ARUP

Health Infrastructure

Lot 2 DP 1281576

Soil Conservation REF Acoustic Assessment

Reference: AC07

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1. Introduction

This acoustic report supports a Review of Environmental Factors (REF) prepared for Health Infrastructure NSW pursuant to part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act) for the undertaking of soil conservation works and the construction of a new road at Lot 2, DP 1281576, Princes Highway, Moruya.

1.1 Site description

The site of the soil conservation works, and ancillary road works is located on the Princes Highway in the NSW south coast town of Moruya. The site is legally described as Lot 2, DP 1281576 and is a large vacant greenfield site. The soil conservation works will facilitate the ongoing management of the greenfield lot. To the west of the site is Moruya TAFE, and to the north is a small residential subdivision called Mynora Estate.

An aerial figure of the site is shown in Figure 1 below.

1.2 Proposed works

The works proposed under this REF include the following:

- Construction of three erosion and sediment basins, ranging between 507m2 and 990m2 in area.
- Construction of an ancillary road into the site to facilitate construction access into the site.
- Associated tree removal

A further detailed description of the proposed works is contained in the Review of Environmental Factors report prepared by Ethos Urban. Refer to Figure 2 which outlines the extent of the proposed works including the route of the access road and the three erosion and sediment basins.

1.3 Scope of assessment

The works are being carried out under State Environmental Planning Policy (Transport and Infrastructure) 2021 [1] as 'Development without Consent' by Health Infrastructure NSW as a public authority.

This document provides noise and vibration advice on:

- Impact on adjacent to sensitive receivers and mitigation measures (during construction and operation.)
- Consideration of noise and vibration impacts with the proposed construction hours for REF works.
- Identification of work equipment and machinery for construction and assessment of impact on surrounding receivers.

The assessment of operational noise relates to road traffic and is therefore assessment against the NSW *Road Noise Policy* (RNP) [2].

The assessment of construction noise impacts has been carried out in accordance with the NSW *Interim Construction Noise Guidelines* [3]. As sensitive receivers may be impacted for greater than 3 weeks, a quantitative assessment is required. Potential impacts from vibration during construction and has been quantified as per *Assessing Vibration: a technical guideline* [4].

Other standards, policies and guidelines referenced in this report include:

- BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Pt2: Guide to damage levels from groundborne vibration, (1993) [5]
- DIN 4150-3: 1999 Structural vibration – Effects of vibration on structures, (1999) [6]
- DIN 4150-2: 1999 Structural vibration – Human exposure to vibration in buildings [7]

Figure 1: Proposed site location

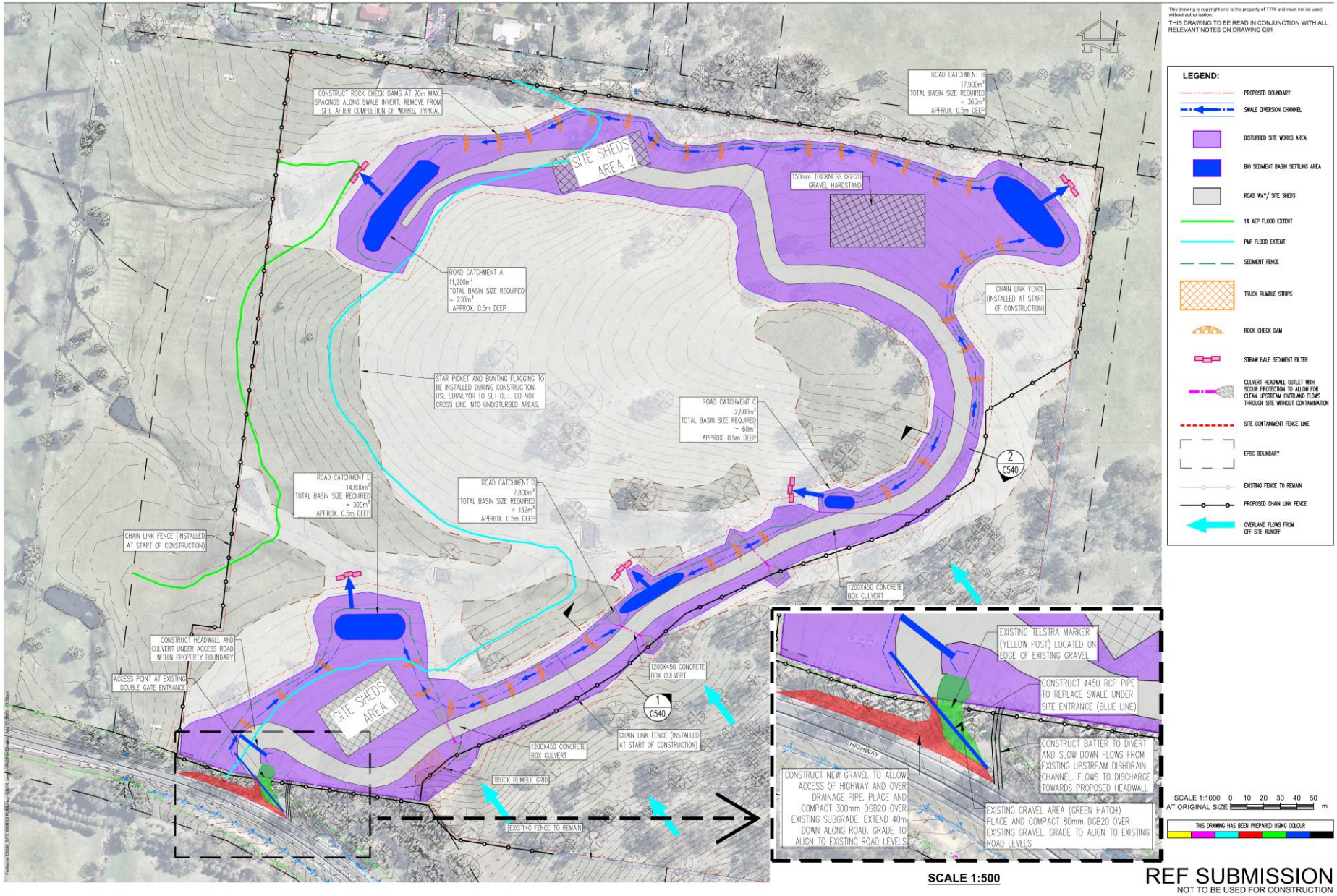

Figure 2: Extent and location of proposed works

2. Existing noise environment

2.1 Assessment locations

In accordance with the *Noise Policy for Industry* [8] (NPfI), the reasonably most-affected residences have been grouped into Noise Catchment Areas (NCAs) based on their acoustic environment as observed on site. For clarity, the assessment of residential receivers presented in this report is isolated to the reasonably most-affected receivers listed in Table 1 and shown in Figure 3.

Table 1: Reasonably most-affected residential receivers

Receiver ID	Address	No. of floors	NCA
R1	2945 Princes Highway, Moruya	1	1
R2	36 Keightley Street, Moruya	1	2

2.2 Noise monitoring

Noise monitoring was undertaken for the purpose of deriving of noise criteria and qualifying the noise environment at nearby receivers.

Long-term unattended and short-term attended monitoring was conducted at locations presented in Table 2 and shown in Figure 4.

Table 2: Monitoring locations

Measurement Type	Purpose	ID	Location
Both long-term unattended and short-term attended	Establish criteria	L1	2945 Princes Highway, Moruya
		L2	36 Keightley Street, Moruya
Short-term attended only	Quantify and qualify noise levels surrounding site	S1	End of Caswell St
		S2	36 Maunsell St

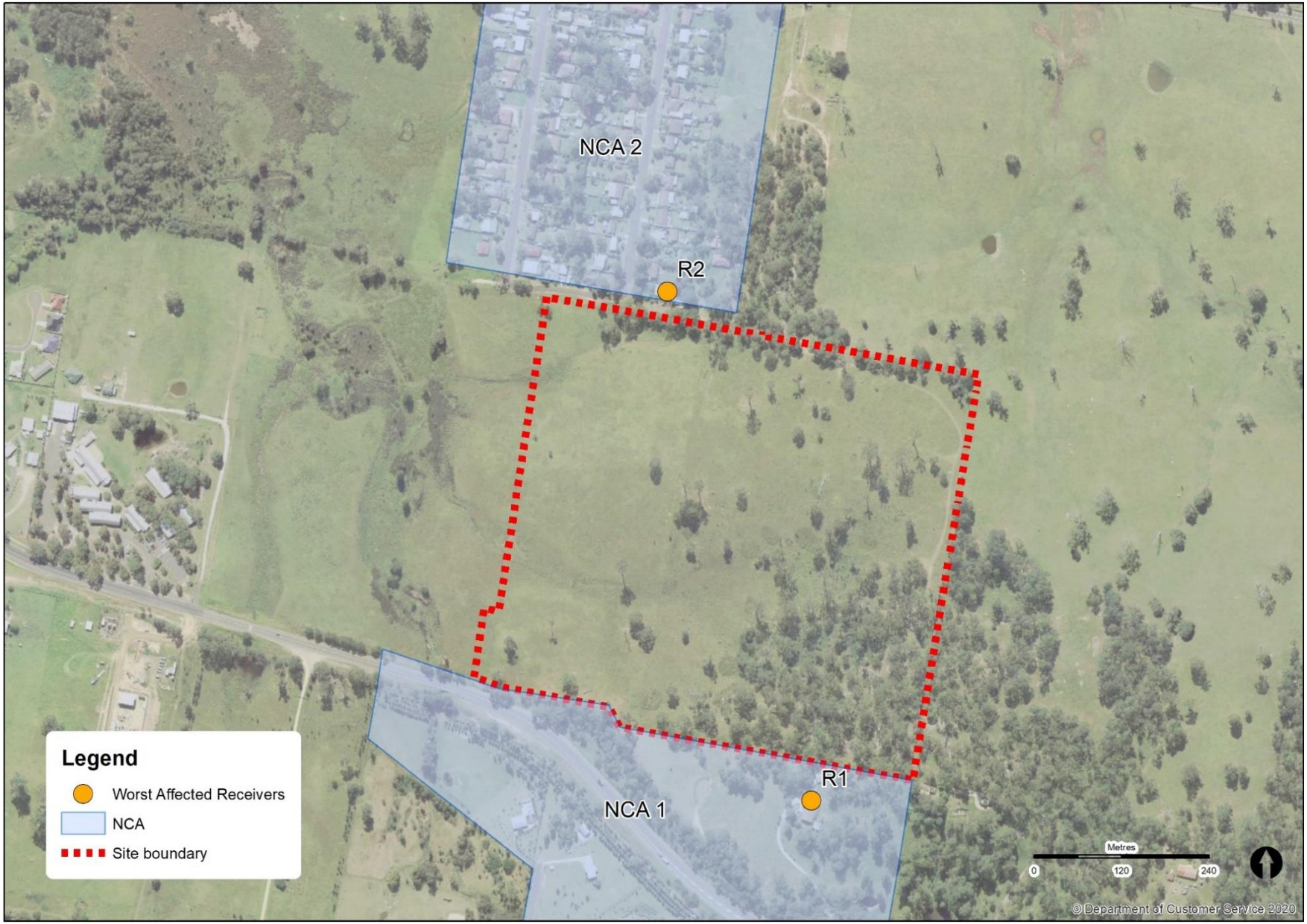

Figure 3: Site map showing noise sensitive receiver locations and NCAs

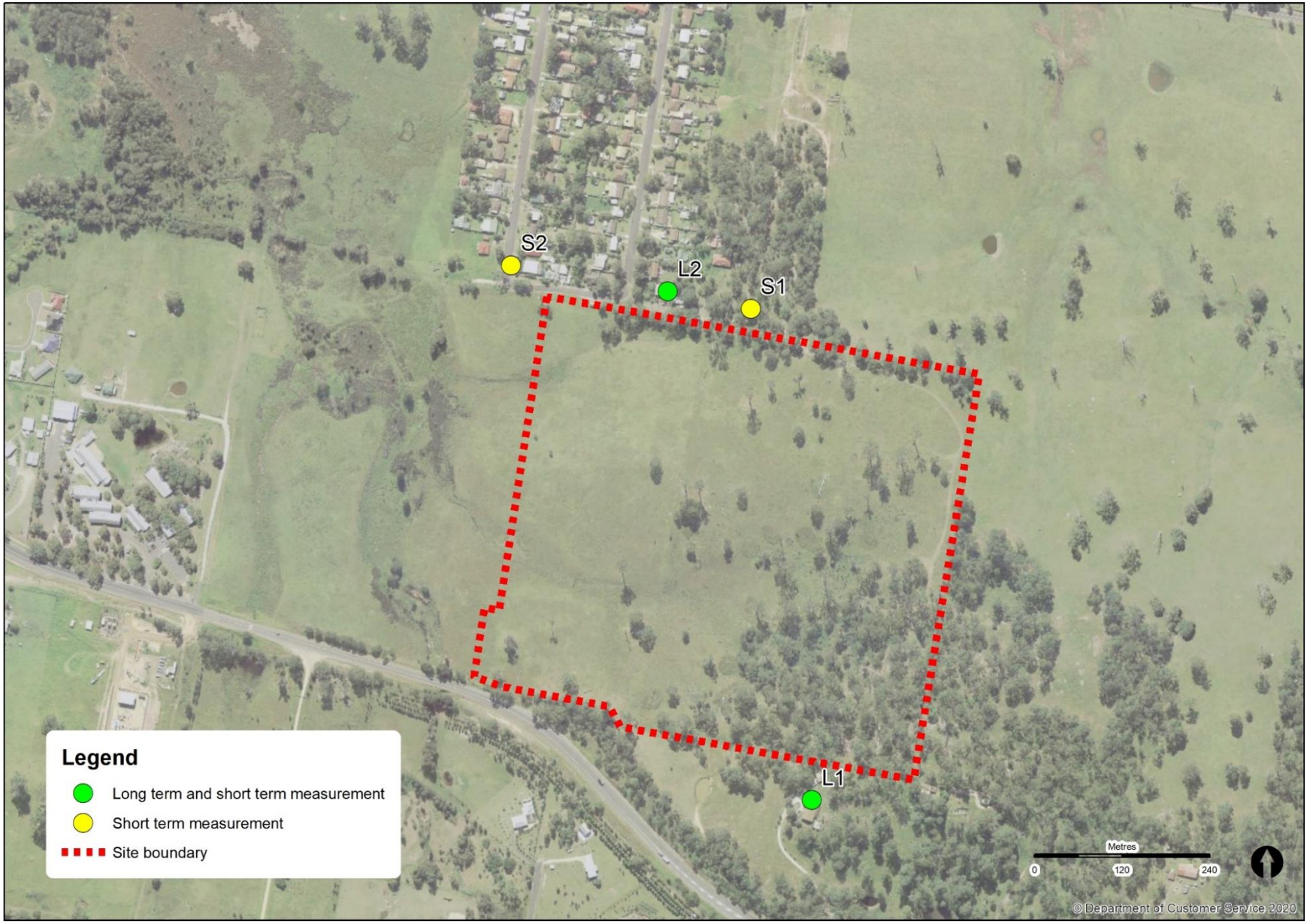

Figure 4: Noise measurement locations

2.2.1 Unattended long-term monitoring

Long-term noise monitoring was carried out on 1 December to 12 December 2021 at two locations shown in Figure 4. The long-term noise monitoring methodology and noise level graphs of the data are included in Appendix B.

Table 3 summarises the background and ambient noise level results.

Table 3: Long-term noise monitoring results, dB(A)

Location ID	NCA	Time period[1]	Rating Background Levels, dBL_{A90}	Ambient dBL_{Aeq} noise levels
L1 2945 Princes Highway	1	Day	40	53
		Evening	36	54
		Night	31	43
L2 36 Keightley Street	2	Day	37	54
		Evening	36	50
		Night	31	47

Notes:

1. The NPfI defines day, evening and night time periods as:
    - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
    - Evening: the period from 6 pm to 10 pm.
    - Night: the remaining period.

As required by the NPfI, the external ambient noise levels presented are free-field noise levels.

2.2.2 Attended short-term monitoring

Short-term 15 minute attended noise measurements were undertaken on 1 December 2021 at four locations shown in Figure 4. The measured noise levels are summarised in Table 4.

Table 4: Short-term noise monitoring results, dB(A)

Location ID	Date and start time	Measured levels		Noise sources contributions
		$dBL_{A90(15min)}$	$dBL_{Aeq(15min)}$	
L1	1 Dec 21 14:50	40	45	Dominated by traffic noise from Princes Highway, with slight contribution from South Head Road
L2	1 Dec 21 15:34	34	45	Natural sounds, with faint traffic noise from South Head Road and Princes Highway
S1	1 Dec 21 17:38	33	45	Natural sounds, with faint traffic noise from South Head Road and Princes Highway
S2	1 Dec 21 18:01	34	47	Natural sounds, with faint traffic noise from South Head Road and Princes Highway

Results show existing noise levels are similar across the northern site boundary. No industrial noise was noted during measurements.

3. Operational noise

3.1 Road traffic noise criteria

Increased traffic generated on the surrounding road network due to the operation of the development is assessed in accordance with the NSW *Road Noise Policy* (RNP) [2]. Table 3 of the RNP which sets out the assessment criteria for particular types of project, road category and land use, shown in Table 5 below.

Table 5: Road traffic criteria for traffic generating development - residential receivers.

Road category	Type of project / land use	Assessment criteria – dB(A)	
		Day (7:00am-10:00pm)	Night (10:00pm-7:00am)
Freeway/arterial/sub-arterial roads - Princes Highway	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments	$L_{Aeq,(15\ hour)}$ 60 (external)	$L_{Aeq,(9\ hour)}$ 55 (external)

Note:

These criteria are for assessment against façade corrected noise levels when measured in front of a building façade.

Regarding the application of the assessment, the RNP states:

> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*

3.2 Operational traffic assessment

It is not expected that vehicular movements and traffic noise levels will significantly increase as a result of the proposed works.

4. Construction noise and vibration

4.1 Construction noise and vibration criteria

4.1.1 Construction noise criteria

The NSW *Interim Construction Noise Guideline* [3] (ICNG or Guideline) provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction noise management levels above which all feasible and reasonable work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

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

This development is expected to warrant a quantitative assessment.

The ICNG sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These noise management levels (NMLs) for residential receivers and other sensitive receivers are reproduced in Table 6.

Table 6: Construction noise management levels (NMLs) at residential receivers.

Time of day	**NML**[1] **$L_{Aeq\ (15\ min)}$**	**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	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.

Time of day	NML[1] $L_{Aeq\ (15\ min)}$	How to apply
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 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.

Notes:

1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 7 summarises relevant project construction noise targets for the project for residential receivers.

Table 7: Noise Management Levels for residential receivers.

Receiver ID	Address	Standard Hours[1] $dBL_{Aeq\ (15\ min)}$
R1	2945 Princes Highway, Moruya	50
R2	36 Keightley Street, Moruya	47

Note:

1. Standard hours are Monday to Friday 7 am to 6 pm and Saturday from 8 am to 1 pm.

4.1.2 Construction traffic noise criteria

Increased traffic generated on the surrounding road network due to the construction activities of the proposed works is assessed in accordance with the NSW *Road Noise Policy* (RNP) [2]. Table 3 of the RNP which sets out the assessment criteria for types of project, road category and land use, shown in Table 8 below.

Table 8: Road traffic criteria for traffic generating development – residential receivers.

Road category	Type of project / land use	Assessment criteria – dBL_{Aeq}	
		Day (7:00am-10:00pm)	Night (10:00pm-7:00am)
Freeway/ arterial/sub-arterial roads (Princes Hwy)	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments	$L_{Aeq,(15\ hour)}$ 60 (external)	$L_{Aeq,(9\ hour)}$ 55 (external)

Note:

These criteria are for assessment against façade corrected noise levels 1 metre in front of a building façade.

Regarding the application of the assessment, the RNP states:

> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*

4.1.3 Construction vibration criteria

4.1.3.1 Human response

The NSW EPA's *Assessing Vibration – A Technical Guideline* [9] provides vibration criteria for maintaining human comfort within different space uses. The guideline recommends 'preferred' and 'maximum' weighted vibration levels for both continuous vibration sources, such as steady road traffic and continuous construction activity, and for impulsive vibration sources. The weighting curves are obtained from BS 6472-1:2008 [10].

For intermittent sources (e.g. passing heavy vehicles, impact pile driving, intermittent construction), the guideline uses the vibration dose value (VDV) metric to assess human comfort effects of vibration. VDV considers both the magnitude of vibration events and the number of instances of the vibration event. Intermittent events that occur less than 3 times in an assessment period (either day, 7 am to 10 pm, or night, 10 pm to 7 am) are counted as 'impulsive' sources for the purposes of assessment.

As noted in the Guideline, situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances, such as a construction or excavation projects. Notwithstanding, the recommended vibration limits for maintaining human comfort in residences and other relevant receiver types are given for continuous/impulsive and intermittent vibration Table 9 and Table 10 respectively.

Table 9: Preferred and maximum criteria for continuous and impulsive vibration

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
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
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

Notes:

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

Table 10: Acceptable vibration dose values for intermittent vibration (m/s1.75).

Location	Daytime 0700-2200 h		Night-time 2200-0700 h	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26

4.1.3.2 Structural damage

British Standard 7385 Part 1: 1993, defines different levels of structural damage as:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 and Section 7.4.2 of BS7385-2 sets limits for the protection against the different levels of structural damage and those levels are reproduced in Table 11 below.

Table 11: BS 7385-2 Structural damage criteria.

Group	Type of structure	Damage level	Peak component particle velocity, mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings[3]	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Notes:

1. Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.
2. Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

The guide values in Table 11 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 11 may need to be reduced by up to 50%.

4.1.3.3 Buried services

DIN 4150-2:2016 sets out guideline values for vibration effects on buried pipework (see Table 12).

Table 12: Guideline values for short-term vibration impacts on buried pipework.

Line	Pipe material	Peak component particle velocity (PCPV) measured on pipe, mm/s
1	Steel, welded	100
2	Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50
-	High pressure gas pipelines[1]	75 Monitoring required if predicted above 50. No piling within 15 m of pipeline without detailed assessment.

Notes:

1. Based on UK National Grid's specification [11]

- For gas and water supply pipes within 2 m of buildings, the levels given in DIN4150-3 [12] should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

- For Rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50%.

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the

connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

4.2 Construction stages and activities

Table 13 provides an outline of the associated construction activities as provided by the project management team.

Table 13: Indicative construction stages for the proposed works

Project stage	Tasks/activity undertaken
Soil conservation	Construction of five erosion and sediment basins,
	Construction of an ancillary road into the site access road
	Associated tree removal

4.3 Indicative programme and schedule

The indicative construction schedule associated with the proposed works is outlined in Table 14.

Table 14: Indicative construction schedule

Element	Commence	Duration
Soil conservation works	Q1 2024	3 months

4.4 Construction hours

The proposed construction hours for the proposed works are summarised in Table 15.

Table 15: Typical proposed construction hours

Day	Proposed construction hours
Monday to Friday	7 am to 6 pm
Saturday	8 am to 1 pm
Sunday and public holiday	No work

4.5 Construction noise

As detail of the construction noise equipment / plant to be used is not known at the time, assumptions have been made based on sources normally found on construction sites similar to the proposed development.

Assessment has been made on construction activities that are expected to be representative of a worst-case condition during the construction programme. Table 16 outlines the expected worst case construction activities and anticipated airborne noise levels for indicative plant items.

Table 16: Expected worst-case construction activity and indicative plant items

Indicative construction equipment	Sound power level (per unit), dB(A)	% of use in worst case 15 mins	No. of plant item operating in worst case 15 mins
			Soil conservation
Asphalt Paver	112	75	1
Backhoe	108	75	1
Bulldozer	114	75	1
Chainsaw - petrol	114	75	1
Compactor	115	75	1

Indicative construction equipment	Sound power level (per unit), dB(A)	% of use in worst case 15 mins	No. of plant item operating in worst case 15 mins
			Soil conservation
Concrete Pump Truck	113	75	1
Crane (Franna)	98	75	1
Elevated Work Platform (Cherry Picker)	105	75	1
Excavator (30t) + hydraulic hammer	122	75	1
Forklift	106	75	1
Loader (Front-end) (23t)	112	75	1
Generator (diesel)	113	100	1
Grader	115	75	1
Hand Tools (Electric)	110	75	1
Mulcher (Chipper)	116	75	1
Roller (Vibrator)	112	75	1
Pavement Laying Machine	114	75	1
Scraper	116	75	1
Truck (>20 Tonne)	107	75	2
Truck (water cart)	108	75	1
Vehicle (Light Commercial e.g. 4WD)	111	75	1

Equipment sound power levels (L_w) have been sourced from *AS2436 – 2010* "Guide to noise and vibration control on construction, demolition and maintenance sites." It should be noted that it is unlikely that all machinery would be operating at the same time (like the modelling assumes) but taking a 'worst-case' scenario approach helps to identify where noise impacts could be a concern and assists in the design of mitigation measures. A conservative adjustment for duration has been applied in the predicted construction noise levels. The adjustment assumes most items of equipment operates for 75% of the 15-minute assessment period.

Predicted construction noise levels, considering standard construction hours, are tabulated in Table 17. Noise levels have been compared to the receiver's relevant Noise Management Level and exceedances have been highlighted.

Table 17: Predicted noise levels at nearest affected off-site receiver locations

Location	Distance to construction works (m)	NML, $dBL_{Aeq(15\ min)}$		Predicted sound level from each construction activity, $dBL_{Aeq(15\ min)}$
		Noise affected	Highly noise affected	Soil conservation
R1	210	50	75	74
R2	47	47	75	83

Note:

Predicted sound pressure level ≤ noise affected level

Noise affected level < predicted sound pressure level ≤ highly noise affected

Highly noise affected < predicted sound pressure level

Results show that construction noise is predicted to exceed 'noise affected' levels during standard hours for all receivers, with residential receiver R2 predicted to be "highly noise affected."

Table 17 shows predicted construction noise levels with indicative noise mitigation measures included. It should be noted that results in Table 17 have conservatively applied a -5 dB reduction from predicted levels shown in Table 16, assuming feasible and reasonable mitigation measures and work practices have been applied during construction (as detailed further in Section 4.8). Predicted noise levels shown in Table 28 are considered indicative only as actual construction noise impacts would depend on final construction methodology and equipment selected.

Table 18: Predicted noise levels at nearest affected off-site receiver locations – with noise mitigation

Location	Distance to construction works (m)	NML, $dBL_{Aeq(15\ min)}$		Predicted sound level from each construction activity, $dBL_{Aeq(15\ min)}$
		Noise affected	Highly noise affected	Soil conservation
R1	210	50	75	69
R2	47	47	75	78

Note:

Predicted sound pressure level ≤ noise affected level

Noise affected level < predicted sound pressure level ≤ highly noise affected

Highly noise affected < predicted sound pressure level

The magnitude of construction noise impacts is dependent upon several aspects including the intensity, location of activities and the type of equipment used during the construction period. Based on these factors, the predicted construction noise levels are generally conservative and do not represent a constant noise emission that would be experienced by the community on a daily basis throughout the project construction period. It is also emphasised that all the equipment listed in Table 16 is not expected to operate continuously for 15-minutes and concurrently in reality. The predicted noise levels would only be experienced for limited periods of time when works are occurring and should not be experienced for full daytime or night-time periods.

In general, construction works are temporary in nature therefore potential noise impact on the community and the surrounding environment will not be permanent or continuous. Where the predicted $L_{Aeq(15min)}$ noise level is greater than the noise management levels, all feasible and reasonable work practices should be applied. However, it is unlikely mitigation measures would reduce the received noise levels below the noise management levels in all cases.

4.6 Construction traffic

Table 19 outlines the expected traffic generated per day by the proposed construction as provided by the traffic consultant [13].

Table 19: Indicative construction traffic vehicle movements

Indicative month	Expected traffic generated per day
January 2024	80
February 2024	120
March 2024	50

It is noted from Table 19 that the maximum amount of traffic generated by construction activities is around 120 vehicle movements per day. It is also advised that around 200-240 worker vehicle movements per day are expected based on estimated haulage needs and number of workers. Both heavy and light vehicles related to construction will be operating within standard construction hours, with peak hours proposed to be between 7am and 1pm.

Table 20 presents the existing day-time traffic volume of the Princes Highway, along with the potential increase in traffic noise caused by the proposed construction activity.

Table 20: Construction traffic assessment due to construction works

	Light vehicles	Heavy vehicles	Total
Existing Princes Highway volume (15 hour day)	5637	985	6623
Traffic generated by construction works	240	120	370
Potential increase in traffic noise level due to development, dBA	**0.18**	**0.50**	**0.68**

As the potential in traffic noise level due to construction traffic generated is less than 2 dB, the proposed construction activity can be considered as a relatively minor impact that would not significantly affect the existing environment.

4.7 Construction vibration

The nearest off-site vibration sensitive receiver locations are presented in Table 21.

Table 21: Nearest off-site vibration receivers

ID	Description	Type of receiver	Approx. distance from structure to nearest works location, m
R1	2945 Princes Highway, Moruya	Residential	210
R2	36 Keightley St, Moruya	Residential	47

4.7.1 Vibration – minimum working distances

Recommended minimum working distances for vibration intensive plant, which are based on international standards and guidance, are provided in Table 22. Minimum working distances are quoted for:

- Cosmetic damage (based on the British Standard 7385 [5])
- Human comfort (based on the DECCs ‘Assessing Vibration; a technical guideline’ [4])

Table 22: Recommended minimum working distances for vibration intensive equipment

Plant item	Rating / description	Minimum working distance (m)			
		Cosmetic damage – screening criteria			Human response DECC Guideline
		Industrial and heavy commercial buildings BS 7385 Line 1 -25 mm/s (see note 2)	Residential and light commercial buildings BS 7385 Line 2 - 7.5 mm/s (See note 2)	Unsound structures DIN 4150 Line 3 - 3 mm/s	
Vibratory roller	< 50 kN (~ 1 to 2t)	2	5	11	15 to 20
	< 100 kN (~ 2 to 4t)	2	6	13	20
	< 200 kN (~ 4 to 6t)	5	12	26	40
	< 300 kN (~ 7 to 13t)	6	15	31	100
	> 300 kN (~ 13 to 18t)	8	20	40	100
	> 300 kN (> 18t)	10	25	50	100
Jackhammer	Hand-held	1 (nominal)	1 (nominal)	3	5
Truck movements	-	-	-	-	10

Notes:

1. Based on TRL document [14] using Godio et al formula, equation 24
2. Where vibration might give rise to resonant responses in structures

4.7.2 Vibration assessment

Noting the minimum working distances in Table 22 and the distance to the nearest sensitive receiver locations (as detailed in Table 21), it is not expected that construction activities to result in vibration impacts upon the nearest residential receivers. However, receiver R2 may be impacted from a human comfort perspective depending on the plant item (i.e. if vibratory rollers >= 4 to 6 t are used during the works).

During development of the detailed Construction Noise and Vibration Management Plan an investigation of vibration impact upon nearby sensitive receivers should take place. It is expected that vibration monitoring will be required under the CNVMP.

4.8 Construction noise and vibration mitigation

Noise mitigation measures for each major construction activity are discussed in the following sections. These mitigation measures are considered to represent ‘feasible and reasonable’ mitigation measures suitable for implementation during construction of the project.

4.8.1 Construction noise and vibration management plan

For all construction works, the contractor would be expected to prepare a detailed Construction Noise and Vibration Management Plan (CNVMP). This plan should include but not be limited to the following:

- Roles and responsibilities
- Noise and vibration sensitive receiver locations
- Areas of potential impact
- Mitigation strategy
- Monitoring methodology

- Community engagement strategy.

General guidance on the control of construction noise and vibration impacts relevant to this study are discussed in the following sections.

4.8.2 General

In general, practices to reduce construction noise impacts will be required, and may include;

- Adherence to the standard approved working hours as outlined in the Project Approval.
- Manage noise from construction work that might be undertaken outside the recommended standard hours
- The location of stationary plant (concrete pumps, air-compressors, generators, etc.) as far away as possible from sensitive receivers
- Using site sheds and other temporary structures or screens/hoarding to limit noise exposure where possible.
- Sealing of openings in the building (temporary or permanent) prior to commencement of internal works to limit noise emission.
- The appropriate choice of low-noise construction equipment and/or methods
- Modifications to construction equipment or the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming should also consider the location of the activities due to occur concurrently.
- Carry out consultation with the community during construction including, but not limited to; advance notification of planned activities and expected disruption/effects, construction noise complaints handling procedures.

4.8.3 Construction equipment

Table 23 shows indicative noise reduction of typical construction equipment taken from British Standards. [15].

It should be noted that the noise reductions presented are indicative only and would be highly dependent on final construction equipment and methodology used by the Contractor.

Table 23: Indicative noise reduction measures for typical construction equipment

Plant	Noise Reduction of Plant		A-weighted Sound Reduction (dB)	Alternative Plant
	Source of Noise	Possible Remedies		
Earth-moving plant (e.g. Bulldozer, compactor, crane, dump truck, dumper, excavator, grader, loader, scraper)	Engine	Fit more efficient exhaust sound reduction equipment Manufacturers' enclosure panels need to be kept closed	5 to 10	Alternative super silenced plant might be available. Consult manufacturers for details
Compressors and generators	Engine Compressor or generator body shell	For more efficient sound reduction equipment Acoustically dampen metal casing Manufacturers' enclosure panels need to be kept closed	Up to 10	Super silenced plant should be available. Consult manufacturers for details. Electric-powered compressors are available as opposed to diesel or petrol. Sound-reduced compressor or generator can be used to supply several pieces of plant. Use centralized generator system.
	Total Machine	Erect acoustic screen between compressor or generator and noise-sensitive area. When possible, line of sight between top of machine and reception point needs to be obscured	Up to 10	
		Enclose compressor or generator in ventilated acoustic enclosure	Up to 20	
Pumps	Engine pulsing	Use machine inside acoustic enclosure with allowance for engine cooling and exhaust	Up to 20	
Materials handling	Impact of material	Do not drop materials from excessive heights. Screen dropping zones, especially on conveyor systems. Line chutes and dump trucks with a resilient material.	Up to 15	

4.8.4 Universal work practices

The following noise mitigation work practices are recommended to be adopted at all times on site:

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied.
- Avoid the use of radios or stereos outdoors.
- Avoid the overuse of public address systems.
- Avoid shouting and minimise talking loudly and slamming vehicle doors.
- Turn off all plant and equipment when not in use.

4.8.5 Vibration – minimum working distances

- Recommended minimum working distances for vibration intensive plant, which are based on international standards and guidance, are provided in Table 22.

5. Conclusion

Arup has completed a noise and vibration assessment in support of a REF application for Soil Conservation works construction at Lot 2, DP 1281576, Princes Highway, Moruya..

Regarding operations, no operational noise sources and traffic impacts are expected from the project.

Regarding the construction works, the proposed activities are predicted to exceed of the relevant noise management levels at the nearest most affected receivers. Accordingly, mitigation and management procedures will need to be considered for the works. Receiver R2 is predicted to be considered as a 'Highly noise affected' receiver during some activities, due to the proximity of the receiver to the construction area. The assessment however represents a 'worst case scenario' of all construction machinery operating continuously and concurrently, which is not expected to occur in practice.

Vibration impact to structures is not expected from the construction works. Exceedance of the human comfort criteria may occur at Receiver R2 dependent of the use and size of vibratory roller. The duration of impact is not expected to be prolonged.

A detailed Construction Noise and Vibration Management Plan (CNVMP) for the project should be prepared, in which specific attention should be given to mitigating and managing potential impacts upon the surrounding receiver locations. It is expected that the detailed CNVMP would be prepared by the contractor prior to the commencement of works.

References

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[14] C. H. D and G. I. Miller, “Transport Reseach Laboratory (TRL), GroundBorne vibration caused by mechanised construction works,” 2000.

[15] British Standards, “BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites. Noise,” British Standards, 2009.

[16] NSW Environment Protection Authority, “NSW Noise Policy for Industry,” EPA, Sydney, 2017.

Appendix A

Acoustic Terminology

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Assessment Background Level (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

Rating Background Level (RBL / $minL_{A90,1hour}$)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and $minL_{A90,1hour}$ in QLD.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m

Sound Pressure Level dB(A)	Example
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L_{90}

The L_{90} statistical level is often used as the "average minimum" or "background" level of a sound level that varies with time.

Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dB(A) or higher for 90% of the 15 minute measurement period.

L_{eq}

The 'equivalent continuous sound level', L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

L_{eq} is often used as the "average" level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB $L_{Aeq.}$ Often the measurement duration is quoted, thus $L_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15 minute measurement.

L_{max}

The L_{max} statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time.

Mathematically, L_{max} is the highest value recorded during the measurement period. As an example, 94 dB L_{Amax} is a highest value of 94 dB(A) during the measurement period.

Since L_{max} is often caused by an instantaneous event, L_{max} levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or "low-pitched" and sounds with a higher frequency are perceived as "treble" or "high pitched".

Sound Power and Sound Pressure

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

Vibration

Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale

Appendix B

Noise Monitoring Methodology

B.1 Noise monitoring

B.1.1 Equipment

Unattended and attended monitoring was carried out using the following equipment:

Table 24: Monitoring equipment details

Measurement location	Equipment/model	Serial No.	SLM Type
L1	ARL Ngara	8780A2	Class 1
L2	ARL Ngara	878002	Class 1
Short term measurements S1	B&K 2270	2754328	Class 1

Notes: All meters comply with AS IEC 61672.1 2004 “Electroacoustics - Sound Level Meters” and are designated either Class 1 or Class 2 as per Table 24, and are suitable for field use.

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

B.1.2 Meteorological conditions

In accordance with the NPfI, any noise monitoring conducted during periods of extraneous weather conditions was excluded from the data set. The NPfI advises that data may be affected where adverse weather, such as wind speeds higher than 5 m/s or rain, occurs. During the measurement period for this assessment, periods of adverse weather occurred during three daytime periods. This was confirmed by using weather data from the Bureau of Meteorology’s (BOM) Moruya Airport automated weather station.

B.1.3 Long-term unattended noise measurements

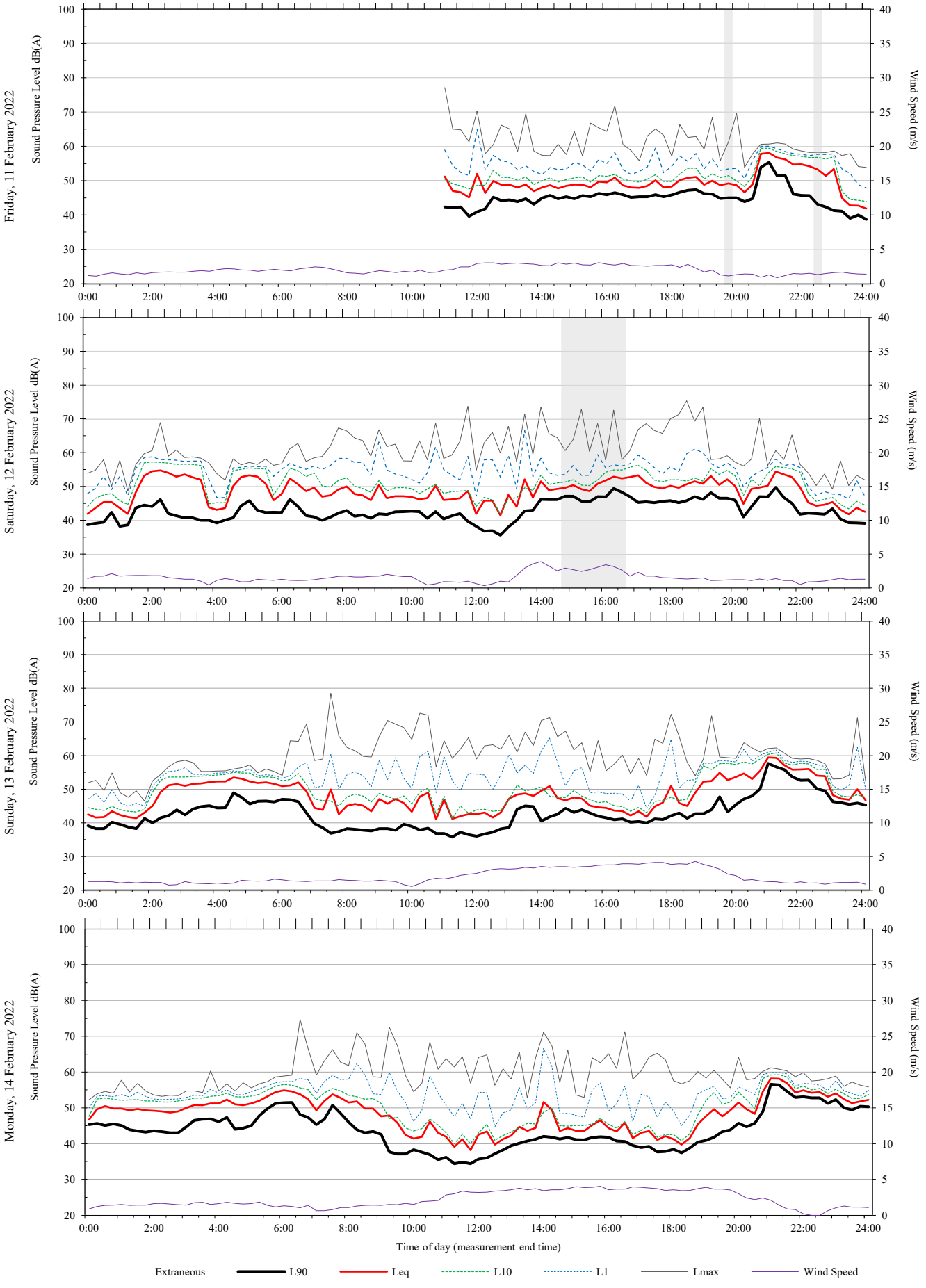
Long-term noise monitoring was carried out by Arup from Wednesday, 1 December 2021 to Monday 12 December 2021. Monitoring was conducted in accordance with Appendix B1 of the NSW *Noise Policy for Industry* (NPfI) [16]. The NPfI separates the 24-hour day into three different time periods – day, evening and night, as detailed below in Table 25.

Table 25: Standard NPfI time periods

Period	Day of Week	Time period
Day	Monday-Saturday Sunday, Public Holidays	7:00 am-6:00 pm 8:00 am-6:00 pm
Evening	Monday-Sunday	6:00 pm -10:00 pm
Night	Monday-Saturday Sunday, Public Holidays	10:00 pm -7:00 am 10:00 pm -8:00 am

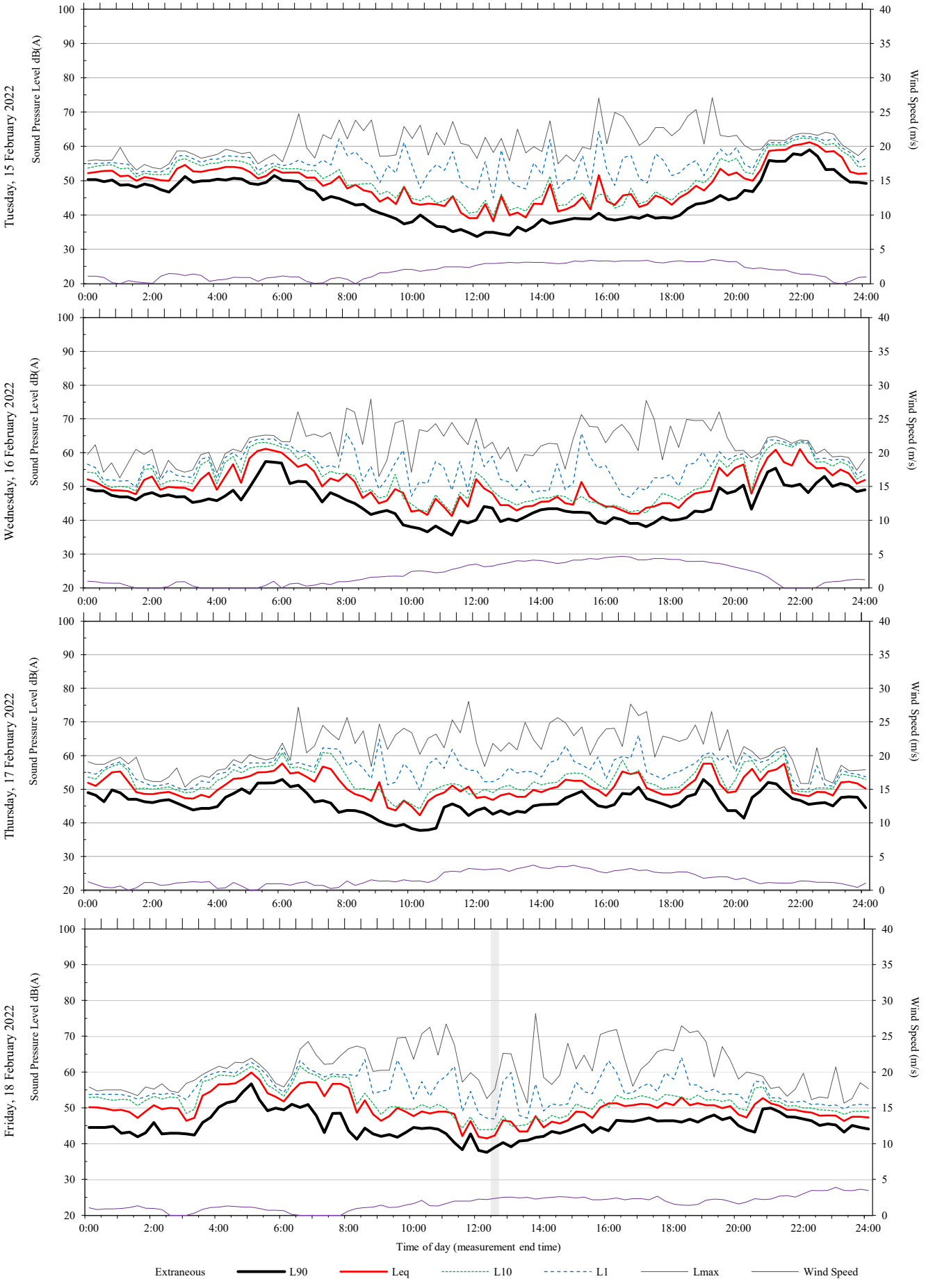
Unattended monitoring: (Free Field)

ARUP



Unattended monitoring: (Free Field)

ARUP



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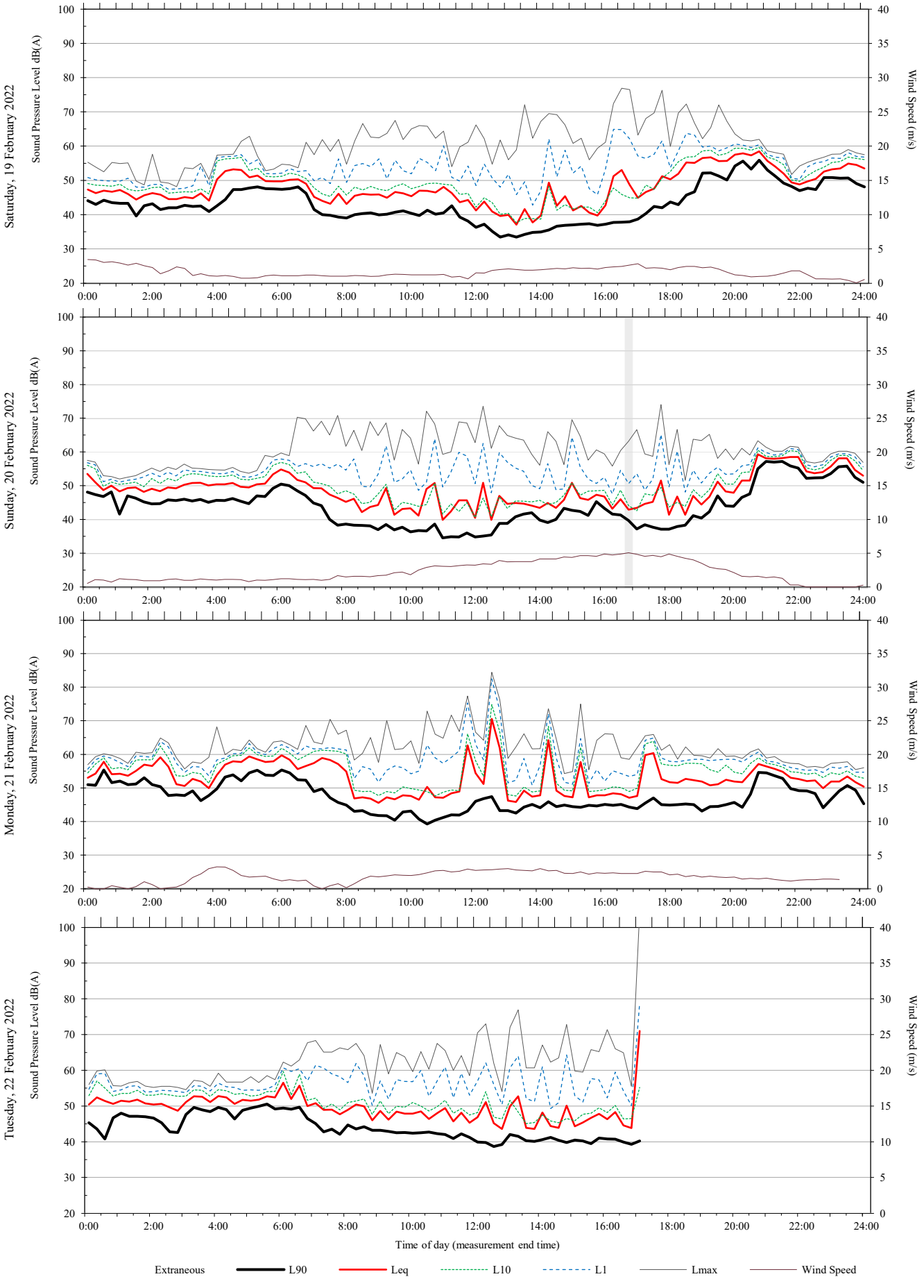

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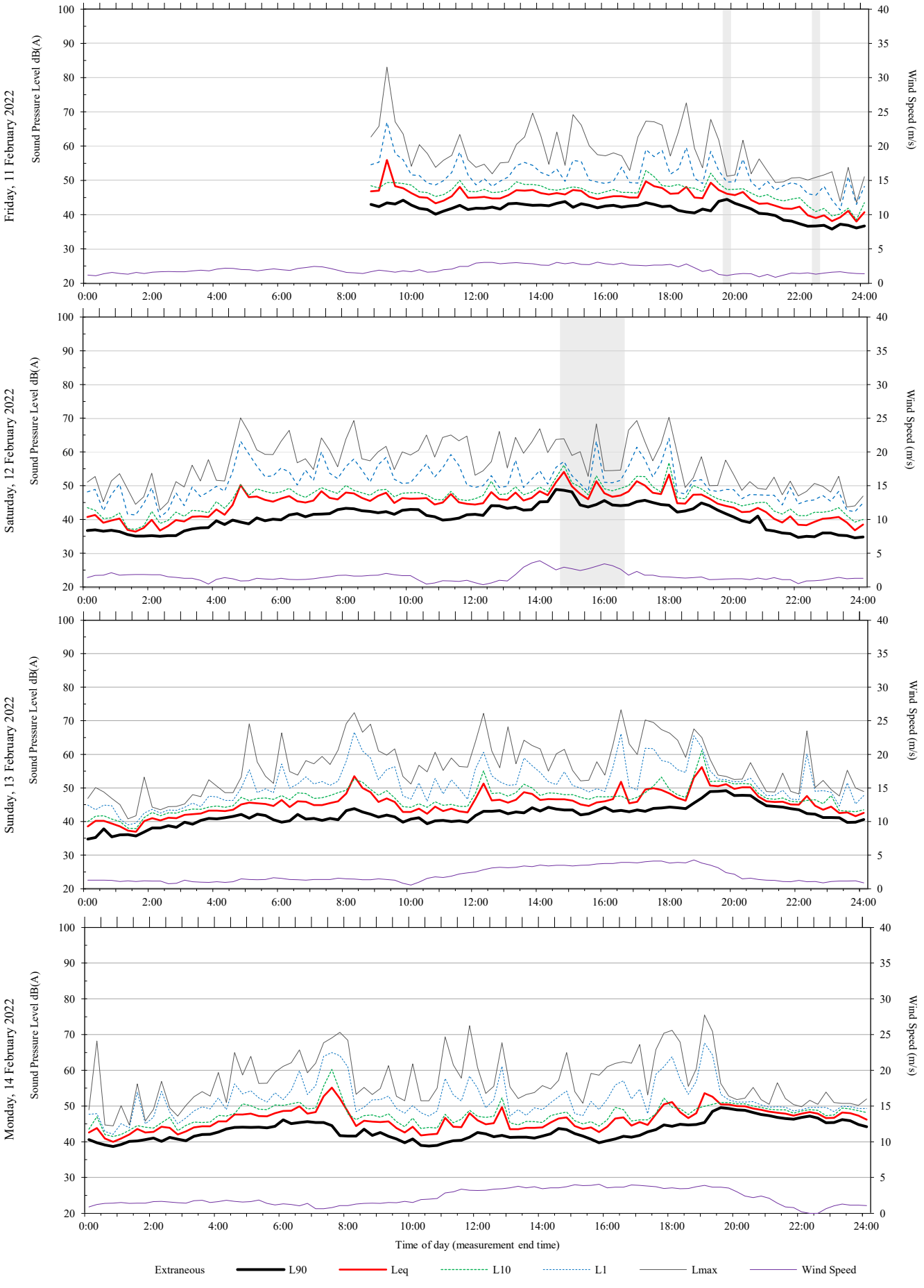

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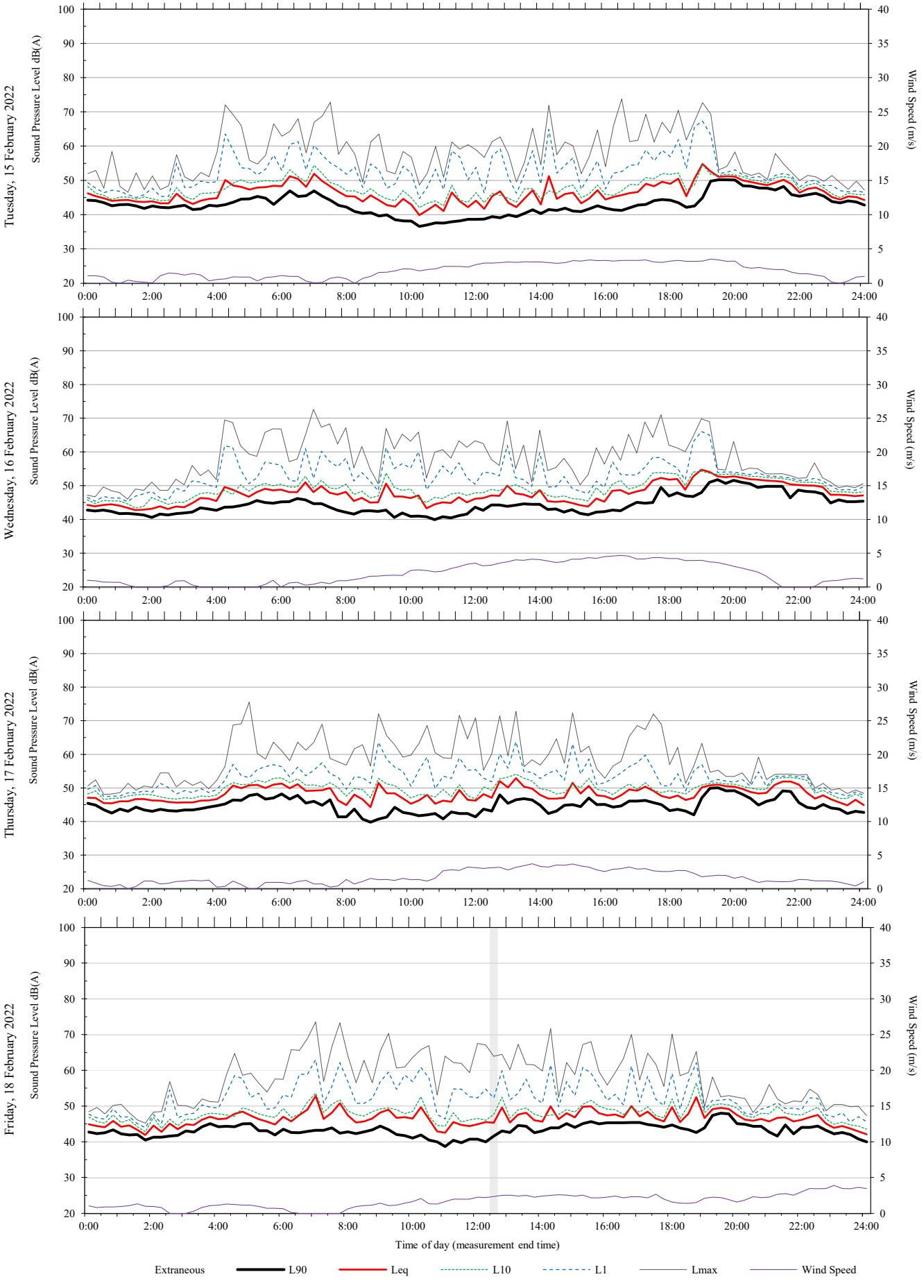

Unattended monitoring: (Free Field)

ARUP