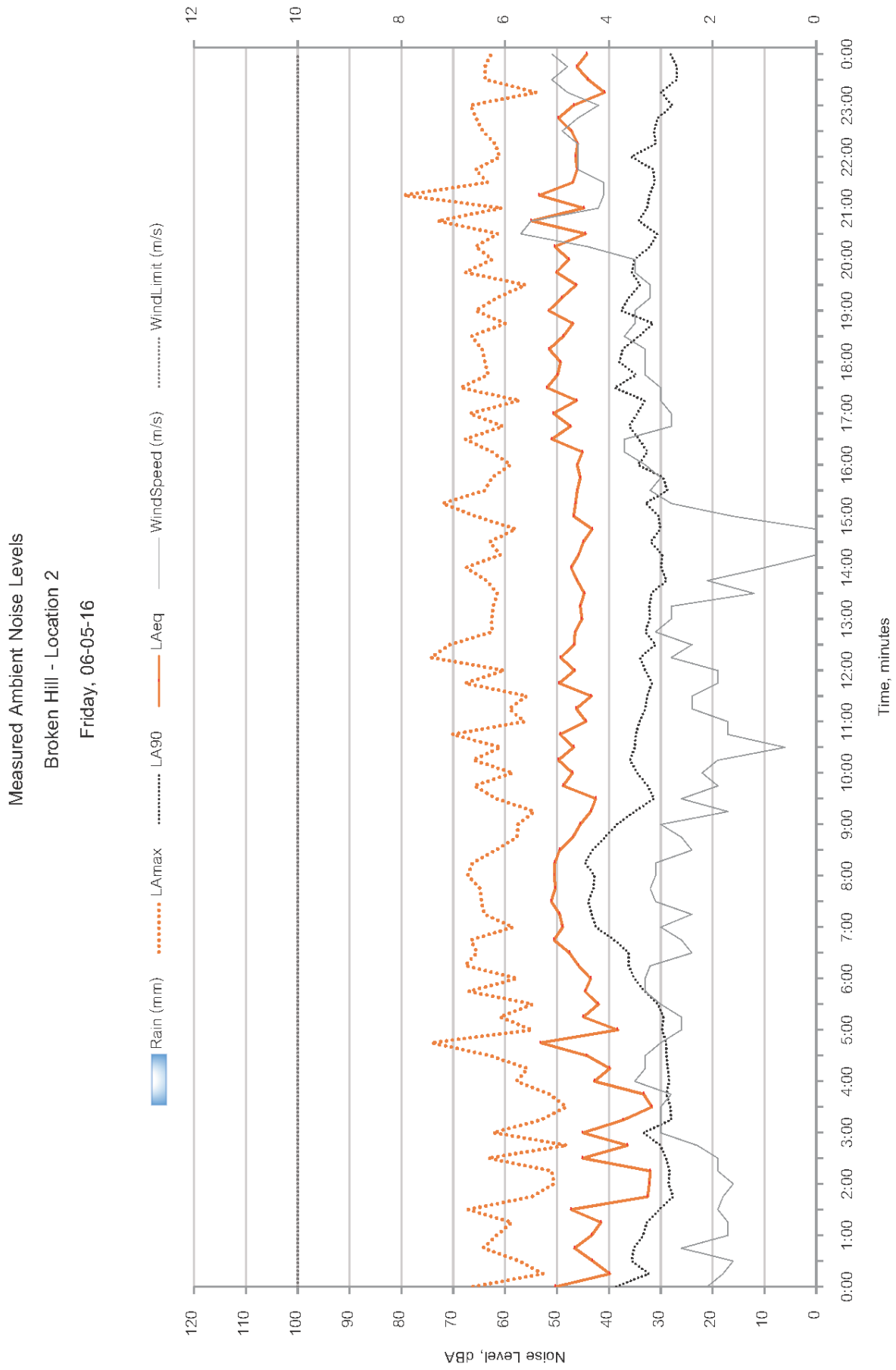

Measured Ambient Noise Levels
Broken Hill - Location 2
Thursday, 05-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 2
Friday, 06-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
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11:00
12:00
13:00
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20:00
21:00
22:00
23:00
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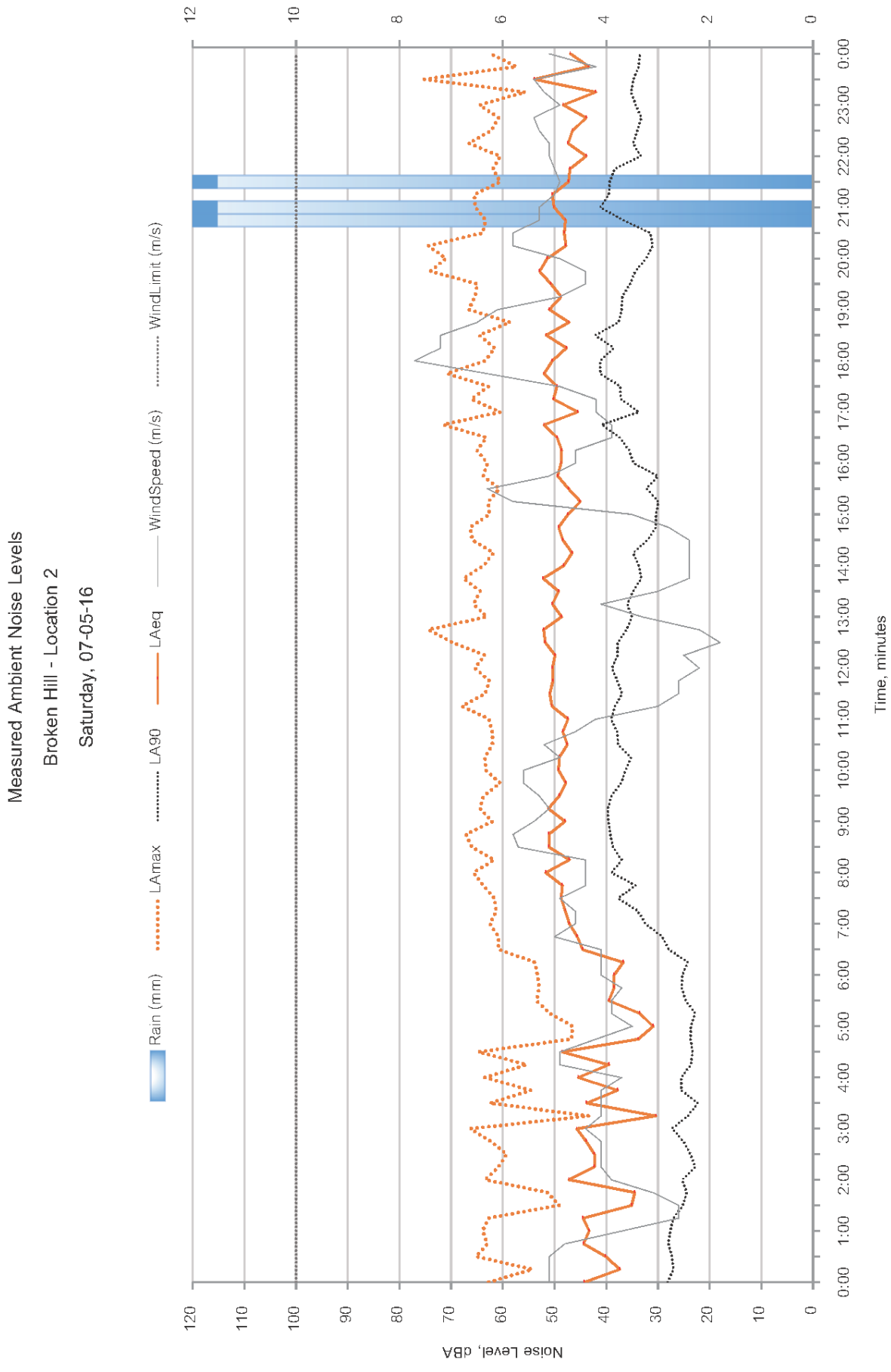
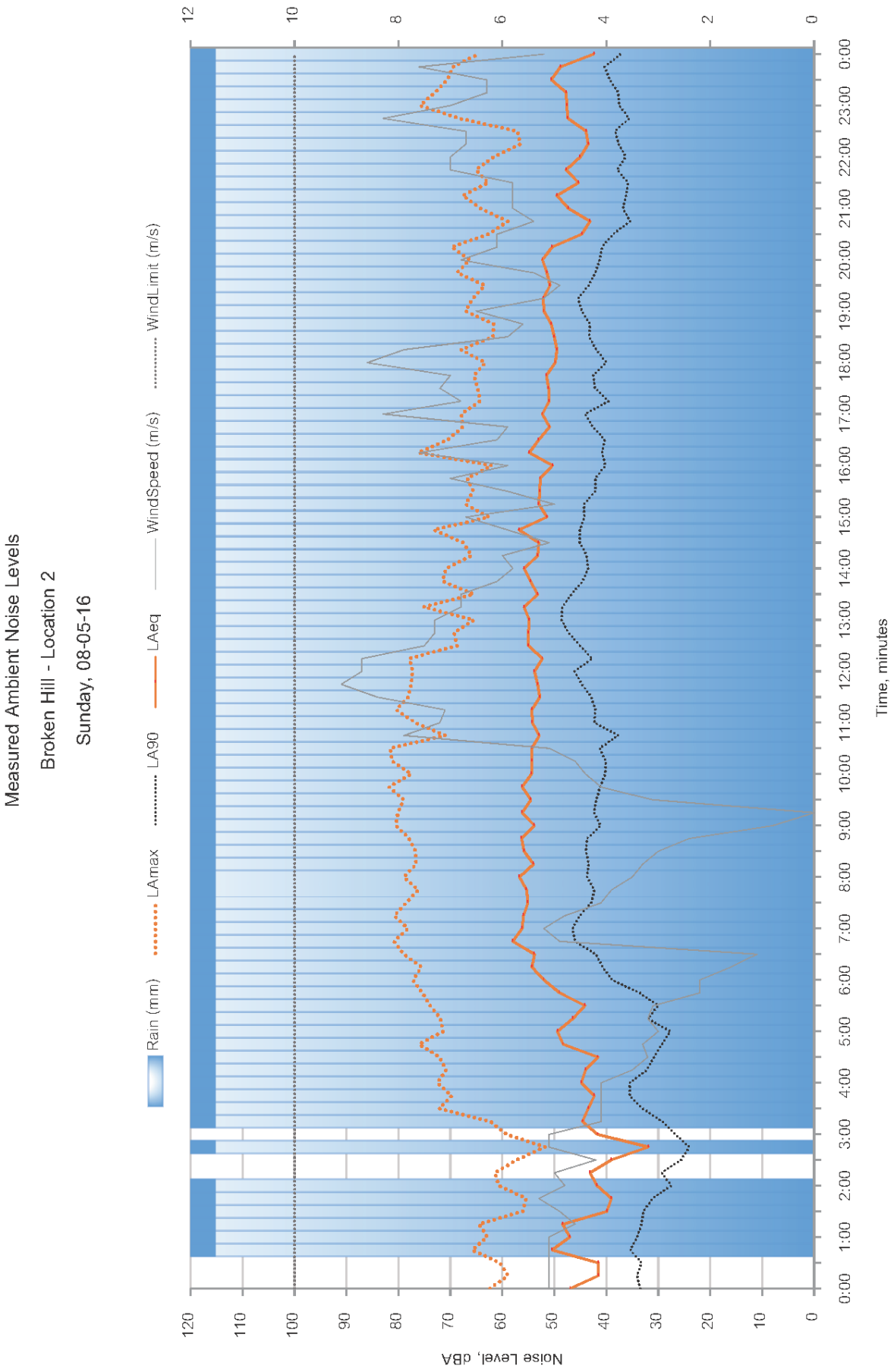

Measured Ambient Noise Levels
Broken Hill - Location 2
Saturday, 07-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 2
Sunday, 08-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
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2
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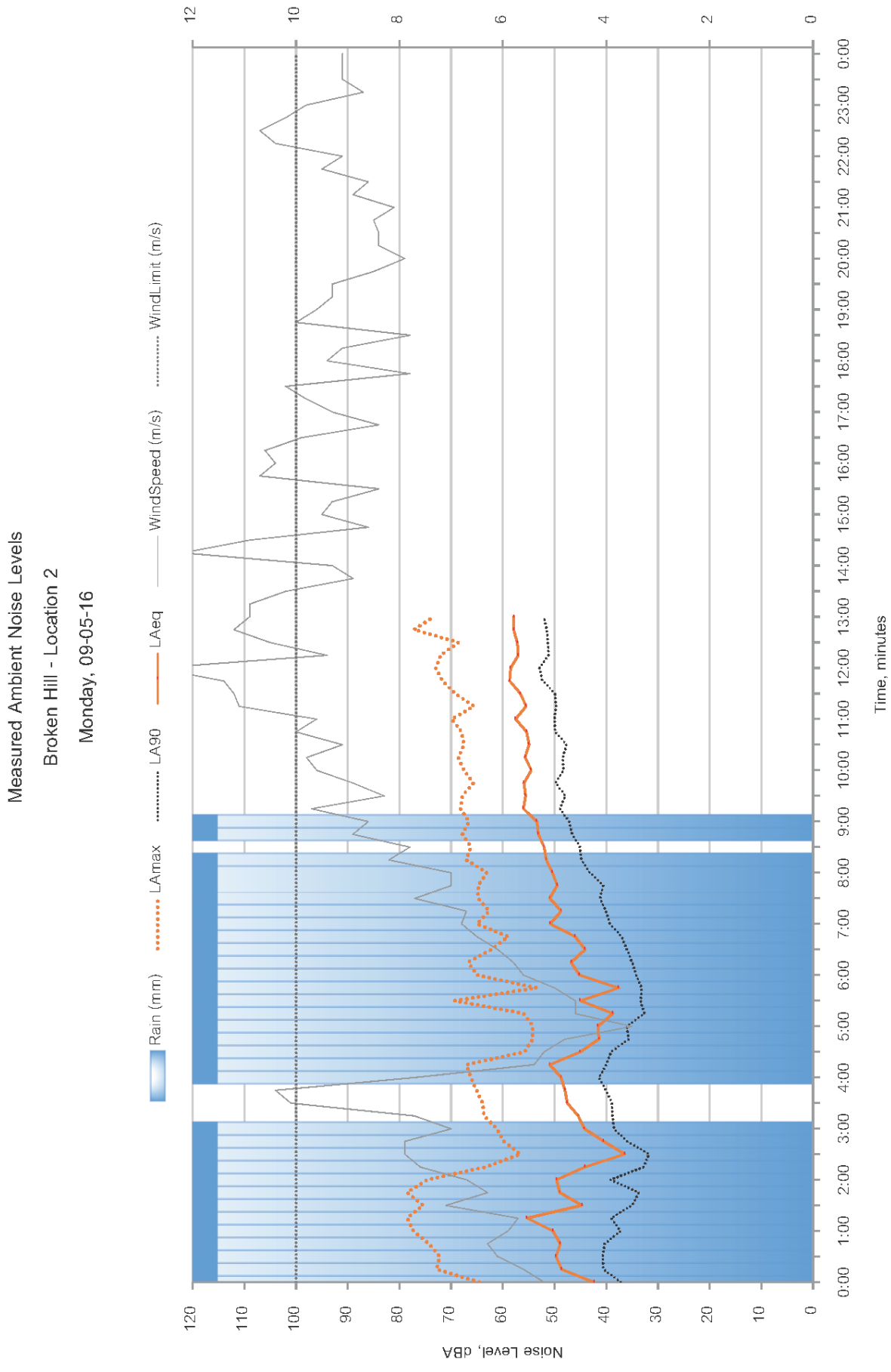
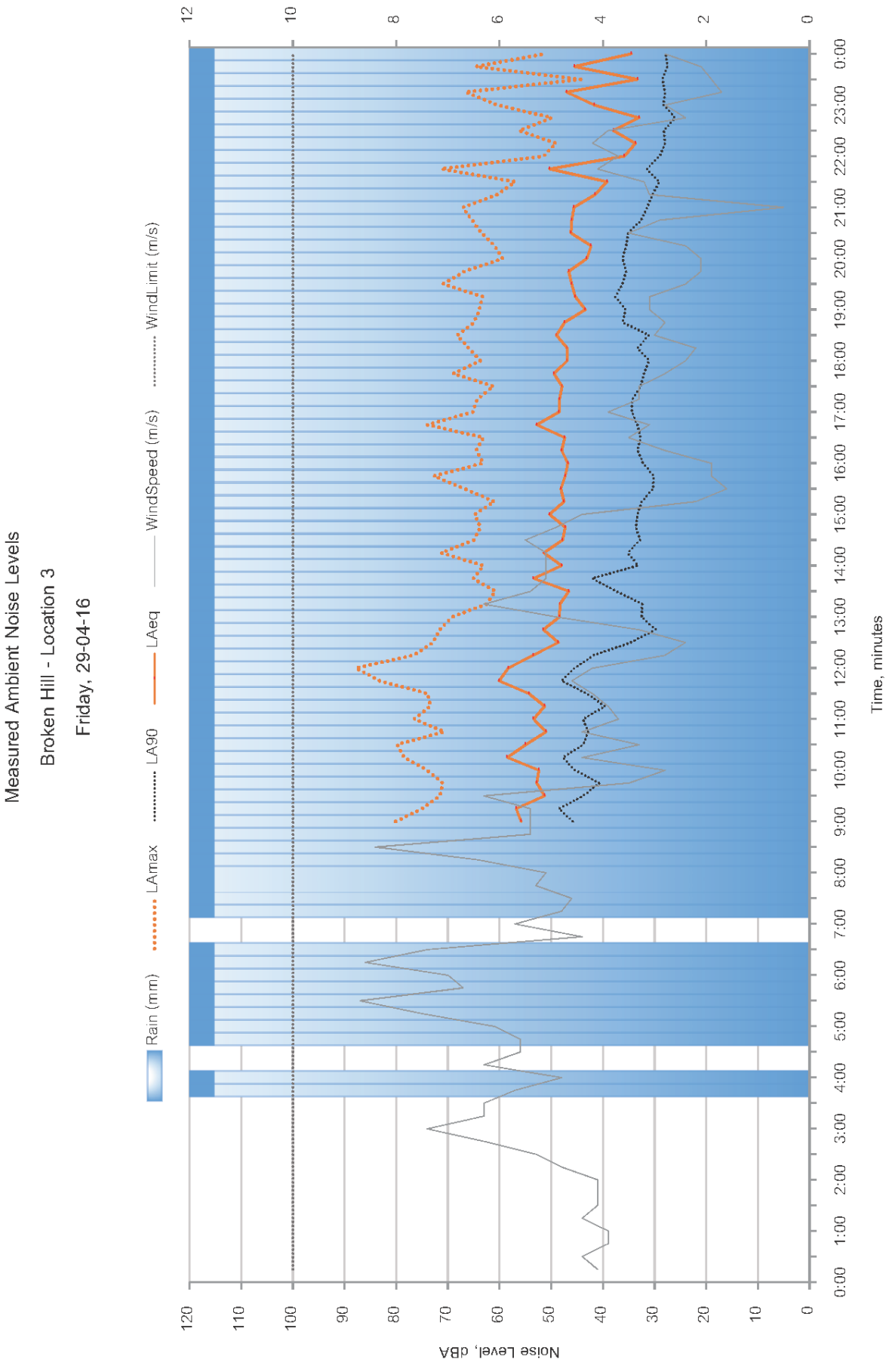
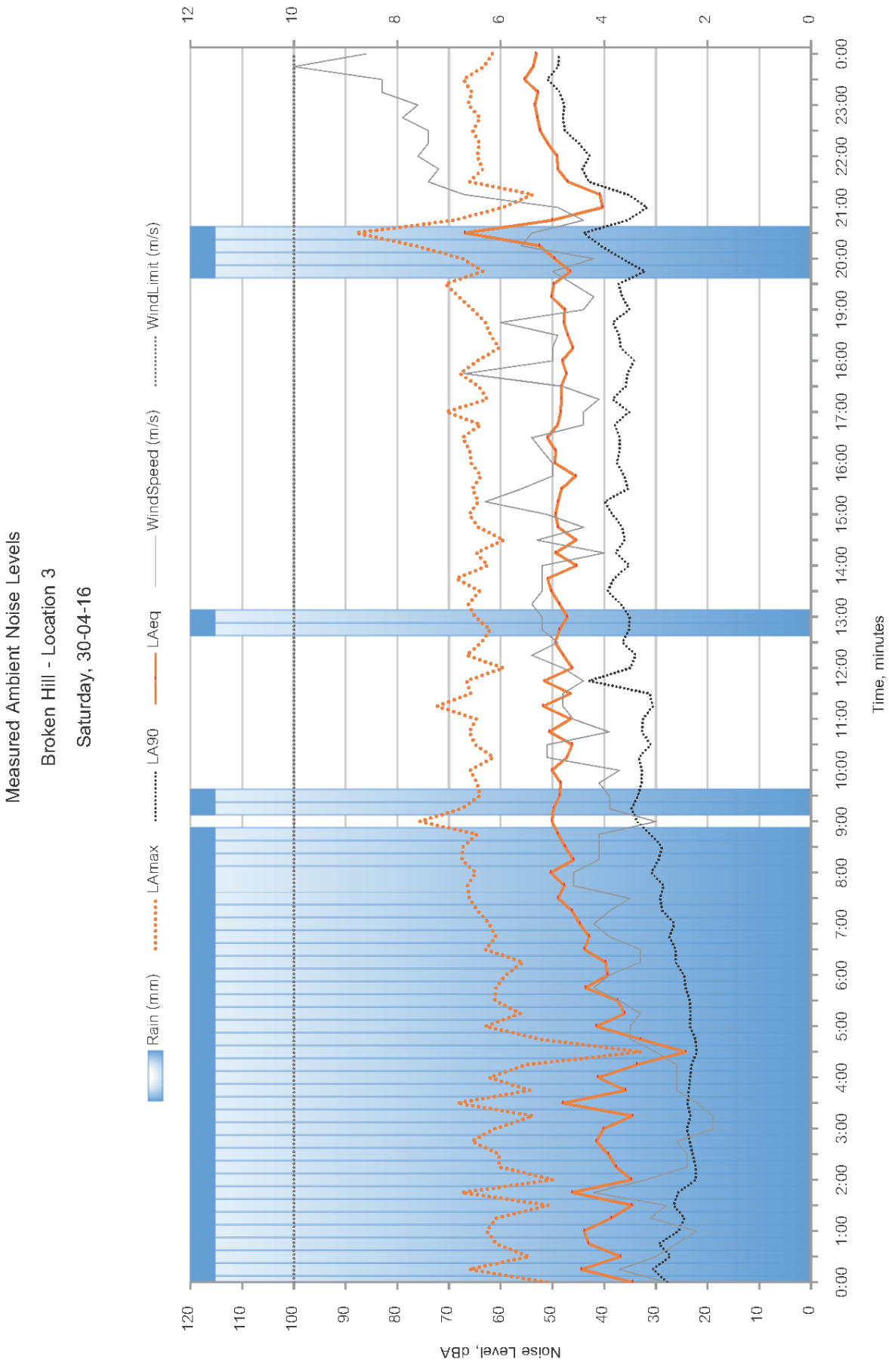
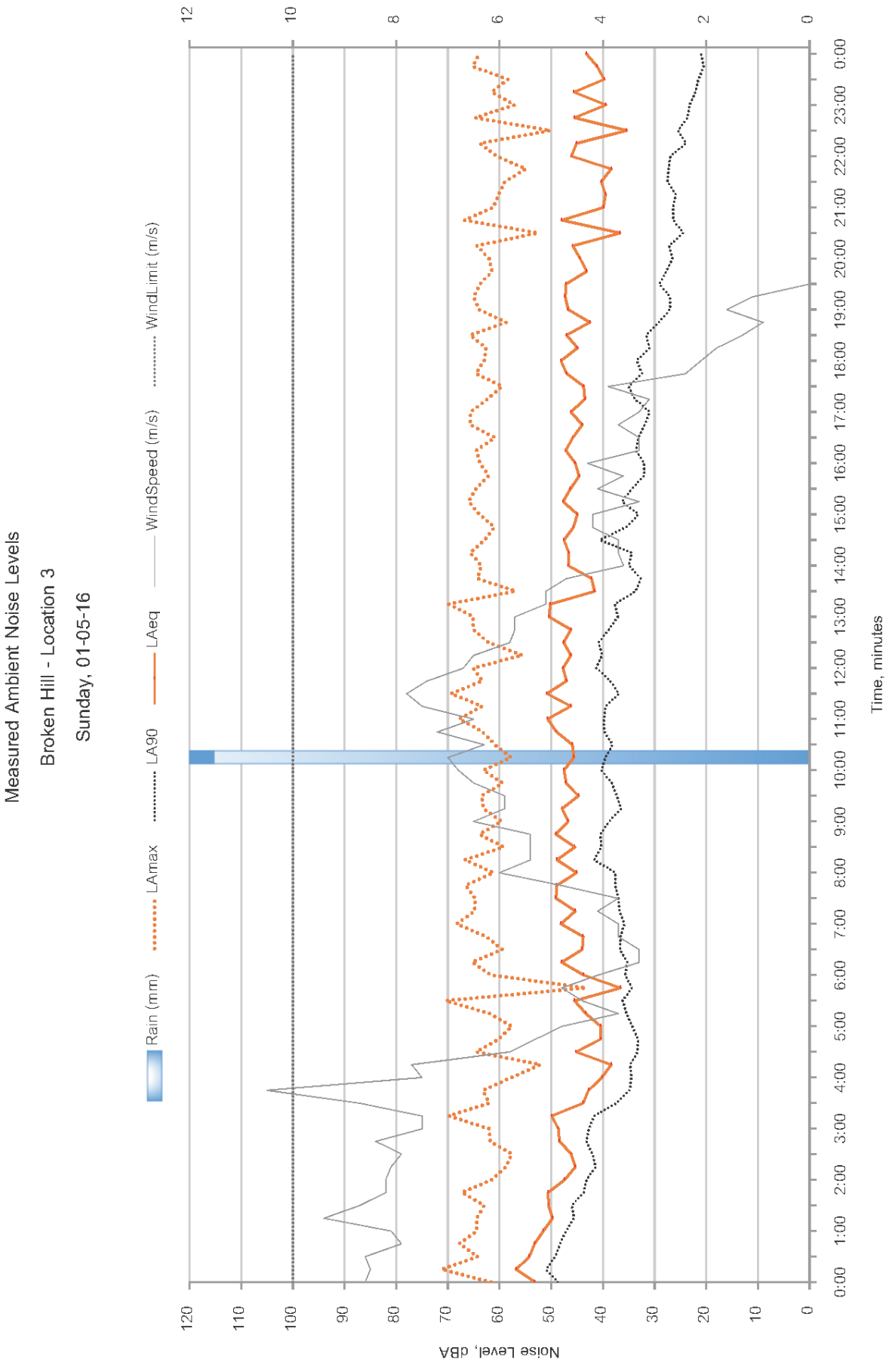

Measured Ambient Noise Levels
Broken Hill - Location 2
Monday, 09-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 3
Friday, 29-04-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 3
Saturday, 30-04-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 3
Sunday, 01-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
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0
12
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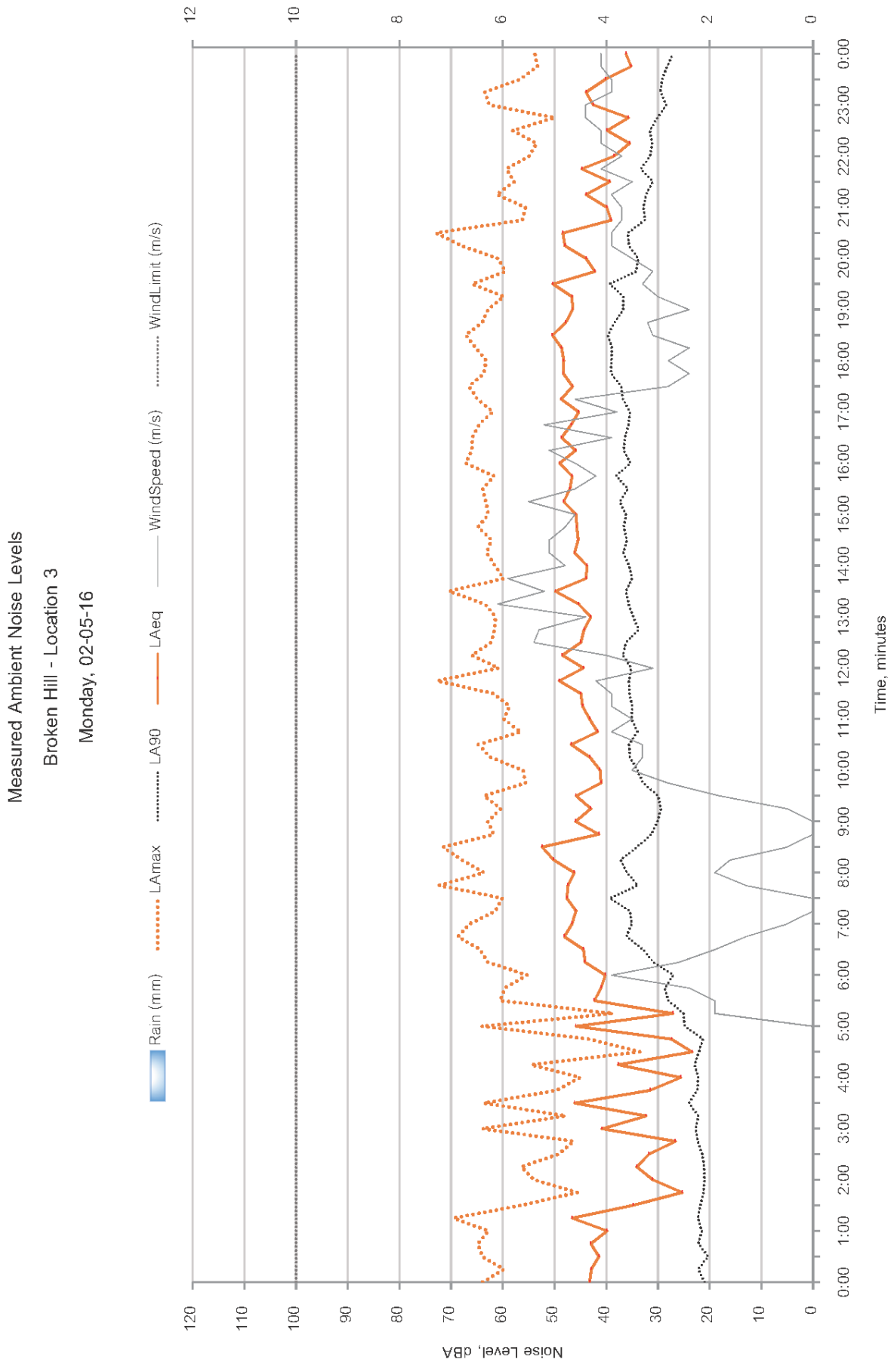
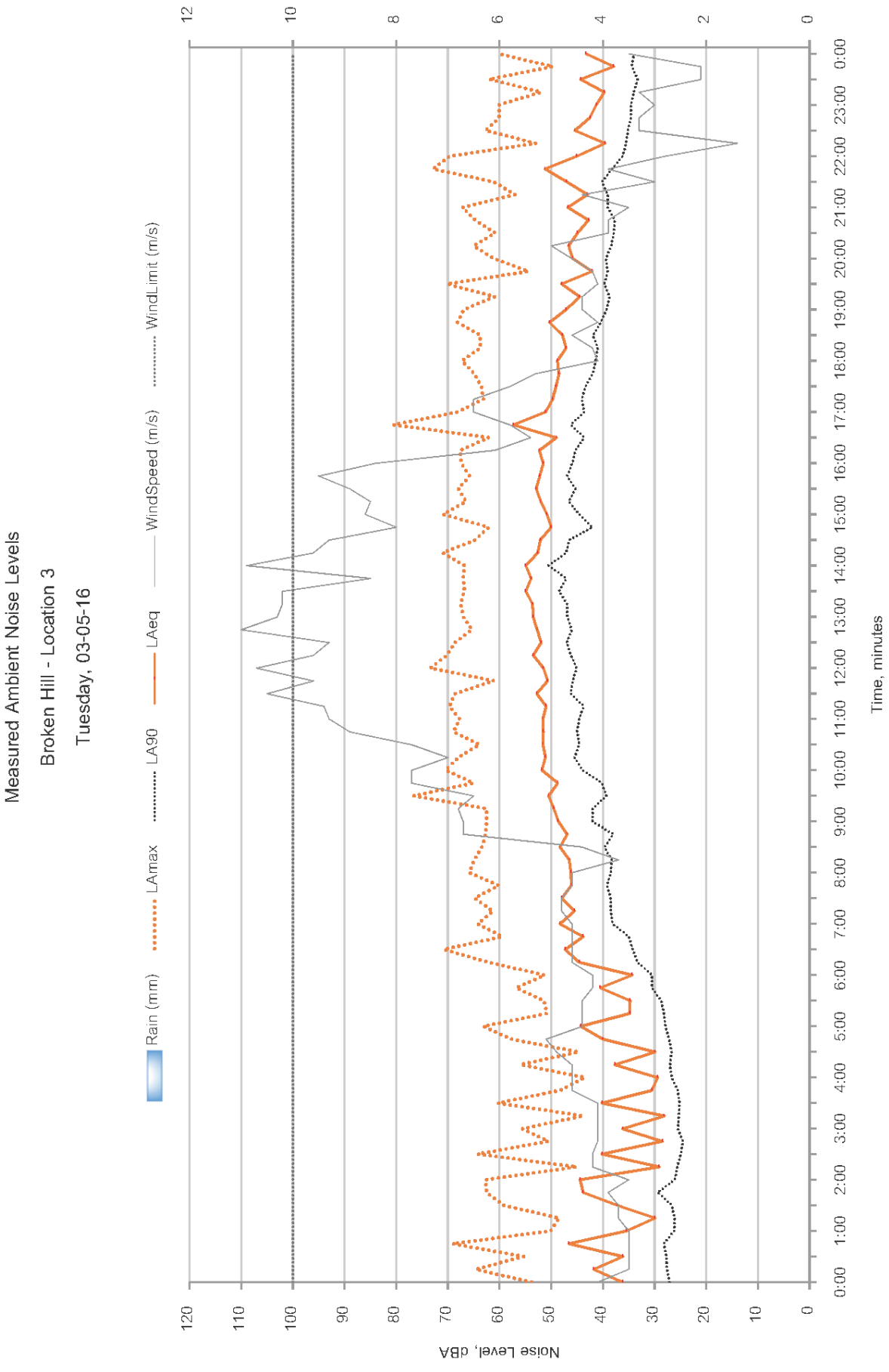

Measured Ambient Noise Levels
Broken Hill - Location 3
Monday, 02-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 3
Tuesday, 03-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
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16:00
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20:00
21:00
22:00
23:00
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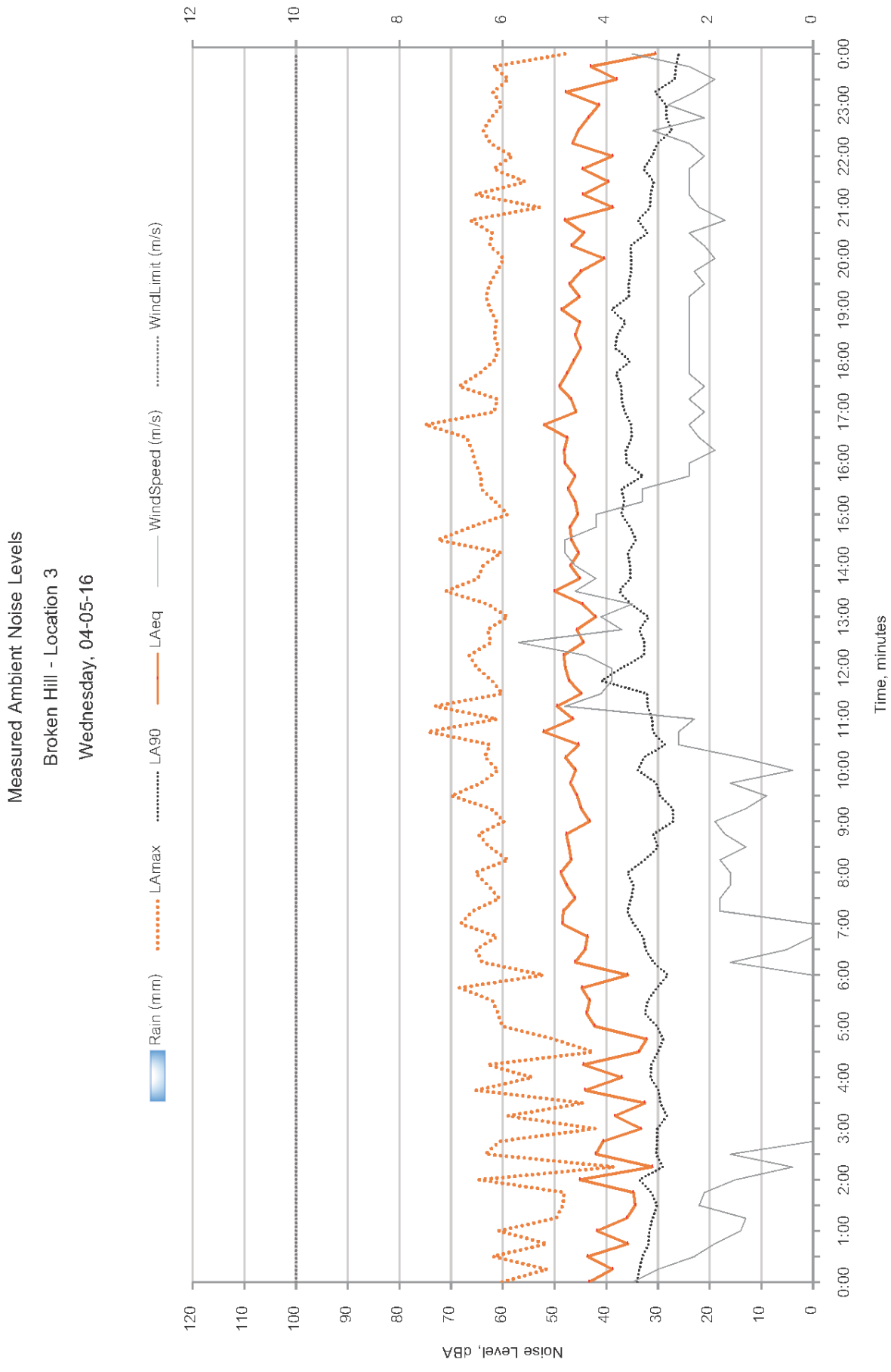
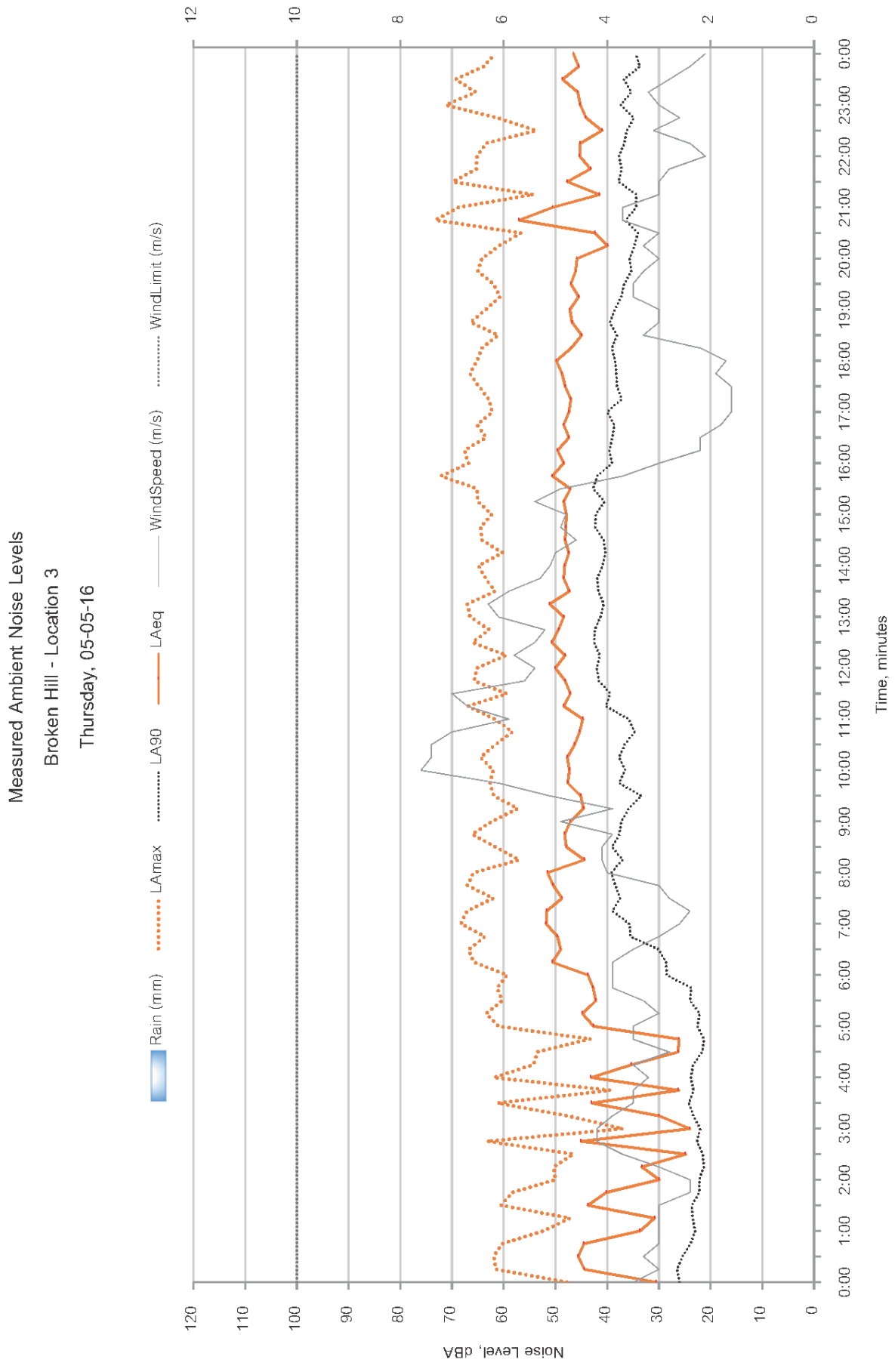
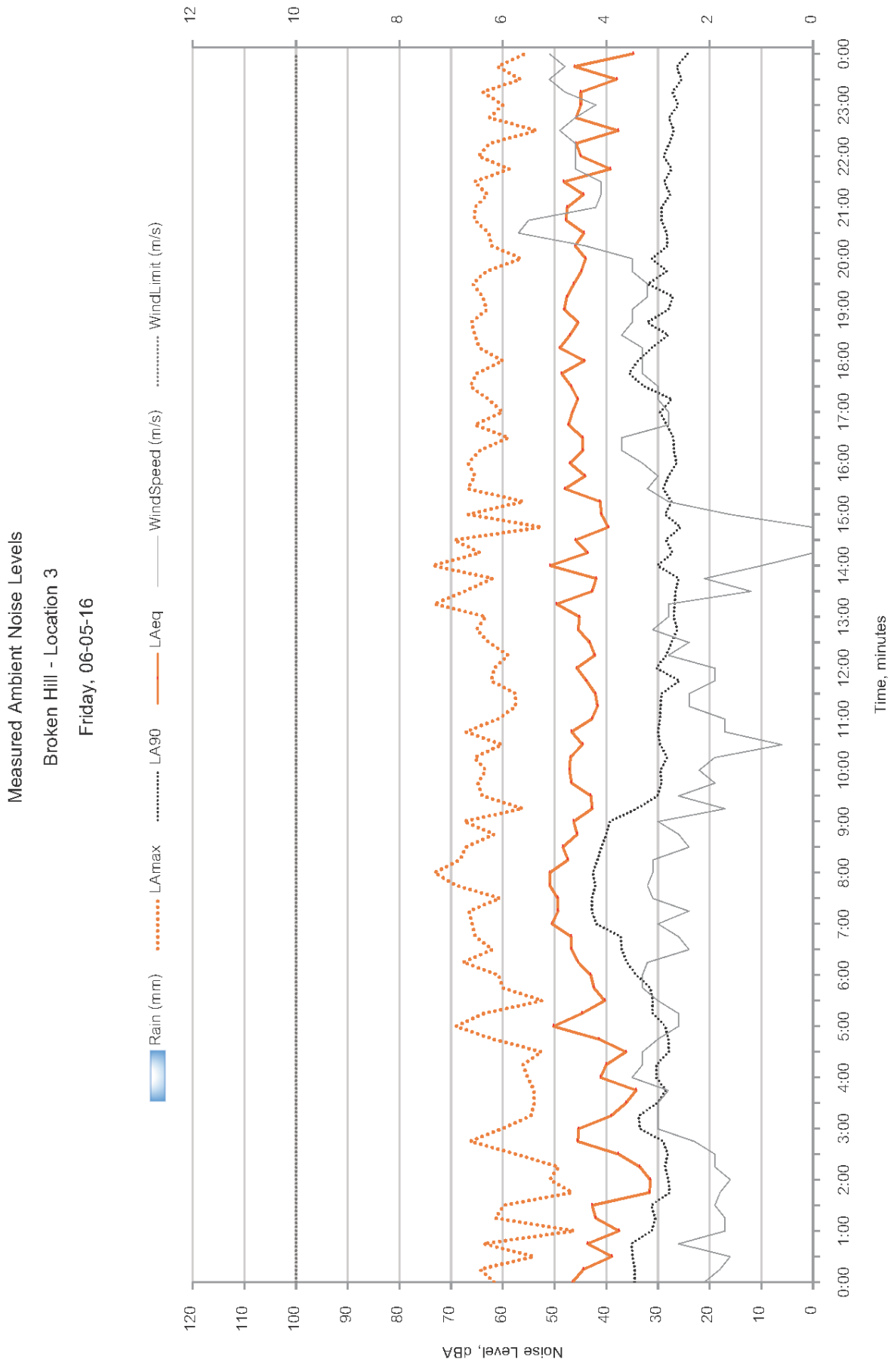
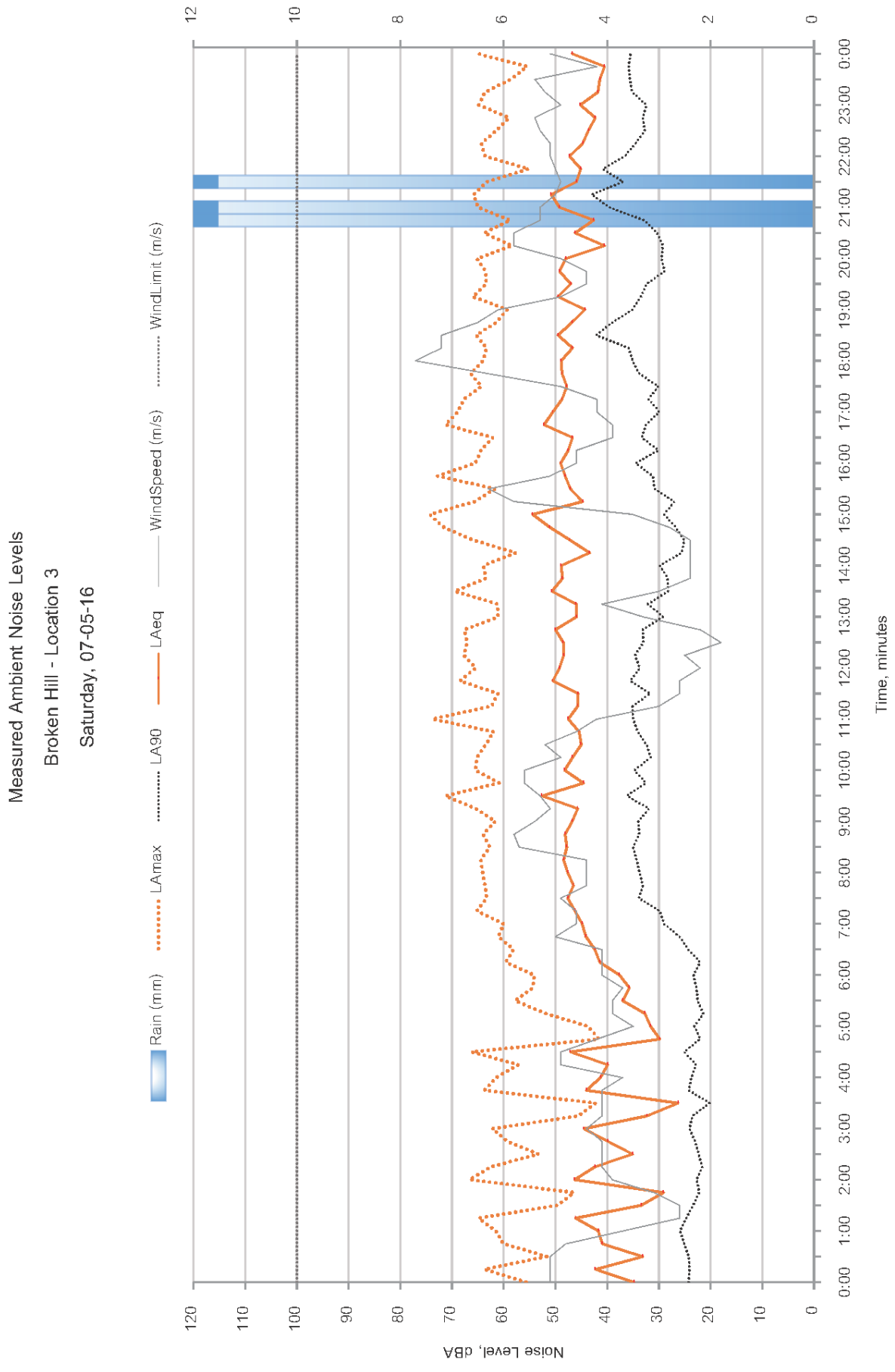
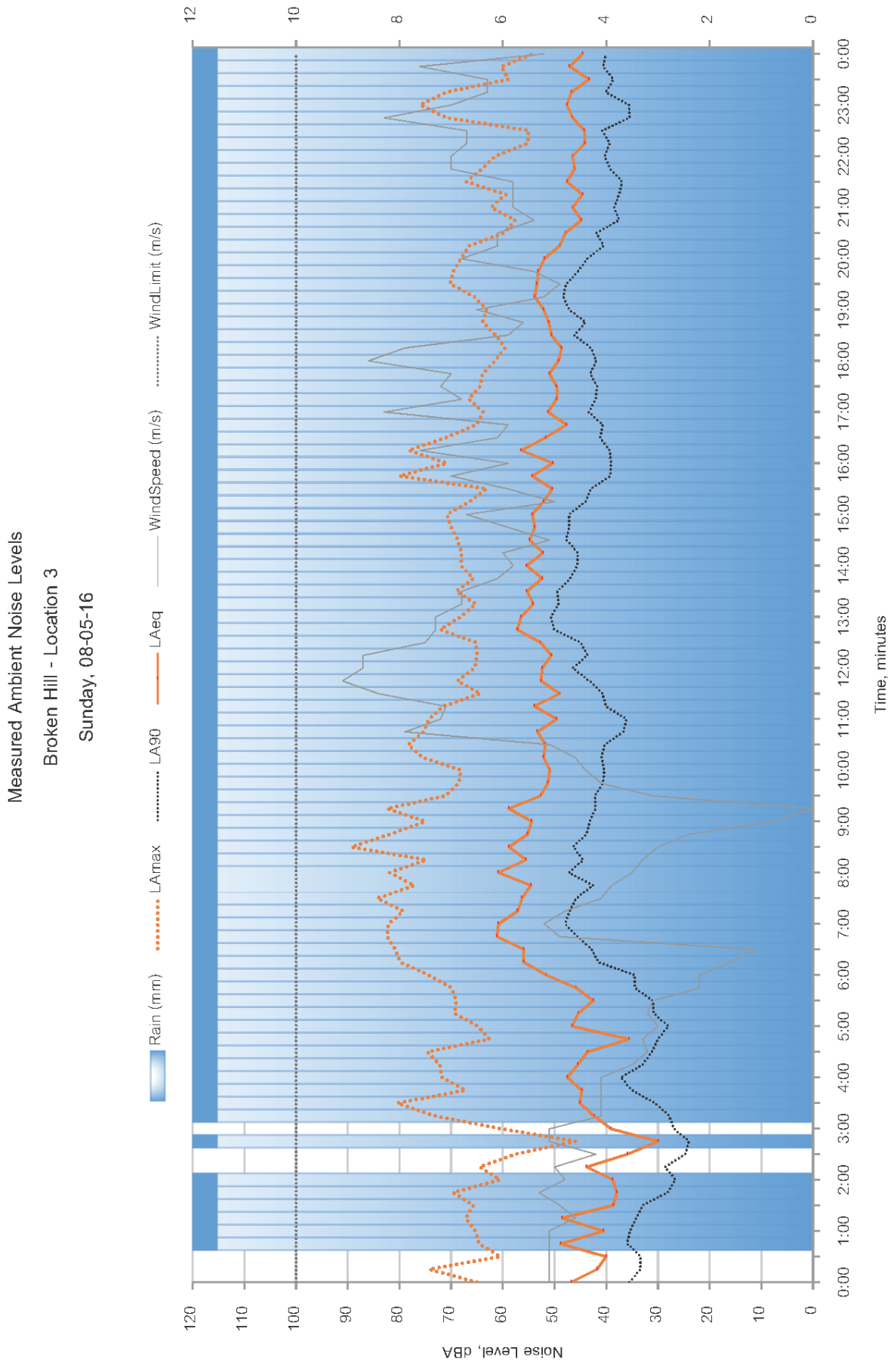
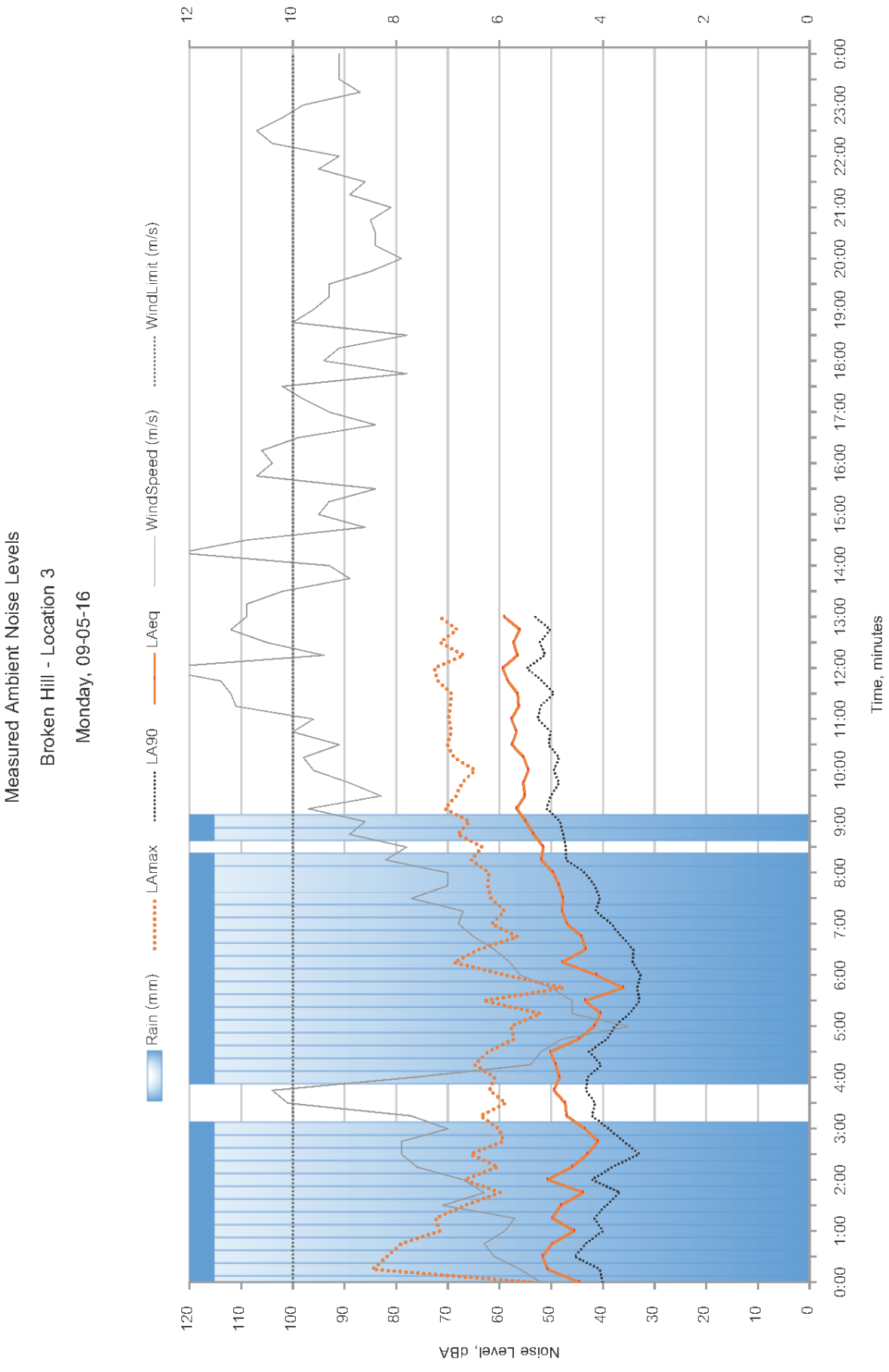

Measured Ambient Noise Levels
Broken Hill - Location 3
Wednesday, 04-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
6
4
2
0


Measured Ambient Noise Levels
Broken Hill - Location 3
Thursday, 05-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
6
4
2
0


Measured Ambient Noise Levels
Broken Hill - Location 3
Friday, 06-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 3
Saturday, 07-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
6
4
2
0


Measured Ambient Noise Levels
Broken Hill - Location 3
Sunday, 08-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes


Measured Ambient Noise Levels
Broken Hill - Location 3
Monday, 09-05-16
Rain (mm)
LAmax
LA90
LAeq
WindSpeed (m/s)
WindLimit (m/s)
Noise Level, dBA
Time, minutes
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
120
110
100
90
80
70
60
50
40
30
20
10
0
12
10
8
6
4
2
0

Appendix C – Plant Equipment Locations

APPENDIX C
PLANT LOCATIONS
REF : MAC160242
0
500m
KEY
Internal Haul Road
Haul Truck
Loader
Crusher
Construction Fleet
Off-site Haul Road
Pastefill Plant
MAC
Muller Acoustic Consulting
*Imagery Source : R.W Corkery P/L
N
Water Storage Tanks
Assay Lab
Former Administration Complex
Change House
Security Gate
No 3 Shaft
Car Park
Haul Road
Site Entrance
Proposed Haul Road Cutting
Cosmopolitan Access Ramp
Cosmopolitan Portal
Winder
Workshop
Core Shed
Store Shed
Office & Store
ROM Pad
Former Concentrator
No 2 Shaft Office and Change House
No 2 Shaft
No 2 Winder House
Former Storage Facility
Magazine

Appendix D – NEWA Meteorology Analysis Summary

Table D1 NEWA Analysed Meteorological Conditions, Broken Hill Airport, NSW									
Direction	Season	Day	Evening	Night	Direction	Season	Day	Evening	Night
		Percentage Occurrence %					Percentage Occurrence %		
0	Summer	5	7	7	180	Summer	7	8	4
0	Autumn	9	14	13	180	Autumn	8	6	4
0	Winter	12	18	16	180	Winter	6	7	4
0	Spring	7	12	13	180	Spring	6	7	2
22.5	Summer	4	7	6	202.5	Summer	8	11	6
22.5	Autumn	7	15	10	202.5	Autumn	8	8	6
22.5	Winter	11	19	12	202.5	Winter	6	9	5
22.5	Spring	6	13	11	202.5	Spring	6	10	5
45	Summer	4	6	4	225	Summer	8	13	11
45	Autumn	7	12	7	225	Autumn	8	13	11
45	Winter	9	17	9	225	Winter	6	13	9
45	Spring	6	12	6	225	Spring	7	12	11
67.5	Summer	4	5	3	247.5	Summer	8	12	14
67.5	Autumn	8	11	6	247.5	Autumn	9	15	14
67.5	Winter	10	17	11	247.5	Winter	8	14	11
67.5	Spring	6	11	5	247.5	Spring	8	13	14
90	Summer	3	3	3	270	Summer	7	10	13
90	Autumn	7	9	6	270	Autumn	10	16	16
90	Winter	10	13	12	270	Winter	10	15	15
90	Spring	6	7	5	270	Spring	8	14	17
112.5	Summer	5	4	2	292.5	Summer	7	10	15
112.5	Autumn	8	6	5	292.5	Autumn	11	16	21
112.5	Winter	10	12	11	292.5	Winter	13	15	23
112.5	Spring	8	5	4	292.5	Spring	10	14	23
135	Summer	5	4	2	315	Summer	7	8	14
135	Autumn	8	5	4	315	Autumn	12	16	20
135	Winter	10	11	10	315	Winter	14	16	21
135	Spring	8	5	2	315	Spring	9	14	21
157.5	Summer	7	7	3	337.5	Summer	4	4	8
157.5	Autumn	8	6	3	337.5	Autumn	8	11	15
157.5	Winter	8	7	6	337.5	Winter	10	12	17
157.5	Spring	7	5	2	337.5	Spring	6	9	14

Appendix E – Octave SWL Data

Table E1 $L_{Aeq(15min)}$, dBA Sound Power Level Spectrum

Noise Source	Octave Band Centre Frequency (Hz), dBA								Total
	63	125	250	500	1000	2000	4000	8000	dBA
Operational Plant									
Mobile Crusher	99	98	99	111	108	106	100	92	114
Loader	77	95	94	100	101	98	93	90	106
Road Truck	89	95	90	89	93	97	92	85	102
Haul Truck	80	83	89	102	107	93	88	76	108
Pastefill Plant	79	89	93	100	104	103	97	90	108

Appendix F – Operational Noise Contours

Appendix F - Daytime Noise Contours, LAeq(15min)

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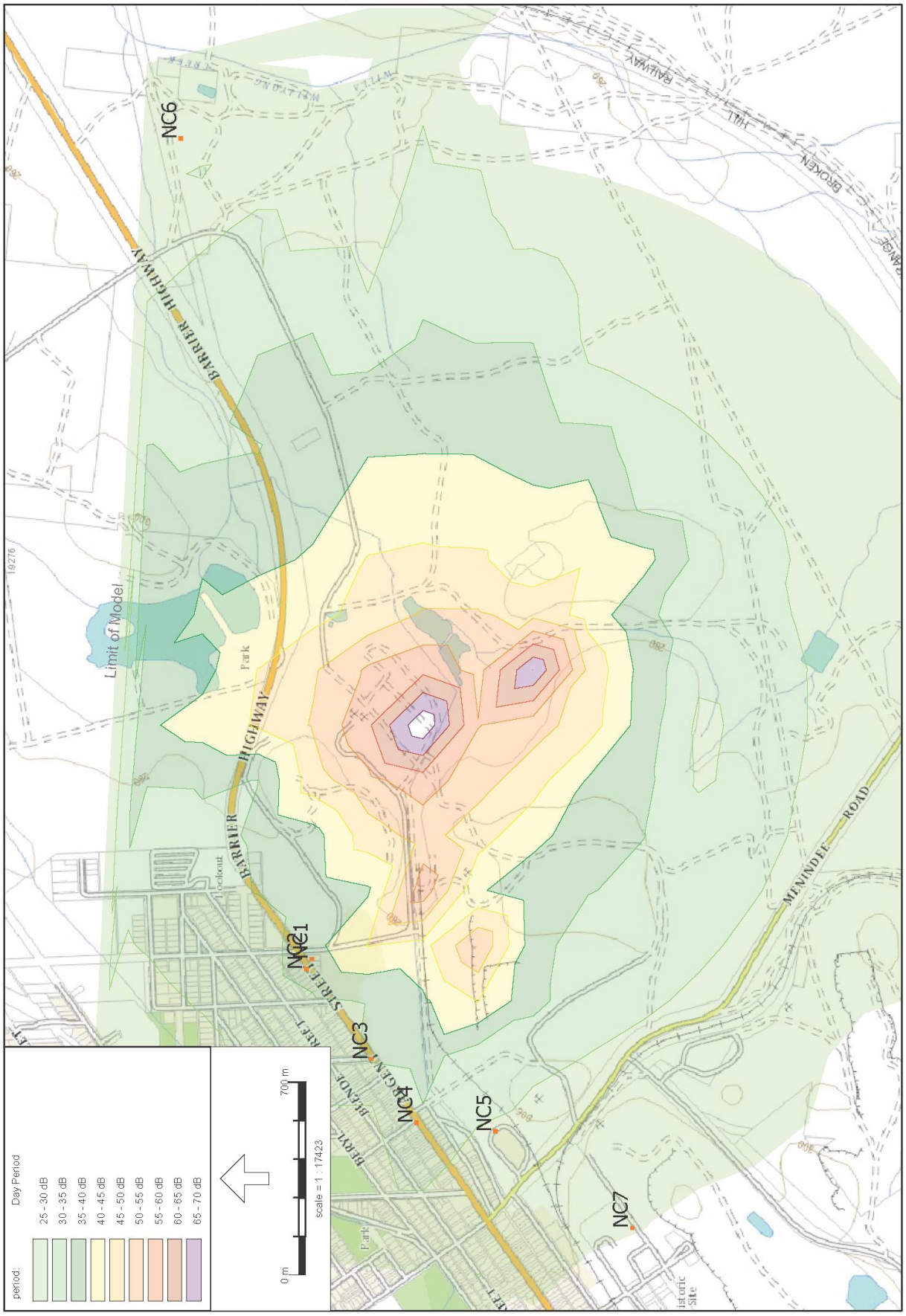
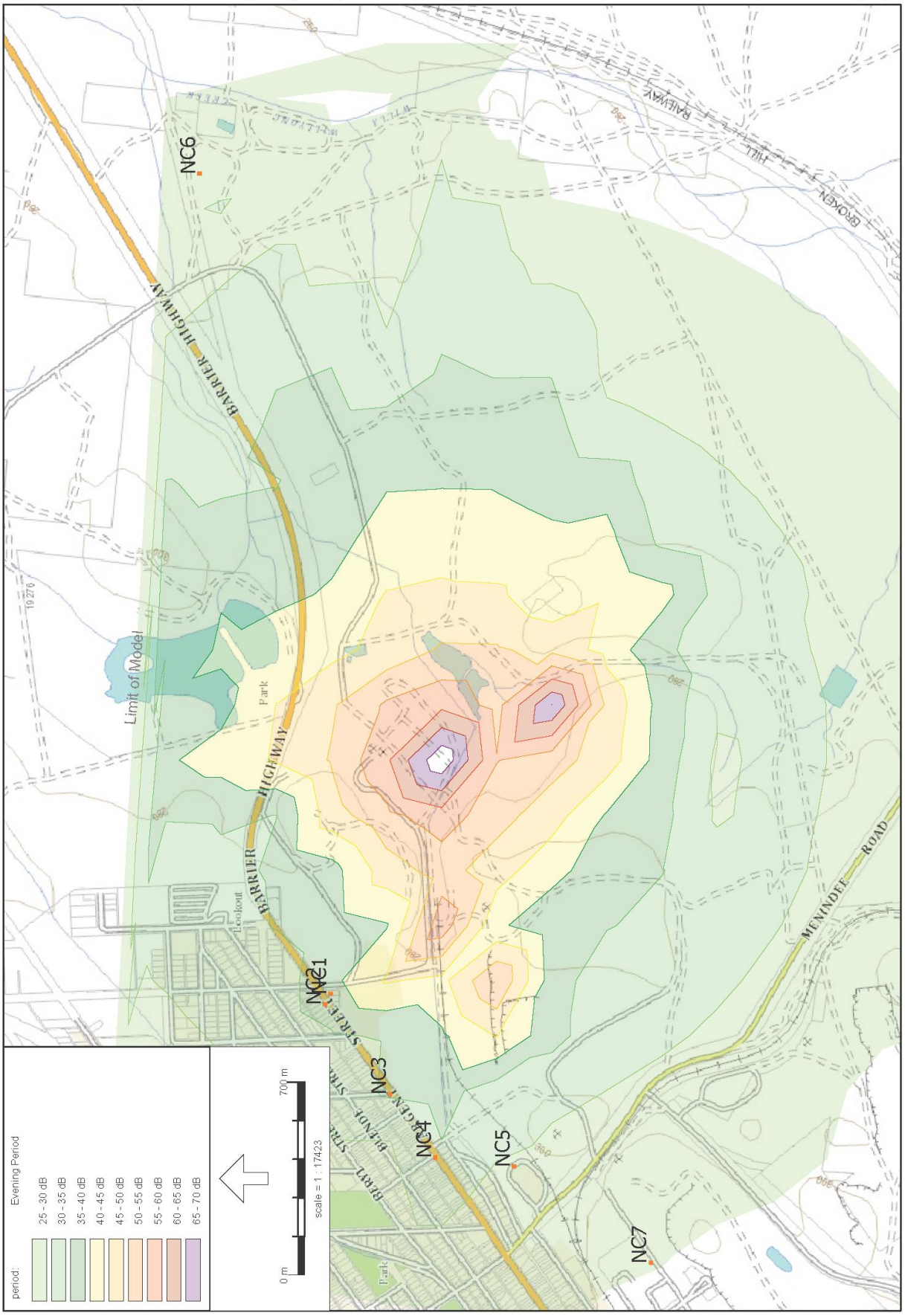


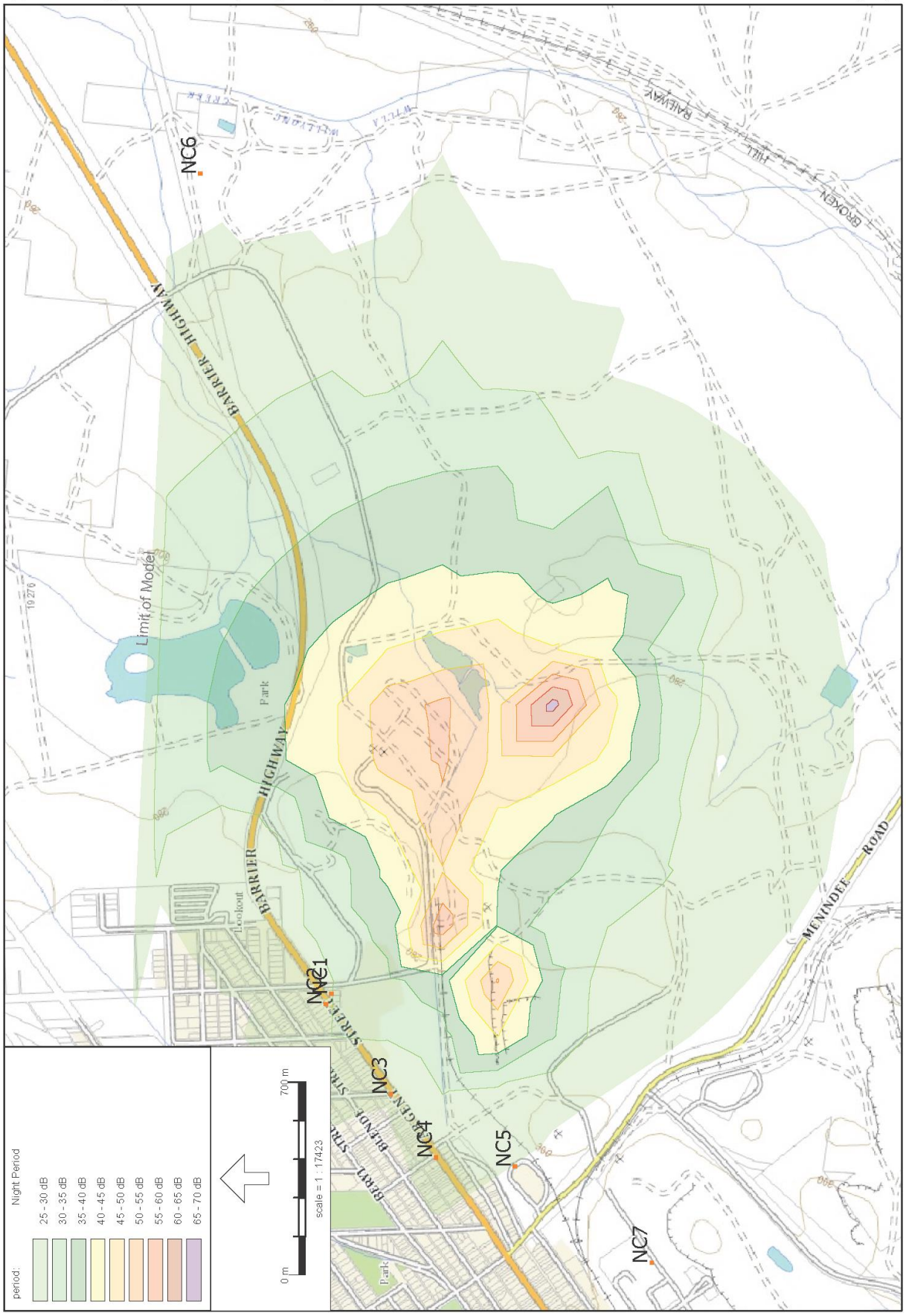
Appendix F -Evening Noise Contours, LAeq(15min)

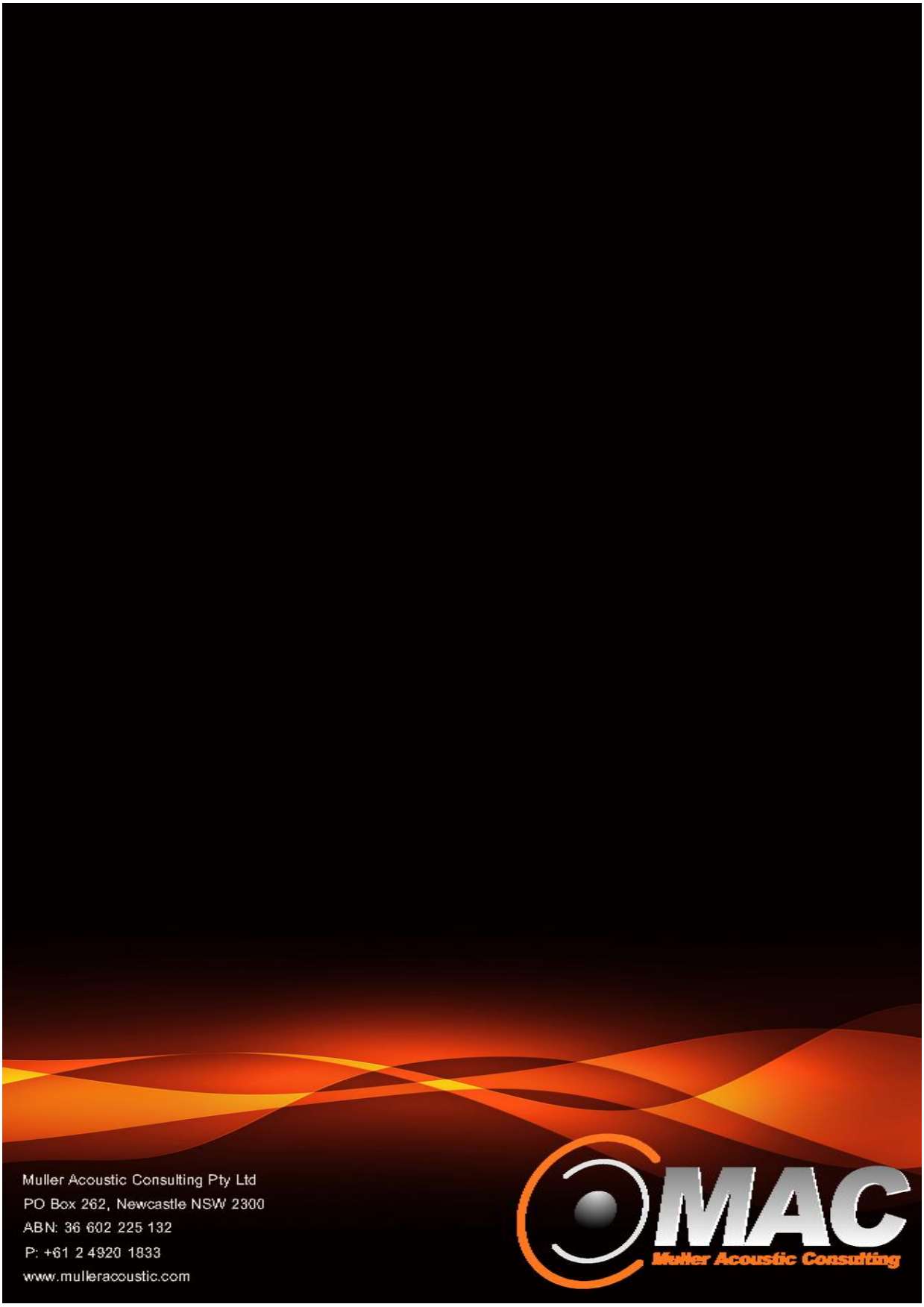
Muller Acoustic Consulting Pty Ltd



Appendix F - Night Noise Contours, LAeq(15min)

Muller Acoustic Consulting Pty Ltd

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MAC
Muller Acoustic Consulting

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