Appendix 6

Noise and Vibration Impact Assessment

(Total No. of pages including blank pages = 78)

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Noise and Vibration Impact Assessment

Proposed South Keswick Quarry Project

Environmental Impact Statement

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

September 2016

Muller Acoustic Consulting

Document Information

Noise and Vibration Impact Assessment

Proposed South Keswick Quarry Project

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

62 Hill Street

ORANGE NSW 2800

Prepared by: Muller Acoustic Consulting Pty Ltd

PO Box 262, Newcastle NSW 2300

ABN: 36 602 225 132

P: +61 2 4920 1833

www.mulleracoustic.com

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CONTENTS

1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by R.W Corkery & Co. Pty. Limited (RWC) on behalf of Regional Hardrock Pty Ltd (RHPL) to prepare a noise and vibration impact assessment (NVIA) for the proposed basalt quarry (the 'quarry'), to be established on Lot 211 DP1220433 of the "South Keswick" property southeast of Dubbo, NSW.

The NVIA was completed to quantify potential acoustic and vibration impacts associated with operation of the quarry on the surrounding community and will accompany the Environmental Impact Statement (EIS) that is being prepared for the project. The NVIA has been prepared in accordance with the following policies and guidelines:

- Environment Protection Authority (EPA) 2000, NSW Industrial Noise Policy (INP);
- NSW Department of Environment, Climate Change and Water (DECCW) 2011, Road Noise Policy (RNP);
- Department of Environment and Climate Change (DECC) 2009, Interim Construction Noise Guideline (ICNG);
- Australian and New Zealand Environment Conservation Council (ANZECC) 1990; Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration;
- Australian Standard, AS2187.2-2006 Explosives – Storage and use, Part 2: Use of explosives; and
- German Standard DIN4150.

A glossary of terms, definitions and abbreviations used in this report, along with a list of common noise sources and their typical sound level is provided in **Appendix A**.

1.1 Background

The proposed quarry is to be located on Lot 211 DP1220433 of an existing rural property, "South Keswick", 20L Sheraton Road, Dubbo, approximately 5kms south of Dubbo NSW. The quarry will produce up to 250, 000tpa of basalt products for a period of up to 30 years. The basalt (and limited volumes of overburden) will be recovered from an Extraction Area of approximately 24ha to a depth of between 12m and 15m (see **Figure 1**).

The quarry proposes to use a combination of drill and blast extraction methods to recover the basalt using a sequential cell based approach. An initial 'box cut' would be established within Cell 1, which is approximately 200m from the northern boundary, with development then proceeding to the south, then north and finally west following the indicative sequence provided by the numbered extraction cells identified on **Figure 1**.

On fragmentation by blasting, the basalt will be processed then would be fed to a primary jaw crusher to be progressively relocated within the extraction area. The crushed basalt will then be delivered by a product conveyor to the secondary processing operations within the Processing and Stockpiling Area which comprise secondary cone crusher(s), screens and stackers. A front end loader (FEL) will then load processed material to either stockpiles or trucks for transport offsite. **Table 1** presents several activities and their proposed hours of operation.

Table 1 Proposed Hours for Quarry Operation

Activity	Monday to Friday	Saturday	Sunday
Site Establishment (construction)	7am [1] – 6pm	7am – 3pm	-
Blasting	9am – 3pm	9am – 3pm	-
Extraction	7am – 6pm	7am –6pm	-
Crushing and Screening	7am – 6pm	7am – 6pm	-
Loading and Transportation	5am – 10pm	5am – 6pm	-
Rehabilitation	7am – 6pm	7am – 6pm	-
Maintenance	7am – 6pm	7am – 6pm	6am – 6pm [1]

Note 1: Low impact noise activities only.

Several construction activities are proposed prior to quarry commencement and include:

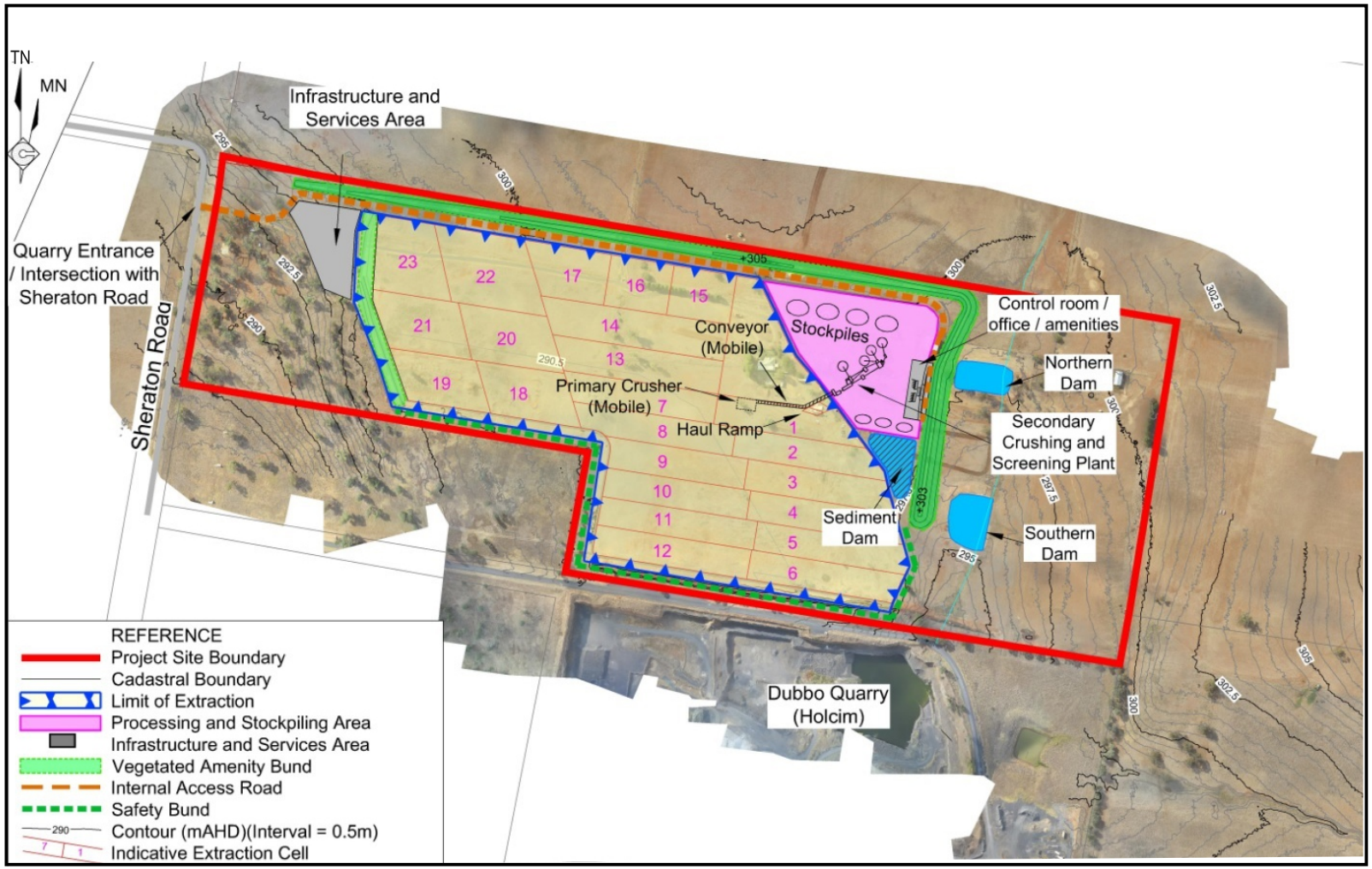
- Upgrade to the Project Site intersection with Sheraton Road;
- Construction of Internal Access Road, including provision of access to Lot 210 DP1220433;
- Excavation of Processing and Stockpiling Area to the immediate east of the extraction area;
- Excavation and establishment of the Infrastructure and Services Area, to include site offices, weighbridge, maintenance workshop and amenities; and
- Construction of a vegetated amenity bund, using excavated material from the Processing and Stockpiling Area, and Infrastructure and Services Area along northern, western and eastern extraction area perimeter. It is noted the western section of this bund will be located within the impact footprint of the extraction area and eventually re-excavated towards the end of Quarry life.

FIGURE 1

PROJECT SITE LAYOUT

REF: MAC160254, SEPTEMBER 2016

0 200m



Source : R.W Corkery Pty Limited

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It is noted, that initial vegetation clearing, soil removal and box cut development within Extraction Cell 1 will also occur during the initial site development phase of the project.

Notwithstanding, as soil removal and box cut establishment noise emissions are very similar to extraction works, this latter task has been assessed as operational noise.

2 Noise Policy and Guidelines

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

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 project 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 (as the RBL).

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 quarry are safeguarded by the EPA's amenity categories as presented in Table 2.1 of the INP. Table 2.1 of the INP for relevant receiver types surrounding the project is reproduced in **Table 2**.

Table 2 Receiver Locations – Assessing Amenity

Type of Receiver	Indicative Noise Amenity Area	Period	Recommended LAeq(Period) Noise Level, dBA	
			Acceptable	Recommended Max
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
School Classroom - internal	All	Noisiest 1-hr period	35	40
Active Recreation	All	When in use	55	60

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

The EPA provides guidance on assessing sleep disturbance for industrial sites in the INP via its application notes. Section 4 of this assessment outlines the relevant EPA approach and criteria for managing impacts of sleep disturbance from industrial sites.

2.3 Road Noise Policy

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

2.4 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.

2.4.1 Standard Hours for Construction

Table 3 summaries the ICNG recommended standard hours for construction activities where the noise from construction is audible at residential premises.

Table 3 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.

2.4.2 Construction Noise Management Levels

Table 4 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 4 ICNG Residential Management Levels

Time of day	Management level $L_{Aeq(15min)}$	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.

Table 4 ICNG Residential Management Levels		
Time of day	Management level $L_{Aeq(15min)}$	How to apply
	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. -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 + 5dB.	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.

For schools the recommended (internal) LAeq (15-min) management level as per the ICNG is 45dBA. For Active Recreation receivers, the recommended LAeq (15-min) management level as per the ICNG is 65dBA.

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. Furthermore, for damage induced vibration, German Standard DIN 4150 - Part 3: 1999 provides the strictest guideline levels of vibration velocity for evaluating the effects of vibration in structures. Blasting and vibration induced damage criteria relevant to this assessment are presented in detail in Section 4.

2.6 Cumulative Noise

Cumulative noise is assessed against the INP amenity criteria and is summarised in Section 4.

3 Existing Environment

3.1 Receiver Review

The quarry is located in a rural area approximately 5km south east of Dubbo, NSW. Receivers in the locality surrounding the quarry are primarily rural/residential. **Figure 2** provides a locality plan identifying the position of receivers in relation to the quarry. The receiver addresses, MGA(55) coordinates and receiver category type are summarised in **Table 5**.

Table 5 Receiver Locations

Receivers	Easting	Northing	Receiver Category
R3	657229	6427728	Residential
R4	657264	6428099	Residential
R7	655818	6428421	Residential
R9	654909	6427533	Residential
R10	655424	6427175	Residential
R11	655340	6426773	Residential
R14	656464	6428796	Residential
R15	657471	6428002	Residential
R18	657773	6427211	Residential
R19	657649	6427645	Residential
R20	657759	6427689	Residential
R22 (St Johns College)	655050	6428838	Educational (School)
R24 (Aussie Cabins)	654846	6428919	Residential (Motel)
R26 (Dubbo Sportsworld)	654903	6429012	Active Recreation
R27 (Dubbo Christian School)	654922	6429145	Educational (School)
R28 (St Johns Primary)	655196	6429199	Educational (School)
R30 Future Residential Subdivision (Lot 1 DP880413)[1]	655196	6428119	Residential
R31 Future Hillview Estate[1]	654751	6427969	Residential
R32 Future Neoen Photovoltaic Power Plant[2]	656031	6427974	Industrial

Note 1: Proposed future residential subdivision.

Note 2: Assessed for vibration only.

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 adjacent to the project site. The locations were selected to represent noise levels in three noise catchments primarily controlled by ambient traffic noise and rural ambient sources. Logger 1 is considered representative of receivers situated to the west in close proximity to Sheraton Road. Logger 2 is considered representative of receivers situated to the north of the project site and Logger 3 is representative of receivers situated to the east in close proximity to the Mitchell Highway. The selected monitoring locations are shown in **Figure 2**.

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 between Wednesday 11 May 2016 to Thursday 19 May 2016. Observations on-site identified the surrounding locality was typical of a rural environment, with wind, birds, traffic noise and adjacent quarry noise audible. It is noted that during the ambient noise assessment on site drilling was occurring. As a result, some logging data may be influenced by drilling operations. Therefore, to exclude any contributions from project related noise, background monitoring data for Sunday 15 May 2016 has been adopted for this assessment. These levels are considered conservative as they also exclude any existing noise contributions from neighbouring quarries. Notwithstanding, the adopted RBLs are considered representative of the surrounding catchments and have been validated against attended noise monitoring data which is consistent with the rural noise catchment category as per the INP.

Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. 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 Chapter 4 of the INP. The results of long-term unattended noise monitoring are provided in **Table 6**. The noise monitoring charts for the background logging assessment are provided in **Appendix B**.

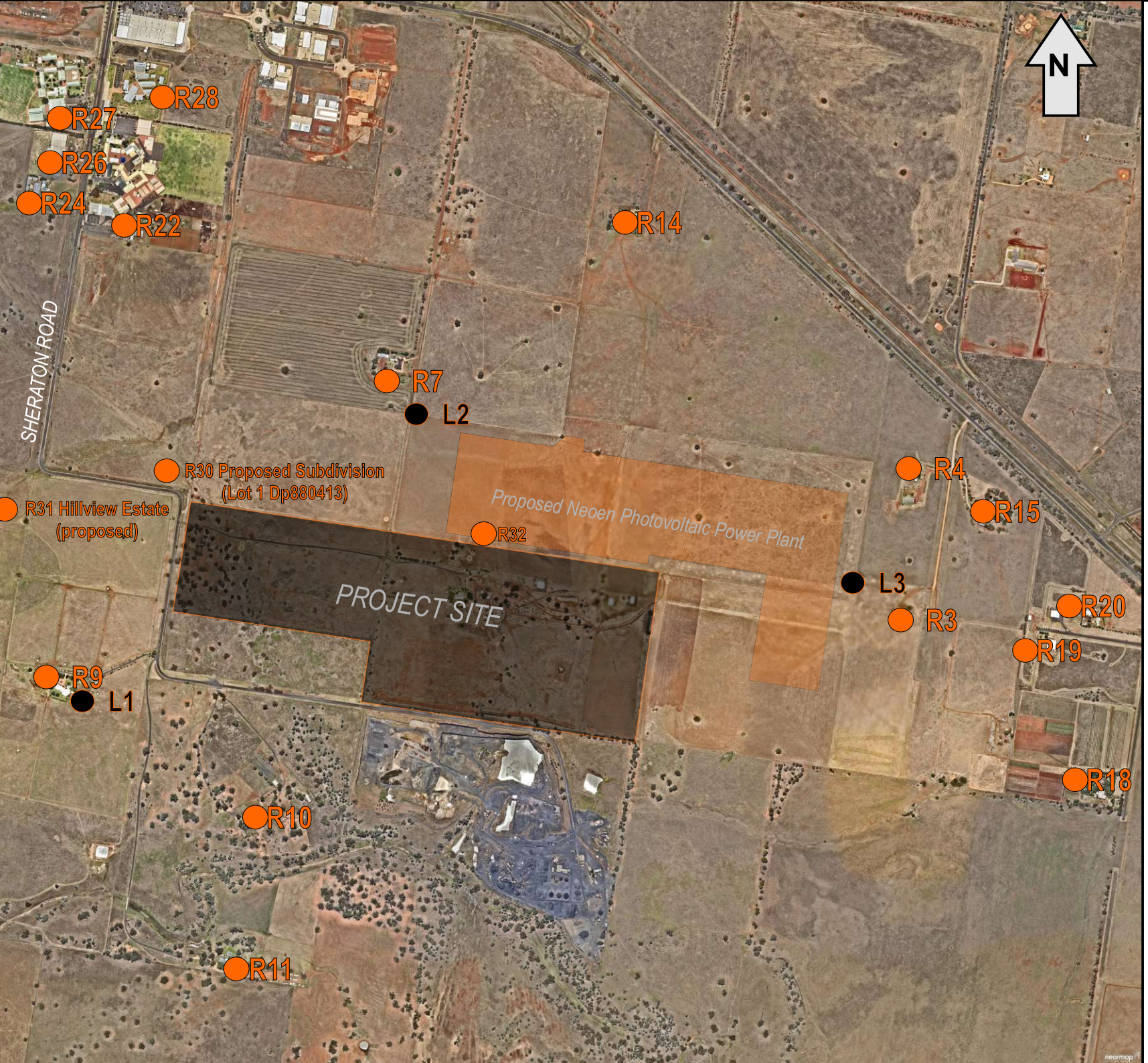

FIGURE 2

LOCALITY PLAN

REF: MAC160254, SEPTEMBER 2016

0 250m

KEY

- R1 ASSESSED RECEIVERS
- PROJECT SITE
- L1 NOISE LOGGER LOCATIONS

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Table 6 Background Noise Monitoring Summary			
Catchment and Representative Residential Receivers	Period[1]	Measured Background Noise Level (LA_{90}), RBL, dBA	Measured LA_{eq}, dBA
L1 (R9, R24, R30, R31)	Day	30	47
	Evening	27	36
	Night	20	39
L2 (R7, R10, R11)	Day	32	44
	Evening	30	40
	Night	21	41
L3 (R3, R4, R14, R15, R18 – R20)	Day	34	45
	Evening	29	53
	Night	19	44

Note 1: Monday to Saturday, Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Daytime 8am to 6pm; Evening 6pm to 10pm; Night-time 10pm-8am.

Note: excludes periods of wind or rain affected data, meteorological data obtained from the Bureau of Meteorology Dubbo Airport Station (BOM # 065070).

To gain a better understanding of the existing noise environment, MAC conducted attended noise monitoring at the unattended locations during calm clear weather conditions. The purpose of the measurements was to ascertain dominant ambient noise sources and to quantify any existing industrial noise contribution. It is noted that the adjacent Holcim quarry was barely audible during attended noise surveys and had a negligible contribution to exiting background levels.

The results of attended noise measurements and observations conducted on 11 May 2016 are summarised in **Table 7**.

Table 7 Operator-Attended Noise Survey Results, 11 May 2016					
Monitoring Location	Time (hrs)	Primary Noise Descriptor (dBA re 20 µPa)			Description and SPL, dBA
		LAmax	LA_{eq}	LA_{90}	
L1	09:30	60	43	33	Wind 43 Rural ambient noise 30 to 33
L2	09:00	65	52	47	Drilling (project) 45 to 49 Wind 42 to 55
L3	08:30	55	42	36	Highway traffic hum 30 to 35, Drilling 33 to 35 Wind 45 to 55

4 Project Specific Noise Criteria

4.1 Operational Noise Criteria

The operational noise emission criteria for the quarry have been set in accordance with Section 2 and Section 3 of the INP. The intrusiveness and amenity design criteria have been set, based on logging measurements conducted at catchments representative of surrounding receivers to the project site.

The Project Specific Noise Levels (PSNLs) (project criteria) is the lower of the intrusive or amenity criteria. It is noted that the daytime assessment period is relevant to extraction and processing of material, while loading and transportation is proposed to occur from 5am to 10pm. Hence loading and transportation has been assessed for day, evening and morning shoulder periods.

The background noise levels for setting the intrusiveness criteria have been determined in the absence of any noise from the proposed quarry sites. The existing LAeq in the area surrounding the site is dominated by traffic and rural noise sources.

A review of transport noise in accordance with Section 2.2.3 of the INP identified that corrections to the amenity criteria to account for high traffic noise is not applicable, as levels are not more than 10dB above the recommended acceptable amenity levels.

Additionally, as there is negligible existing industrial noise contribution at representative receivers, no adjustment to the amenity criteria is necessary and the recommended acceptable amenity levels from Table 2.1 of the INP has been adopted as the amenity criteria.

Furthermore, as the project is proposing to transport material from site from 5am, the morning shoulder period has been adopted for this project. As per Section 3.3 of the INP the morning shoulder is the mid-point between the day and night time RBL. The PSNLs for the quarry are presented in **Table 8**.

Table 8 Project Specific Noise Criteria, dBA $LA_{eq(15min)}$					
Receiver	Period	Measured RBL L_{A90}, dBA	Intrusiveness Criteria $LA_{eq(15min)}$, dBA	Amenity Criterion $LA_{eq(period)}$,dBA	PSNL
R3	Morning Shoulder	32[2]	37	45	37
	Day	34	39	50	39
	Evening	30[2]	35	45	35
R4	Morning Shoulder	32[2]	37	45	37
	Day	34	39	50	39
	Evening	30[2]	35	45	35
R7	Morning Shoulder	31[2]	36	45	36
	Day	32	37	50	37
	Evening	30	35	45	35
R9	Morning Shoulder	30[2]	35	45	35
	Day	30	35	50	35
	Evening	30[2]	35	45	35
R10	Morning Shoulder	31[2]	36	45	36
	Day	32	37	50	37
	Evening	30	35	45	35
R11	Morning Shoulder	31[2]	36	45	36
	Day	32	37	50	37
	Evening	30	35	45	35
R14	Morning Shoulder	32[2]	37	45	37
	Day	34	39	50	39
	Evening	30[2]	35	45	35
R15	Morning Shoulder	32[2]	37	45	37
	Day	34	39	50	39
	Evening	30[2]	35	45	35
R18	Morning Shoulder	32[2]	37	45	37
	Day	34	39	50	39
	Evening	30[2]	35	45	35
R19	Morning Shoulder	32[2]	37	45	37
	Day	34	39	50	39
	Evening	30[2]	35	45	35
R20	Morning Shoulder	32[2]	37	45	37
	Day	34	39	50	39
	Evening	30[2]	35	45	35
R22	Noisiest 1-hr period	N/A	N/A	35	35
R24	Morning Shoulder	30[2]	35	45	35
	Day	30	35	50	35
	Evening	30[2]	35	45	35
R26	When in use	N/A	N/A	65	65
R27	Noisiest 1-hr period	N/A	N/A	35	35
R28	Noisiest 1-hr period	N/A	N/A	35	35
R30[1]	Morning Shoulder	30[2]	35	45	35
	Day	30	35	50	35
	Evening	30[2]	35	45	35
R31[1]	Morning Shoulder	30[2]	35	45	35
	Day	30	35	50	35
	Evening	30[2]	35	45	35

Note 1: Proposed future residential subdivisions.

Note 2: Where the RBL is lower than 30 dBA, an RBL of 30 dBA is applied.

Note 3: Internal criteria.

4.2 Sleep Disturbance Screening Criterion

The INP criterion considers the average noise emission from a noise generating industry over a 15 minute day, evening and night period (where applicable) and is appropriate for assessing noise from relatively steady-state sources. However, noise from intermittent or impulsive sounds are required to be assessed using the L_{A1} or L_{Amax} noise metrics.

The most important impact of such intermittent noises would be the disturbance of sleep of nearby residents. The EPA provides guidance on assessing sleep disturbance for industrial sites. The EPA via its application notes, nominate a screening criteria of background noise level (L_{A90}) plus 15dB shall apply to maximum noise level events from the site. These noise levels are to be calculated at one metre from the bedroom facade at the nearest residential properties. Where noise levels have been calculated above the screening criteria, additional analysis should be undertaken, referencing guidance on maximum noise levels and sleep disturbance listed in the RNP (EPA, 2011). This guidance states:

- maximum internal noise levels below 50 to 55dBA are unlikely to wake sleeping occupants; and
- one or two noise events per night, with maximum internal noise levels of 65 to 70dBA, are not likely to affect the health and wellbeing of occupant's significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies that a partially open window will reduce external noise levels by 10dBA. Therefore, external noise levels in the order of 60 to 65dBA calculated at the facade of a residence are unlikely to cause sleep disturbance affects at worst case (ie with windows open).

The descriptors L_{Amax} and L_{A1} may be considered interchangeable, which is accepted by EPA.

If noise levels over the screening criterion were identified, then additional analysis would 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).

It is noted that for sleep disturbance, the approach noted in the INP for developing intrusive criteria for the shoulder period is not appropriate for determining maximum noise levels for the shoulder period. Therefore, the sleep disturbance criterion has been derived based on the night RBL.

Based on the night RBL of 30dBA, the sleep disturbance screening criterion for this project is 45dBA.

4.3 Road Traffic Noise Criteria

The road traffic noise criteria are provided in the NSW EPA's Road Noise Policy (RNP) (2011). Section 2.2.2 of the RNP refers to 'Principal Haulage Routes' and states the following:

> *'Some industries such as mines and extractive industries are, by necessity, in locations that are often not served by arterial roads. Heavy vehicles must be able to access these often more remote sites and this may mean travelling on local public roads. Good planning practice acknowledges this type of road use and develops ways of managing any associated adverse noise impacts. Principal haulage routes are distinct from private haul roads – further guidance on private haul roads is provided in Appendix C4.*
>
> *Where local authorities identify a 'principal haulage route', the noise criteria for the route should match those for arterial/sub-arterial roads, recognising that they carry a different level and mix of traffic to local roads.'*

Therefore, in accordance with the RNP, this assessment has adopted the 'Freeway/arterial/sub-arterial road' category for Sheraton Road and this assessment. **Table 9** reproduces the road traffic noise assessment criteria reproduced from the RNP relevant for this road type.

Table 9 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, LAeq(15hour)	55dBA, LAeq(9hour)

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 2 dB, which is generally accepted as the threshold of perceptibility to a change in noise level.

4.3.1 Relative Increase Criteria

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 10** due to the addition of quarry vehicles on Sheraton Road should be considered for mitigation.

Table 10 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) +12 dB (external)	Existing traffic LAeq(9hr) +12 dB (external)

4.4 Construction Noise Management Levels

The construction noise management levels for this project have been established using results obtained from background monitoring data. Noise associated with construction activities for extractive industries are often assessed as operational noise, as the emissions from plant and associated equipment are similar. However, construction works away from the quarry area include the haul road construction, intersection upgrades and perimeter and wall construction. These activities have several differences when compared to extractive activities, including a short duration of works compared with the proposed quarry life and the construction locations are generally geographically removed from the main extraction area.

Conversely, construction activities within the extraction area including vegetation clearing, soil removal and box cut development within Extraction Cell 1 have been considered equivalent to operational noise Scenario 1 provided in Section 5 of this report.

Proposed construction of the access/haul road, intersection upgrade and bund construction will be limited to daytime hours (ie. standard hours). Therefore, the management levels have been developed for nearby residential receivers based on standard hours for weekday periods. **Table 11** provides a summary of the project construction management levels.

Table 11 Construction Noise Management Levels			
Receiver	Assessment Period	RBL, dBA[1]	Criteria $LA_{eq(15min)}$ dBA
R3	Day	34	44
R4	Day	34	44
R7	Day	32	42
R9	Day	30	40
R10	Day	32	42
R11	Day	32	42
R14	Day	34	44
R15	Day	34	44
R18	Day	34	44
R19	Day	34	44
R20	Day	34	44
R22	Day	N/A	45 (internal)
R24	Day	30	40
R26	Day	N/A	65
R27	Day	N/A	45 (internal)
R28	Day	N/A	45 (internal)
R30[1]	Day	30	40
R31[1]	Day	30	40

Note 1: Proposed future residential subdivisions.

4.5 Blasting Criteria

4.5.1 Residential Receivers

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.

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.

Ground Vibration

Peak particle velocity (PPV) from ground vibration at residential receivers 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 12**.

Table 12 Airblast Overpressure and Ground Vibration Limits

Airblast	
Overpressure level dB(Linpeak)	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%

4.5.2 Structural Damage Criteria – Future Neoen Photovoltaic Power Plant

Vibration Criteria

Table J4.5B of Appendix J of Australian Standard AS21072.-2006 *'Explosives-Storage and use Part 2: Use of explosives'*, recommends that for unoccupied structures constructed of reinforced concrete or steel construction, a maximum peak component velocity criteria of 100mm/s should be adopted. Notwithstanding, for the Future Neoen Photovoltaic Power Plant, this assessment has adopted a more conservative criterion as prescribed in DIN4150- 1 *'Structural Vibration Part 3: Effects of vibration on structures'* of 10mm/s for commercial/industrial style buildings that are unoccupied. The criteria adopted for the Future Neoen Photovoltaic Power Plant (R32) is provided in **Table 13**.

Table 13 Guideline Values for Vibration Velocity to Be Used When Evaluating the Effects of Long Term Vibration on Structures

Type of Structure	Guideline values for velocity, vi, in mm/s, of vibration in horizontal plane of highest floor at all frequencies
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	10

Airblast Criteria

Section 5.3 of Appendix J of Australian Standard AS21072.-2006 *'Explosives-Storage and use Part 2: Use of explosives'*, identifies that damage (for residential dwellings) from airblasts have not been found to occur at levels below 133dBL. Therefore, this assessment has adopted a criterion of 133dBL for Airblast impacts at R32.

4.6 Cumulative Noise Criteria

To limit continuing increases in industrial noise within a particular area, ambient industrial noise should not exceed the levels specified in Table 2.1 of the INP. Cumulative operational noise from industrial sources surrounding the project (ie Holcim quarry) has been considered in this assessment and compared against the INP's acceptable and recommended maximum amenity criteria levels. The acceptable and maximum amenity criteria levels are reproduced in **Table 14**.

Table 14 Cumulative Noise Criteria

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

5 Noise and Vibration Assessment Methodology

5.1 Operational Noise Modelling Methodology

A computer model was developed to determine the acoustic impact of quarry noise emissions to neighbouring receivers for two worst case operational stages. Brüel and Kjær Predictor Type 7810 (Version 11.10) noise modelling software was used to assess potential noise impacts associated with the quarry. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process.

Additionally, 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 receivers. Plant and equipment were modelled at various locations and heights, representative of realistic operating conditions for assessed scenarios. **Appendix C** provides modelled plant locations adopted for this assessment.

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'.

5.2 Operational Noise Modelling Parameters

The model incorporated three-dimensional digitised ground contours for the quarry, as derived from proposed site plans, proposed barriers and the surrounding land base topography, superimposed on each other. 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.

5.2.1 Meteorological Analysis

Noise emissions from industry can be significantly affected by prevailing weather conditions. Wind has the potential to increase noise at a receiver when it is at low velocities and travels from the direction of the noise source. As the strength of the wind increases the noise produced by the wind will mask 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 of speeds up to 3m/s for 30% or more of the time in any seasonal period (ie day, evening or night), is considered to be a feature wind and predictions must incorporate these conditions.

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 10 m height) of 3 m/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 quarry, weather data during the period May 2014 to May 2016 was obtained from the Bureau of Meteorology's (BOM) Dubbo Airport weather station located approximately 10km north west of the project site. 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 15 summarises the results of the wind analysis and includes the dominant wind direction and percentage occurrence during each season for each assessment period. The results of the detailed analysis of meteorological data is presented in **Appendix D**.

Table 15 Seasonal Frequency of Occurrence Wind Speed Intervals

Season	Period	Wind Direction ±(45°)	% Wind Speeds (m/s)
			0.5 to 3 m/s
Summer	Day	225	8
	Evening	225	13
	Night	292.5	15
Autumn	Day	315	12
	Evening	315	16
	Night	292.5	21
Winter	Day	315	14
	Evening	22.5	19
	Night	292.5	23
Spring	Day	292.5	10
	Evening	270	14
	Night	292.5	23

Based on the results of this analysis, the relevant meteorological conditions adopted in the noise modelling assessment are summarised in **Table 16**.

Table 16 Modelled Site Specific Meteorological Parameters				
Assessment Condition	Temperature	Wind Speed / Direction	Relative Humidity	Stability Class
Morning Shoulder - Inversion	10°C	n/a	90%	F
Daytime - Calm	20°C	n/a	60%	n/a
Evening- Calm	15°C	n/a	60%	n/a

5.2.2 Modelling Scenarios

Two modelling scenarios were adopted in this assessment to represent noise emissions at various stages of the quarry life as the quarry progresses from east to west. The stages are summarised below:

- Scenario 1: Extraction, processing and transportation of material from Cell 1 of the extraction area and includes (off-site) product transportation during morning shoulder and evening periods. This scenario assumes the 3m perimeter bund will be in place, however, includes the primary crushing plant operating at surface to represent initial excavation activities.
- Scenario 2: Extraction, processing and transportation of material from Cell 23 of the extraction area and includes (off-site) product transportation during morning shoulder and evening periods. The primary crushing plant is placed on the extraction floor in close proximity to the northern extraction face of Cell 23 (to represent noise mitigation commitments of the Applicant).

Appendix C provides modelled plant locations adopted for this assessment.

5.3 Noise Attenuation Assumptions

The noise model adopted the following noise controls.

- Construction of a 3m high vegetated amenity bund along the northern, eastern and western site boundary.
- The primary crushing plant and secondary/tertiary cone crusher will have an overall sound power level of 105dBA (LAeq15-min) and 107dBA (LAeq15-min) respectively. This can be achieved via application of several acoustic treatment options. The treatments include such options as noise suppression or establishment of near-field screens, stockpiles or cladding (or a combination of each). Primarily the barriers should attenuate noise from the north and western elements of the crushing plant.

- The primary crushing plant is assumed to operate on the extraction area floor following the development of the initial box cut within Cell 1.
- The primary crushing plant is assumed to operate as close to a completed extraction face as possible, in particular when operating south to north (as per Scenario 2).

5.3.1 Sound Power Levels - Operation

Mobile plant noise emission data used in modelling for this assessment were obtained from the MAC noise database for relevant noise sources that are proposed to be used in the quarry. The noise emission levels used in modelling are summarised in **Table 17**. **Appendix E** provides the octave sound power data of modelled plant for the operational scenarios.

Table 17 Equipment Sound Power Levels

Item	$LA_{eq(15min)}$ Sound Power Level (SWL),	Period of Operation		
Operational Noise Sources		**Day**	**Evening**	**Morning Shoulder**
Primary Crusher (x1)	110 (105)[1]	✓	x	x
Secondary / Tertiary	113 (107)[1]	✓	x	x
Excavator (x1)	106	✓	x	x
Loader (x2)	106	✓	✓ (x1)	✓ (x1)
Road Trucks (x3)	102	✓	✓	✓
Road Truck Idle (x3)	86	✓	✓	✓
Water Truck (x1)	101	✓	x	x
Product conveyor (x1)	67dB/m	✓	x	x
Drill Rig (x1)	114	✓	x	x
Haul Truck (x1)	108	✓	x	x

Note 1: Attenuated sound power level shown in brackets.

5.3.2 Sound Power Levels - Construction

The construction noise emission levels used in modelling are summarised in **Table 18**. The construction scenario adopted a generic construction fleet representative of plant used in road upgrade activities or the haul road and bund construction. Plant items for this assessment were situated in and around the site access gate and at the northern site boundary (ie north of cell 16) to provide an indicative worst case representation of noise emissions during construction. The construction modelling assessment adopted methodologies consistent with the operational assessment.

Table 18 Equipment Sound Power Levels, Construction	
Item	Sound Power Level (SWL), dBA[1]
Compactor	110
Road Trucks (x2)	102
Grader	108
Backhoe/Small Excavator	101
Total Equivalent Fleet Sound Power[1]	113

Note 1: The adopted fleet sound power level is considered representative of construction activities and plant combinations for this type of project

5.4 Blast Assessment Methodology

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, relevant for blasting of hard rock. This formula has been shown to be conservative in calculating overpressure and vibration.

The relevant formulae are as follows:

$$PVS = 500\ (R/Q\ ^{0.5})^{-1.6}$$

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

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)

Blast emission predictions were completed using a combination of the above formula and relevant receiver offset distances from blasting locations (near and far) within project cells. Section 6.5 presents the predicted blast overpressure and vibration levels for surrounding receivers to the quarry.

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6 Noise Modelling Results and Discussion

6.1 Operational Noise Results

Predicted quarry operations include extraction, processing, product loading and transportation. The predicted noise levels at each receiver during calm and prevailing meteorological conditions are provided in **Table 19**.

The results of the model show that noise emissions from the quarry for all assessed scenarios satisfy the PSNL at all residential receivers. **Appendix F** provides noise contour results for quarry operations.

Table 19 Predicted Operational Noise Levels, dBA $LA_{eq(15min)}$

Receiver	Period	Scenario 1	Scenario 2	PSNL
R3	Morning Shoulder	33	33	37
	Day	31	27	39
	Evening	26	26	35
R4	Morning Shoulder	32	32	37
	Day	30	26	39
	Evening	25	25	35
R7	Morning Shoulder	35	35	36
	Day	35	35	37
	Evening	30	30	35
R9	Morning Shoulder	31	31	35
	Day	30	30	35
	Evening	24	24	35
R10	Morning Shoulder	34	34	36
	Day	35	30	37
	Evening	28	28	35
R11	Morning Shoulder	31	31	36
	Day	30	26	37
	Evening	24	24	35
R14	Morning Shoulder	32	32	37
	Day	29	28	39
	Evening	26	26	35
R15	Morning Shoulder	30	30	37
	Day	28	25	39
	Evening	23	23	35
R18	Morning Shoulder	27	27	37
	Day	26	22	39
	Evening	21	21	35
R19	Morning Shoulder	29	29	37
	Day	27	23	39
	Evening	22	22	35
R20	Morning Shoulder	28	28	37
	Day	26	22	39

Table 19 Predicted Operational Noise Levels, dBA $LA_{eq(15min)}$				
Receiver	Period	Scenario 1	Scenario 2	PSNL
	Evening	21	21	35
R22	Noisiest 1-hr period	27	26	35[2]
R24	Morning Shoulder	27	27	35
	Day	25	24	35
	Evening	20	20	35
R26	When in use	25	25	65
R27	Noisiest 1-hr period	24	23	35[2]
R28	Noisiest 1-hr period	25	24	35[2]
R30[1]	Morning Shoulder	34	34	35
	Day	34	35	35
	Evening	29	29	35
R31[1]	Morning Shoulder	30	30	35
	Day	29	29	35
	Evening	23	23	35

Note 1: Proposed future residential subdivisions.

Note 2: Internal criteria.

6.2 Sleep Disturbance Results

In assessing sleep disturbance, typical LAmax noise levels from transient noise events such as metallic impact noise (ie tailgate impact) from the quarry's processing and stockpiling area were assessed to the nearest residential receivers. The use of the LAmax noise level provides a worst-case prediction since the LA1(1minute) noise level of a noise event is likely to be less than the LAmax. 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.

Noise modelling quantified the noise levels from maximum night time events of product dispatch during the morning shoulder (ie 5am to 7am) to each assessed residential receiver during F Class stability conditions (ie worst case). Noise level predictions from LA_{max} events are presented in **Table 20** and do not exceed the sleep disturbance screening criterion at any assessed residential receiver.

Furthermore, internal noise levels within all receivers (assuming -10dB for a partially opened window) are expected to remain below the maximum internal noise criteria of 50 to 55dB that would wake sleeping occupants.

Table 20 Predicted Operational Noise Levels, dBA LAmax			
Receiver	Period	LAmax Noise Predictions, dBA	Sleep Disturbance Screening Criterion, LAmax, dBA
R3	Morning Shoulder	42	45
R4	Morning Shoulder	41	45
R7	Morning Shoulder	45	45
R9	Morning Shoulder	39	45
R10	Morning Shoulder	43	45
R11	Morning Shoulder	40	45
R14	Morning Shoulder	41	45
R15	Morning Shoulder	39	45
R18	Morning Shoulder	36	45
R19	Morning Shoulder	38	45
R20	Morning Shoulder	37	45
R24	Morning Shoulder	35	45
R30[1]	Morning Shoulder	42	45
R31[1]	Morning Shoulder	38	45

Note 1: Proposed future residential subdivisions.

6.3 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 future receivers within the proposed subdivision at Lot 1 DP880413, Sheraton Road. 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.

Maximum product dispatch from the quarry will be up to 60 loads per day (120 movements) and up to a maximum of 10 loads per hour (20 movements). For this assessment, it has been assumed that 120 truck movements travel along Sheraton Road in the day assessment period (ie 15hr LAeq) and that 20 loads (40 movements) travel along Sheraton Road in the night assessment period (ie 9hr LAeq) between the hours of 5am and 7am. Therefore, results should be considered worst case. The results of the traffic noise calculations are presented in **Table 21** and demonstrate the noise levels from quarry road trucks would remain below the relevant day and night criteria.

Table 21 Operational Road Traffic Noise Levels					
Distance to Nearest Receiver (m)	Assessment Criteria	Existing Traffic	Future Project Traffic Noise[1]	Existing + Future Quarry Combined	Total Change
Day $L_{Aeq(15hr)}$, dBA					
30	60	48.3[1]	41.4	49.1	0.8
Night $L_{Aeq(9hr)}$, dBA					
30	50	44.2[1]	39.1	45.3	1.1

Note 1: Calculated based on peak AM and PM traffic flows as per Barnson Traffic Impact Assessment Report, August 2016.

The traffic noise contribution from the quarry is predicted to remain below the relevant day and night assessment criteria at dwellings situated in the proposed Sheraton Road subdivision, hypothetically assumed to be 30m from the centre line of Sheraton Road (ie Lot 1 DP 880413). Furthermore, additional traffic from the project will not increase existing noise levels by more than 2dB, hence satisfy the relative increase criteria.

6.4 Construction Noise Results

Predicted $L_{Aeq(15min)}$ noise emissions for construction satisfy relevant construction noise management levels for all assessed receivers with the exception of the proposed residential subdivision (R30). Notwithstanding, the quarry will adopt reasonable and feasible noise management initiatives to reduce construction noise impacts to the surrounding community. **Table 22** presents the results of the construction noise model assessment.

Table 22 Construction Noise Assessment Results			
Receiver	Assessment Period	Predicted $L_{Aeq(15min)}$, dBA	Noise Management Level $L_{Aeq(15min)}$, dBA
R3	Day	27	44
R4	Day	27	44
R7	Day	40	42
R9	Day	38	40
R10	Day	35	42
R11	Day	31	42
R14	Day	31	44
R15	Day	26	44
R18	Day	23	44
R19	Day	24	44
R20	Day	23	44
R22	Day	34	45 (internal)
R24	Day	32	40
R26	Day	31	65
R27	Day	30	45 (internal)
R28	Day	30	45 (internal)
R30[1]	Day	53	40
R31[1]	Day	39	40

Note 1: Proposed future residential subdivisions.

It is noted that due to development schedules, the coincidence of project construction activities and dwellings being established at R30 may not eventuate. Notwithstanding, where dwellings are constructed within the proposed R30 subdivision at the commencement of project construction works, it is recommended that noise management and mitigation measures be adopted during noise intensive construction activities to minimise noise impacts on surrounding receivers.

Recommendations for consideration during construction activities for this project may include:

- toolbox and induction of personnel prior to shift to discuss noise control measures that may be implemented to reduce noise emissions to the community;
- implement boundary fences/retaining walls as early as possible to maximise their attenuation benefits;
- where possible use mobile screens or construction hording to act as barriers between construction works and receivers;
- all plant should be shutdown when not in use. Plant to be parked/started at farthest point from relevant assessment locations (ie northern boundary);
- operating plant in a conservative manner (no over-revving);
- selection of the quietest suitable machinery available for each activity;
- avoidance of noisy plant/machinery working simultaneously where practicable;
- minimisation of metallic impact noise;
- all plant are to utilise a broadband reverse alarm in lieu of the traditional hi frequency type reverse alarm; and
- undertake letter box drops to notify receivers of potential works.

6.5 Blasting Results

Nearest receivers to the quarry include R7 (existing residential) R30 (proposed residential) and the Neoen Photovoltaic Power Plant (R32) proposed to be established to the north of the project site. **Table 23** provides the calculated blast MICs for the minimum and maximum offset distances where blasting may occur within future extraction areas of the quarry. It is noted that 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. A hypothetically maximum MIC of 150kg has been adopted for this assessment.

Table 23 Blast Overpressure and Vibration Results, Minimum and Maximum Blast Distances						
Receiver	Approximate minimum blast distance to receivers (m)	Calculated overpressure (dB(L)peak)	Airblast criteria (dB(L)peak)	Calculated vibration PPV (mm/s)	Vibration criteria (mm/s)	Calculated MIC (kg) to achieve criteria
Minimum Offset Distances						
R7	480	111.5	115	0.4	5	30
R30	300	115.1	115	0.6	5	20
R32	50	132.7	133	8.3	10	15
	100	127.9	133	4.8	10	30
	200	126.2	133	5.7	10	150
Maximum Offset Distances						
R7	900	110.5	115	0.5	5	150
R30	1145	108.0	115	0.4	5	150
R32	475	117.2	133	1.4	10	150

The conservatively predicted blast overpressure and vibration levels identify that MICs should be carefully managed when in close proximity to receivers. With respect to the Neoen Photovoltaic Power Plant, careful management of MIC levels demonstrate that achievement of the ground vibration and airblast criteria is feasible. Notwithstanding, it is recommended that trial blasting in conjunction with vibration monitoring be completed during the start-up phase (ie Cell 1) of the quarry to quantify the relationship between MIC and received levels and to establish a site law for the project. It is recommended that this commence with smaller sized (MIC) blasts, progressively increasing to allow for analysis of the relationship between MIC, vibration and effect on the Photovoltaic solar panels of receiver R32.

6.6 Cumulative Noise Results

The cumulative noise assessment has reviewed existing industrial noise in the locality surrounding the proposed quarry.

Existing daytime noise levels in the catchment surrounding the quarry identified existing industrial noise level contributions during noise enhancing winds as 32dBA $LA_{eq(15min)}$ at R7 (ie the centre of the project noise catchment).

The predicted contribution of quarry noise to the surrounding catchment is generally <35 dBA. Therefore, the overall change to existing industrial noise levels is expected to remain below 37dBA and satisfy the INPs daytime amenity criteria of 50dBA, $LA_{eq(period)}$ for rural receivers.

7 Conclusion

MAC has conducted a NVIA of potential impacts from the proposed basalt quarry, to be established at the "South Keswick" property southeast of Dubbo, NSW. The assessment has quantified potential operational noise emissions pertaining to extraction, processing, drilling and dispatch via road trucks. The results of the NVIA demonstrate that operational noise levels comply with the relevant INP criteria for the morning shoulder, daytime and evening assessment periods once noise controls outlined in this assessment are implemented to site. The controls include the following.

- Construction of a 3m high vegetated amenity bund along the northern, eastern and western site boundary.
- The primary crushing plant and secondary/tertiary cone crusher will have an overall sound power level of 105dBA (LAeq15-min) and 107dBA (LAeq15-min) respectively. This can be achieved via application of several acoustic treatment options. The treatments include such options as noise suppression or establishment of near-field screens, stockpiles or cladding (or a combination of each). Primarily the barriers should attenuate noise from the north and western elements of the crushing plant.
- The primary crushing plant is assumed to operate on the extraction area floor following the development of the initial box cut within Cell 1.
- The primary crushing plant is assumed to operate as close to a completed extraction face as possible, in particular when operating south to north (as per Scenario 2).

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

Additionally, the NVIA demonstrates that the road noise criteria as specified in the RNP will be satisfied at receiver distances of greater than 30m.

Results identify that noise levels from the proposed construction works are anticipated to satisfy standard hours construction noise management levels at all of the surrounding receivers, with the exception of R30. It is likely that dwellings may not be established within the proposed residential development (R30) at the commencement of project construction activities. Notwithstanding, where this is not the case, it is recommended that the project incorporate noise management measures as per Section 6.4 of this report to minimise the potential for construction noise impacts.

MIC blast patterns for the project will be designed specifically to meet the relevant ANZECC guidelines at receivers and be completed in conjunction with an appropriate blast monitoring program. Furthermore, trial blast events in conjunction with vibration monitoring will be completed to quantify levels of overpressure and vibration at the proposed Neoen Photovoltaic Power Plant when operation commences in Cell 1 of the quarry.

Catchments surrounding the quarry are anticipated to have a negligible increase in cumulative industrial noise as a result of the quarry and remain below the INPs amenity criteria.

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

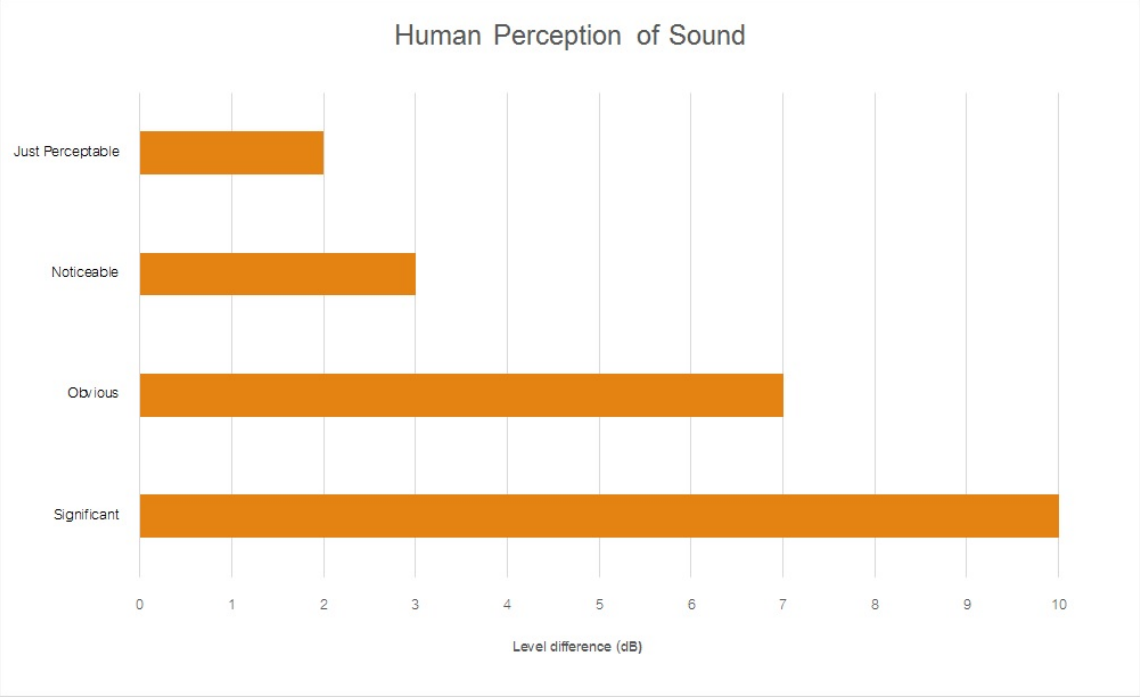
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 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

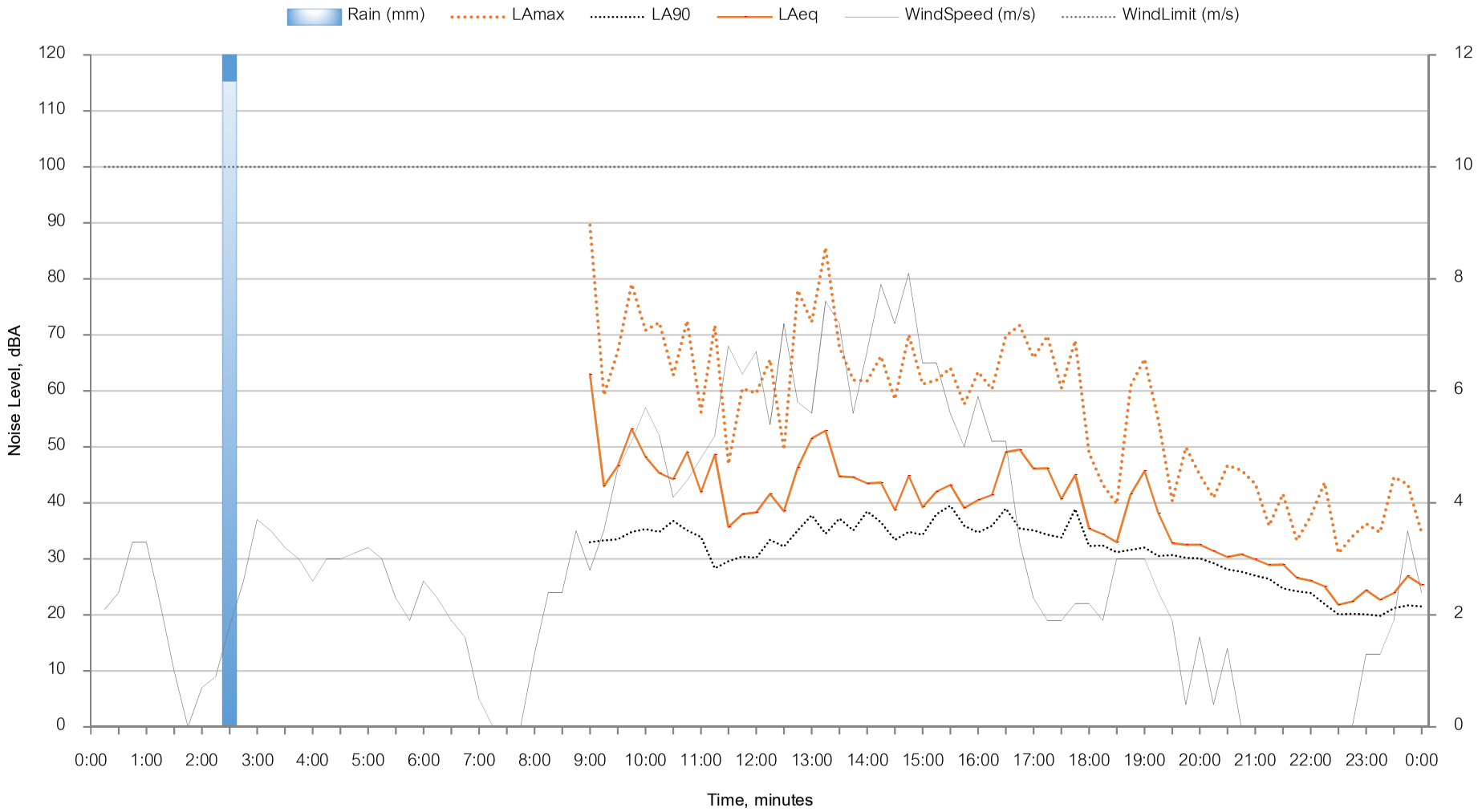


Appendix B – Noise Logging Data

Measured Ambient Noise Levels

Logger 1 - South Keswick Quarry - MAC160254

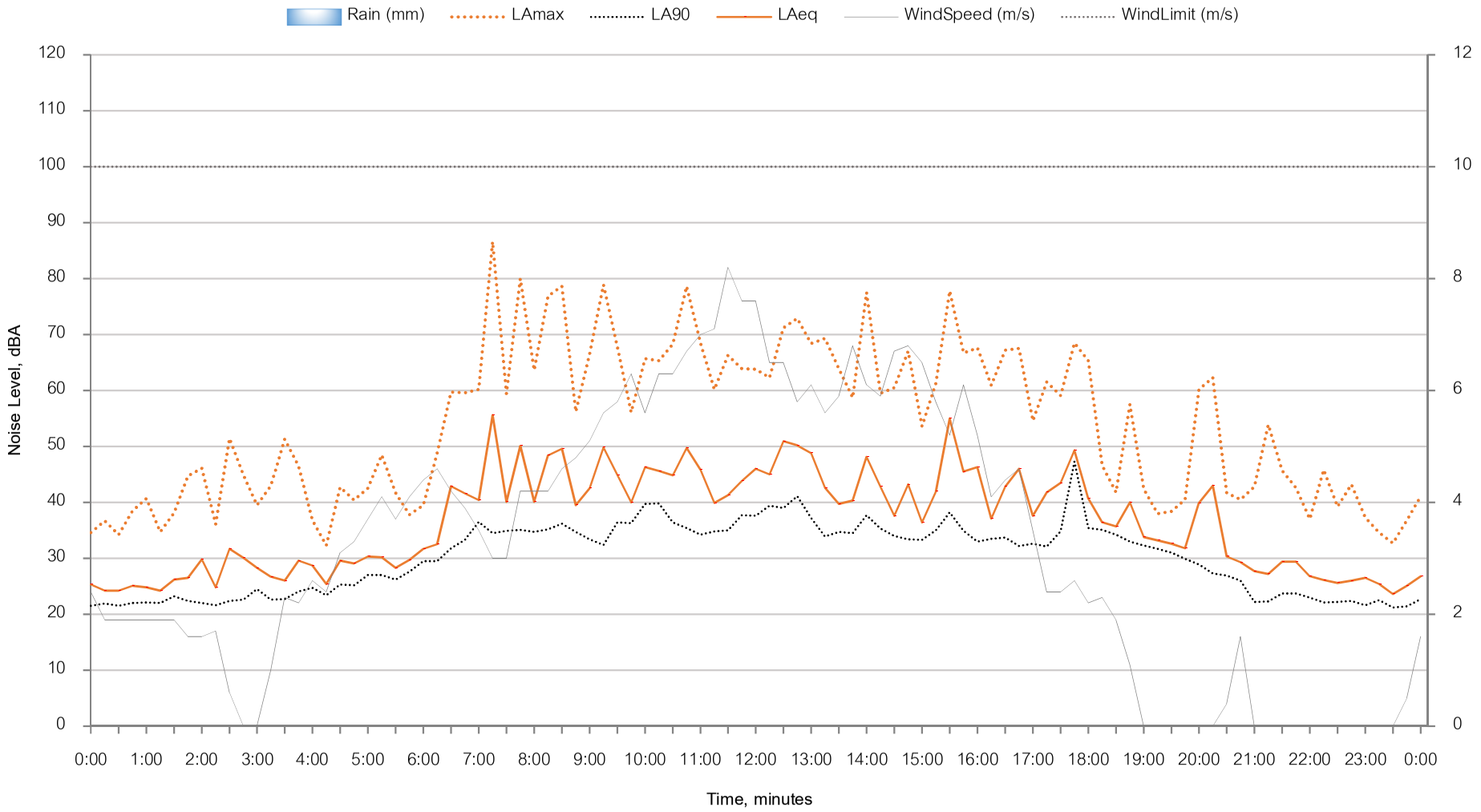
Wednesday, 11-05-16



Measured Ambient Noise Levels

Logger 1 - South Keswick Quarry - MAC160254

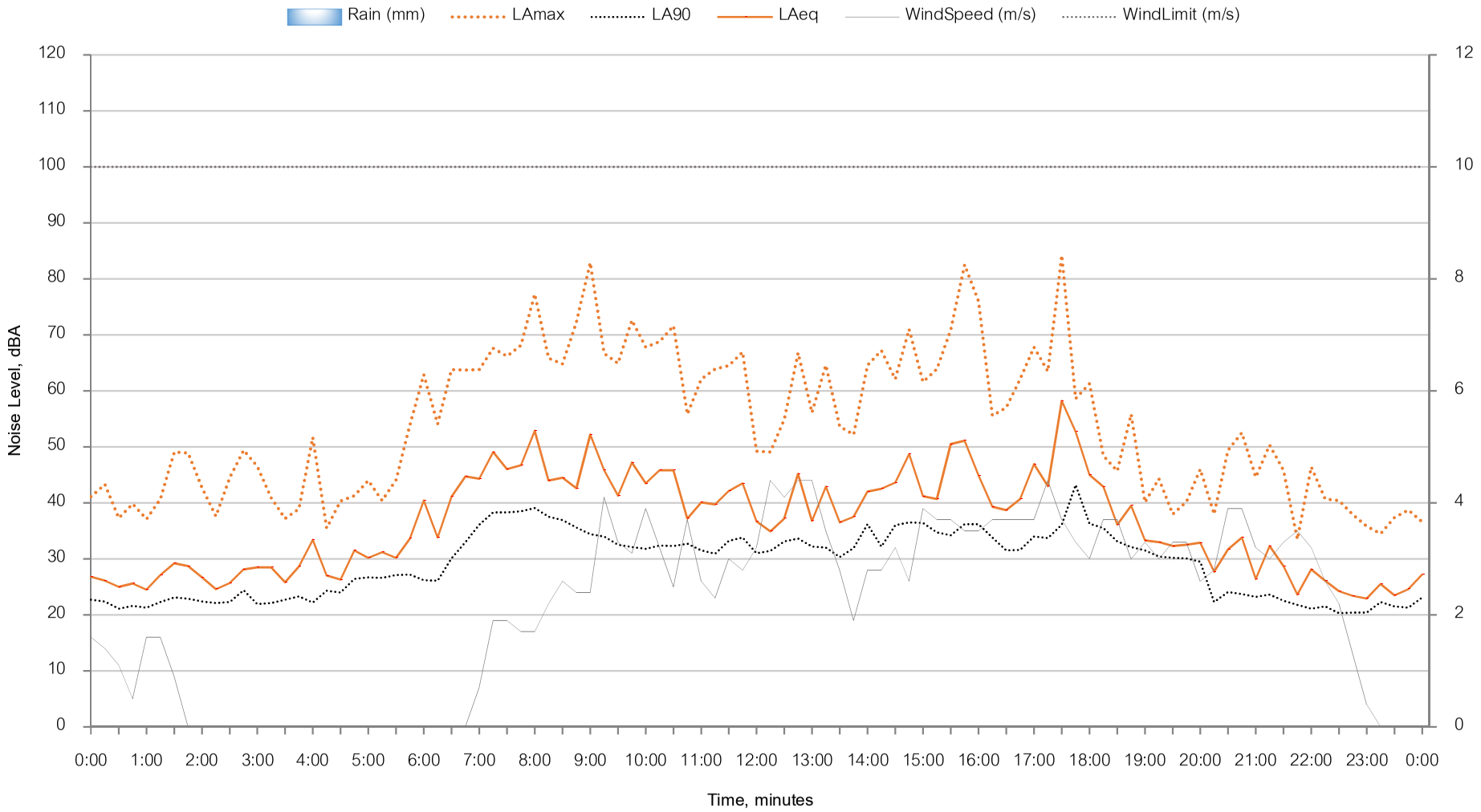
Thursday, 12-05-16



Measured Ambient Noise Levels

Logger 1 - South Keswick Quarry - MAC160254

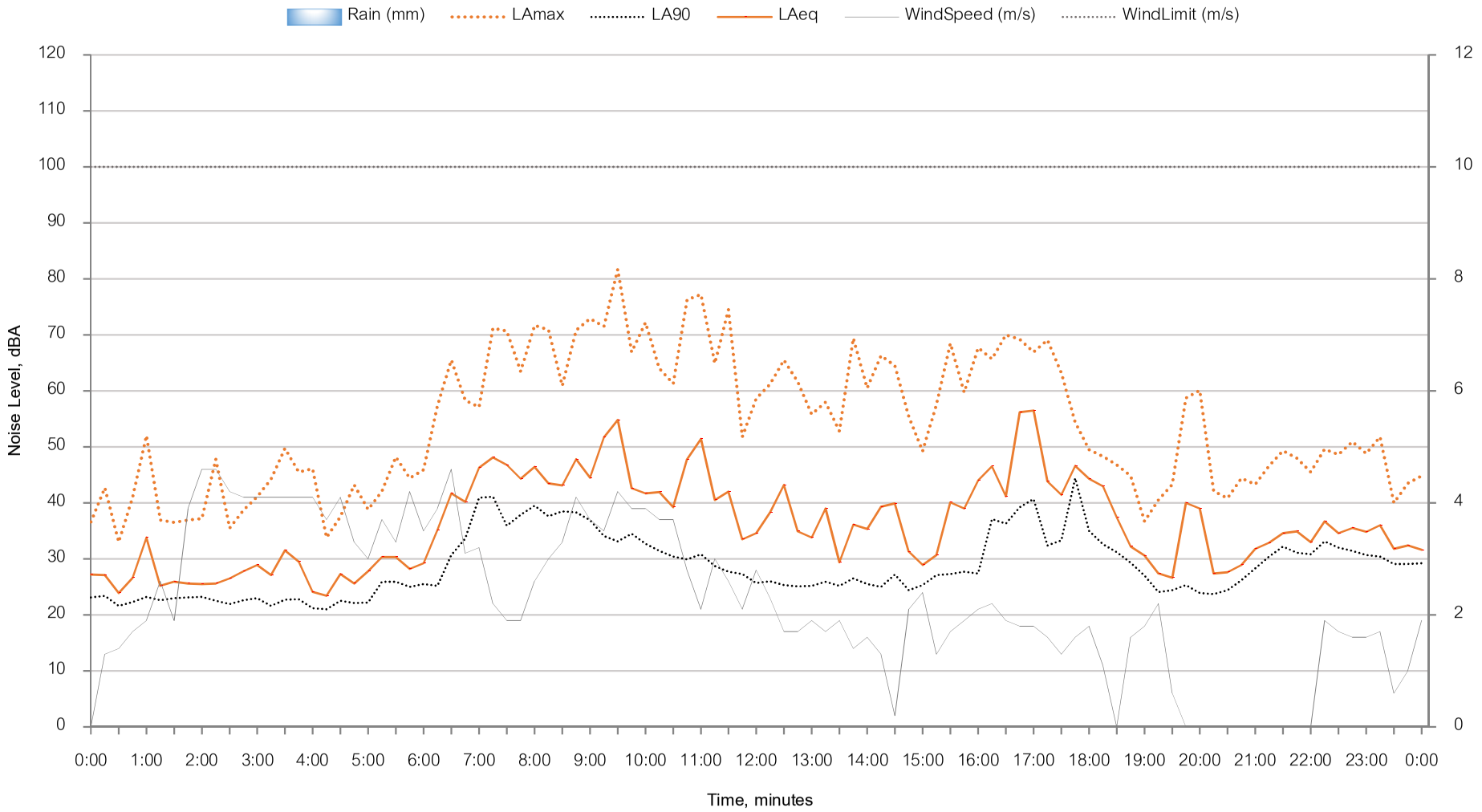
Friday, 13-05-16



Measured Ambient Noise Levels

Logger 1 - South Keswick Quarry - MAC160254

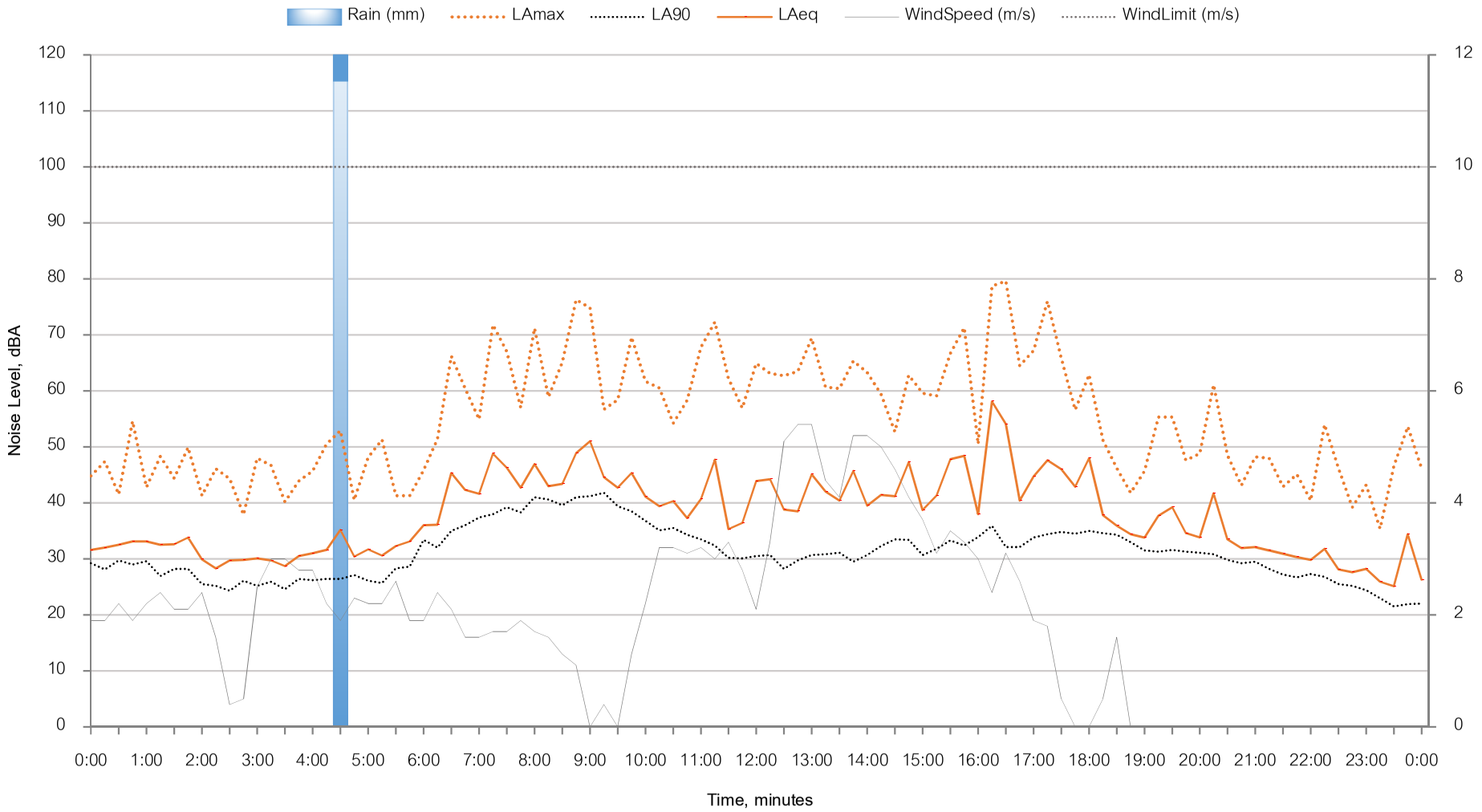
Saturday, 14-05-16



Measured Ambient Noise Levels

Logger 1 - South Keswick Quarry - MAC160254

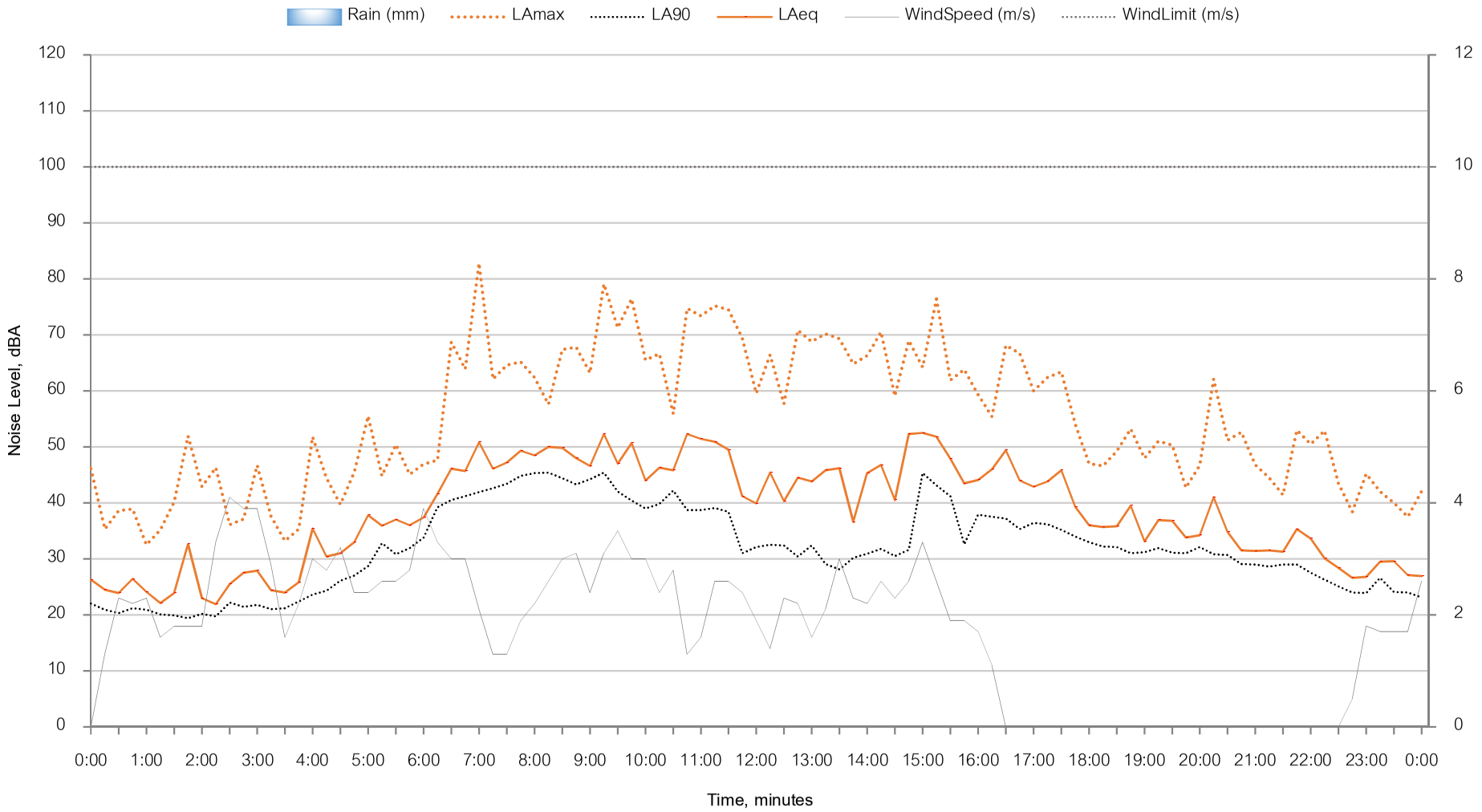
Sunday, 15-05-16



Measured Ambient Noise Levels

Logger 1 - South Keswick Quarry - MAC160254

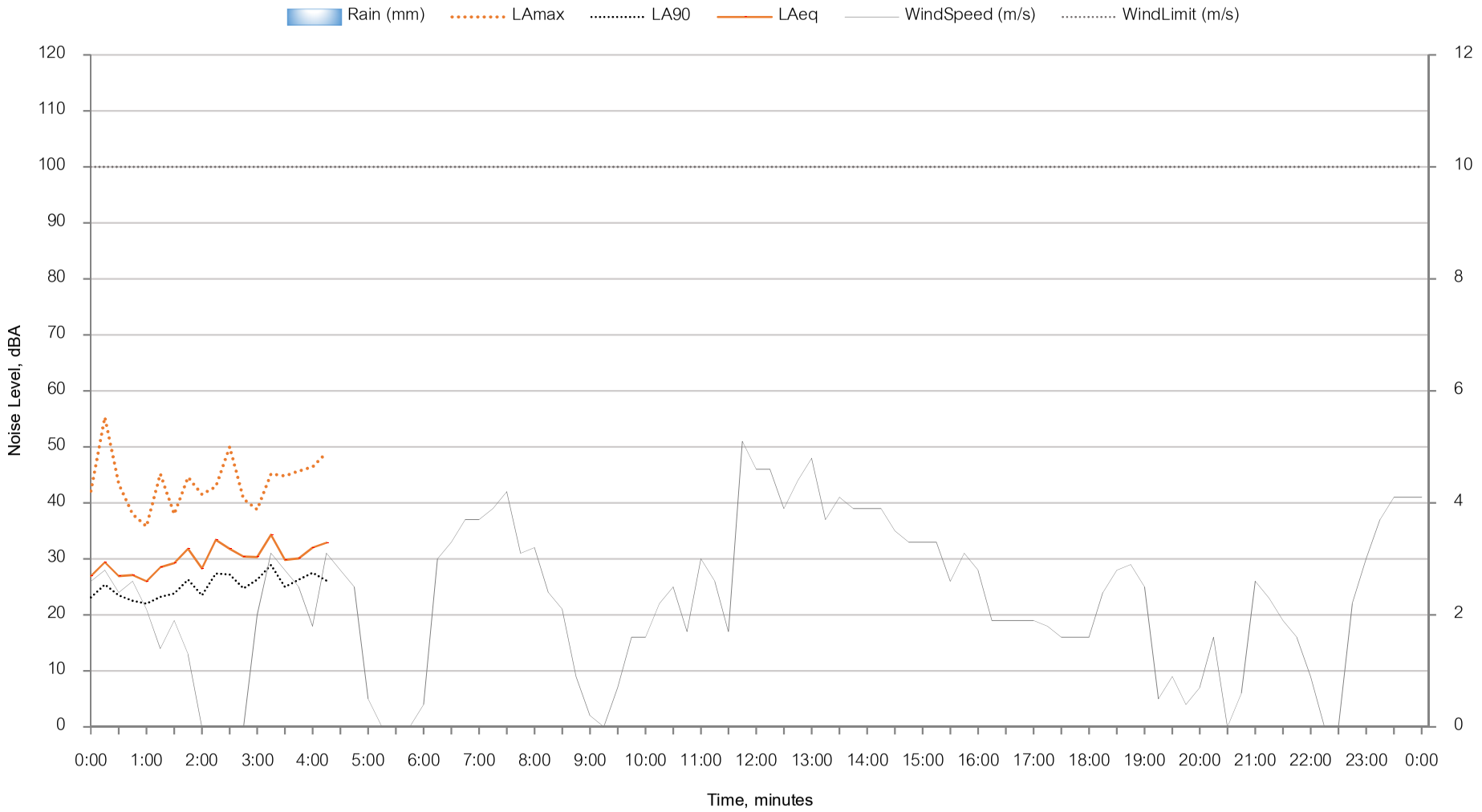
Monday, 16-05-16



Measured Ambient Noise Levels

Logger 1 - South Keswick Quarry - MAC160254

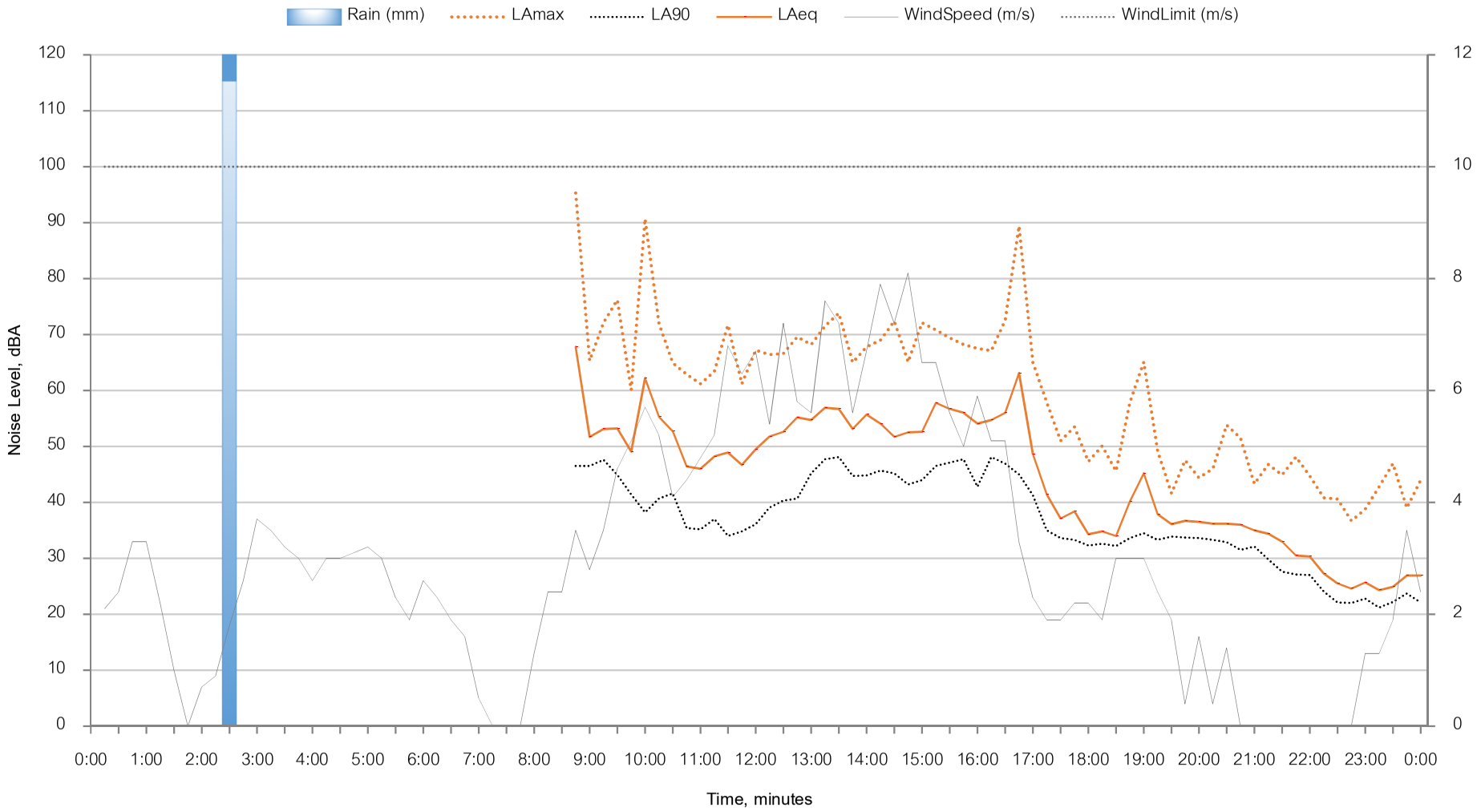
Tuesday, 17-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

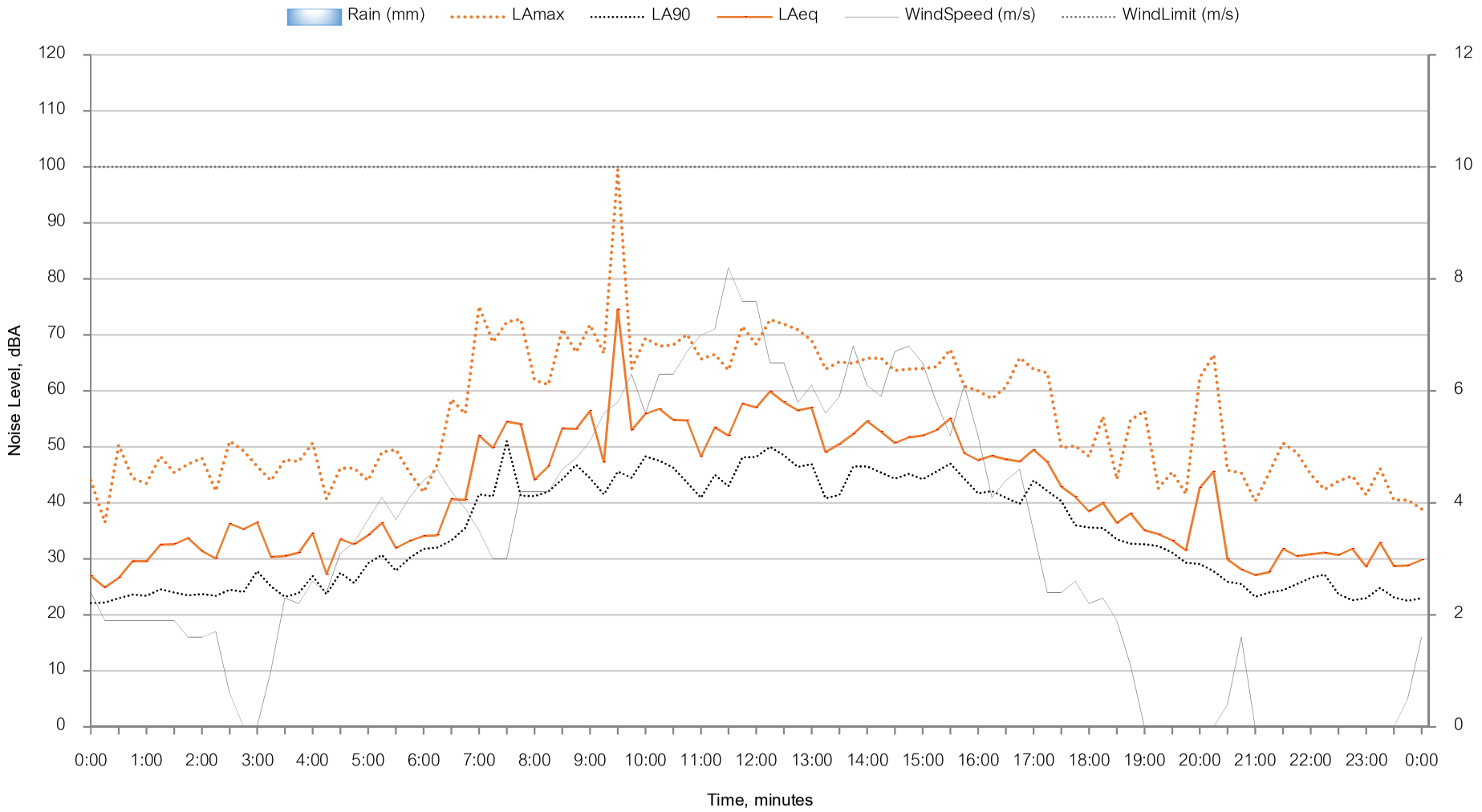
Wednesday, 11-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

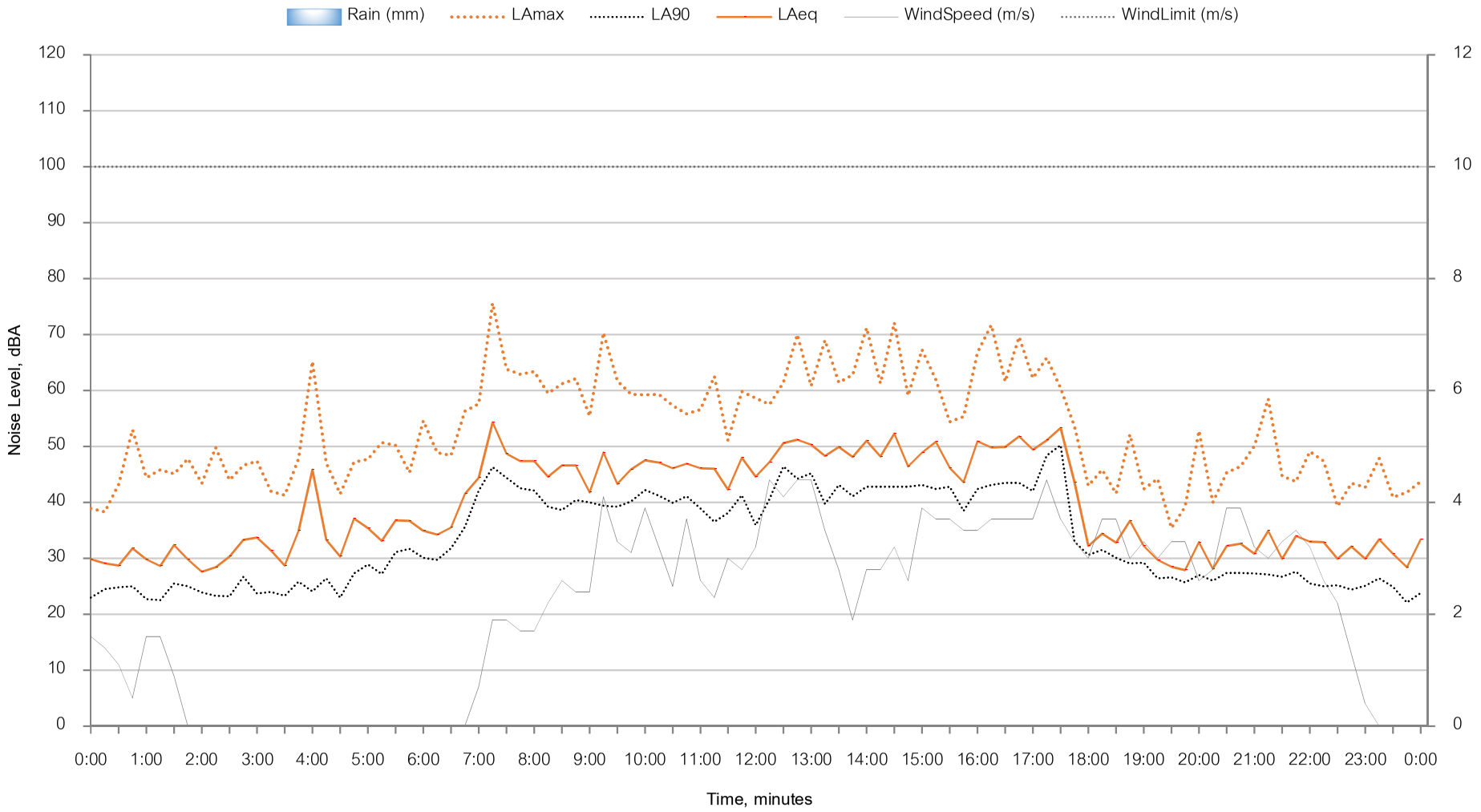
Thursday, 12-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

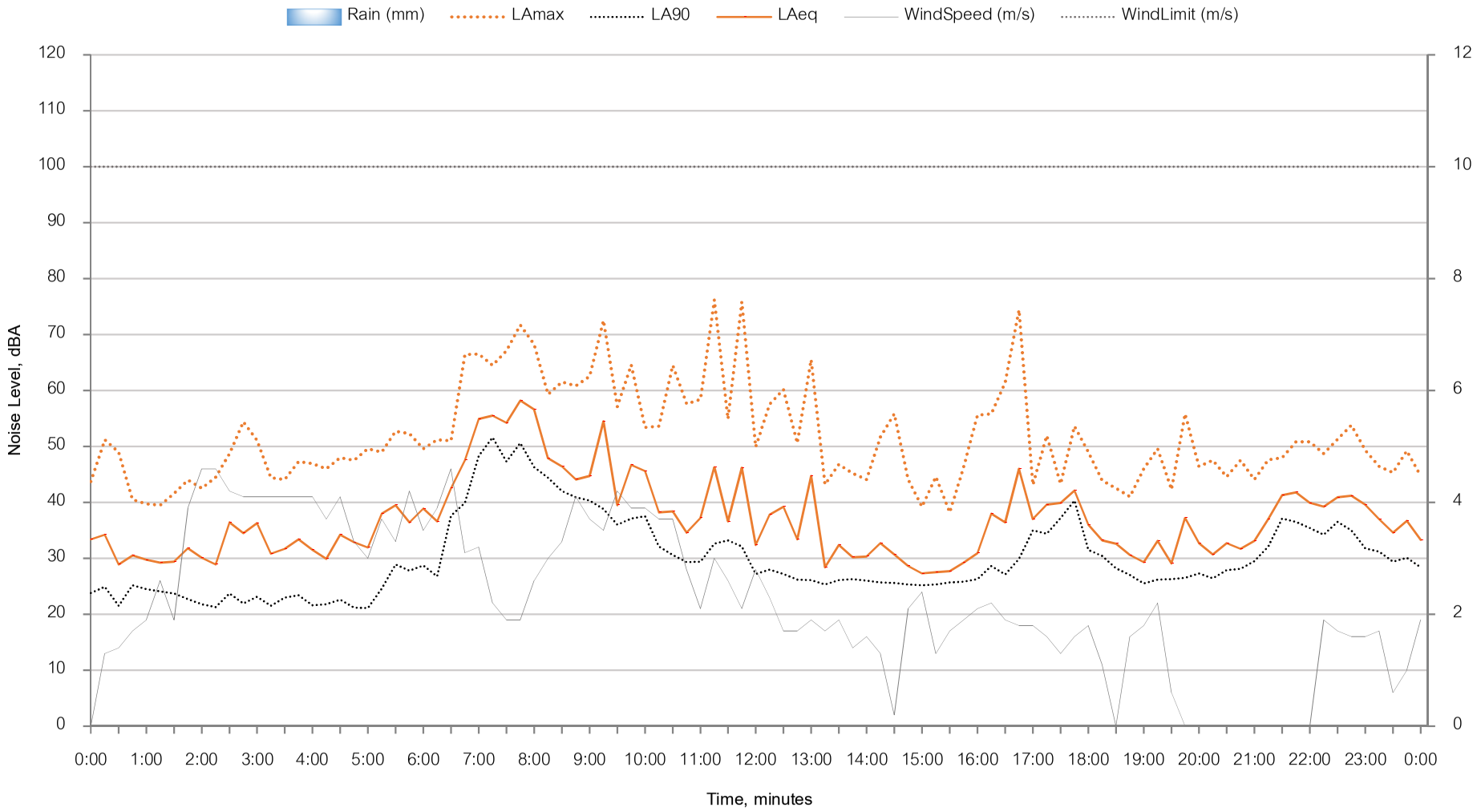
Friday, 13-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

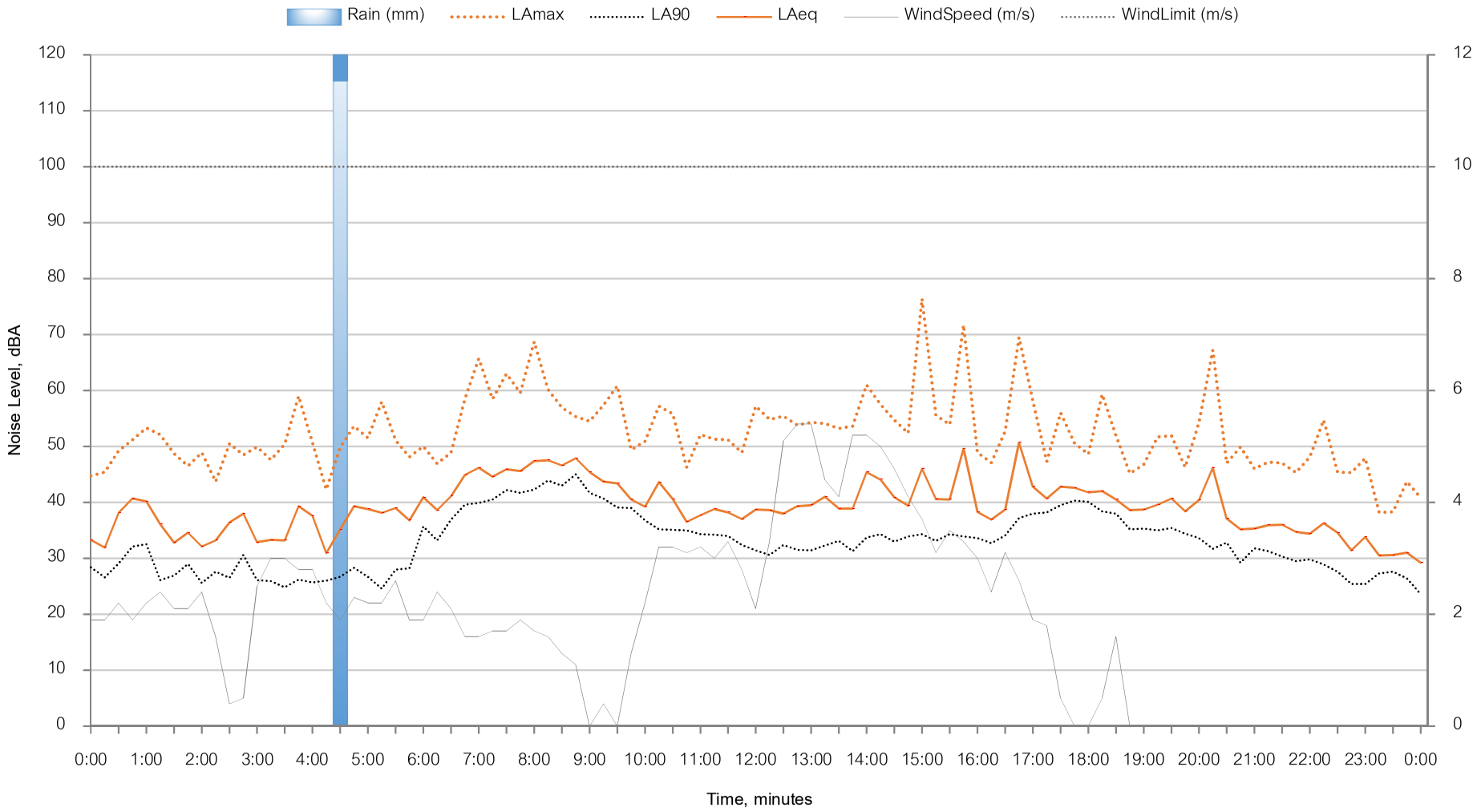
Saturday, 14-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

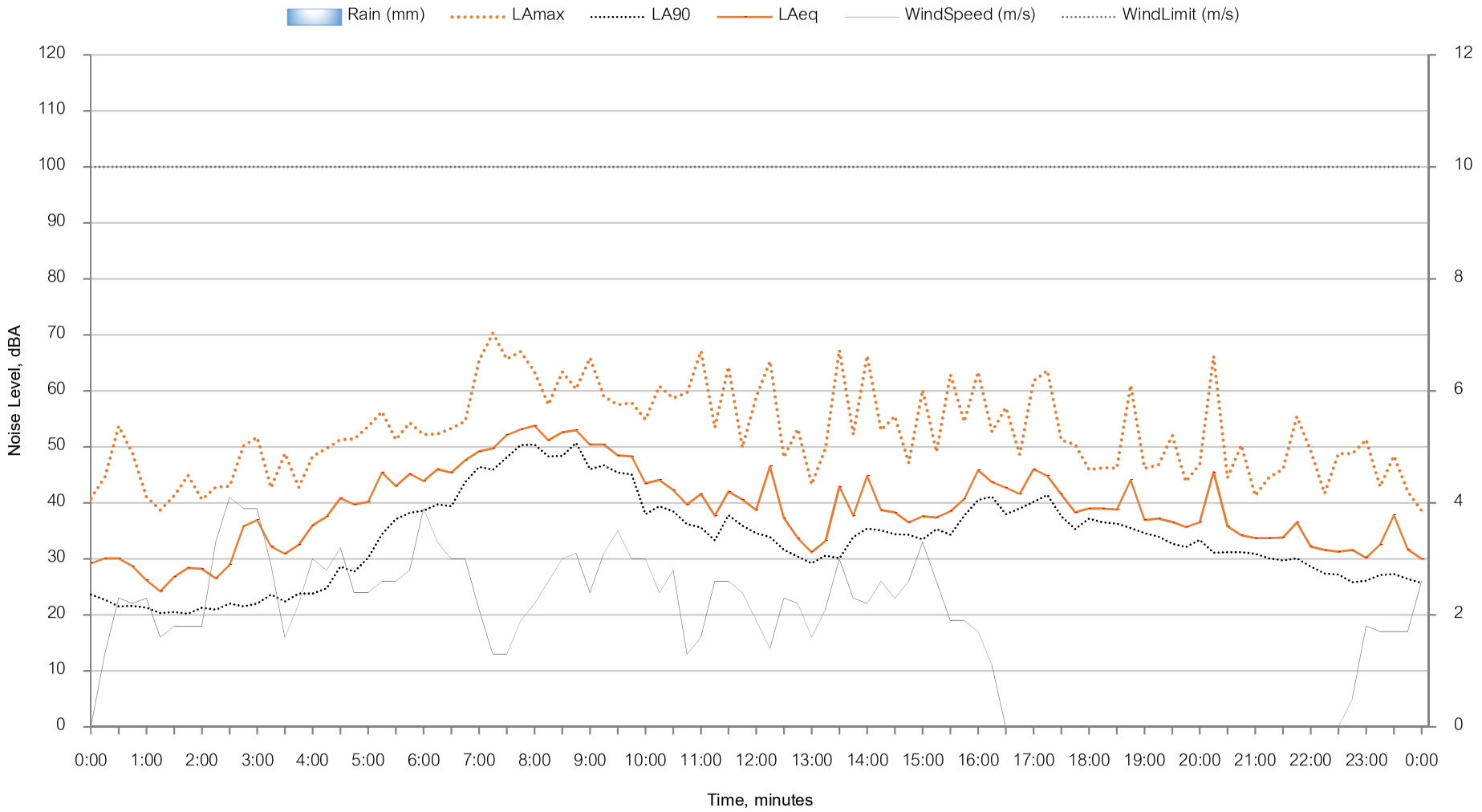
Sunday, 15-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

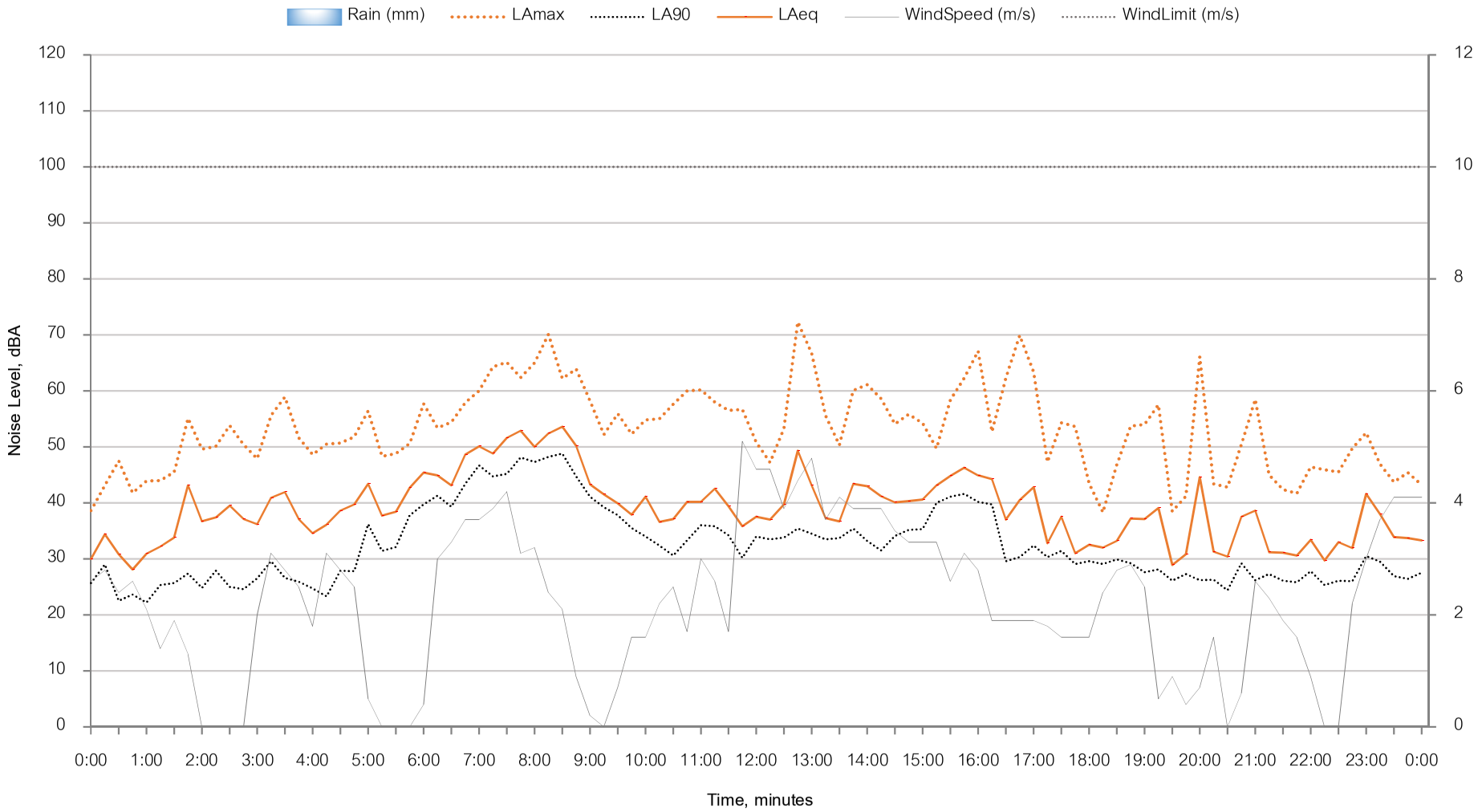
Monday, 16-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

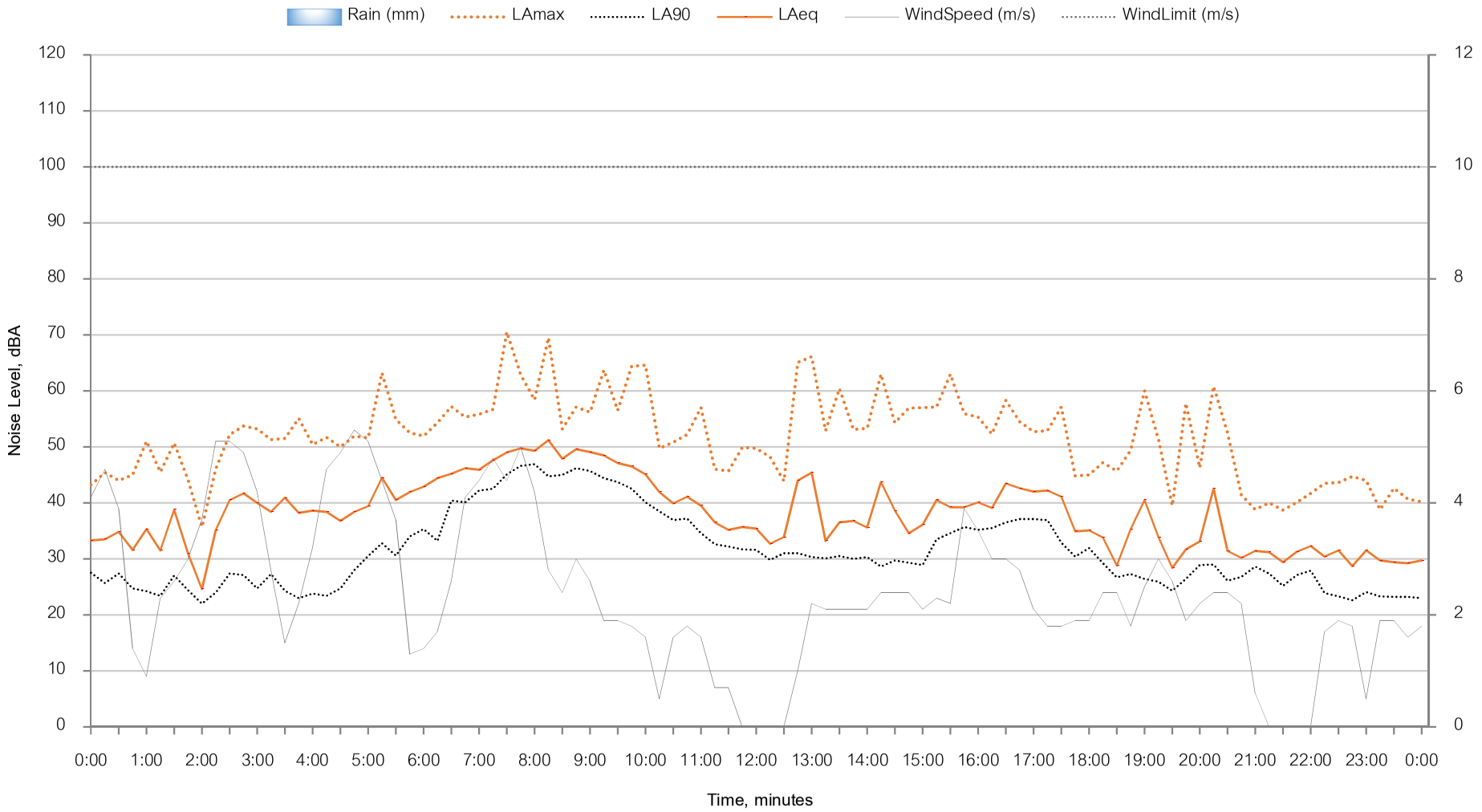
Tuesday, 17-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

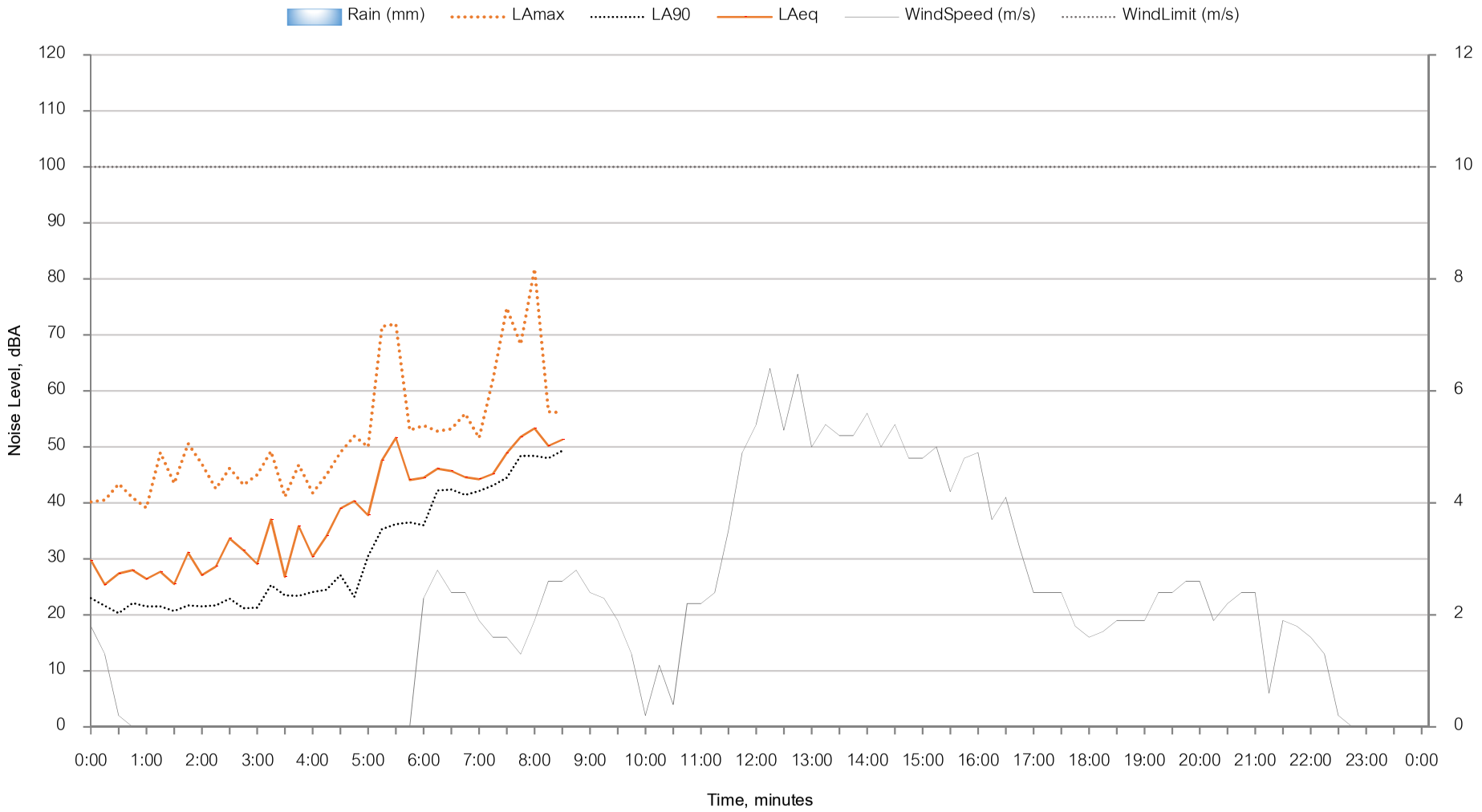
Wednesday, 18-05-16



Measured Ambient Noise Levels

Logger 2 - South Keswick Quarry - MAC160254

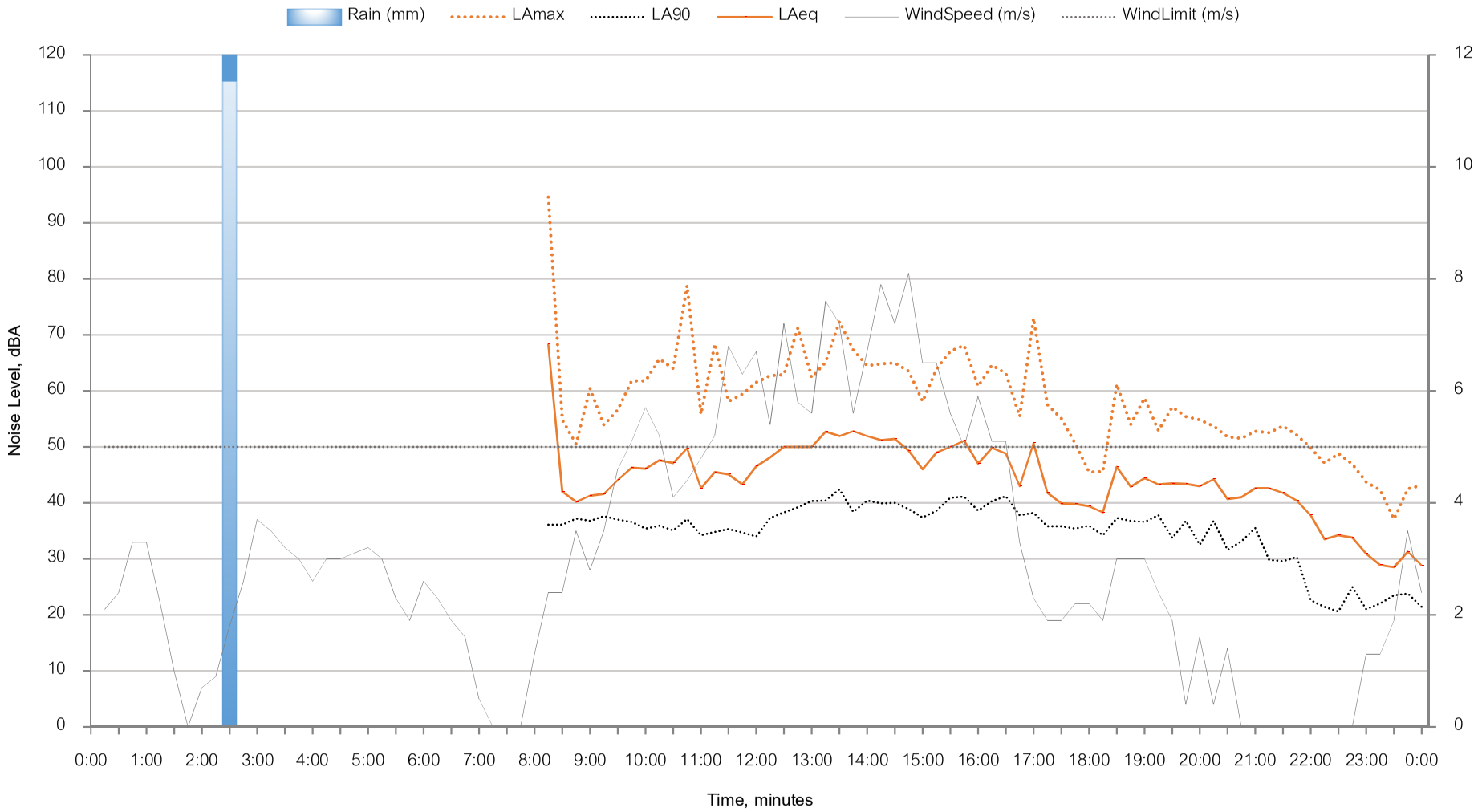
Thursday, 19-05-16



Measured Ambient Noise Levels

Logger 3 - South Keswick Quarry - MAC160254

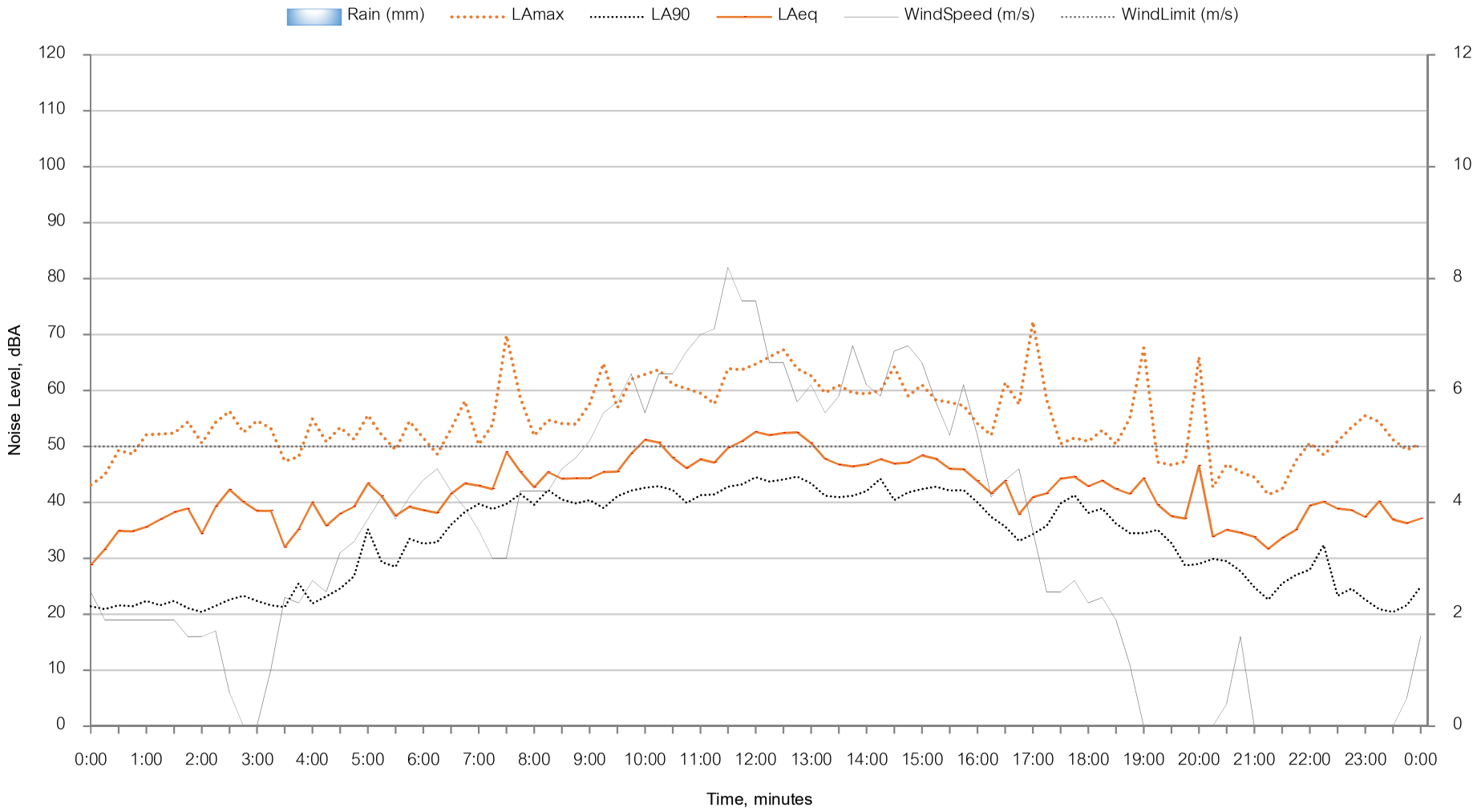
Wednesday, 11-05-16



Measured Ambient Noise Levels

Logger 3 - South Keswick Quarry - MAC160254

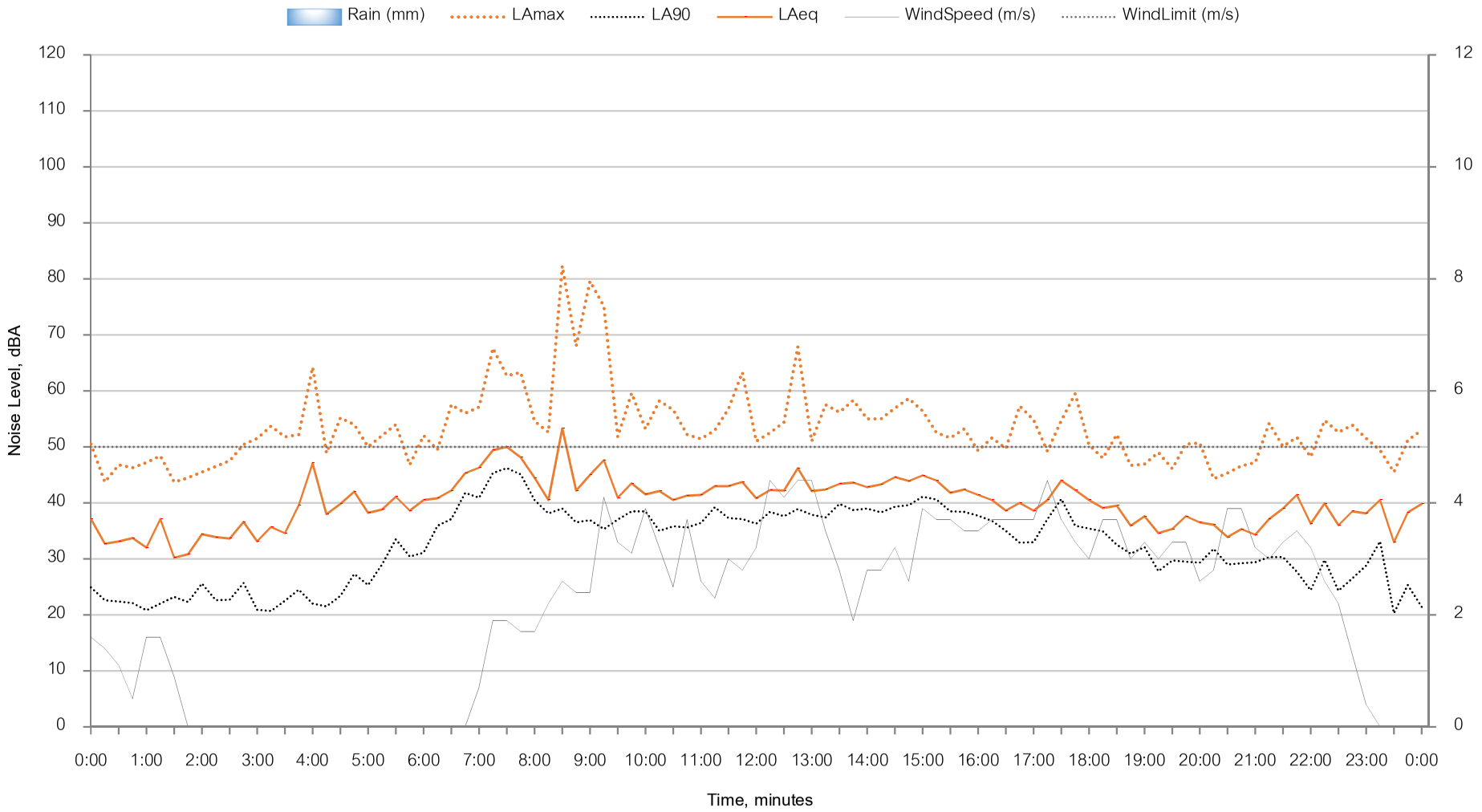
Thursday, 12-05-16



Measured Ambient Noise Levels

Logger 3 - South Keswick Quarry - MAC160254

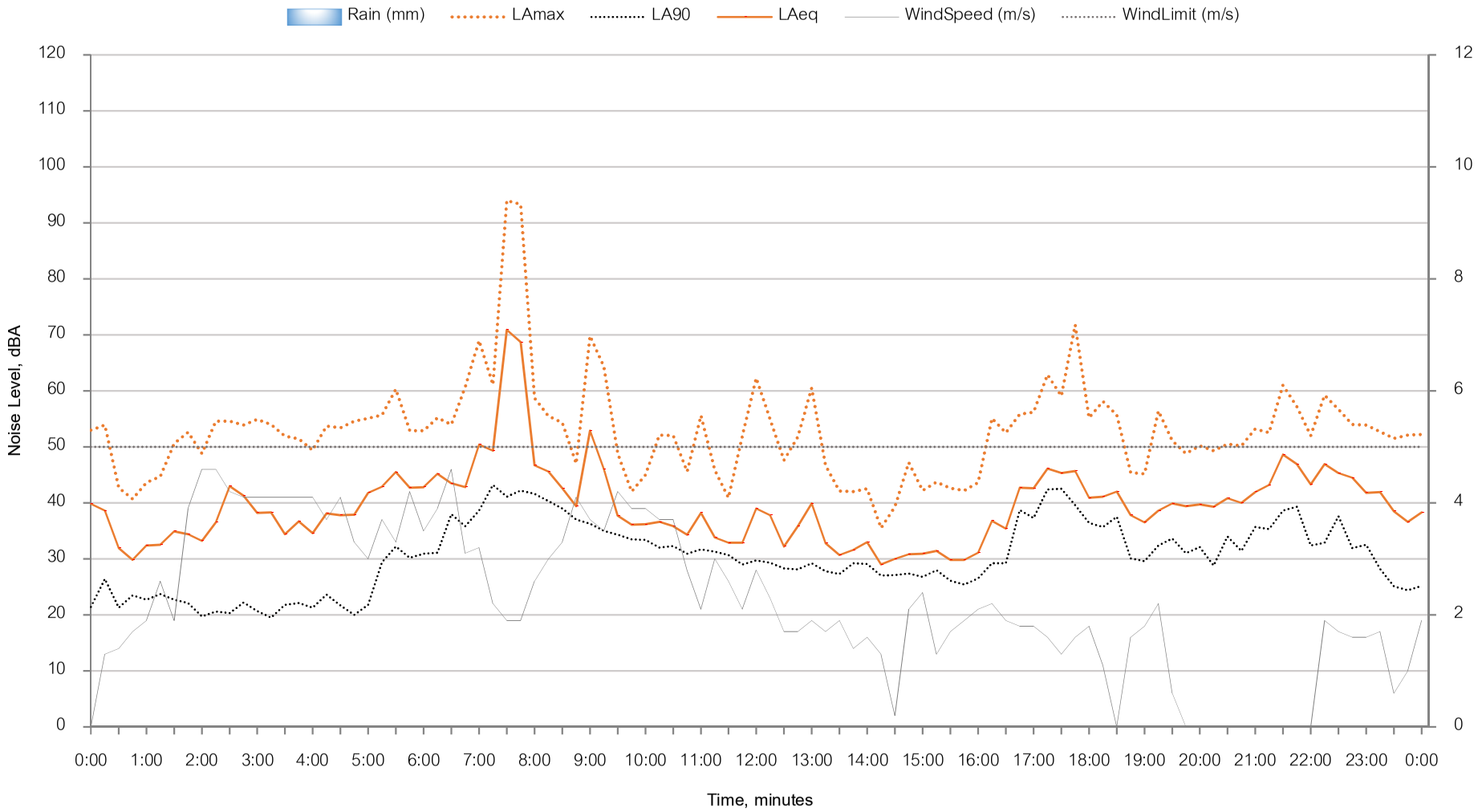
Friday, 13-05-16



Measured Ambient Noise Levels

Logger 3 - South Keswick Quarry - MAC160254

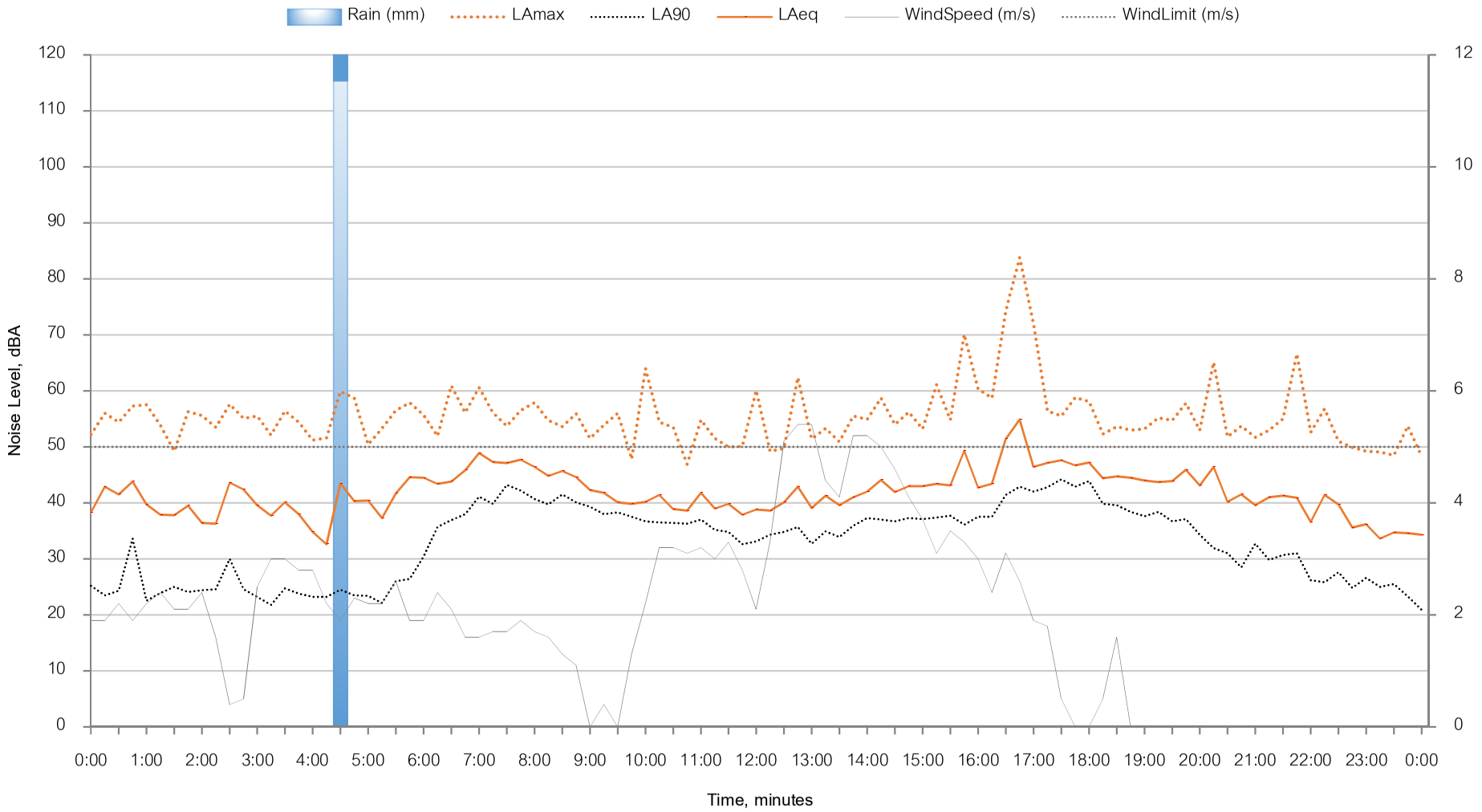
Saturday, 14-05-16



Measured Ambient Noise Levels

Logger 3 - South Keswick Quarry - MAC160254

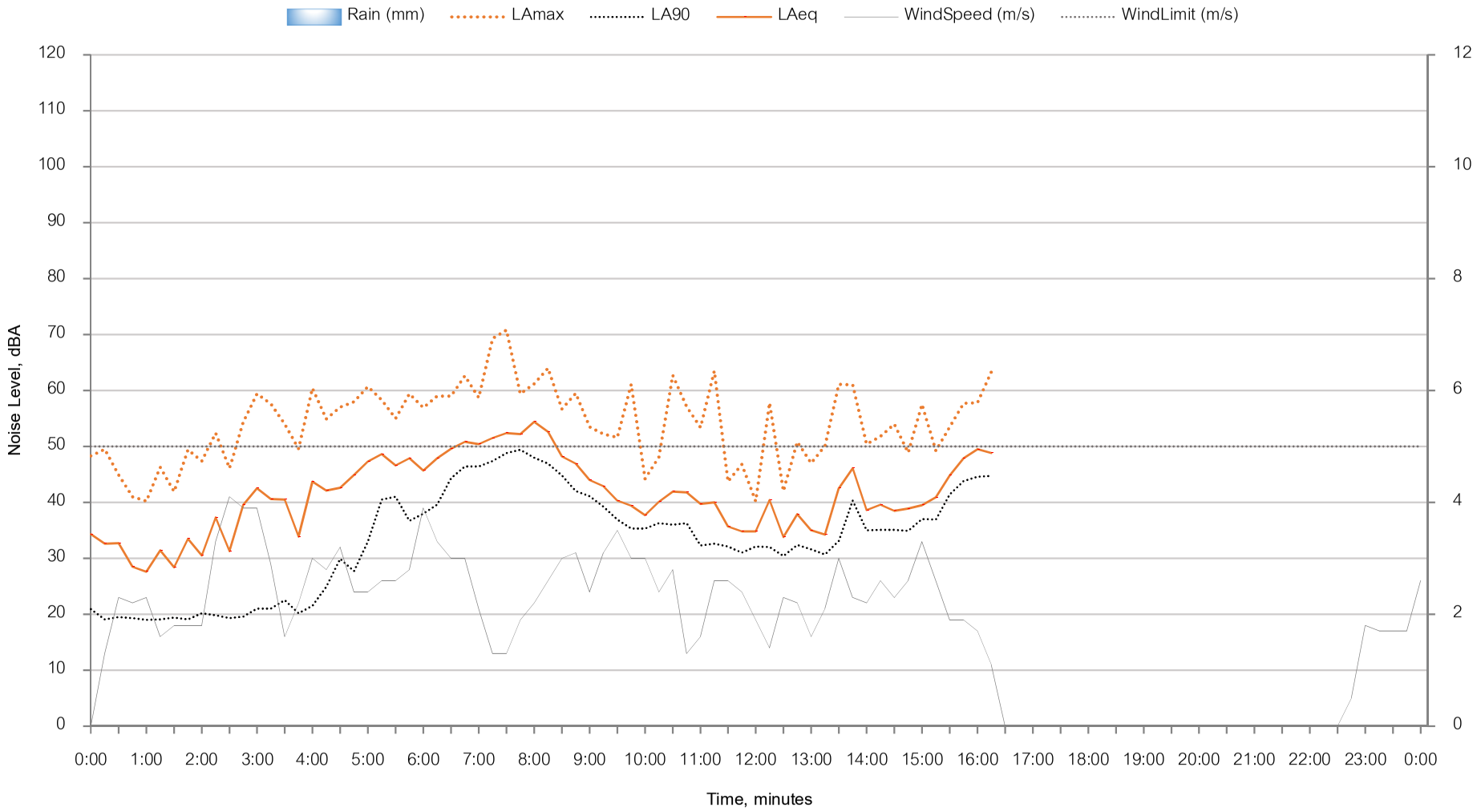
Sunday, 15-05-16



Measured Ambient Noise Levels

Logger 3 - South Keswick Quarry - MAC160254

Monday, 16-05-16



Appendix C – Modelled Plant Locations

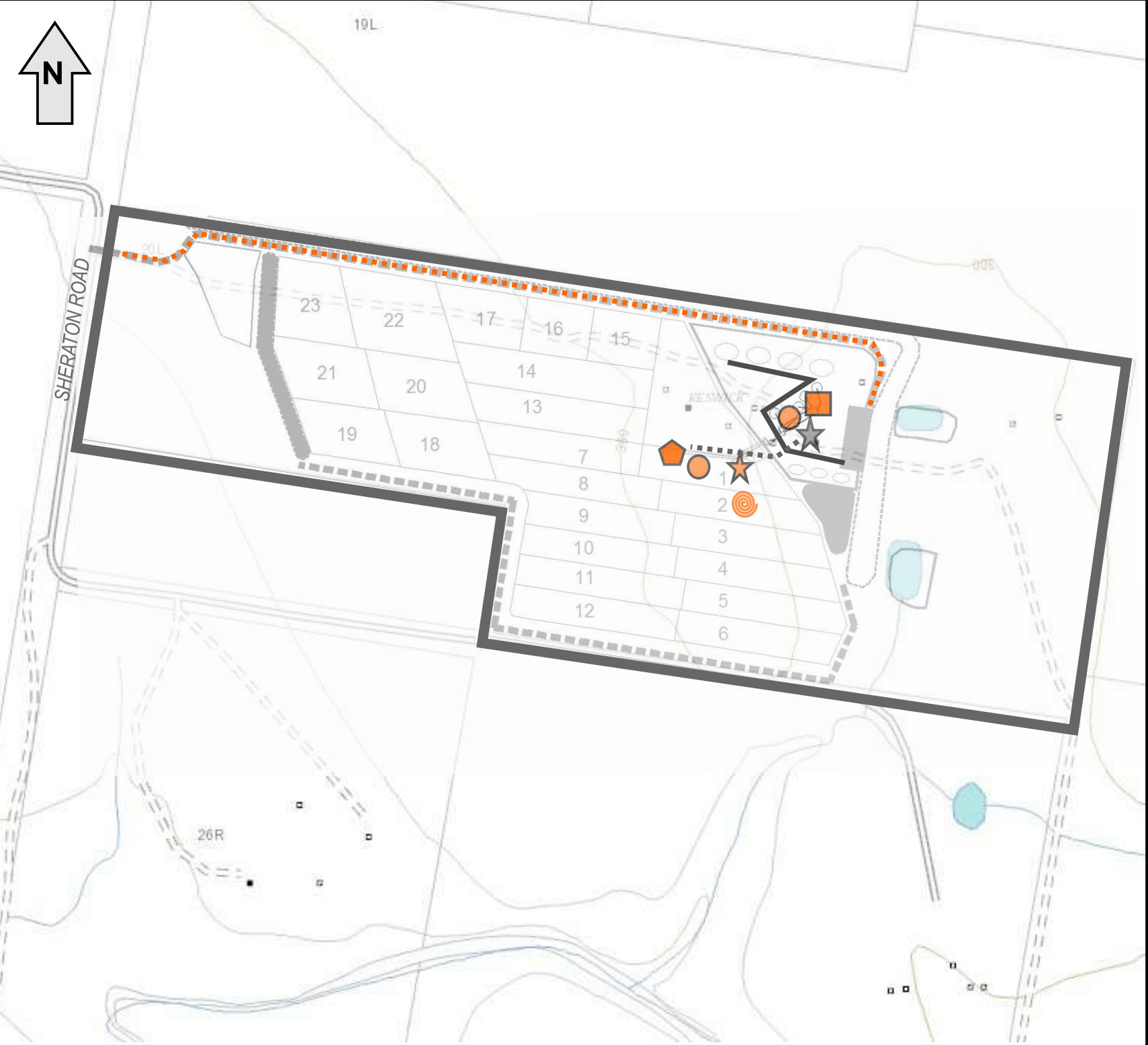


FIGURE C1

MODELLED PLANT LOCATIONS STAGE 1

REF: MAC160254

0 200m

Key

- Loader
- Excavator
- Water Cart
- Product Conveyor
- Primary Crushing Plant
- Secondary/Tertiary Crushers
- Drill
- Haul Path
- Road Truck Path
- Approximate Project Area

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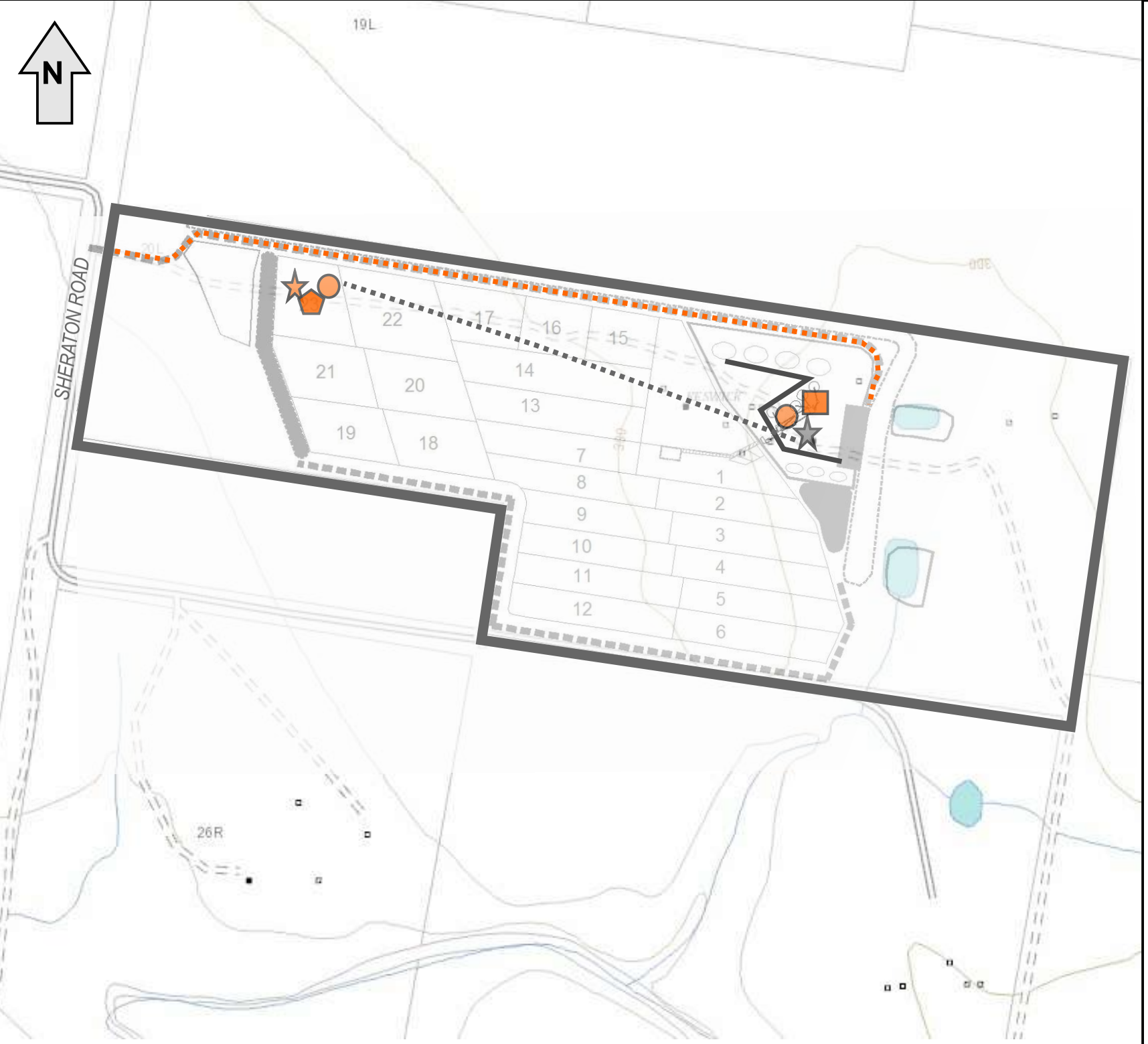

FIGURE C2

MODELLED PLANT LOCATIONS STAGE 23

REF: MAC160254

0 200m

Key

- Loader
- Excavator
- Water Cart
- Product Conveyor
- Primary Crushing Plant
- Secondary/Tertiary Crushers
- Haul Path
- Road Truck Path
- Approximate Project Area

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Appendix D – Analysed Meteorology

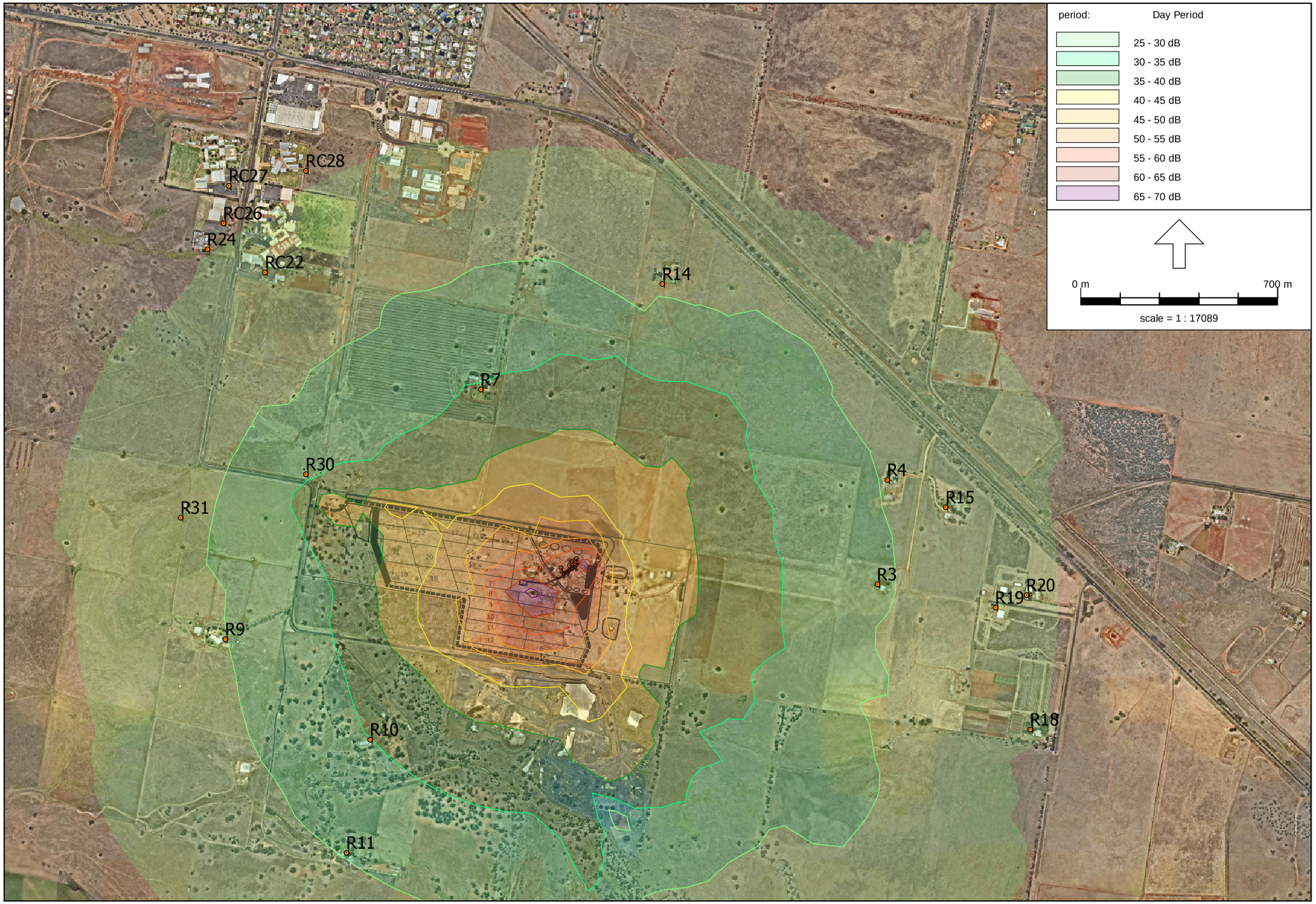
Table D1 NEWA Analysed Meteorological Conditions, Dubbo Airport NSW									
Direction	Season	Day	Evening	Night	Direction	Season	Day	Evening	Night
		Percentage Occurrence %					Percentage Occurrence %		
0	Summer	5	7	7	180	Summer	7	8	4
0	Autumn	9	14	13	180	Autumn	8	6	4
0	Winter	12	18	16	180	Winter	6	7	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 LAeq(15-min) dB(A) Sound Power Level Spectrum									
Noise Source	Octave Band Centre Frequency (Hz), dBA								Total
	63	125	250	500	1000	2000	4000	8000	dB(A)
Operational Plant									
Primary Crushing Plant[1]	80	89	94	104	105	105	101	88	110
Secondary/Tertiary Crushing Plant[1]	85	96	101	107	109	107	100	88	113
Haul Truck	92	96	102	102	103	100	93	84	108
Excavator	80	94	94	101	100	98	94	87	106
Loader	77	95	94	100	101	98	93	90	106
Road Truck	89	95	90	89	93	97	92	85	102
Road Truck Idle (being loaded)	84	77	74	69	68	67	62	54	86
Water Truck	81	82	89	91	95	97	89	81	101
Drill Rig	81	103	104	106	109	108	100	92	114
Product conveyor (dB/m)	51	55	57	64	61	57	52	42	67

Note 1 : Untreated Noise Level.

Appendix F – Operational Noise Contours



Scenario 1 - Cell 1, Day Operational Noise LAeq(15min), dBA

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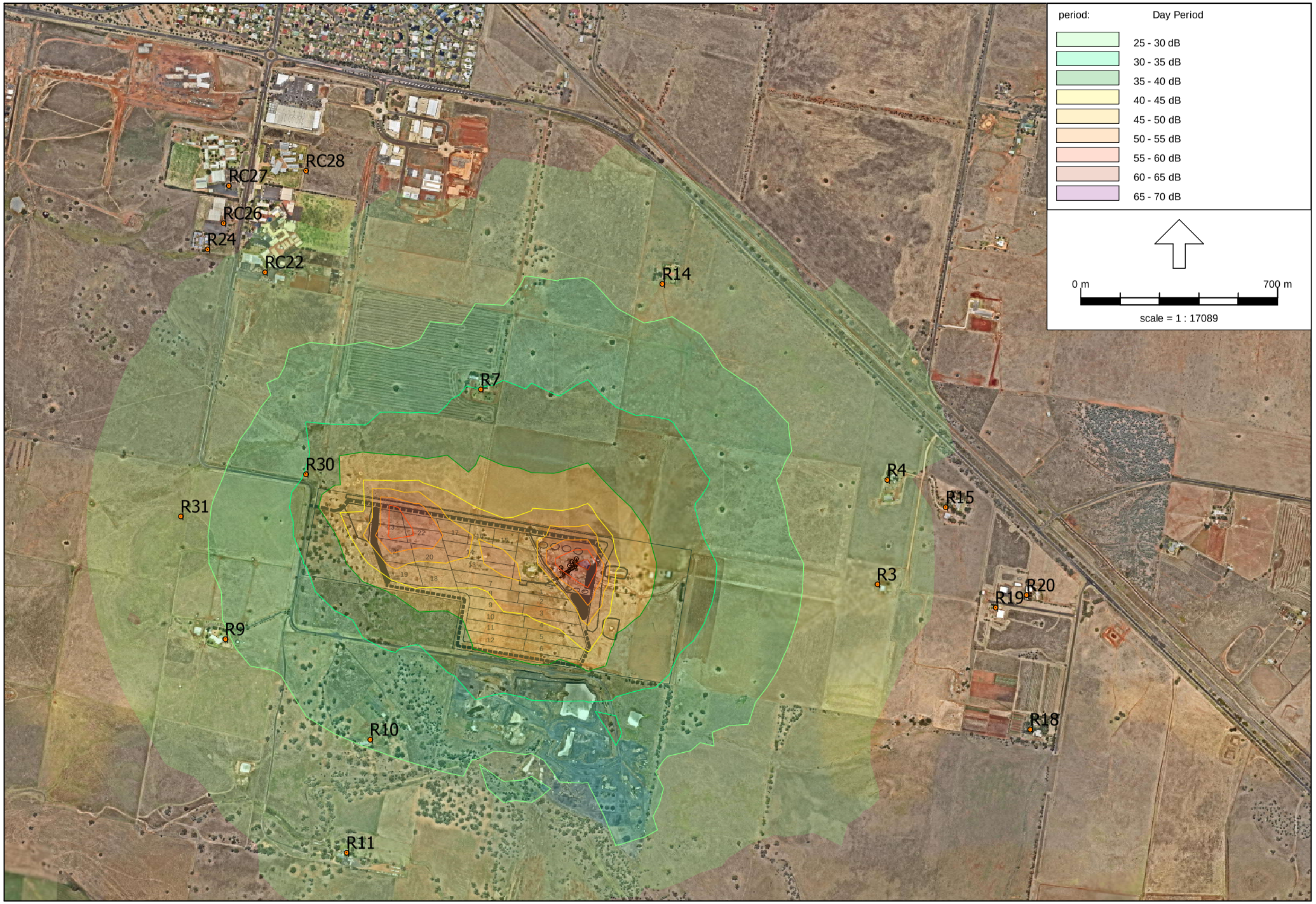

Scenario 2 - Cell 23, Day Operational Noise LAeq(15min), dBA

Muller Acoustic Consulting Pty Ltd

Muller Acoustic Consulting Pty Ltd
PO Box 262, Newcastle NSW 2300
ABN: 36 602 225 132
P: +61 2 4920 1833
www.mulleracoustic.com

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