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DUNEDOO SOLAR FARM

Construction & Operational Noise & Vibration Assessment

3 September 2020

NGH Environmental

TJ855-01F01 Noise Vibration Assessment (r3)

35 1982-2017 ACOUSTIC ENGINEERING EXCELLENCE

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Contents

List of Tables

List of Figures

1 Introduction

Renzo Tonin & Associates was engaged to conduct an environmental noise and vibration assessment of the proposed Dunedoo Solar Farm located approximately two kilometre north of the town of Dunedoo in New South Wales as part of the Environmental Impact Statement (EIS) for the Proposal. Noise and vibration impacts from the construction and operation phases of the Proposal will be addressed in this report in accordance with relevant Council and EPA requirements and guidelines.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Proposal Description

2.1 Background Information

The Dunedoo Solar Farm proposal includes the construction and operation of a solar photovoltaic (PV) plant and associated infrastructure, with a capacity of approximately 66 MW DC. The Proposal is located approximately two kilometres north of the town of Dunedoo in New South Wales, within the Warrumbungle Regional Council Local Government Area (LGA).

2.2 Regulatory Requirements

Noise and vibration impacts are assessed in accordance with the applicable policies, guidelines and standards, including:

- NSW 'Interim Construction Noise Guideline' (ICNG – DECC 2009);
- NSW 'Noise Policy for Industry' (NPfI – EPA 2017);
- 'Assessing Vibration: A Technical Guideline' (DECC 2006); and
- NSW 'Road Noise Policy' (RNP – DECCW 2011).

2.3 Receiver Locations

The nearest affected receivers were identified through aerial maps as follows:

- **Receiver R1 – Lot 157, DP754291, Dunedoo – Polocrosse Club**
  Commercial property located approximately 1,150m south of the Proposal
- **Receiver R2 – 202 All Weather Road, Dunedoo (involved receiver)**
  Residential property located approximately 220m west of the Proposal
- **Receiver R3 – 485 Castlereagh Highway, Dunedoo – Stud Manager's residence**
  Residential property located approximately 620m west of the Proposal
- **Receiver R4 – 485 Castlereagh Highway, Dunedoo – Farm Manger's residence**
  Residential property located approximately 310m northeast of the Proposal
- **Receiver R5 – 332 Digilah Road, Dunedoo**
  Residential property located approximately 1,570m northeast of the Proposal
- **Receiver R6 – 126 Lawson Park Road, Dunedoo**
  Residential property located approximately 1,730m east of the Proposal
- **Receiver R7 – 1 Evans Street, Dunedoo**
  Residential property located approximately 1,730m south of the Proposal and approximately 120m south of the Option 1 transmission line easement

- **Receiver R8 – Lot 2, DP749515, Dunedoo**
  Residential property located approximately 1,780m south of the Proposal and approximately 150m south of the Option 2 transmission line easement
- **Receiver R9 – 27 Nott Street, Dunedoo**
  Residential property located approximately 1,900m south of the Proposal and approximately 280m south of the Option 2 transmission line easement

Figure 1 provides details of the site, surrounds and receiver locations.

2.4 Hours of Operation

2.4.1 Construction

It is proposed that construction of the Proposal will take approximately 10-12 months. Construction will occur during the following standard daytime construction hours:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 7:00am to 1:00pm
- No work on Sundays or public holidays

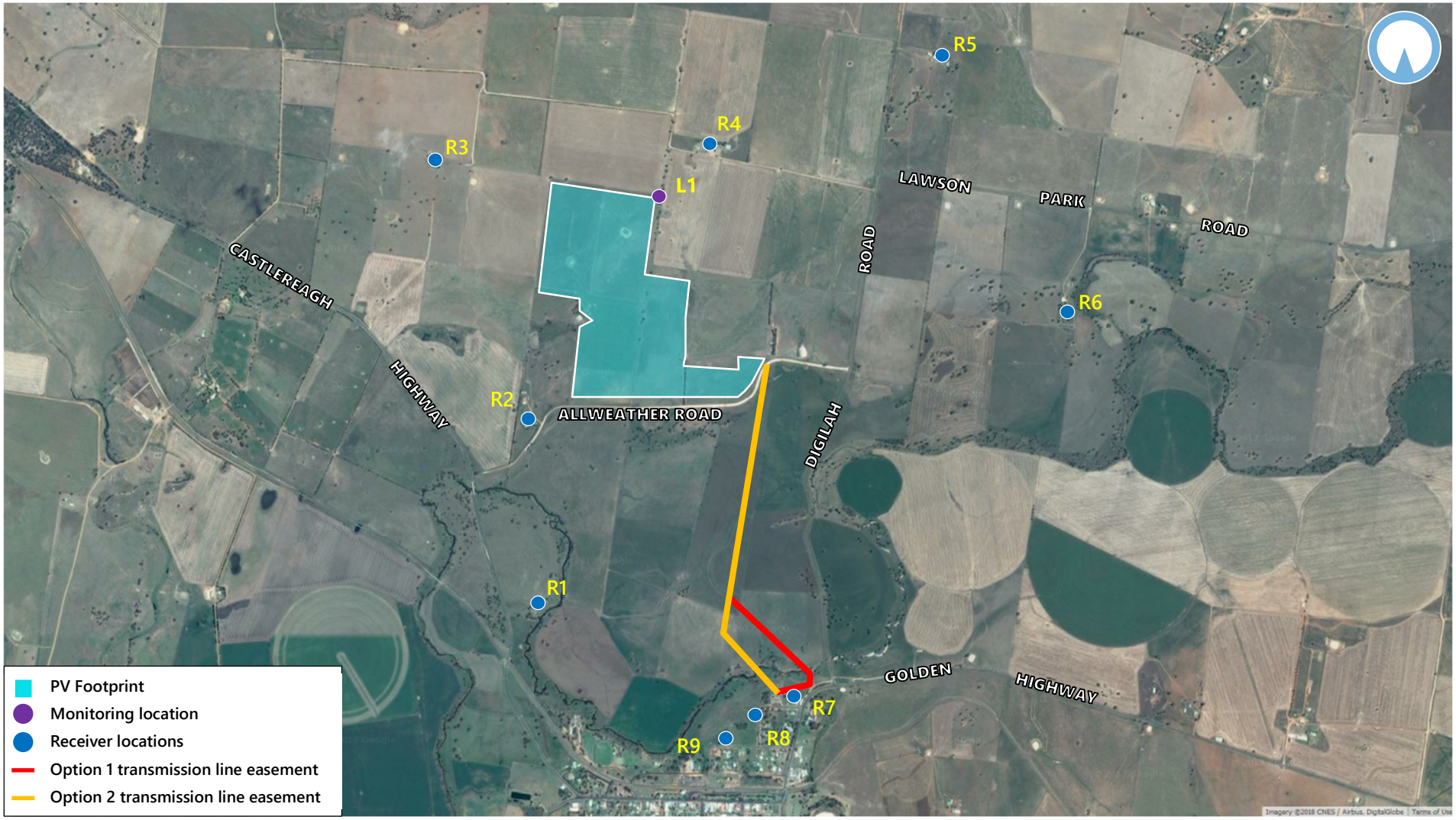
2.4.2 Operation

The solar farm will operate autonomously during times when there is sunlight. This will predominantly be during day and evening periods (7am-6pm and 6pm-10pm, respectively) throughout the year and potentially part of the night time period (prior to 7am) during the summer months.

Furthermore, there will be staff on site during the following standard hours, except during any emergency or maintenance that is required outside of these hours:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 8:00am to 1:00pm

Figure 1 – Site, Surrounds and Receiver and Noise Monitoring Locations



3 Existing Noise Environment

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW 'Noise Policy for Industry' (NPfI – Environment Protection Authority NSW 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The NSW NPfI defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

3.1 Noise Monitoring Locations

Noise monitoring is usually undertaken at the nearest or potentially most affected residential location. In this case, due to lot sizes and distance of the receiver's dwelling from the receiver's property boundary, the nearest and potentially most affected residential receiver was not accessible. Consequently, noise monitoring was undertaken at the lot boundary of the nearest sensitive receiver located on the north side of the development site. The background and ambient noise environment at this location was considered to be representative of the most affected sensitive receivers surrounding the site. Details of the noise monitoring location is described below.

- **Location L1 –** **Coordinates: -31°59'4.63", 149°23'36.24" (near Receiver R4)**
  The noise monitor was installed in the 'free field' (ie. away from building facades). Noise data represents the background and ambient noise environment for residences surrounding the Proposal.

To quantify the existing ambient noise environment, long term (unattended) noise monitoring was conducted at Location L1 between Tuesday 5th December and Wednesday 13th December 2017.

Appendix A of this report presents a description of noise terms. Appendix B details the noise monitoring methodology and the graphical recorded outputs from long term noise monitoring are included in Appendix C. The graphs in Appendix C were analysed to determine an assessment background level (ABL) for each day, evening and night period in each 24 hour period of noise monitoring, and based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NSW NPfI.

3.2 Existing Background & Ambient Noise Levels

Existing background and ambient noise levels are presented in Table 3.1 below. The noise monitor was positioned outdoors in the 'free-field' (ie. away from building facades). Construction and operation noise from the site should be assessed away from the facade at the potentially most affected residential boundaries and therefore, the representative noise levels listed in Table 3.1 are directly applicable.

Table 3.1 – Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)

Location	L_{90} Background Noise Levels			L_{eq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
L1 (-31°59'4.63", 149°23'36.24")	26	23	18	50	43	43

The identified receivers surrounding the subject site are all classified as rural under NPfI guidelines. It was found that the background noise levels were typical for a rural area, with a day RBL less than 40dB(A), an evening RBL less than 35 dB(A) and a night RBL less than 30 dB(A).

Based on Table 2.1 of the NPfI, where background noise levels are less than the minimum assumed RBLs, the minimum assumed RBL's are adopted instead for all receiver locations nominated in Section 2.3. Therefore, the background noise levels have been set at the levels detailed in the fourth column of Table 3.2 below.

Table 3.2 – Rating Background Noise Level, dB(A)

Time of Day	Measured Existing Background (L_{90})	Minimum Assumed RBLs	Rating Background Level (used for assessment)
Day	26	35	**35**
Evening	23	30	**30**
Night	18	30	**30**

4 Construction Noise Assessment

4.1 Construction Noise Management Levels

The NSW 'Interim Construction Noise Guideline' (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- *Use of L_{Aeq} as the descriptor for measuring and assessing construction noise*

  NSW noise policies, including the NPfI, RNP and RING have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

- *Application of reasonable and feasible noise mitigation measures*

  As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice and is practical to build given the project constraints.

  Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the length of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

4.1.1 Residential Receivers

Table 4.1 reproduced from the ICNG, sets out the noise management levels and how they are to be applied for residential receivers.

Table 4.1 – Noise Management Levels at Residential Receivers

Time of Day	Management Level $L_{eq\ (15\ min)}$	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	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 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • 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)	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 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Table 4.2 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring results presented in Table 3.1, the proposed construction hours and the above ICNG requirements. The receiver locations are marked in Figure 1.

Table 4.2 – Construction Noise Management Levels at Residential Receivers, dB(A)

Location Description	Day L_{90} Background Noise Level (RBL)	Day Noise Management Level $L_{eq(15min)}$
All residential receivers (Receivers R2 to R9)	35[1]	45

Notes: 1. Construction works occur during the daytime period only, hence only the day period assessed

4.1.2 Commercial Receivers

Given that Receiver R1 (Polocrosse Club) has been designated as a commercial type receiver, Table 4.3 sets out the ICNG noise management levels for commercial receivers, as applicable for this Proposal.

Table 4.3 – Noise Management Levels at Commercial Receivers, dB(A)

Land Use	Where Objective Applies	Management Level $L_{aeq\ (15\ Min)}$
Receiver R1 – Lot 157 DP754291, Dunedoo (Polocrosse Clubhouse)	External noise level	70

Notes: 1. Noise Management Levels only apply when premises are in use

4.2 Construction Noise Sources

Table 4.4 lists typical plant and equipment likely to be used by the contractor to carry out the necessary construction works within the PV footprint depicted in Figure 1, while Table 4.5 details the equipment required to construct the easement (Option 1 or Option 2) for the Proposal.

Table 4.4 – Typical Solar Farm Construction Plant & Equipment & Sound Power Levels, dB(A)

Plant Item	Plant Description	L_{Aeq} Sound Power Levels, dB(A) re. 1pW Single Item
1	Small Pile Driver	114
2	Fixed Crane	113
3	Front End Loader	113
4	Backhoe	111
5	Grader	110
6	Vibratory Roller	109
7	Concrete Truck	109
8	Delivery Truck	108
9	Water Cart	107
10	Concrete Pump	105
11	Power Generator	103
12	Concrete Vibrator	103
13	Light Vehicles (eg 4WD)	103

Table 4.5 – Easement Construction Plant & Equipment & Sound Power Levels, dB(A)

Plant Item	Plant Description	L_{Aeq} Sound Power Levels, dB(A) re. 1pW Single Item
1	Front End Loader	113
2	Grader	110
3	Vibratory Roller	109
4	Delivery Truck	108
5	Water Cart	107
6	Light Vehicles (eg 4WD)	103

The sound power levels for the majority of activities presented in the above table are provided by the client, based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', the ICNG, information from past projects and/or information held in our library files.

4.3 Construction Noise Assessment

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using CadnaA (version 2018) noise modelling computer program. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction models take into account:

- Location of noise sources and receiver locations;
- Height of sources and receivers;
- Separation distances between sources and receivers;
- Ground type between sources and receivers (soft); and
- Attenuation from barriers (natural and purpose built).

Noise levels at any receptors resulting from construction would depend on the above and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary substantially over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Table 4.6 presents construction noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant equipment associated with the works conducted within the PV footprint and transmission line easement. Table 4.7 and Table 4.8 refers to the noise levels likely to be experienced at the nearby affected receivers due to the construction of the easement for Option 1 and Option 2, respectively. The noise level ranges represent the noise source being located at the furthest to the closest proximity to each receiver location.

Table 4.6 – Predicted $L_{Aeq,15min}$ Solar Farm Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq(15min)}$ Construction Noise Levels								
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**
Noise Management Level[1]		*70*[2]	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*
1	Small pile driver	<20-33	22-**61**	<20-35	21-42	<20-28	<20-29	<20-23	<20-23	<20-22
2	Fixed Crane	<20-32	21-**60**	<20-34	<20-41	<20-27	<20-28	<20-22	<20-22	<20-21
3	Front End Loader	<20-32	21-**60**	<20-34	<20-41	<20-27	<20-28	<20-22	<20-22	<20-21
4	Backhoe	<20-30	<20-**58**	<20-32	<20-39	<20-25	<20-26	<20-20	<20-20	<20-<20
5	Grader	<20-29	<20-**57**	<20-31	<20-38	<20-24	<20-25	<20-<20	<20-<20	<20-<20
6	Vibratory Roller	<20-28	<20-**56**	<20-30	<20-37	<20-23	<20-24	<20-<20	<20-<20	<20-<20
7	Concrete Truck	<20-28	<20-**56**	<20-30	<20-37	<20-23	<20-24	<20-<20	<20-<20	<20-<20
8	Delivery Truck	<20-27	<20-**55**	<20-29	<20-36	<20-22	<20-23	<20-<20	<20-<20	<20-<20
9	Water Cart	<20-26	<20-**54**	<20-28	<20-35	<20-21	<20-22	<20-<20	<20-<20	<20-<20
10	Concrete Pump	<20-24	<20-**52**	<20-26	<20-33	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20
11	Power Generator	<20-22	<20-**50**	<20-24	<20-31	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20
12	Concrete Vibrator	<20-22	<20-**50**	<20-24	<20-31	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20
13	Light vehicles (eg 4WD)	<20-22	<20-**50**	<20-24	<20-31	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20
Up to 3 (noisiest) plant operating concurrently		22-37	26-**65**	22-40	25-**46**	<20-32	<20-33	<20-28	<20-27	<20-26

Notes:
1. Noise Management Levels for day period (ie. standard construction hours)
2. Noise Management Level for commercial type premises
3. **Bold** font represents exceedance of the relevant NML

Table 4.7 – Predicted $L_{Aeq,15min}$ Option 1 Easement Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq(15min)}$ Construction Noise Levels								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
Noise Management Level[1]		*70*[2]	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*
1	Front End Loader	22-28	<20-26	<20-<20	<20-26	<20-22	<20-22	22-**51**	21-**49**	20-40
2	Grader	<20-25	<20-23	<20-<20	<20-23	<20-<20	<20-<20	<20-**48**	<20-**46**	<20-37
3	Vibratory Roller	<20-24	<20-22	<20-<20	<20-22	<20-<20	<20-<20	<20-**47**	<20-45	<20-36
4	Delivery Truck	<20-23	<20-21	<20-<20	<20-21	<20-<20	<20-<20	<20-**46**	<20-44	<20-35
5	Water Cart	<20-22	<20-20	<20-<20	<20-<20	<20-<20	<20-<20	<20-45	<20-43	<20-34
6	Light vehicles (eg 4WD)	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20	<20-41	<20-39	<20-30
Up to 3 (noisiest) plant operating concurrently		25-31	22-29	<20-22	<20-28	<20-24	<20-25	24-**53**	24-**51**	23-43

Notes: 1. Noise Management Levels for day period (ie. standard construction hours)
2. Noise Management Level for commercial type premises
3. **Bold** font represents exceedance of the relevant NML

Table 4.8 – Predicted $L_{Aeq,15min}$ Option 2 Easement Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq(15min)}$ Construction Noise Levels								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
Noise Management Level[1]		*70*[2]	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*
1	Front End Loader	22-28	<20-26	<20-<20	<20-26	<20-22	<20-22	22-**47**	21-**49**	20-43
2	Grader	<20-25	<20-23	<20-<20	<20-23	<20-<20	<20-<20	<20-44	<20-**46**	<20-40
3	Vibratory Roller	<20-24	<20-22	<20-<20	<20-22	<20-<20	<20-<20	<20-43	<20-45	<20-39
4	Delivery Truck	<20-23	<20-21	<20-<20	<20-21	<20-<20	<20-<20	<20-42	<20-44	<20-38
5	Water Cart	<20-22	<20-20	<20-<20	<20-<20	<20-<20	<20-<20	<20-41	<20-43	<20-37
6	Light vehicles (eg 4WD)	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20	<20-<20	<20-37	<20-39	<20-33
Up to 3 (noisiest) plant operating concurrently		25-31	23-29	<20-22	<20-28	<20-24	<20-25	24-**50**	24-**51**	23-45

Notes: 4. Noise Management Levels for day period (ie. standard construction hours)
5. Noise Management Level for commercial type premises
6. **Bold** font represents exceedance of the relevant NML

Based on the construction noise levels presented in Table 4.6 for the construction of the solar farm, the noise management levels at Receivers R2 (involved receiver) and R4 may be exceeded when construction works are conducted within close proximity to the receivers. At Receiver R4, exceedances only occur when three of the noisiest plant and equipment are operating concurrently within close proximity of the receiver. However, this would highly be unlikely in practice given the layout and size of the site and the transient nature of the construction activities.

For the construction of the two easement options, Table 4.7 and Table 4.8 indicate that construction noise levels could exceed the noise management levels at Receivers R7 and R8. However, the overall construction activities within the easements would occur for a relatively short period.

It is noted that construction noise levels at all receivers are predicted to be less than the highly noise affected level of 75dB(A) for all construction stages of the solar farm Proposal.

In light of the predicted noise levels above, it is recommended that a feasible and reasonable approach towards noise management measures be applied to reduce noise levels as much as possible to manage the impact from construction noise.

Further details on construction noise mitigation and management measures that could be implemented are provided in Section 4.4 below.

4.4 Construction Noise Mitigation and Management Measures

The following recommendations provide in-principle feasible and reasonable noise control solutions to reduce noise impacts to sensitive receivers. Where actual construction activities differ from those assessed in this report, more detailed design of noise control measures may be required once specific items of plant and construction methods have been chosen and assessed on site.

Given the nature of the works and the layout and size of the site, it is expected that an appropriate combination (but not necessarily all) of engineering and general control measures can be used on site. The following sections detail come of the possible mitigation measures that could be implemented during construction works.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

4.4.1 General Engineering Noise Controls

Implementation of noise control measures, such as those suggested in Australian Standard 2436-2010 "Guide to Noise Control on Construction, Demolition and Maintenance Sites", are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C of AS2436 presents typical examples of noise reductions achievable

after treatment of various noise sources. Table C3 in Appendix C of AS2436 presents the relative effectiveness of various forms of noise control treatment.

Table 4.9 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects, that could form part of the noise mitigation measures implemented at the site, as required.

Table 4.9 – Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical Noise Reduction Possible in Practice		Maximum Noise Reduction Possible in Practice	
		AS 2436	Renzo Tonin & Associates	AS 2436	Renzo Tonin & Associates
Distance	Doubling of distance between source and receiver	6	6	6	6
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	5 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 25	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25	-	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436.

Table 4.10 below identifies possible noise control measures, which are applicable on the construction plant likely to be used on site.

Table 4.10 – Noise Control Measures for Likely Construction Plant

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Small pile driver	✓	x	✓	✓
Fixed Crane	✓	✓	✓	x
Front End Loader	✓	x	✓	x
Backhoe	✓	x	✓	x
Grader	✓	x	✓	x
Vibratory Roller	✓	x	✓	x
Concrete Truck	✓	x	✓	x
Delivery Truck	✓	x	✓	x
Water Cart	✓	x	✓	x
Concrete Pump	✓	✓	✓	✓

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Power Generator	✓	✓	✓	x
Concrete Vibrator	✓	x	x	x
Light vehicles (eg 4WD)	✓	x	x	x

4.4.2 Noise Management Measures

In addition to physical noise controls, the following general noise management measures are available to be followed, if required.

- Use less noisy plant and equipment, where feasible and reasonable.
- Manage work sequencing so that noise intensive plant and equipment are not concentrated in one location for long periods.
- Plant and equipment should be properly maintained.
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods during construction work should be switched off.
- In addition to the noise mitigation measures outlined above, a management procedure would need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.
- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community should be adequately trained and experienced in such matters.

Where noise level exceedances cannot be avoided, then consideration may be given to implementing time restrictions and/or providing periods of repose for residents, where feasible and reasonable and to be negotiated with Council and the residents. That is, daily periods of respite from noisy activities may also be scheduled for building occupants during construction hours.

Alternatively, allowing the construction activities to proceed, despite the noise exceedance may be the preferred method in order to complete the works expeditiously.

5 Operational Noise Assessment

5.1 Operational Noise Criteria

Noise impact from the general operation of the proposed solar farm is assessed against the NSW 'Noise Policy for Industry' (NPfI, 2017). The assessment procedure in terms of the NPfI has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for residences and other land uses.

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level which is the lower value of the project intrusiveness noise levels and project amenity noise levels.

5.1.1 Intrusive Noise Impacts

According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does not exceed the background noise level measured in the absence of the source by more than 5dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$L_{Aeq,15minute}$ Intrusiveness noise level = Rating Background Level (RBL) plus 5dB(A)

Based on the RBLs set in Table 3.2, the intrusiveness noise levels for the residential receivers are determined in Table 5.1.

Table 5.1 – NPfI Intrusive Noise Levels at Residential Receivers, dB(A)

Period	Rating Background Level	Intrusiveness Noise Level, $L_{Aeq,15min}$
Daytime	35	35+5 = **40**
Evening	30	30+5 = **35**
Night-time	30	30+5 = **35**

5.1.2 Protecting Noise Amenity

The project amenity noise levels for different time periods of a day are determined in accordance with Section 2.4 of the NSW NPfI. The NPfI recommends amenity noise levels ($L_{Aeq, period}$) for various receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These "recommended amenity noise levels" represent the objective for **total** industrial noise experienced at a receiver location. However, when assessing a **single** industrial development and its impact on an area, "project amenity noise levels" apply.

To ensure that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level that applies for each new industrial noise source is determined as follows:

$$\mathbf{L_{Aeq,period}\ Project\ amenity\ noise\ level = L_{Aeq,period}\ Recommended\ amenity\ noise\ level - 5dB(A)}$$

Furthermore, given that the intrusiveness noise level is based on a 15 minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, the NPfI provides the following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15min}$ level in order to standardise the time periods.

$$\mathbf{L_{Aeq,15min} = L_{Aeq,period} + 3dB(A)}$$

The policy, in accordance with the NPfI, applies an adjustment of (+3 dB) to the recommended noise levels ($L_{Aeq,\ period}$) in order to standardise the time periods for the intrusiveness and amenity noise levels. The project amenity noise levels ($L_{Aeq,\ 15min}$) applied for this project are reproduced in Table 5.2.

It is noted that the residential receivers in the vicinity of the site have been categorised as being in a 'rural' area in accordance with Table 2.3 of the NPfI.

Table 5.2 – NPfI Project Amenity Noise Levels, dB(A)

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended Noise Level	
			$L_{Aeq,\ Period}$	$L_{Aeq,\ 15min}$
Residence	Rural	Day	50 – 5 = 45	45 + 3 = **48**
		Evening	45 – 5 = 40	40 + 3 = **43**
		Night	40 – 5 = 35	35 + 3 = **38**
Commercial Premises	All	When in use	65 – 5 = 60	60 + 3 = **63**

Notes: 1. Monday to Saturday – Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
2. On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am

5.2 Summary of Project Noise Trigger Levels

In accordance with the NPfI the project noise trigger level, which is the lower (ie. more stringent) value of the project intrusiveness noise level and project amenity noise level, has been determined and reproduced in Table 5.3 below.

Table 5.3 – Project Noise Trigger Levels, dB(A)

Receiver Location	$L_{Aeq, 15min}$ Project Noise Trigger Levels		
	Day	Evening	Night
Receiver R1 – Lot 157 DP754291, Dunedoo[3]	63	63	63
Receiver R2 – 202 All Weather Road, Dunedoo (involved receiver)	40	35	35
Receiver R3 – 485 Castlereagh Highway, Dunedoo – Stud Manager's residence	40	35	35
Receiver R4 – 485 Castlereagh Highway, Dunedoo – Farm Manger's residence	40	35	35
Receiver R5 – 332 Digilah Road, Dunedoo	40	35	35
Receiver R6 – 126 Lawson Park Road, Dunedoo	40	35	35
Receiver R7 – 1 Evans Street, Dunedoo	40	35	35
Receiver R8 – Lot 2 DP749515, Dunedoo	40	35	35
Receiver R9 – 27 Nott Street, Dunedoo	40	35	35

Notes: 1. Monday to Saturday – Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
2. On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am
3. Project Noise Trigger Levels only apply when premises are in use

5.3 Operational Noise Sources

The proposed solar farm will operate solar panels installed on single-axis trackers that are driven by motors that track the arc of the sun to maximise the solar effect. Hence, the tracking motors are a potential source of mechanical noise and therefore, has been included for a more conservative assessment. Approximately 2,850 tracking motors (NexTracker or equivalent) will be employed to drive the solar panels and are to be evenly distributed across the PV footprint area depicted in Figure 1. It is assumed that the tracking motors would turn no more than five (5) degrees every 15 minutes and would operate no more than one (1) minute out of every 15 minute period. Should the final system be significantly different, then a review of noise impacts will be undertaken during the detailed design stage of the Proposal.

In addition to the trackers, the site will require the operation of up to 25 inverters (SMA SC2750MVPS) distributed over 13 stations, which are further distributed across the PV footprint. Furthermore, there will be up to 13 containerised Battery Energy Storage Systems (BESS) located within the PV footprint, with one (1) BESS per inverter station. The BESS utilise air conditioning units to maintain stable temperatures for the batteries, which have also been identified as a potential noise source.

A new substation will be located near the south east end of the site. At this early stage of the Proposal the specific size of the transformer is yet to be confirmed. For a conservative assessment it has been assumed that the size of the transformers would be up to 80MVA with a sound power level of 90dB(A). A Synchronous Condenser, or similar as may be required through the network connection process, would also be installed in the substation, the expected sound power level would be 93dB(A).

During operations, it is assumed that three (3) staff members will attend site daily during the day time period to inspect the equipment and will travel around the site using light vehicles.

Based on the above, the following table lists associated plant and equipment likely to be used for the operation of the proposed solar farm and their corresponding sound power levels.

Table 5.4 – Typical Operational Plant and Equipment & Sound Power Levels

Plant Item	Plant Description	L_{Aeq} Sound Power Levels, dB(A) re. 1pW
1	Tracker Motor (up to 2,850 in total)	50 (each)
2	Sunny Central SMA SC2750MVPS Inverters (25 in total)	92 (each)
3	BESS Air Conditioning Units (13 in total)	75 (each)
4	Substation Transformer (1 in total)	90 (each)
5	Synchronous Condenser or similar (1 in total)	93 (each)
6	Light vehicle (3 in total)	103 (each)

The sound power levels for the plant and equipment presented in the above table are provided by the client, manufacturer, information from past projects and/or information held in our library files.

5.4 'Modifying Factor' Adjustments

Further to the above and in accordance with the NPfI, where the character of the noise in question is assessed as particularly annoying (ie. if it has an inherently tonal, low frequency, impulsive or intermittent characteristic), then an adjustment of 5dB(A) for each annoyance aspect, up to a total of 10dB(A), is to be added to the predicted value to penalise the noise for its potential increase in annoyance.

Table C1 in Fact Sheet C of the NSW NPfI provides definitive procedures for determining whether a penalty or adjustment should be applied from increased annoyance. For the assessment of the solar farm, the noise from the inverters and transformers (storage and substation) are considered to be tonal in nature. Therefore, a 5dB(A) penalty has been applied individually to the predicted noise contributions from the inverters and transformer. Other equipment such as the tracking motors and the synchronous condenser do not have tonal characteristics.

5.5 Operational Noise Assessment

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using CadnaA (version 2018) noise modelling computer program. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction models takes into account:

- Location of noise sources and receiver locations;
- Height of sources and receivers;
- Separation distances between sources and receivers;

- Ground type between sources and receivers (soft); and
- Attenuation from barriers (natural and purpose built).

Furthermore, in accordance with the NPfI noise predictions were prepared for each of the following meteorological conditions:

1. **Calm & isothermal conditions (acoustically neutral)** – no wind and no temperature inversion
2. **Slight to gentle breeze** – 3m/s wind velocity at 10m from ground level between each noise source and each noise receiver (as per NPfI default wind conditions). Wind direction was based on wind travelling from the source to the receiver.
3. **Moderate temperature inversion** – applicable for noise predictions during night-time periods only

Table 5.5 below present the predicted noise levels for the worst case scenario based on concurrent operation of all the plant and equipment shown in Table 5.4. The tracker motors were time corrected based on their operation of one (1) minute out of a 15-minute period.

Table 5.5 – Predicted $L_{Aeq,15min}$ Operational Noise Levels at Residential Receiver Locations, dB(A)

Receiver Location	Project Noise Trigger Levels			Predicted Operational Noise Levels, $L_{Aeq, 15min}$			Comply? (Yes/No)
	Day	Evening	Night	Calm & Isothermal Conditions	Slight to Gentle Breeze	Moderate Temperature Inversion[1]	
Receiver R1[2]	*63*	*63*	*63*	21	27	28	Yes
Receiver R2[3]	*40*	*35*	*35*	33	**36**	**37**	**No**
Receiver R3	*40*	*35*	*35*	26	31	33	Yes
Receiver R4	*40*	*35*	*35*	30	35	**36**	**No**
Receiver R5	*40*	*35*	*35*	<20	26	27	Yes
Receiver R6	*40*	*35*	*35*	<20	24	24	Yes
Receiver R7	*40*	*35*	*35*	<20	24	24	Yes
Receiver R8	*40*	*35*	*35*	<20	24	24	Yes
Receiver R9	*40*	*35*	*35*	<20	23	24	Yes

Notes:
1. Applicable for the night time period only
2. Commercial receiver assessed only for when in use
3. Receiver R2 is an involved receiver
4. **Bold** font represents exceedance over project trigger level

Based on the predicted operational noise levels presented in the table above, predicted noise levels at the nearest receivers generally comply with the nominated project noise trigger levels under all meteorological conditions. Minor exceedances of up to 2dB(A) and 1dB(A) were predicted for Receivers R2 and R4, respectively, during slight to gentle wind and/or moderate temperature inversion conditions.

However, it is noted that in accordance with Tables 4.1 and 4.2 of the NPfI, an exceedance of up to 2dB(A) is considered to be negligible as a 2dB(A) change in noise level is not discernible or noticeable to the average person.

Therefore, the predicted noise levels at Receivers R2 and R4 are determined to be acceptable and no further reasonable and feasible noise mitigation measures are required to reduce operational noise impacts.

5.6 Sleep Disturbance Assessment

To assess the likelihood of sleep disturbance, the potential of maximum noise level events from operation of the solar farm during the night-time period has been considered in this assessment. In accordance with the NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development night-time noise levels at a residential location exceed:

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

Where there are noise events found to exceed the initial screening level, further analysis is undertaken to identify:

- The likely number of events that might occur during the night assessment period,
- The extent to which the maximum noise level exceeds the rating background noise level.

During the night-time period (before 7am during summer months) only mechanical plant will be operating, including the tracking motors, inverters, air conditioning units for the BSS and transformers. Noise emissions from these plant items are considered to be continuous with no potential for high peak noise level events. Therefore, the L_{Amax} noise levels experienced at the identified receivers will be similar to the predicted $L_{Aeq,15min}$ noise levels shown in Table 5.5. Hence, it is expected that both the $L_{Aeq,15min}$ and L_{AFmax} will be well below the nominated sleep disturbance criteria of 40dB(A) and 52dB(A), respectively.

6 Vibration Assessment

Vibration generating activities would occur only during the construction phase of the Proposal. There are no vibration generating activities expected during the operational phase. As the nearest identified receivers unrelated to the Proposal in excess of 150m from the proposed construction activities, structural damage due to vibration is not expected. Assessment for vibration impact on human comfort is assessed in accordance with EPA requirements.

6.1 Vibration Criteria

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the EPA's *'Assessing Vibration; a technical guideline'* (DECC, 2006). The guideline provides criteria which are based on British Standard BS 6472-1992 *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. Table 6.1 provides definitions and examples of each type of vibration.

Table 6.1 – Types of Vibration

Type of Vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

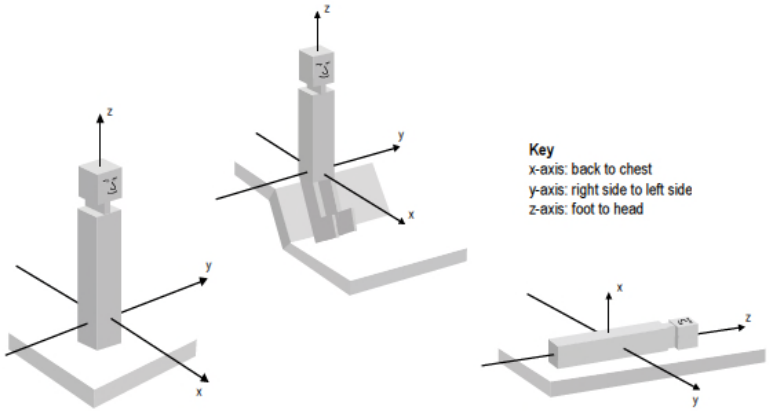
The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *"Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472)."*

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore,

application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 2. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 2 – Orthogonal Axes for Human Exposure to Vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 6.2 for the applicable receivers.

Table 6.2 – Preferred and Maximum Levels for Human Comfort

Location	Assessment Period[1]	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92

Notes: 1. Daytime is 7:00am to 10:00pm and Night-time is 10:00pm to 7:00am

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 6.3 for the applicable receiver type.

Table 6.3 – Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80

Notes: 1. Daytime is 7:00am to 10:00pm and Night-time is 10:00pm to 7:00am

6.2 Potential Vibration Impacts

Based on the proposed plant items presented in Table 4.4 and Table 4.5, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 6.4 below. The assessment is relevant to the identified receiver locations.

Table 6.4 – Potential Vibration Impacts for Identified Receivers

Receiver Location	Approx. Distance to Nearest Buildings from Works	Type of Nearest Sensitive Buildings	Assessment on Potential Vibration Impacts	Vibration Monitoring
Receiver R1	1,080m	Commercial	Very low risk of adverse comments	Not required
Receiver R2[1]	30m	Residential	Low risk of adverse comments	Not required
Receiver R3	910m	Residential	Very low risk of adverse comments	Not required
Receiver R4	730m	Residential	Very low risk of adverse comments	Not required
Receiver R5	1,210m	Residential	Very low risk of adverse comments	Not required
Receiver R6	1,220m	Residential	Very low risk of adverse comments	Not required
Receiver R7[2]	100m	Residential	Very low risk of adverse comments	Not required
Receiver R8[2]	150m	Residential	Very low risk of adverse comments	Not required
Receiver R9[2]	270m	Residential	Very low risk of adverse comments	Not required

Notes: 1. Receiver R2 is an Involved receiver
2. Approximate distance based on closest distance to easement construction works (Option 1 or 2)

The potential for adverse comments to vibration impacts during the construction works was determined to be low to very low due to the large distances between the receiver locations and the construction activities. Furthermore, it was noted that the closest receiver, Receiver R2, is an involved receiver; hence, it is expected to have no adverse comments despite it being located closer to the proposed works. Therefore, additional vibration mitigation measures and vibration monitoring are not required at the identified receiver locations during construction works associated with the Proposal.

7 Road Traffic Noise Assessment

Noise impact from the potential increase in traffic on the surrounding road network due to construction and operational activities is assessed against the NSW 'Road Noise Policy' (RNP). The RNP sets out criteria to be applied to particular types of road and land uses. These noise criteria are to be applied when assessing noise impact and determining mitigation measures for sensitive receivers that are potentially affected by road traffic noise associated with the construction and operation of the Proposal with the aim of preserving the amenity appropriate to the land use.

Vehicle access to the Proposal will be via Allweather Road, Digilah Road and Castlereagh Highway. Based on the traffic assessment report prepared by Stantec (Stantec Ref: 15321, dated 2 June 2020), the peak vehicle movements during the construction stage of the Proposal are presented in the following table. Furthermore, vehicle movements will only occur during the day time period when construction works occur.

Table 7.1 – Summary of the Estimated Construction Traffic Volumes During Peak Construction

Vehicle Type	Movements Per Day (Peak)	Average Hourly Movements[1]
Cars/ light vehicles	24 (12 in / 12 out)	3
Trucks/ heavy vehicles	80 (40 in / 40 out)	8

Notes: 1. Average hourly movements based on movements per day / 11 (representing construction hours from 7am to 6pm)

During the operational stage, vehicle access to the site will be maintenance vans and delivery trucks (3 x site staff light vehicle and 5 x miscellaneous courier deliveries per week) which would occur on an irregular basis. Therefore, traffic noise impacts during the operational stage of the Proposal would be minimal and insignificant and will not be assessed further.

7.1 Road Traffic Noise Criteria

Based on functionality, Allweather Road and Digilah Road are categorised as local roads and Castlereagh Highway is classified as an arterial road. For a conservative assessment, only residences along the local roads will be assessed for traffic noise impacts. For existing residences affected by additional traffic on existing local roads generated by land use developments, the following RNP road traffic noise criteria apply.

Table 7.2 – RNP Road Traffic Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria	
		Day 7am – 10pm	Night 10pm – 7am
Local road	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,(1\ hour)}$ 55 (external)	$L_{Aeq,(1\ hour)}$ 50 (external)

7.2 Predicted Road Traffic Noise

Results of the road traffic noise predictions are presented in the table below. It is noted that the predicted noise levels represent the traffic noise contribution from the vehicle movements associated with the construction works and does not take into account existing traffic noise levels as existing traffic volumes along Allweather Road and Digilah Road are unknown; however, in accordance with the Stantec traffic report it is estimated that the current daily traffic volumes along both these roads are around 10 to 20 vehicles per day.

Table 7.3 – Predicted Road Traffic Noise Contribution Levels Along Public Roads, dB(A) $L_{Aeq(1\ Hour)}$

Receiver	Criteria	Traffic Movements[1]	Speed (km/h)	Approx. Distance to Road	Predicted Noise Level	Comply?
Nearest receivers	$L_{Aeq,\ (1\ hour)}$ 55	As per Table 7.1 plus up to existing 20 vpd	60	70m	44	Yes

Notes: 1. For a conservative assessment, it is assumed that all 20 existing vehicles per day utilise the road during the construction hours of 7am to 6pm.

From the above table, traffic noise levels from the additional traffic during the construction stage of the Proposal is predicted to comply with the applicable noise criterion at the nearest affected receivers along Allweather Road and Digilah Road.

As the construction traffic noise levels are temporary and comply with the RNP criteria set above, it indicates that the traffic noise levels due to the construction works for the solar farm would not adversely affect the existing residences along Allweather Road and Digilah Road.

8 Conclusion

Renzo Tonin and Associates has completed an environmental noise and vibration assessment of the proposed Dunedoo Solar Farm.

Noise emissions from the construction phase of the Proposal were predicted to generally comply with the construction noise management levels at the nearest affected receivers; however, some exceedances were predicted for Receivers R2 (involved receiver) and R4 during the construction of the solar farm and Receivers R7 and R8 during the construction of the easement (for both easement options). A suite of in-principle recommendations were provided in Section 4.4 that can be selected and combined as required, to limit the impact of noise generated by construction activities to acceptable levels.

Noise emissions from the operational phase of the solar farm were predicted to generally comply with the nominated project noise trigger levels at the nearest affected receivers. However, exceedances of up to 2dB(A) and 1dB(A) were predicted for Receivers R2 (involved receiver) and R4, respectively, which are considered to be negligible in accordance with the NPfI. Therefore, no noise mitigation measures are required during operations.

Given the large separation distance between the nearest affected receivers and the Proposal, vibration impacts resulting in structural damage to buildings at the nearest affected receivers were determined to be negligible and there would be low risk of adverse comments from occupants of dwellings due to construction vibration.

Road traffic noise impacts on residential properties along the access routes were found to comply with the relevant RNP criteria.

APPENDIX A Glossary of Terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 110dB Operating a chainsaw or jackhammer 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Long-Term Noise Monitoring Methodology

B.1 Noise Monitoring Equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave Band Data	Logger Location(s)
RTA04 (CESVA SC310)	Type 1	1/1	L1

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology During Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW NPfI. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B.3 Noise vs Time Graphs

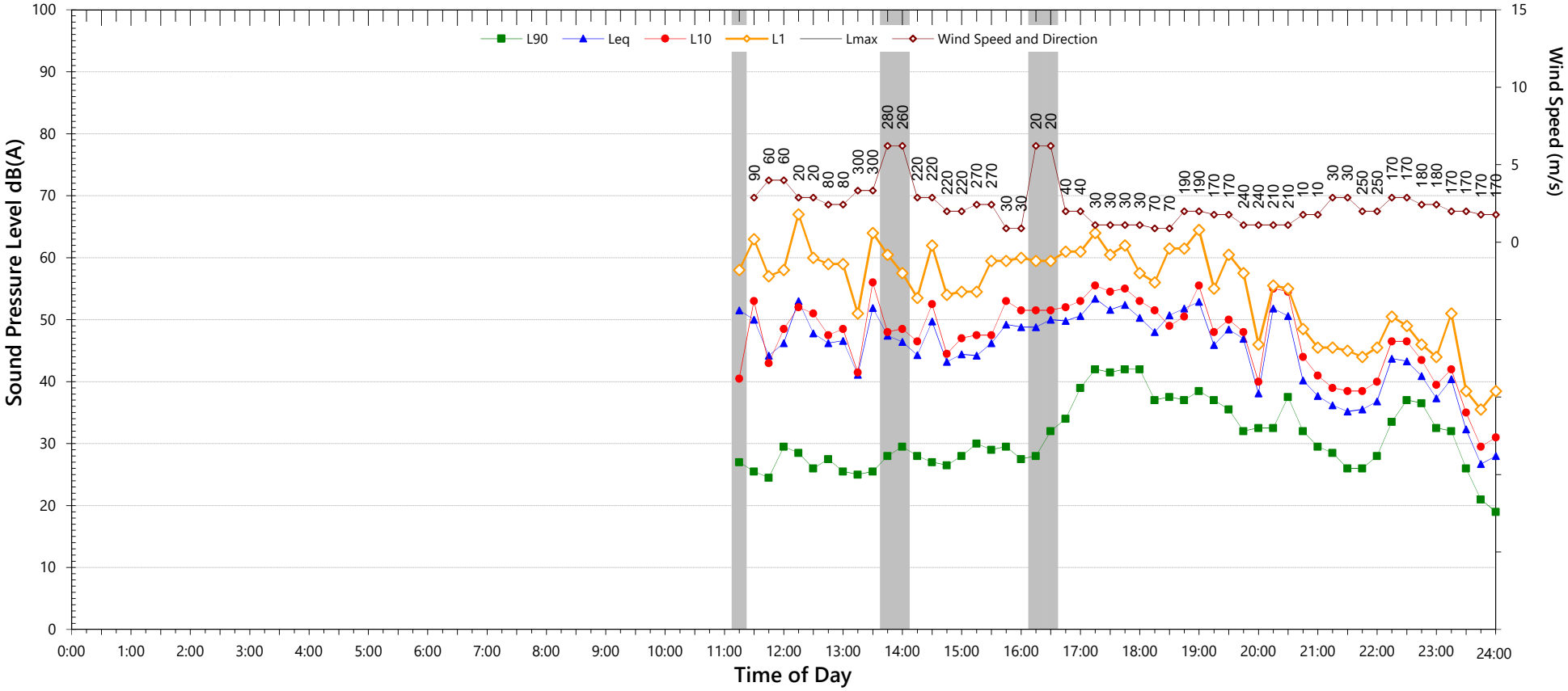
Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Long Term Noise Monitoring Results

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Tuesday, 5 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	25.5	26.0	16.0
LAeq	49.2	47.9	40.7

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51.2	43.2
$L_{eq\ 1hr}$ upper 10 percentile	54.5	50.6
$L_{eq\ 1hr}$ lower 10 percentile	41.3	25.7

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

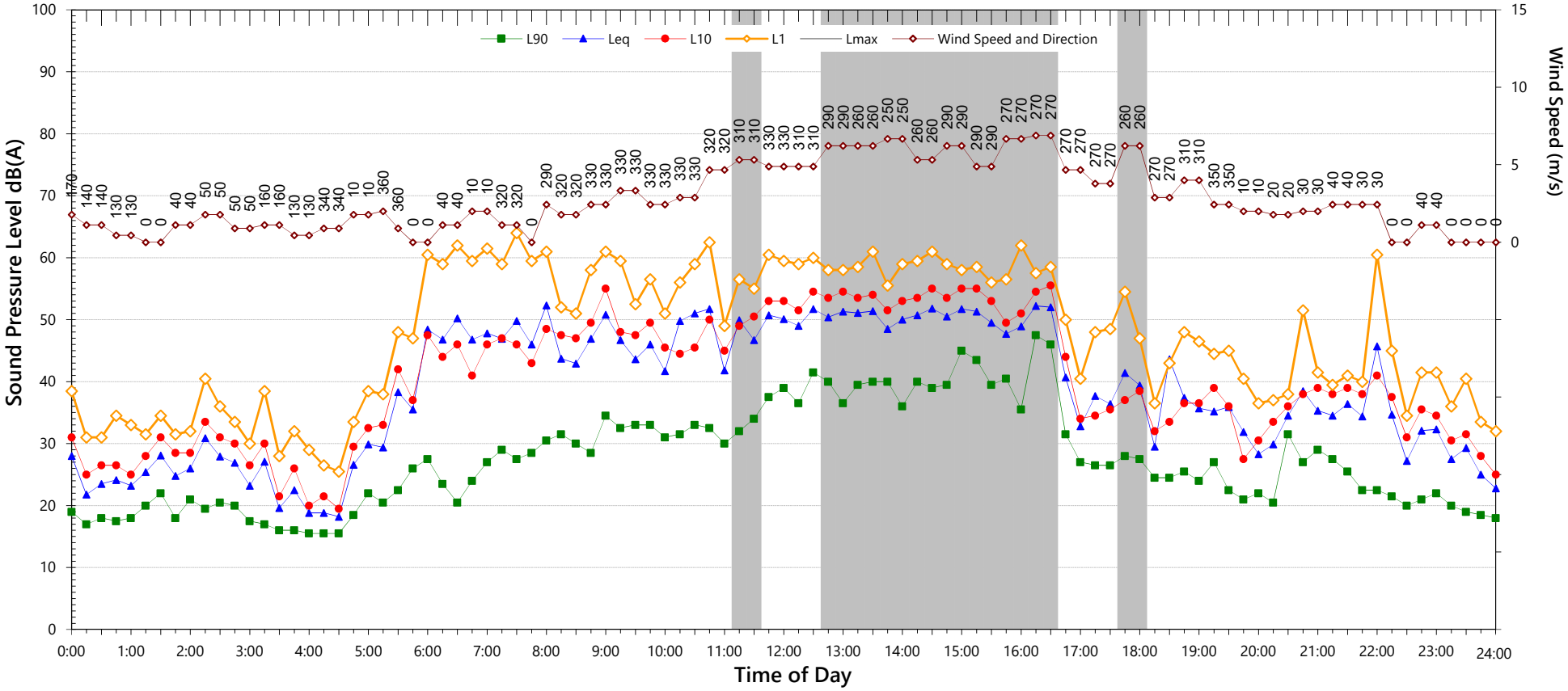
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Wednesday, 6 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	27.0	21.0	16.0
LAeq	48.1	38.1	41.2

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	48.7	43.7
$L_{eq\ 1hr}$ upper 10 percentile	53.0	52.3
$L_{eq\ 1hr}$ lower 10 percentile	36.6	24.4

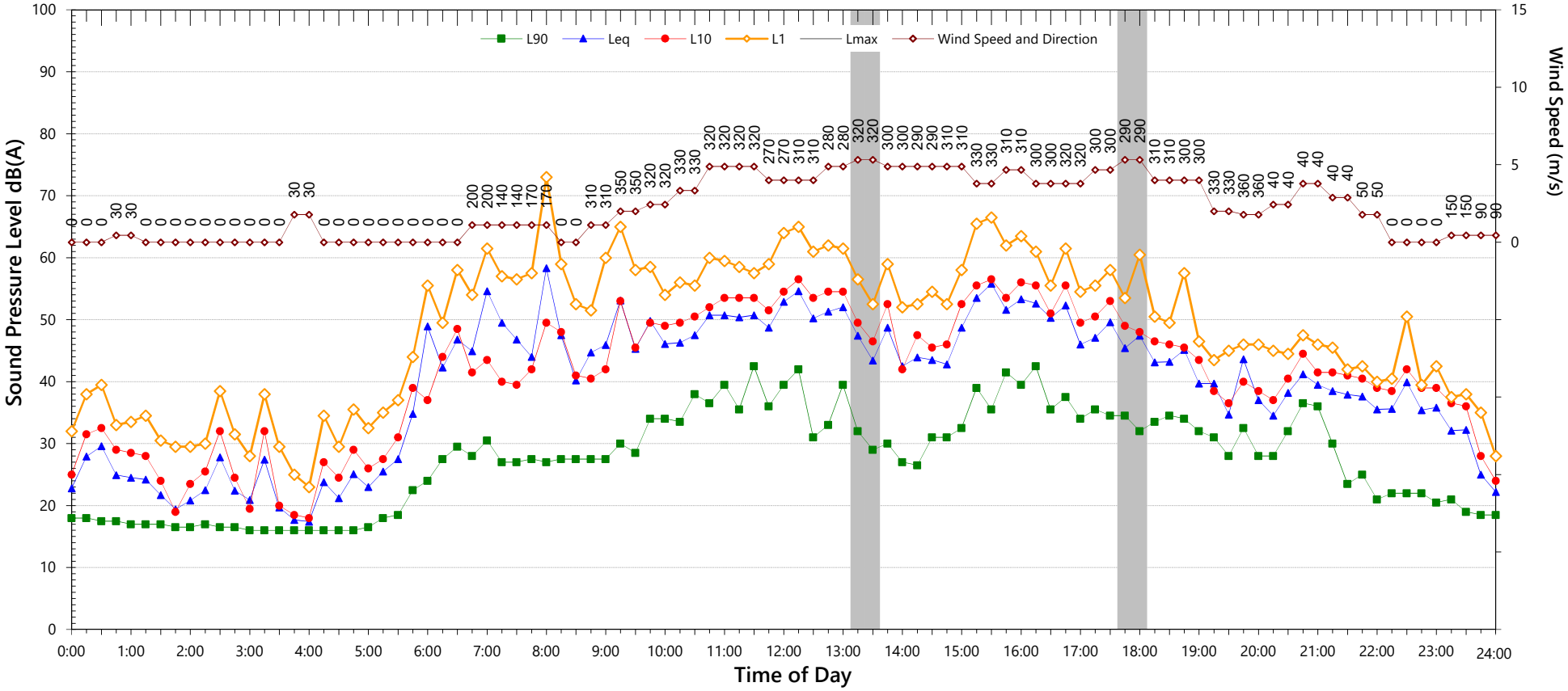
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Thursday, 7 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	27.0	23.5	18.5
LAeq	50.7	40.4	36.7

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51.9	39.2
$L_{eq\ 1hr}$ upper 10 percentile	56.0	44.6
$L_{eq\ 1hr}$ lower 10 percentile	40.8	29.8

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

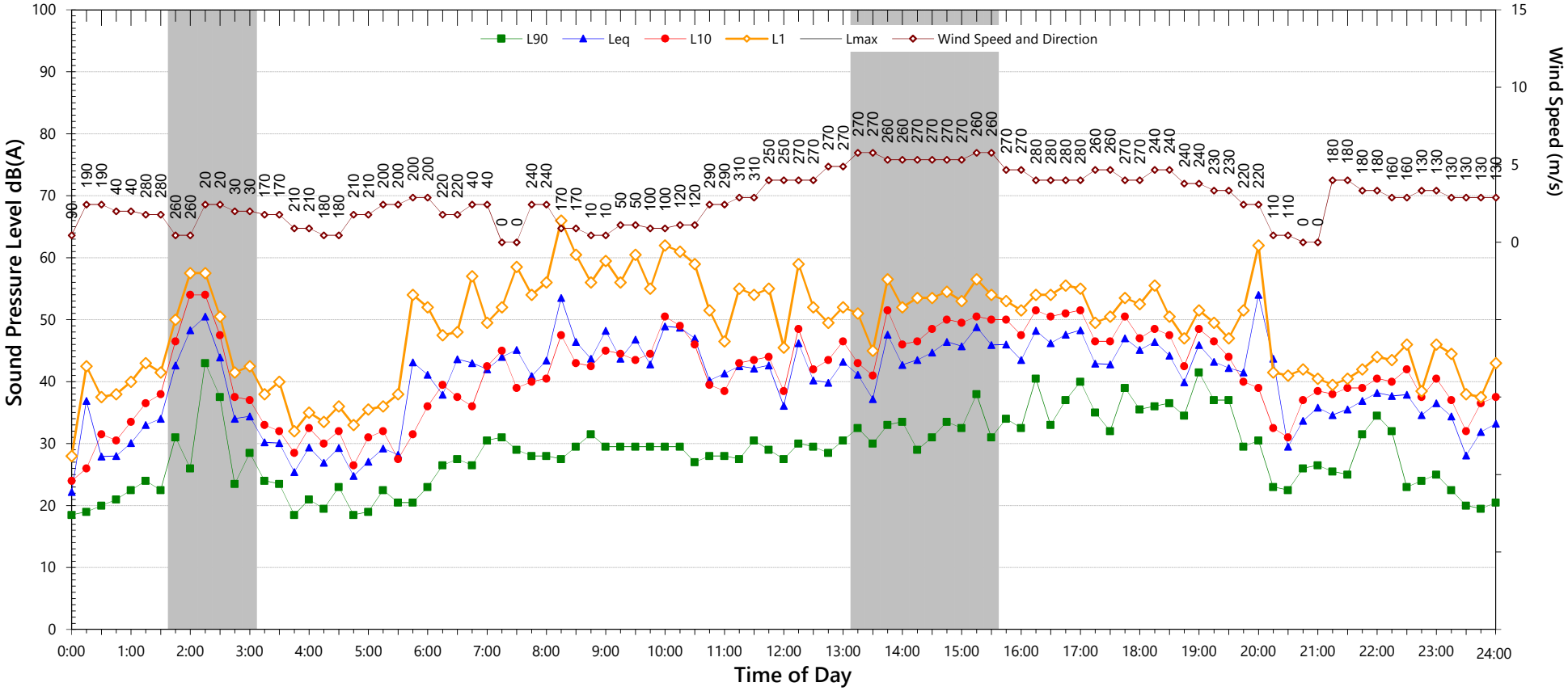
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Friday, 8 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	27.5	23.0	17.0
LAeq	45.9	44.7	38.9

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	48.0	41.4
$L_{eq\ 1hr}$ upper 10 percentile	51.8	48.3
$L_{eq\ 1hr}$ lower 10 percentile	39.8	25.0

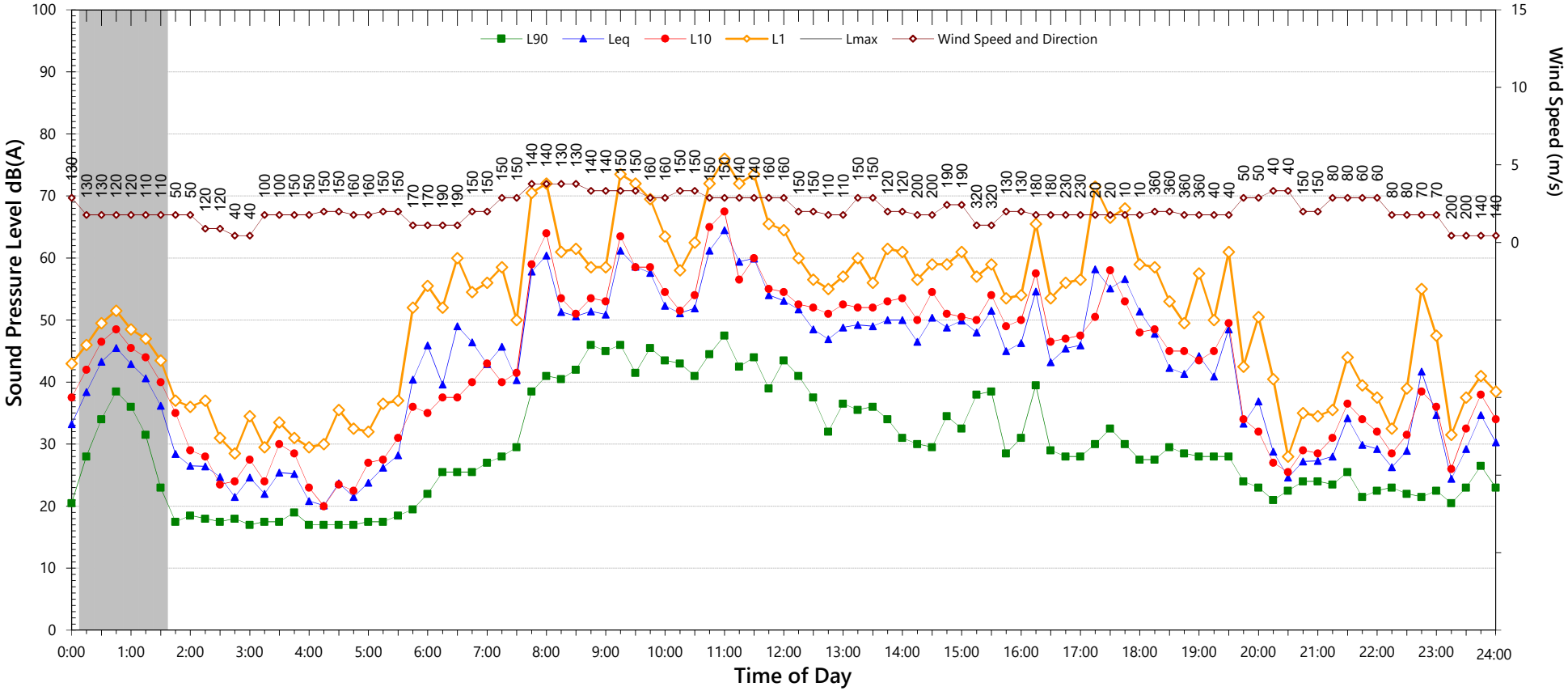
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Saturday, 9 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	28.5	21.5	18.0
LAeq	55.3	41.3	44.3

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	56.6	45.2
$L_{eq\ 1hr}$ upper 10 percentile	62.0	53.5
$L_{eq\ 1hr}$ lower 10 percentile	32.0	24.5

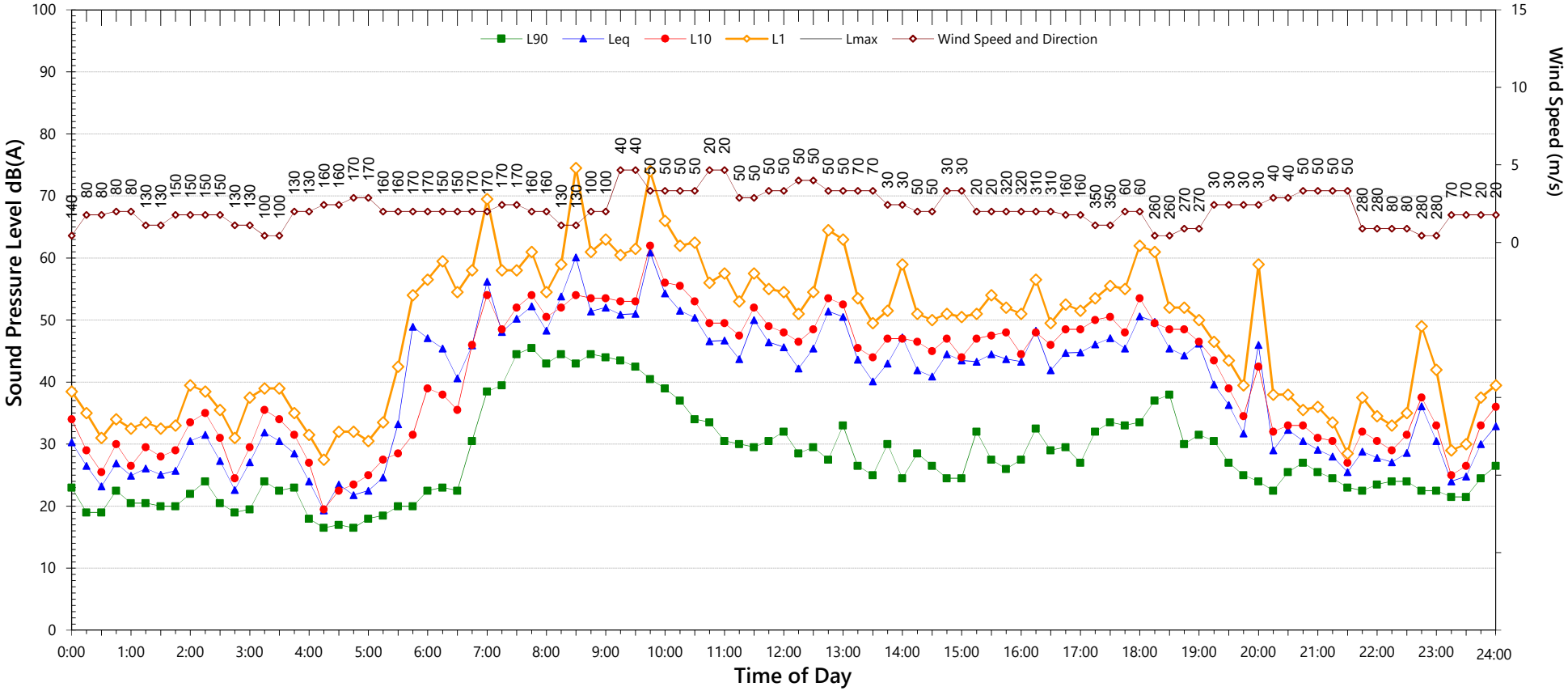
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Sunday, 10 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	25.5	22.5	20.5
LAeq	50.8	42.1	49.0

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52.1	51.5
$L_{eq\ 1hr}$ upper 10 percentile	58.7	60.4
$L_{eq\ 1hr}$ lower 10 percentile	31.8	27.5

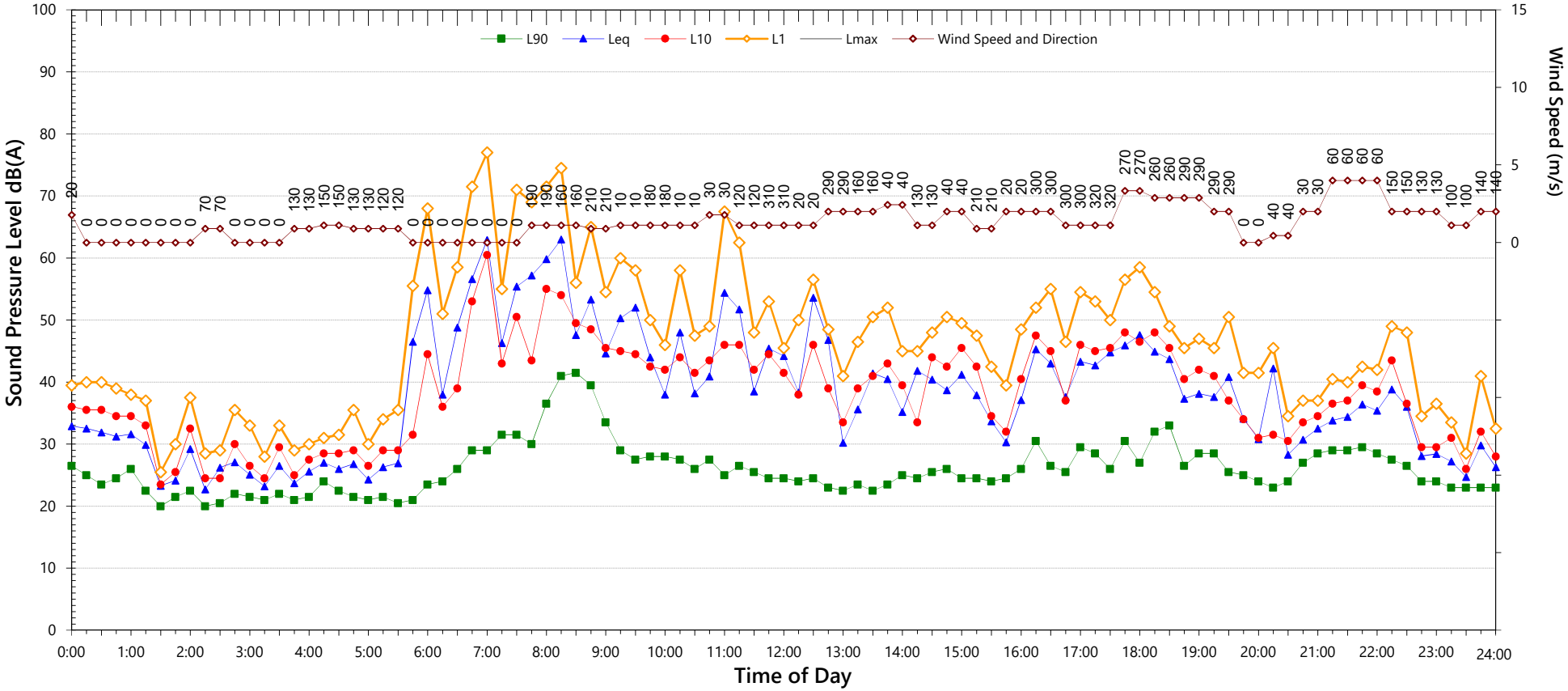
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Monday, 11 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	23.5	24.0	21.0
LAeq	51.1	38.8	37.9

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52.3	40.4
$L_{eq\ 1hr}$ upper 10 percentile	59.7	48.2
$L_{eq\ 1hr}$ lower 10 percentile	37.9	28.2

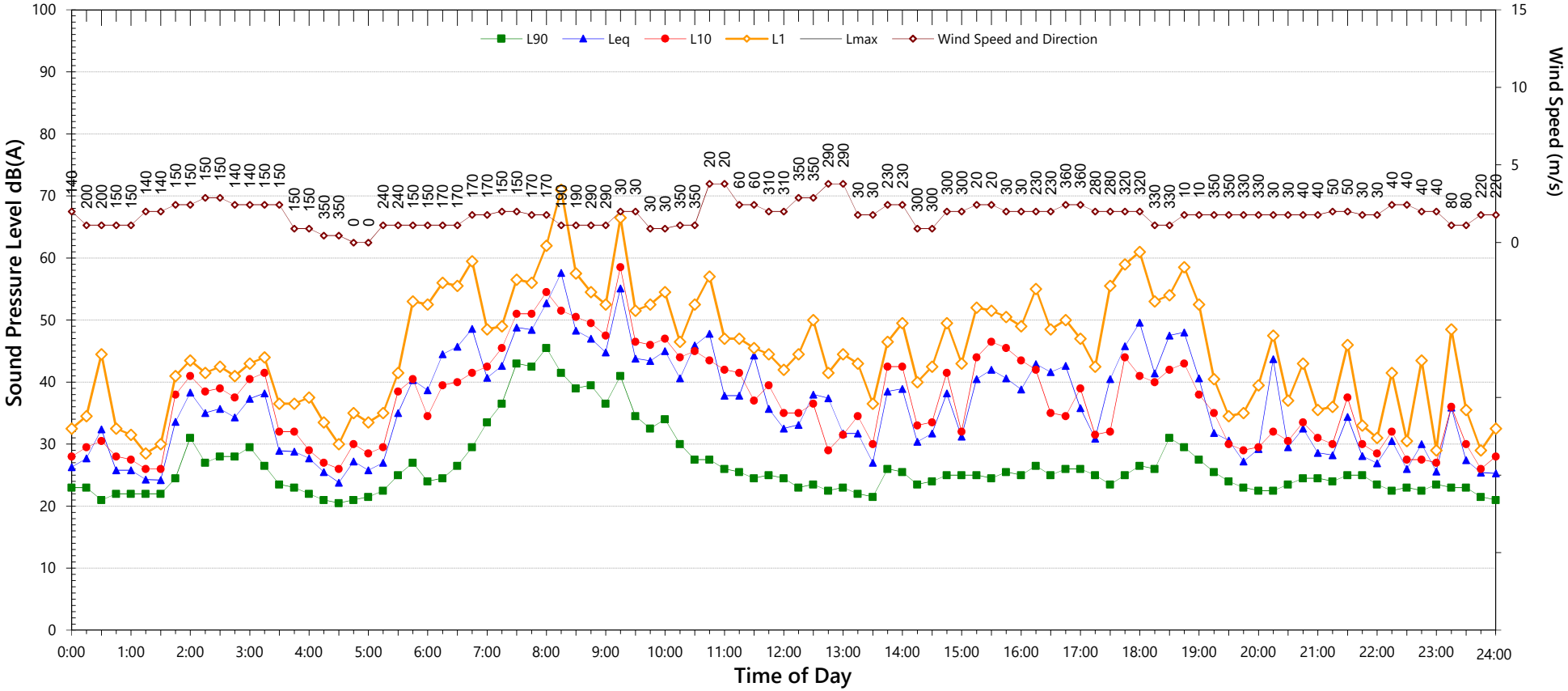
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Tuesday, 12 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	23.0	22.5	19.5
LAeq	46.4	40.5	42.3

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	47.9	44.8
$L_{eq\ 1hr}$ upper 10 percentile	54.0	51.9
$L_{eq\ 1hr}$ lower 10 percentile	32.8	25.6

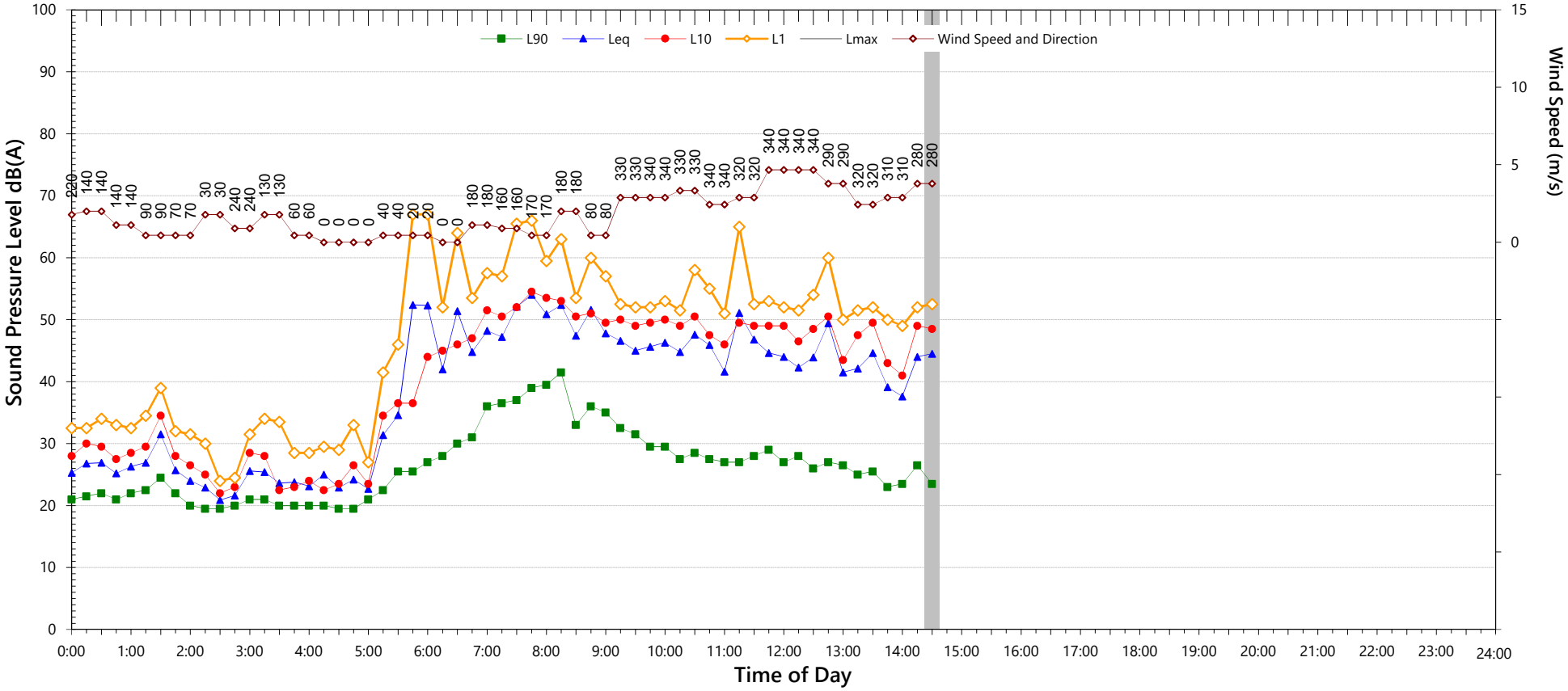
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

Dunedoo Solar Farm

Wednesday, 13 December 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	25.0	-	-
LAeq	47.9	-	-

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	50.4	-
$L_{eq\ 1hr}$ upper 10 percentile	54.2	-
$L_{eq\ 1hr}$ lower 10 percentile	44.2	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)