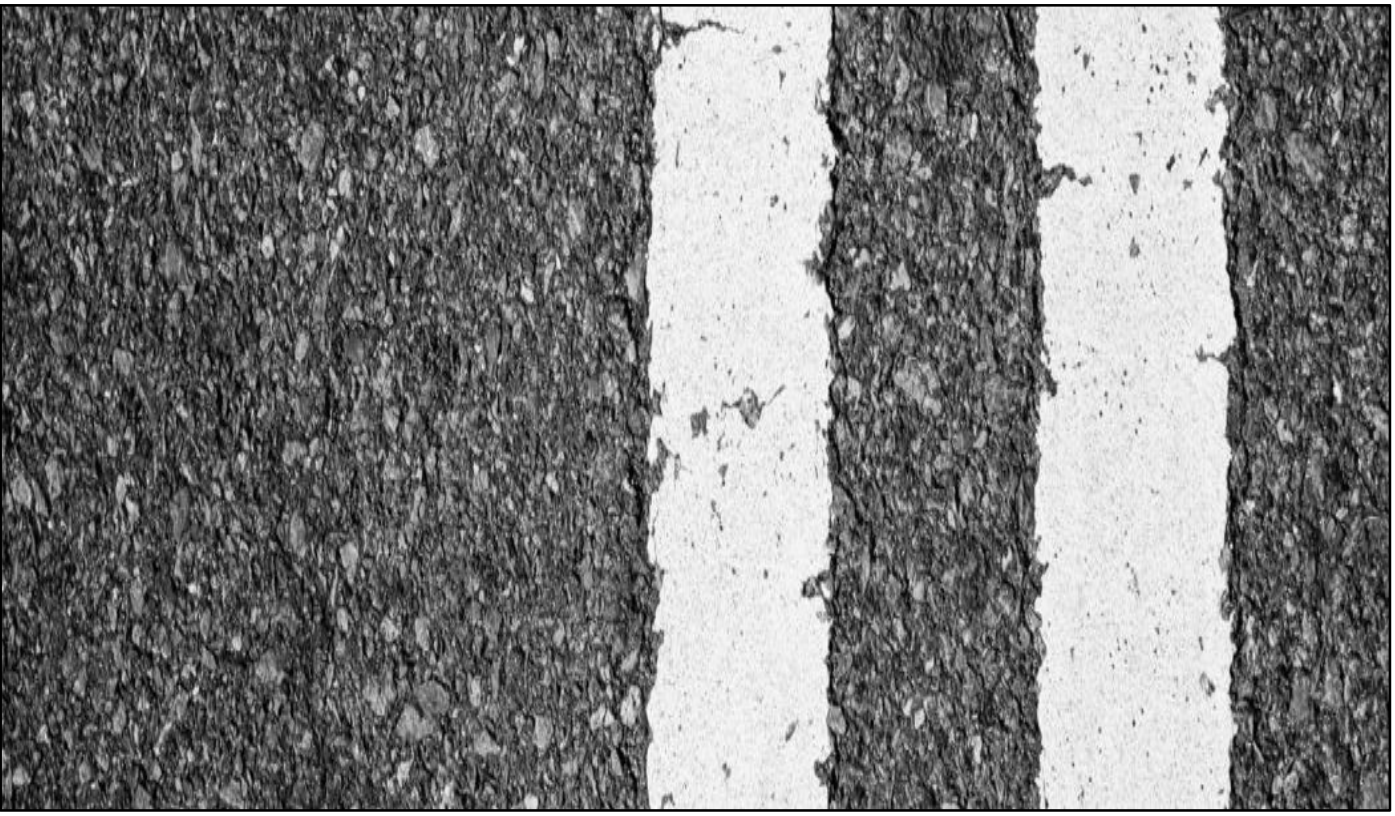

Assured Environmental

SOUTHERN FEEDER ROAD STAGE 3: ROAD TRAFFIC NOISE ASSESSMENT

PREMISE NSW PTY LTD

Project ID. 11755

R_3

DATE OF RELEASE: 25/06/2019

ABN: 87 604 851 078

Unit 7, 142Tennyson Memorial Avenue – Tennyson – Queensland - 4105

Table 1: Document Approval

	Name	Position Title	Signature	Date
Author	Michelle Clifton	Senior Consultant		25/06/2019
Reviewer	Craig Beyers	Consulting Services Manager		25/06/2019
Approver	Craig Beyers	Consulting Services Manager		25/06/2019

Table 2: Revision Register

Revision	Date	Name	Issued to	Comment
R0	18/04/2019	M. Clifton	D. Walker	Initial release
R1	11/05/2019	M. Clifton	D. Walker	Comments / Name Change
R2	6/06/2019	M. Clifton	D. Walker	Corrected existing road surface
R3	25/06/2019	M. Clifton	D. Walker	Mitigation

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1 INTRODUCTION

1.1 Background

The Southern Feeder Road (SFR) is a staged arterial road project, which will provide improved traffic connectivity to the southern suburbs of Orange and service future development in the area. Orange City Council have completed Stage 1 of the project, constructing a new signalised intersection and a 400 m section of the SFR from Anson Street to Forest Road.

The proposed Stages 2 of the Southern Feeder Road involves construction of a section of road from the Forest Road intersection through to Dairy Creek Road. As part of the Stage 2 works, a new road bridge will be constructed over the Main Western rail line and Edwards Street will be extended south to a new intersection with the Southern Feeder Road.

Stage 3 of the SFR extends along the existing road alignment of Blowes/Dairy Creek Road from Elsham Avenue to Mitchell Highway.

1.2 Scope of Assessment

Assured Environmental (AE) was appointed by Premise NSW Pty Ltd (Premise) to undertake a noise and vibration impact assessment of the SFR Stage 3 (the Project). The potential noise and vibration impacts associated with the SFR Stage 3 project can be separated as follows:

- Noise and vibration impact on surrounding areas during the construction phase of the project due to the building of the new road and ancillary works; and
- Noise impacts on surrounding areas during the operational phase of the project after commissioning due to changed road traffic conditions.

The noise study has been undertaken to assess the potential operational impacts of the proposed alignment of the SFR on nearby sensitive receptors in accordance with the following NSW policies and guidelines:

- NSW Environment Protection Authority (EPA) – "*The NSW Road Noise Policy (RNP)*";
- Roads and Maritime Services (RMS) – "*Noise Criteria Guideline (NCG)*";
- Roads and Maritime Services (RMS) – "*Noise Mitigation Guideline (NMG)*";
- Roads and Maritime Services (RMS) – "Construction Noise and Vibration Guideline";
- NSW Environment Protection Authority (EPA) – "The Interim Construction Noise Guidelines (ICNG)";
- NSW DECC "Assessing Vibration - A Technical Guide"
- Australian Standard AS 2436-2010 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites ".

In accordance with the requirements of the above guidelines, computational modelling and first principle calculations have been undertaken to support the assessment of the potential for adverse amenity impacts as a result of the alignment.

1.3 This Report

This report summarises the methodology, results and conclusions of the noise and vibration impact assessment. A glossary of terms is presented in Appendix A to assist the reader.

2 PROJECT DESCRIPTION

The proposed Stage 3 SFR design extends along the existing road alignment of Blowes/Dairy Creek Road from Elsham Avenue to Mitchell Highway. The following design parameters imperative to the noise assessment are:

- Proposed speed is 50 km/hour and 80 km/hour and will be designed to accommodate B-double vehicles;
- The ground height of the existing Dairy Creek Road centre line will be lowered by undertaking a cutting along a section between Lone Pine Avenue and Kurim Avenue; and
- Proposed pavement design is a 250 mm gravel overlay and a 40 mm AC seal.

The proposed alignment is presented in Figure 1.

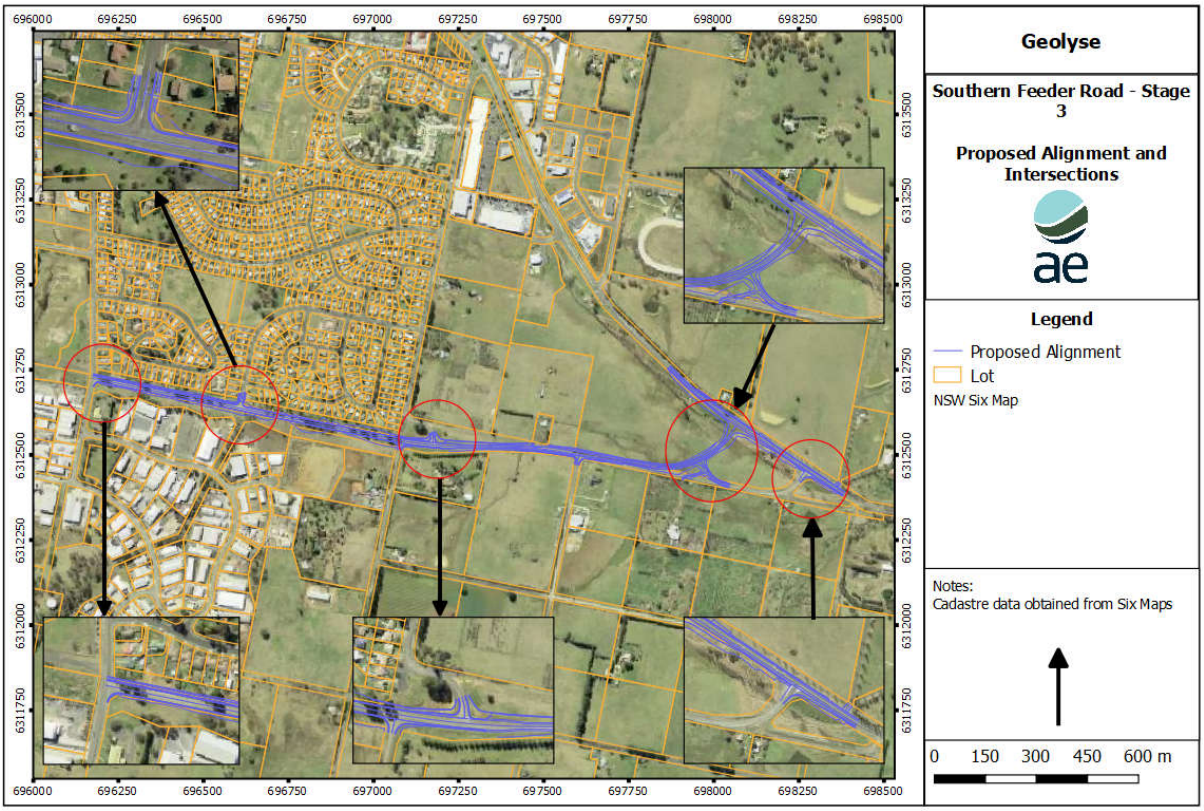


Figure 1: Proposed Alignment

The road alignment is bordered by a number of residential and industrial receptors, with the closest receptors located approximately 30 m from the proposed centreline. A number of selected receptors have been assessed based on the varying distances from the road centreline. Table 3 details the selected sensitive receptors, receptor type, distance from the road centreline and whether there is any shielding from the road. Figure 2 illustrates the location of the selected sensitive receptors.

Table 3: Sensitive Receptors

Receptor ID	Receptor Type	Location	
		X	Y
C01	Industrial	696192	6312640
C02	Industrial	696268	6312632
C03	Industrial	696331	6312657
C04	Industrial	696529	6312569
C05	Industrial	696596	6312494
C06	Industrial	696679	6312501
C07	Industrial	696716	6312504
R01	Residential	696206	6312751
R02	Residential	696198	6312770
R03	Residential	696244	6312777
R04	Residential	696268	6312764
R05	Residential	696288	6312759
R06	Residential	696304	6312749
R07	Residential	696323	6312754
R08	Residential	696339	6312740
R09	Residential	696356	6312743
R10	Residential	696370	6312742
R11	Residential	696386	6312735
R12	Residential	696404	6312723
R13	Residential	696420	6312732
R14	Residential	696437	6312722
R15	Residential	696451	6312722
R16	Residential	696467	6312715
R17	Residential	696485	6312714
R18	Residential	696506	6312710
R19	Residential	696538	6312685
R20	Residential	696522	6312701
R21	Residential	696558	6312700
R22	Residential	696591	6312673
R23	Residential	696600	6312696
R24	Residential	696602	6312711
R25	Residential	696629	6312672
R26	Residential	696628	6312691
R27	Residential	696667	6312671
R28	Residential	696687	6312668
R29	Residential	696703	6312664
R30	Residential	696727	6312659

Receptor ID	Receptor Type	Location	
		X	Y
R31	Residential	696740	6312678
R32	Residential	696760	6312666
R33	Residential	696767	6312647
R34	Residential	696788	6312641
R35	Residential	696806	6312638
R36	Residential	696828	6312636
R37	Residential	696845	6312632
R38	Residential	696866	6312627
R39	Residential	696883	6312623
R40	Residential	696903	6312633
R41	Residential	696917	6312641
R42	Residential	696932	6312624
R43	Residential	696949	6312614
R44	Residential	696968	6312611
R45	Residential	696989	6312605
R46	Residential	697026	6312618
R47	Residential	697017	6312585
R48	Residential	697061	6312577
R49	Residential	697064	6312602
R50	Residential	697069	6312617
R51	Residential	696992	6312430
R52	Residential	697214	6312440
R53	Residential	697498	6312583
R54	Residential	697654	6312438
R55	Residential	697593	6312341
R56	Residential	697892	6312315
R57	Residential	698181	6312371
R58	Residential	698211	6312363
R59	Residential	698028	6312660
R60	Residential	698522	6312442

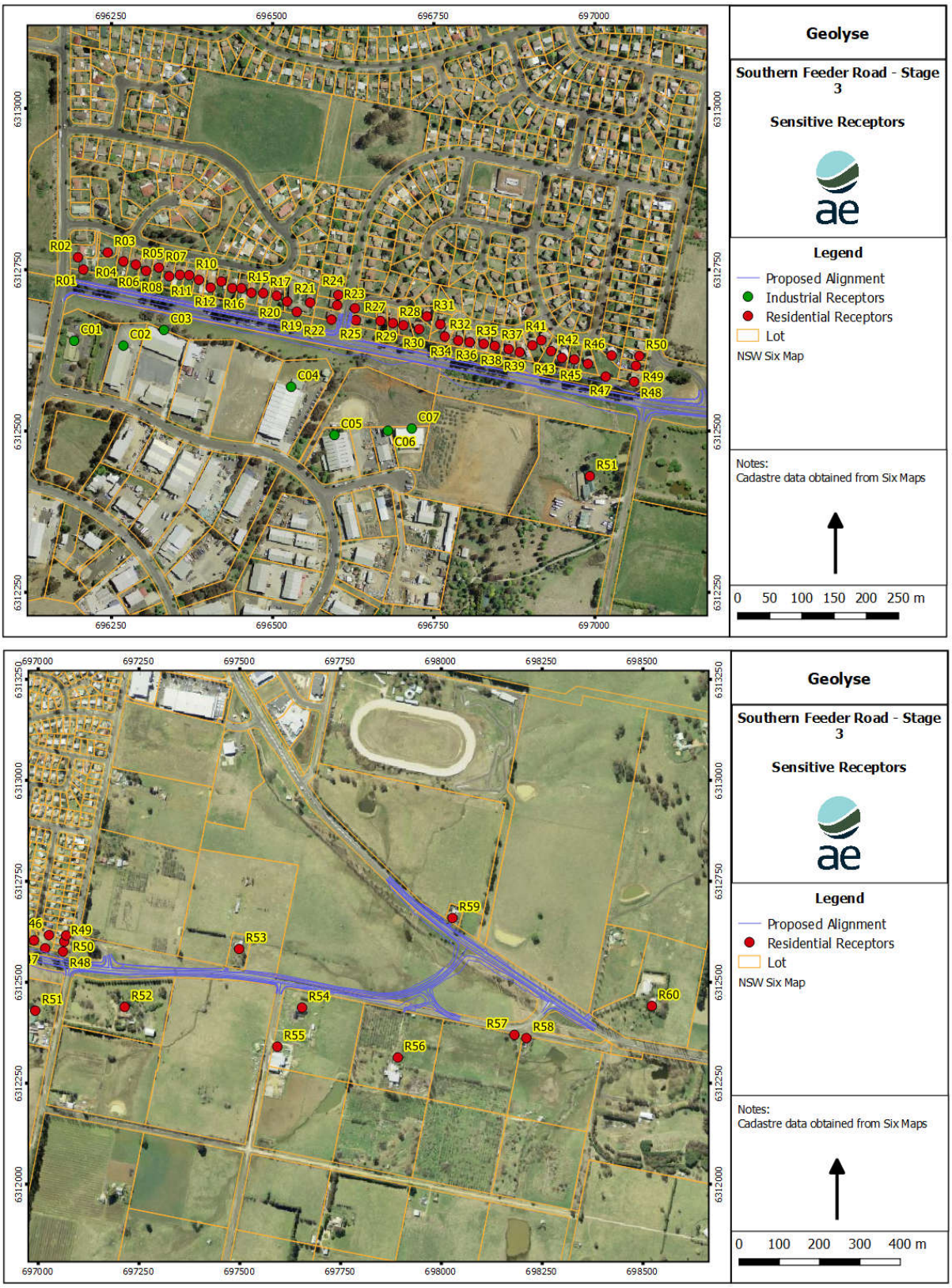


Figure 2: Sensitive Receptors

3 EXISTING NOISE ENVIRONMENT

3.1 Noise Monitoring Methodology

Background noise and weather monitoring was undertaken at two locations from 15 January to 23 January 2019 as shown in Figure 3.

Figure 3: Noise Monitoring Locations

Noise measurements were undertaken in accordance with the requirements of Australian Standard AS 1055-1997 *'Acoustics – Description and measurement of environmental noise'*. Two environmental noise loggers were used for the continuous monitoring. The instruments were situated in a free-field position and an averaging time of 15 minutes adopted for the monitoring. Microphones were positioned at a height of 1.2 metres above ground level and fitted with a windshield throughout the measurements.

The instrument serial numbers and calibration information are presented in Table 4.

Table 4: Equipment Information

Instrument	Serial No.	Monitoring Dates	NATA Calibration Current to:	Pre-/Post Calibration (dB)
ML1: Rion NL22	01047100	15 – 23/01/19	12/07/2019	94/94
ML2: Norsonic 139	1392800	15 – 23/01/19	18/12/2020	94/94
Larson Davis: CAL200	8356	N/A	23/11/2019	N/A

Noise monitoring has a potential to be affected by rainfall and wind speeds above 5 m/s (as described in the NSW Noise Policy for Industry (2017). To enable determination of the suitability of conditions for noise monitoring, weather parameters were obtained from BOM Orange Airport (station number 095726). A review of meteorological data from the weather station installed onsite indicates that 18 hours were affected by rainfall or high wind speeds. These periods were excluded from the analysis to minimise the potential for weather related bias in the monitoring results.

3.2 Background Monitoring Results

This section a summary of average noise levels of each period for a variety of noise parameters. The periods are defined as follows:

- Day – 7 am to 6 pm;
- Evening – 6 pm to 10 pm; and
- Night – 10 pm to 7 am.

Table 5 presents the summary of noise monitoring data for both monitoring locations for all days. The similarities of data between the two sites can be seen from the table.

For the purposes of this study, the NML1 monitoring data is representative of R1 – R8 receptors, whilst NML2 is representative of R9 - R13 receptors based on distance to the road and surrounding land uses.

Table 5: Summary of Noise Monitoring Data for Entire Monitoring Period

Location	Period [a]	L_{Amax}	L_{10}	L_{90}	L_{eq}	RBL	Road Traffic	
							L_{Aeq} [b]	$L_{A10,\ 18\ hr}$ [c]
NML1	Day	95	60	40	59	38	58	57
	Evening	90	54	37	54	34		
	Night	92	48	35	53	32	53	
NML2	Day	94	61	42	62	38	61	58
	Evening	91	54	37	58	33		
	Night	89	50	35	58	32	57	

a) Periods are defined as Day – 7 am to 6 pm; Evening – 6 pm to 10 pm; and Night – 10 pm to 7 am.

b) Road traffic descriptors as defined by Day – 7 am to 10 pm and Night – 10 pm to 7 am.

c) $L_{A10,\ 18hour}$ is defined as 6 am to 12 am

4 CONSTRUCTION NOISE ASSESSMENT

4.1 Construction Noise & Vibration Guideline

Guidance on the assessment and management of construction noise from road projects in NSW is provided in the Construction Noise and Vibration Guideline (CNVG) published by the NSW RMS.

This guideline provides the detail needed to identify feasible and reasonable noise mitigation measures for construction, minor works and maintenance projects. The CNVG provides guidance on the level of assessment of noise and vibration during road works depending on the following aspects:

- number of receptors affected;
- construction hours; and
- duration of construction works.

The guideline presents that standard construction hours for road projects, aimed to minimise noise impacts during the evening and night time periods, when background noise levels are lower. The standard construction hours are identified in Table 6.

Table 6: Construction Hours (CNVG)

Construction Hours	Monday to Friday	Saturday	Sunday/ Public Holiday
Standard construction hours	07:00 – 18:00	08:00 – 13:00	No work
Construction activities with impulsive or tonal emissions	08:00 – 17:00 a)	09:00 – 13:00 a)	No work
Blasting	09:00 – 17:00	09:00 – 13:00	No blasting

a) Works may be carried out in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. 'Continuous' includes any period during which there is less than a one-hour respite between ceasing and recommencing any of the work the subject of this condition.

When identifying feasible and reasonable noise mitigation, the noise level from construction sites is considered in isolation from road traffic or operational noise as construction noise is different in character to that of operational noise. This is reflected in the criteria for construction noise which are determined relative to background noise levels, as presented in Table 7.

Table 7: NSW EPA Construction Noise Criteria – Residential Receivers

Time of Day	Management Level (Free-field)	How to Apply
Recommended standard hours: Monday to Friday, 7 am to 6 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.

Time of Day	Management Level (Free-field)	How to Apply
Saturday, 8 am to 1 pm		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.
No work on Sundays or public holidays	Highly noise affected 75 dB(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 + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

For other non-residential sensitive land uses, such as schools, noise from construction is assessed where the individual properties are in use (such as during school times). Table 8 presents Noise Management Levels (NML) for noise at other sensitive land uses as detailed in the CNVG based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed.

Table 8: Applicable Noise Management Levels for Other Sensitive Land Uses (CNVG)

Non-Residential Receptors	Noise Management Level		
	Day (0700 – 1800)	Evening (1800 – 2200)	Night (2200 – 0700)
Classrooms at schools and other educational institutions	55 [a)]	-	-
Hospital wards and operating theatres	65 [b)]	65 [b)]	65 [b)]
Place of worship	55 [a)]	55 [a)]	55 [a)]
Active recreation	65	65	-
Passive recreation	60	60	

Non-Residential Receptors	Noise Management Level		
	Day (0700 – 1800)	Evening (1800 – 2200)	Night (2200 – 0700)
Industrial premise	75	75	75
Offices, retail outlets	70	70	70

a) NML assumed equivalent to external noise level with windows open

b) NML assumed equivalent to external noise level with windows closed

4.2 Construction Methodology

For the construction phase of the proposed project, predictive noise calculations for each activity have been undertaken using the Construction Noise Estimator published by RMS which implements the CNVG methodology.

The estimator uses four (4) steps to predict the noise level at receptors based on distance from each construction activity. The steps illustrated in Figure 4 were followed:

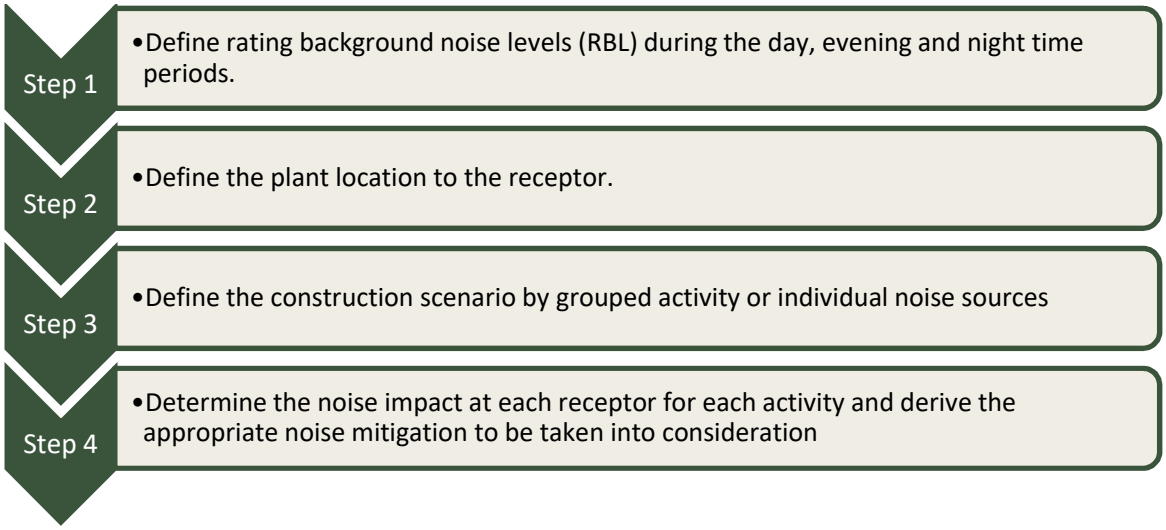


Figure 4: Construction Methodology Overview

4.3 Construction Scenarios

The following construction scenarios will be undertaken as part of the SFR 3a:

- mobilisation & site establishment;
- utility, property, service adjustment;
- corridor clearing (trees only);
- bulk earthworks;
- drainage infrastructure;
- paving /asphalting;
- construction compound site establishment (likely to be on the north eastern corner of Lone Pine Ave);
- road furniture installation; and

- re-surfacing works.

In terms of noise emissions, the CNVG provides a number of typical road construction activities. For each activity, the quantity of plant, the acoustical usage factor and the Sound Power Level (SWL) have been provided. The overall activity sound power levels have been adjusted to reflect the proposed construction equipment for the Stage 3 project and are summarised in Table 9 below.

Table 9: Construction Phases and Activity SWL based on Typical Equipment Quantities and Acoustical Usage Factors (RMS, 2016)

Construction Phase	Description of Activity	Plant Item	Sound Power Level, dB(A)	Activity SWL	
				L_{Aeq}	L_{A1}
Mobilisation & Site Establishment	Installing construction boundary hoardings/ fences and traffic barriers	Truck (medium rigid)	103	115	116
		Road truck	108		
		Scissor Lift	98		
		Franna crane	98		
Utility, property, service adjustment	Adjustment of property boundaries (where required); relocation of services	Excavator (tracked) 35t	110	116	116
		Dump truck	110		
		Franna crane 20t	98		
		Pneumatic hammer	113		
		Concrete saw	118		
		Vacuum truck	109		
		Backhoe	111		
		Power generator	103		
Corridor Clearing	General land clearing, tree and stump removal, topsoil stripping, loading	Bulldozer D9	116	121	Not recommended as OOHW
		Excavator (tracked) 35t	110		
		Chainsaw 4-5hp	114		
		Tub grinder/ mulcher 40-50hp	116		
		Dump truck	110		
Bulk Earthworks	Formation of road alignment. Excavation of soil and rock, hammering/rock breaking, drilling, loading, haulage, compaction of fill areas, grading	Bulldozer D9	116	123	Not recommended as OOHW
		Scraper 651	110		
		Excavator (tracked) 35t	110		
		As above + hydraulic hammer	122		
		Grader	113		
		Dump truck	110		
		Compactor	106		
		Roller (large pad foot)	109		
		Water cart	107		
Drainage infrastructure	Excavation of trenches and pits; Delivery and placement of precast pipes and pits; filling and compacting.	Backhoe	110	115	116
		Franna crane 20t	98		
		Excavator (tracked) 35t	110		
		Concrete truck	109		
		Truck compressor	75		
		Vibratory roller	109		
		Road truck	108		
Paving/ asphalting	Delivery of raw materials.	Pavement laying machine	114	118	130
		Dump truck	110		
		Asphalt truck & sprayer	103		

Construction Phase	Description of Activity	Plant Item	Sound Power Level, dB(A)	Activity SWL	
				L_{Aeq}	L_{A1}
(inc. concrete sawing)	Placement of surface material. Saw cutting.	Concrete truck	109		
		Smooth drum roller	107		
		Concrete saw	118		
Road furniture installation	Signposting and line marking	Road truck	108	110	116
		Scissor lift	98		
		Franna crane 20t	98		
		Line marking truck	108		
Construction Compound Site Establishment	Construction Compound Site Establishment	Chainsaw 4-5hp	114	119	Not recommended as OOHW
		Pneumatic hammer	113		
		Fixed crane	113		
		Front end loader	112		
		Excavator (tracked) 35t	110		
		Grader	113		
		Vibratory roller	109		
		Concrete truck	109		
		Dump truck	110		
		Water cart	107		
		Concrete vibrator	113		
		Concrete pump	109		
		Power generator	103		
		Light vehicles (e.g. 4WD)	103		
Re-surfacing works	Milling the asphalt to expose the underlying concrete, then laying new asphalt	Daymakers	98	118	123
		Pavement profiler	117		
		Dump truck	110		
		Front end loader	112		
		Pavement laying machine	114		
		Asphalt truck & sprayer	106		
		Smooth drum roller	107		

It is noted that construction works are expected to progress along the alignment such that plant and equipment associated with each activity would only be in a single area for a short period of time. Given this, the potential for adverse impacts at any one receptor from one activity is expected to only occur for a short period of time.

4.4 Assessment of Construction Impacts

Table 10 below presents the estimated receptor noise levels during each construction scenario detailed in Table 9. Review of the estimated receptor noise levels indicates that there are a number of receptors located within 30 m of the road alignment which may exceed the 'highly affected' assessment criteria of 75 dB(A) during the daytime periods, particularly receptors C03, R01, R22, R30, R35, R43, R47, R53 and R59.

The activities which are most likely to exceed the highly affect noise criteria are bulk earthworks, paving, corridor clearing, and resurfacing works. As these activities are temporary as the works progress along the road alignment, the highest noise levels would

not be expected to be experienced at a single receptor for a prolonged period while construction activity is at the closest point to the receptor.

Table 10: Predicted Receptor Noise Levels – Construction Activities, dB(A)

Receptor	Distance from Road Centreline (m)	Predicted Construction Noise Levels by Activity, $L_{Aeq, 15min}$								
		Site Establishment	Utility Adjustment	Corridor Clearing	Bulk Earthworks	Drainage Infrastructure	Paving	Compound Establishment	Road Furniture	Re-surfacing Works
C03	35	72	73	**78**	**80**	72	75	44	67	75
C04	83	65	66	71	73	65	68	49	60	68
C07	106	63	64	69	71	63	66	56	58	66
R01	30	73	74	**79**	**81**	73	**76**	43	68	76
R11	53	69	70	75	**77**	69	72	46	64	72
R22	32	72	73	**78**	**80**	72	75	50	67	75
R30	39	71	72	**77**	**79**	71	74	54	66	74
R35	37	71	72	**77**	**79**	71	74	57	66	74
R43	44	70	71	**76**	**78**	70	73	65	65	73
R47	28	73	74	**79**	**81**	73	**76**	71	68	**76**
R52	85	65	66	71	73	65	68	61	60	68
R53	62	68	69	74	**76**	68	71	57	63	71
R54	72	67	68	73	75	67	70	47	62	70
R56	150	59	60	65	67	59	62	42	54	62
R57	230	55	56	61	63	55	58	38	50	58
R59	35	72	73	**78**	**80**	72	75	41	67	75

4.5 Mitigation of Construction Noise Levels

4.5.1 Best Practice Mitigation

Compliance with the 'highly affected' construction criteria is not achieved at all receptors; therefore, mitigation is recommended. Given the variable and mobile nature of the construction works, the use of permanent or temporary acoustic barriers for the most affected receptors (C03, R01, R22, R30, R35, R43, R47, R53 and R59) is considered feasible where noise levels are predicted to exceed 75 dB(A).

Potential controls available to the construction contractor to minimise potential impacts for construction works outside standard hours could include:

- The layout of the construction compound should be considered so that primary noise sources are at a maximum distance from residences, with solid structures (sheds, containers, etc) placed between residences and noise sources (and as close to the noise sources as is practical);

- Enclosures to shield fixed noise sources such as pumps, compressors, fans, screens (where practicable);
- Limiting the type and scale of activities undertaken outside normal construction hours;
- Using broad-band reversing alarms on all mobile plant and equipment;
- Examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine;
- Select quieter items of plant and equipment where feasible and reasonable.;
- Operating plant in a quiet and efficient manner with activities generating high noise and/or vibration levels would be scheduled during less sensitive time periods if practicable.;
- Traffic flow, parking and loading and unloading areas would be planned to minimise reversing movements within the construction areas;
- Vehicle delivery times to should be scheduled where feasible to recommended construction hours to minimise noise impacts from heavy vehicle movements and deliveries;
- Noise-emitting plant would be directed away from sensitive receivers where possible;
- Reduce throttle setting and turn off equipment when not being used; and
- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

4.5.2 Additional Mitigation Measures

In addition to the best practice noise mitigation practices, the following additional management measures are recommended to assist in managing community disturbance during construction. Table 11 provides a description of each of the additional measures and Appendix C provides a summary of those measures recommended to be adopted dependent on the receptor and stage of construction:

Table 11: Additional Mitigation (RMS, 2016)

Mitigation Measure	Description
Notification (N) (letterbox drop or equivalent)	Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of 5 working days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them.
Specific notifications (SN)	Specific notifications are letterbox dropped (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. The specific notification provides additional information when relevant and informative to more highly affected receivers than covered in general letterbox drops.

Mitigation Measure	Description
Phone calls (PC)	Phone calls detailing relevant information made to identified/affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.
Individual briefings (IB)	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. Where the resident cannot be met with individually then an alternative form of engagement should be used.
Respite Offers (RO)	Respite Offers should be considered made where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers. The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis, and may not be applicable to all projects.
Respite Period 1 (R1)	Out of hours construction noise in out of hours period 1 shall be limited to no more than three consecutive evenings per week except where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and no more than 6 evenings per month.
Duration Respite (DR)	Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer duration projects. In this instance and where it can be strongly justified it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly.
Alternative Accommodation (AA)	Alternative accommodation options may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels. The specifics of the offer will be identified on a project-by-project basis. Additional aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.
Verification (V)	Please see Appendix F for more details about verification of Noise and Vibration levels as part of routine checks of noise levels or following reasonable complaints. This verification should include measurement of the background noise level and construction noise. Note this is not required for projects less than three weeks unless to assist in managing complaints.

Table 12 and Table 13 provides a summary of the noise management measures for each activity for each receptor for the standard construction hours and out of work hours respectively.

Table 12: Recommended Management Measures for each Receptor during Standard Hours

Receptor	Management Measured by Activity								
	Mobilisation & Site Establishment	Utility Adjustment	Corridor Clearing	Bulk Earthworks	Drainage Infrastructure	Paving	Compound Establishment	Road Furniture	Re-surfacing Works
C03	75	-	-	N, V, PC, RO	N, V, PC, RO	-	N, V, PC, RO	-	-
C04	75	-	-	-	-	-	-	-	-
C07	75	-	-	-	-	-	-	-	-
R01	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V, PC, RO	N, V	N, V
R11	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V	N, V	N, V
R22	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V, PC, RO	N, V	N, V
R30	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V	N, V	N, V
R35	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V	N, V	N, V
R43	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V	N, V	N, V
R47	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V, PC, RO	N, V	N, V
R52	48	N, V	N, V	N, V	N, V	N, V	N, V	N, V	N, V
R53	48	N, V	N, V	N, V	N, V, PC, RO	N, V	N, V	N, V	N, V
R54	48	N, V	N, V	N, V	N, V, PC, RO	N, V	N, V	N, V	N, V
R56	48	N, V	N, V	N, V	N, V	N, V	N, V	N, V	N, V
R57	48	N, V	N, V	N, V	N, V	N, V	N, V	N, V	N, V
R59	48	N, V	N, V	N, V, PC, RO	N, V, PC, RO	N, V	N, V, PC, RO	N, V	N, V

Table 13: Recommended Management Measures for each Receptor during OOHW

Receptor	Management Measured by Activity								
	Mobilisation & Site Establishment	Utility Adjustment	Corridor Clearing	Bulk Earthworks	Drainage Infrastructure	Paving	Compound Establishment	Road Furniture	Re-surfacing Works
C03	75	-	-	-	-	-	-	-	-
C04	75	-	-	-	-	-	-	-	-
C07	75	-	-	-	-	-	-	-	-
R01	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	-	V, IB, N, R1, DR, PC, SN

Receptor	Management Measured by Activity								
	Mobilisation & Site Establishment	Utility Adjustment	Corridor Clearing	Bulk Earthworks	Drainage Infrastructure	Paving	Compound Establishment	Road Furniture	Re-surfacing Works
R11	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	-	V, IB, N, R1, DR
R22	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	N, R1, DR	V, IB, N, R1, DR
R30	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	N, R1, DR	V, IB, N, R1, DR
R35	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	N, R1, DR	V, IB, N, R1, DR
R43	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR	V, IB, N, R1, DR
R47	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN
R52	43	V, IB, N, R1, DR	V, IB, N, R1, DR	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR	V, IB, N, R1, DR
R53	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	N, R1, DR	V, IB, N, R1, DR
R54	43	V, IB, N, R1, DR	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR	V, IB, N, R1, DR, PC, SN	-	V, IB, N, R1, DR
R56	43	V, IB, N, R1, DR	V, IB, N, R1, DR	V, IB, N, R1, DR	V, IB, N, R1, DR	V, IB, N, R1, DR	V, IB, N, R1, DR	-	N, R1, DR
R57	43	N, R1, DR	N, R1, DR	V, IB, N, R1, DR	V, IB, N, R1, DR	N, R1, DR	V, IB, N, R1, DR	-	N, R1, DR
R59	43	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	V, IB, N, R1, DR, PC, SN	-	V, IB, N, R1, DR

5 CONSTRUCTION VIBRATION ASSESSMENT

5.1 Introduction

A review of the proposal indicates there is potential for impacts as a result of vibration generated by plant and equipment during the construction activities. Given this, an assessment of the potential for vibration impacts has been undertaken. In particular, the assessment has considered the potential for impacts on both human comfort and structural damage for the nearest residence to the construction activities.

5.2 Assessment Criteria

The vibration criteria presented in the Environmental Noise Management – *Assessing Vibration: A Technical Guide* (2006) published by the NSW Department of Environment Climate Change and Water (DECCW) have been adopted for the assessment. The technical guide provides vibration criteria associated with amenity impacts (human annoyance) for the three categories of vibration:

- Continuous vibration (e.g. road traffic, continuous construction activity);
- Impulsive vibration includes less than three (3) distinct vibration events in an assessment period (e.g. occasional dropping of heavy equipment); and
- Intermittent vibration includes interrupted periods of continuous vibration (e.g. drilling), repeated periods of impulsive vibration (e.g. crushers) or continuous vibration that varies significantly in amplitude.

Table 14 and Table 15 present the criteria for continuous and impulsive vibration and intermittent vibration, respectively.

Table 14: Continuous & Impulsive Vibration Criteria for Residences – Peak Velocity

Location	Vibration Type	Preferred Limit (mm/s)	Maximum Limit (mm/s)
Residences	Continuous	0.28	0.56
Residences	Impulsive	8.6	17

Table 15: Intermittent Vibration Criteria for Residences

Location	Assessment Period	Preferred Value ($m/s^{1.75}$)	Maximum Value ($m/s^{1.75}$)
Residences	Day-time	0.20	0.40

The above criteria are suitable for assessing human annoyance in response to vibration levels. In order to assess potential damage to buildings, reference has been made to British Standard *BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration*. Table 16 presents vibration criteria for assessing the potential for building damage.

Table 16: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Particle Velocity (mm/s)	
	4 Hz to 15 Hz	15 Hz and above
Unreinforced or light framed structures – residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

For blasting, in addition to the criteria provided in the DEC technical guideline, reference has also been made to the Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZECC 1990). Table 17 provides a summary of the criteria applied in the assessment of potential blasting vibration and airblast overpressure levels.

Table 17: Blasting Vibration Criteria

Criteria	Values
Airblast Overpressure	The recommended maximum level for airblast overpressure is 115 dB(Lin Peak). The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB (Lin Peak) at any time.
Peak Particle Velocity	The recommended maximum level for ground vibration is 5 mm/sec (peak particle velocity (ppv)). The ppv level of 5 mm/sec may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/sec at any time. However, it is recommended that a level of 2 mm/sec (ppv) be considered as the long-term regulatory goal for the control of ground vibration.

5.3 Assessment of Impacts

Table 18 identifies the vibration source levels for the equipment and likely to be used for the construction of the roadway.

Table 18: Vibration Source levels – Peak Particle Velocity

Equipment Item	PPV at 10 metres (mm/s)	Source
Roller	5 – 6	NSW RTA [b)]
15 tonne Roller	7 – 8	NSW RTA [b)]
Loader (breaking kerbs)	6 - 8	NSW RTA [b)]
Pavement breaker	4.5 – 6	NSW RTA [b)]
7 tonne compactor	5 – 7	NSW RTA [b)]
Backhoe	1	NSW RTA [b)]
Jackhammer	0.5	NSW RTA [b)]
Loaded trucks (rough surface)	5	USA DT [a)]

Equipment Item	PPV at 10 metres (mm/s)	Source
Loaded trucks (smooth surface)	1 – 2	USA DT [a)]
Excavator	2.5 – 4	NSW RTA [b)]

a) Transit Noise and Vibration Impact Assessment, US Department of Transportation, May 2006.

b) NSW RTA Environmental Noise Management Manual (2001)

Based on the vibration source levels at 10 metres (presented in Table 18), peak particle velocities have been predicted at various separation distances. The NSW DECCW indicates that in predicting vibration levels, it can be assumed that the vibration level is inversely proportional to distance (with the relationship varying between $d^{-0.8}$ to $d^{-1.6}$ based on field data).

The US Department of Transportation's Transit Noise and Vibration Impact Assessment (May 2006) presents the following construction vibration propagation formula assuming an inverse relationship:

$$PPV@d_2 = PPV@d_1 \times (d_1/d_2)^{1.5}$$

where: d_1 = distance 1 (reference distance for source data) (m)
d_2 = distance 2 (separation distance for predicted PPV) (m)
PPV = peak particle velocity (mm/s)

The above formula has been considered for predicted PPVs at various distances from construction equipment. Based on the above information, Table 19 presents PPV predictions for the various construction equipment.

Table 19: Predicted Peak Particle Velocity at Sensitive Receptors (mm/s)

Distance from Source	Source of Vibration									
	Roller	15 tonne Roller	Loader (breaking kerbs)	Pavement breaker	Excavator	7 tonne compactor	Backhoe	Jackhammer	Loaded trucks (rough surface)	Loaded trucks (smooth surface)
10	5 - 6	7 - 8	6 - 8	4.5 - 6	2.5 - 4	5 - 7	1	0.5	5	1 - 2
20	1.77 - 2.12	2.47 - 2.83	2.12 - 2.83	1.59 - 2.12	0.88 - 1.41	1.77 - 2.47	0.35	0.18	1.77	0.35 - 0.71
30	0.96 - 1.15	1.35 - 1.54	1.15 - 1.54	0.87 - 1.15	0.48 - 0.77	0.96 - 1.35	0.19	0.10	0.96	0.19 - 0.38
40	0.63 - 0.75	0.88 - 1	0.75 - 1	0.56 - 0.75	0.31 - 0.5	0.63 - 0.88	0.13	0.06	0.63	0.13 - 0.25
50	0.45 - 0.54	0.63 - 0.72	0.54 - 0.72	0.4 - 0.54	0.22 - 0.36	0.45 - 0.63	0.09	0.04	0.45	0.09 - 0.18
60	0.34 - 0.41	0.48 - 0.54	0.41 - 0.54	0.31 - 0.41	0.17 - 0.27	0.34 - 0.48	0.07	0.03	0.34	0.07 - 0.14
70	0.27 - 0.32	0.38 - 0.43	0.32 - 0.43	0.24 - 0.32	0.13 - 0.22	0.27 - 0.38	0.05	0.03	0.27	0.05 - 0.11

Distance from Source	Source of Vibration									
	Roller	15 tonne Roller	Loader (breaking kerbs)	Pavement breaker	Excavator	7 tonne compactor	Backhoe	Jackhammer	Loaded trucks (rough surface)	Loaded trucks (smooth surface)
80	0.22 - 0.27	0.31 - 0.35	0.27 - 0.35	0.2 - 0.27	0.11 - 0.18	0.22 - 0.31	0.04	0.02	0.22	0.04 - 0.09
90	0.19 - 0.22	0.26 - 0.3	0.22 - 0.3	0.17 - 0.22	0.09 - 0.15	0.19 - 0.26	0.04	0.02	0.19	0.04 - 0.07
100	0.16 - 0.19	0.22 - 0.25	0.19 - 0.25	0.14 - 0.19	0.08 - 0.13	0.16 - 0.22	0.03	0.02	0.16	0.03 - 0.06
150	0.09 - 0.1	0.12 - 0.14	0.1 - 0.14	0.08 - 0.1	0.04 - 0.07	0.09 - 0.12	0.02	0.01	0.09	0.02 - 0.03
Type	Continuous								Intermittent	
Human Comfort Criteria	Just Perceptible in Residential Environments: 0.3 mm/s Tolerable with Prior Warning in Residential Areas: 1.0 mm/s Likely to be Intolerable for More than Brief Exposure: 10 mm/s									

The predicted vibration levels presented in Table 19 indicate non-compliance with the continuous preferred vibration nuisance criteria (0.56 mm/s) for locations within 50-60 metres of the vibration source. Compliance with the building damage criteria is predicted at 10 metres from operations for each source.

For intermittent vibration associated with haul vehicles, it is difficult to provide an appropriate comparison with the relevant criteria (which is presented as a Vibration Dose Value (VDV) in $m/s^{1.75}$). The calculation of a VDV requires both the overall weighted RMS (root mean square) acceleration (m/s^2) typically obtained from on-site measurements and the estimated time period for vibration events.

It is noted, however, that heavy truck movements (on smooth surfaces) at distances of >10 m is predicted to be within the maximum continuous criteria of 17 mm/s.

The following mitigation measures are recommended for managing vibration:

- Where construction activities involve vibration-intensive plant within 20 metres of buildings alternative methods should be considered or, if any monitoring indicates levels are excessive, time restrictions negotiated with affected receivers.
- It is recommended that where reasonable and feasible a buffer distance of 60 metres for rolling and compacting activities be implemented. Where work is required within these buffer distances it is recommended that potentially impacted residents be informed of the nature and duration of the works and provided contact details.
- Where construction works are to be located within 60 metres of an occupied building or 20 metres of any buildings it is recommended that vibration monitoring be undertaken at the beginning of the given construction activity. Where measurements indicate building damage criteria are exceeded, vibration generating activities are to immediately halt and alternative low vibration work practices are to be implemented.

6 ROAD TRAFFIC NOISE ASSESSMENT

6.1 Road Noise Policy

6.1.1 Residential Receivers

The Road Noise Policy provides non-mandatory road traffic noise target levels for existing sensitive receivers due to development of major roadways. In doing so, it is intended that the target levels should be achieved at project opening and the project design year (taken as 10 years after project opening).

Noise criteria for residential land uses provided in the NSW Road Noise Policy (RNP) are based on the type of roadway and type of project. Table 20 below presents the applicable road traffic noise criteria for existing residences affected by new or redeveloped roads.

Table 20: Applicable Road Traffic Noise Criteria for Residential Land Uses

Road Category	Type of Project & Land Use	Assessment Criteria	
		Day (07:00-22:00)	Night (22:00-07:00)
Freeway/Sub Arterial / Arterial	Existing residences affected by noise from new freeway/ arterial/ sub-arterial road corridors	$L_{Aeq,15\text{-}hour}$ 55 dB(A) (external)	$L_{Aeq,9\text{-}hour}$ 50 dB(A) (external)
	Existing residences affected by noise from redevelopment of existing freeway /arterial/ sub arterial roads	$L_{Aeq,15\text{-}hour}$ 60 dB(A) (external)	$L_{Aeq,9\text{-}hour}$ 55 dB(A) (external)
Local roads	Existing residences affected by noise from new local road corridors or redevelopment of local roads	$L_{Aeq,1\text{-}hour}$ 55 dB(A) (external)	$L_{Aeq,1\text{-}hour}$ 50 dB(A) (external)

In order to determine if the "New" or "Redeveloped" criteria apply to an individual residence, the procedures set out in the NCG have been adopted. In doing so, a receiver is considered to be subject to noise from a new road traffic source if the project would result in any of the following:

- A new road where a road of the same category did not previously exist;
- A new road within an existing corridor that was previously undeveloped;
- An alignment or realignment producing noise at the receiver from a different direction which makes a significant contribution to noise exposure, on top of any increase in traffic noise from the same direction as at present. A significant increase in traffic noise is taken to be an increase of more than 2 dB(A) at any exposed façade.

A redeveloped road represents a project proposes to increase the traffic carrying capacity by widening without substantial realignment of the existing road.

For the purposes of this assessment the project assessment years considered are 2019 and 2029 for the year of opening and design year respectively. The SFR is a planned arterial road which includes a realignment and increase carrying capacity. Based on the classifications listed in the RNP, the SFR Stage 3 would be considered an arterial road.

The RNP also sets guidelines for the assessment of traffic noise on sensitive land uses such as schools, hospitals, places of worship and recreation areas. There are no non-residential sensitive landuses relevant to SFR Stage 3.

The RNP relative increase criterion assesses any increase in the total traffic noise level at a receiver due to the proposed project. According to the RNP "*a relative increase of 12 dB represents slightly more than an approximate doubling of perceived loudness and is likely to trigger community reaction, particularly in environments where there is a low existing level of traffic noise*."

The relative increase criterion is exceeded if the 'build option' noise levels increase by more than 12 dB(A) above the 'no-build option' noise levels. The 12 dB(A) relative increase criteria are not applicable to local roads. Where the existing $L_{Aeq, (period)}$ road traffic noise level is found to be less than 30 dB(A), it is deemed to be 30 dB(A).

The RNP requires residential receivers to be considered 600 m from the road centre line for the assessment of the relative increase criteria, which is applicable to new roads for this proposal. Due to the traffic volumes and receptor density surrounding the SFR, the worst-case receptors have been presented in this assessment. Table 21 presents the relative increase criteria relevant to the Project.

Table 21: Relative Increase Criteria for Residential Land Uses

Road Category	Type of Project & Land Use	Assessment Criteria	
		Day (07:00-22:00)	Night (22:00-07:00)
Freeway/ arterial/ sub-arterial roads & transitways	New road corridor /redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic $L_{Aeq,15\text{-}hour}$ + 12 dB(A) (external)	Existing traffic $L_{Aeq,9\text{-}hour}$ + 12 dB(A) (external)

6.2 Sleep Disturbance Guidelines

The RNP includes a discussion of current knowledge regarding sleep disturbance due to road traffic noise, and states "despite intensive research, the triggers for and effects of sleep disturbance have not yet been conclusively determined." Current research does indicate that the main acoustic characteristic that influences sleep disturbance is the emergence (e.g. magnitude) and number of noisy events heard distinctly above the background level. The RNP suggests that intermittent noisy events, such as truck pass-bys, could be assessed on the basis of emergence events determined as the difference between Lmax levels and the steadier L_{eq} or L_{90} levels.

The RNP makes reference to Practice Note iii of the ENMM which suggests that the $L_{eq,9h}$ road traffic noise guidelines should sufficiently account for sleep disturbance impacts except where both of the following conditions are met:

- the L_{max} is greater than 15 dB above the $L_{eq,1h}$ (i.e. L_{max} emergence is greater than 15 dB)
- the L_{max} level is greater than 65 dB(A).

In these cases, additional consideration of sleep disturbance impacts may be required.

6.3 Noise Modelling Methodology

For the purposes of predicting impacts associated with road traffic noise emissions was completed using the proprietary software CadnaA (version 2019 build 165.4911) developed by DataKustik. The model incorporates the influence of terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with Calculation of Road Traffic Noise (CRTN) methodology developed by the UK Department of Transport. In accordance with the requirements of the RNP, the predictive noise modelling incorporated the following assumptions:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CRTN methodology using the approximation $L_{Aeq,1\ hour} = L_{A10,1\ hour} - 3$.
- Noise source heights were set at 0.5 m above road level for cars and heavy vehicle tyre noise, 1.5 m for heavy vehicle engines and 3.6 m for heavy vehicle exhausts.
- Noise from heavy vehicle exhausts is 8 dB lower than the steady continuous engine noise; and
- Corrections established for Australian conditions applied through a negative correction to the CRTN predictions of -1.7 dB and +0.5 dB for façade-corrected levels for day and night periods respectively (Samuels and Saunders, 1982).

6.4 Scenarios

The RNP states that "*the contribution from the new road project refers to the noise from the new road project alone and not the total level of road traffic noise*." However, the completion of the SFR will have significant impacts on the traffic flows of existing roads and therefore several of the existing roads are also included in this assessment.

The following scenarios have been modelled:

- No Build – The No Build scenario for 2019 takes into consideration the 2019 traffic volumes of the existing road network. The No Build scenario for 2029 uses the 2028 traffic volumes and adjusted for annual growth of 1%[a] for the existing road network (from 2028 to 2029 traffic volumes only).

- Build (2019 and 2029) – The Road Noise Policy New Road Criteria requires noise from the SFR only. As there is no existing road, this scenario is void for 2019 scenario but takes into consideration the future SFR Stage 3 route only for 2019 traffic volumes and do not include the noise contributions of the surrounding road network;

- Build Total (2019 and 2029) - The Road Noise Policy relative increase criteria requires assessment of the increase in the total road traffic noise between the 'Build' and 'No Build' scenarios for the relevant design year. Therefore, to assess the relative increase

[a] Stantec (2018). Orange Strategic Transport Model Update Report.

criteria the 'Build' design and the noise contributions from the surrounding road network are included.

6.5 Traffic Data

The CoRTN calculation method calculates traffic noise emissions levels based on traffic flows, heavy vehicle percentages, vehicle speeds, road gradients and road pavement types. The CoRTN calculation method requires hourly or 18-hour traffic counts (6 am to 12 am midnight).

AADT volumes and heavy vehicle percentages for the years 2019 and 2029 have been determined based on the Orange Traffic Management Model data supplied by OCC. The 2018 traffic count data was used to provide an average heavy vehicle percentage and conversion factors from AM and PM peak periods to Annual Average Daily Traffic (AADT) and 18-hour traffic (06:00 – 00:00 hours). The assumptions are detailed below:

- Heavy vehicle percentage =
  - 6% (day) and 1% (night) for residential roads feeding into Dairy Creek Road and Blowes Road based on traffic counts for Orange Southern Road;
  - 15% (day) and 5% (night) for Mitchell Highway based on traffic counts; and
  - 6% (day) and 1% (night) for Blowes Road based on traffic counts for Orange Southern Road. It is noted that daytime traffic counts for Blowes Road have been undertaken, but the duration and time of these counts is not considered sufficient for noise modelling purposes.
- Annual traffic growth rate = 1% (to derive 2029 traffic volumes from 2028 data);
- AADT was calculated by adding the AM and PM peaks together and multiplying by the daily MRCagney factor of 5.73 (for SFR) and a daily factor of 4.44 (for local roads) as advised by OCC;
- 18-hour traffic volumes were determined to be 96.8% of the AADT based on 2018 traffic volumes for Orange City Council. Mitchell Highway 18-hour traffic volumes were determined to be 95.5% of the AADT based on 2018 traffic volumes for Orange City Council.

Table 22 presents the modelled road parameters for the existing and future SFR roads based on data provided by OCC.

Table 22: Road Parameters

Road	Road Classification	Road Surface	Speed (km/h)
SFR - Dairy Creek Road (Mitchell Hwy to Calton Rd)	Primary Collector [d]	DGA [a] [c]	80 [d]
SFR - Dairy Creek Road (Calton Rd to Lone Pine Ave)	Primary Collector [d]	DGA [a] [c]	80 [d]
SFR - Lone Pine Intersection	Primary Collector [d]	DGA [a] [c]	80 [d]
SFR - Blowes Road (Lone Pine Ave to Kurim Ave)	Primary Collector [d]	DGA [a] [c]	80 [d]
Blowes Road (Kurim Ave to Elsham Ave)	Primary Collector [d]	Existing: 14 mm chip seal [a] Future: DGA	50/80 [d]
Lone Pine Avenue (North)	Collector [d]	DGA [b] [c]	50 [d]

Road	Road Classification	Road Surface	Speed (km/h)
Lone Pine Avenue (South)	Residential [d]	DGA [b] [c]	80 [d]
Elsham Avenue (North)	Industrial [d]	DGA [b] [c]	50 [d]
Elsham Avenue (South)	Industrial [d]	DGA [b] [c]	50 [d]
Leeward Drive	Industrial [d]	DGA [b] [c]	50 [d]
Kurim Avenue	Residential [d]	DGA [b] [c]	50 [d]
Hawthorne Place	Industrial [d]	DGA [b] [c]	50 [d]
Mitchell Hwy - West Dairy Creek	Arterial [d]	DGA [b] [c]	80 [d]
Mitchell Hwy - East Dairy Creek	Arterial [d]	DGA [b] [c]	100 [d]

a) Identified during site visit / provided by OCC. A 4 dB(A) correction applied to road section where speed >60 km/hour

b) Assumed surface

c) No correction applied in the noise model as the speed is too low; therefore, the noise is dominated by the vehicle's engine, not road/wheel interaction

d) Provided by Orange City Council

Table 23 provides the 2019 and 2029 traffic volumes for each road for both the No Build and Build scenarios.

Table 23: Modelled Traffic Volumes by Scenario (18-hour)

Road	No Build				Build	
	Year 2019		Year 2029		Year 2029	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
Dairy Creek Road (Mitchell Hwy to Calton Rd)	3036	197	4667	303	4667	303
Dairy Creek Road (Calton Rd to Lone Pine Ave)	3010	196	4688	305	4688	305
Lone Pine Intersection	4310	280	6835	444	6835	444
Lone Pine Ave to Kurim Ave	2973	193	4904	319	4904	319
Blowes Road (Kurim Ave to Elsham Ave)	3156	205	6977	453	6977	453
Lone Pine Ave (North)	995	65	1268	82	1268	82
Lone Pine Ave (South)	1297	84	1578	103	1578	103
Elsham Avenue (North)	6503	422	6503	422	- [a]	- [a]
Elsham Avenue (South)	8208	533	6699	435	6699	435
Leeward Drive	5297	344	5651	367	5651	367
Kirim Avenue	1631	106	1925	125	1925	125
Hawthorne Place	3988	259	4134	269	4134	269
Mitchell Hwy - West Dairy Creek Rd	5251	813	8569	1327	8569	1327
Mitchell Hwy- East Dairy Creek Rd	6920	1071	12403	1920	12403	1920

Road	No Build				Build	
	Year 2019		Year 2029		Year 2029	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles

a) Elsham Avenue (North) will be turned into a cul-de-sac as part of the upgrade. Therefore, these values are the same as 2019.

6.6 Noise Model Validation

Comparison of the measured L_{Aeq} noise levels with the predicted noise level for the monitoring position indicates that the modelling is over-predicting by 0.1 dB on average as shown in Table 24 below.

Table 24: Model Calibration

Receptor	Period	2019 L_{Aeq} (dB(A))		Accuracy
		Predicted	Measured	
NML1	Day	59.8	58.1	1.7
	Night	52.0	53.0	-1.0
NML2	Day	63.1	61.3	1.8
	Night	55.1	57.1	-2

These predictions are within the maximum 2 dB(A) variation specified in the RNP, for the purposes of the assessment, the model is considered to have been calibrated and conservative.

6.7 Noise Predictions

A summary of noise modelling predictions for 2019 and 2029 build and no-build scenarios is presented in Table 25 and shown in Appendix D. A review of Table 25 identifies that daytime traffic noise is approximately 10 dB higher than night time traffic noise, the day-time predictions are the controlling case in relation to mitigation treatments.

When assessing the residences affected by noise from the new road against the new road noise assessment criteria, only noise level contributions from the project are considered and noise levels from the existing traffic network are not considered. However, when assessing the increase in noise levels between the 'no build' and 'build' options the total level of road traffic noise should be compared. As such, the results for residences affected by the new road corridor in have been presented showing:

- The 'no build' noise levels;
- The 'build' noise level contribution from the project; and
- The total level of road traffic noise including the 'build' noise level contribution from the project and the contribution from the surrounding network.

The predicted noise levels indicate that several residential receivers in the study area exceed the road traffic noise assessment criteria of $L_{Aeq,\ 15\text{-}hour}$ 60 dB(A) during the daytime and $L_{Aeq,\ 9\text{-}hour}$ 55 dB(A) during the night time periods as presented in Table 25 for existing residences affected by redevelopment of sub-arterial road corridors.

It should be noted that noise levels presented in Table 25, have been assessed at the nearest noise sensitive receivers to the project and predicted noise level increases or decreases at these locations are representative of receivers at greater distances.

Noise modelling indicates the following:

- road traffic noise levels are not predicted to exceed an increase of 12 dB at any receptors modelled for the 2029 build option;
- receptor R60 is predicted to have the same noise level with or without the SFR;
- receptors R54, R55, and R56, are predicted to experience an increase in noise as a result of the SFR, however all increases in noise level are ≤2 dB(A), which is below the criterion where noise mitigation should be considered;
- 63 receptors are predicted to experience a decrease in noise level up to 5 dB. For receptors R01 to R05, this is a result of the northern section of Elsham Avenue changing into a cul-de-sac. Receptors R57, R58 and R59 are predicted to experience decreased noise levels of up to 4.7 dB as a result of the realignment of the Dairy Creek Road motorway junction when compared to the 'no-build' case;
- all other receptors are predicted to experience a decrease in noise level as a result of the road surface changing from the existing 14 mm chip seal to the proposed DGA surface; and
- it is noted that for some receptors, the degraded condition of the existing road surface may also be contributing to higher noise levels. For these receptors, a minor additional benefit may be experienced in the short-term as a result of the resurfacing of the roadway.

Table 25: External Façade Corrected Predicted Noise Levels (2019 and 2029) Scenarios

ID	2019 No Build		Criteria		2029 No Build		2029 Build		Change in Noise Level	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
R01	61	51	60	55	62	52	60	50	-2.3	-2.3
R02	62	52	60	55	62	52	57	47	-5.5	-5.4
R03	56	46	60	55	58	48	56	46	-2.0	-2.0
R04	56	46	60	55	58	48	57	47	-1.4	-1.3
R05	56	47	60	55	59	49	57	48	-1.3	-1.3
R06	57	47	60	55	60	50	58	49	-1.3	-1.2
R07	57	47	60	55	59	50	58	48	-1.5	-1.6
R08	58	48	60	55	61	51	59	49	-1.6	-1.7
R09	58	48	60	55	60	51	59	49	-1.9	-2.0
R10	58	48	60	55	61	51	58	49	-2.2	-2.2
R11	58	49	60	55	61	52	59	49	-2.5	-2.5
R12	60	50	60	55	63	53	60	50	-2.8	-2.9
R13	59	49	60	55	62	52	59	49	-2.9	-2.9
R14	60	50	60	55	63	53	60	50	-3.2	-3.2
R15	59	50	60	55	62	53	59	50	-3.2	-3.3
R16	60	51	60	55	63	54	60	50	-3.4	-3.4
R17	60	50	60	55	63	53	59	50	-3.4	-3.4

ID	2019 No Build		Criteria		2029 No Build		2029 Build		Change in Noise Level	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
R18	60	50	60	55	63	53	59	50	-3.4	-3.5
R19	63	53	60	55	66	56	62	53	-3.6	-3.6
R20	60	51	60	55	63	54	60	50	-3.5	-3.5
R21	60	50	60	55	62	53	59	50	-3.3	-3.3
R22	63	54	60	55	66	57	63	54	-3.1	-3.1
R23	61	51	60	55	63	53	61	51	-2.3	-2.3
R24	59	50	60	55	61	52	59	50	-2.0	-2.1
R25	63	53	60	55	65	56	63	53	-2.3	-2.4
R26	62	52	60	55	64	54	62	53	-1.6	-1.6
R27	61	52	60	55	64	54	61	52	-2.6	-2.4
R28	61	51	60	55	63	54	61	51	-2.5	-2.3
R29	60	51	60	55	63	53	60	51	-2.5	-2.3
R30	60	50	60	55	62	52	60	50	-2.5	-2.2
R31	56	47	60	55	59	49	56	47	-2.4	-2.2
R32	57	47	60	55	59	49	56	47	-2.3	-2.1
R33	59	49	60	55	61	52	59	50	-2.3	-2.0
R34	60	50	60	55	62	52	60	50	-2.2	-2.0
R35	59	50	60	55	61	52	59	50	-2.1	-1.8
R36	59	49	60	55	61	52	59	50	-2.1	-1.8
R37	59	49	60	55	61	52	59	50	-2.1	-1.7
R38	59	49	60	55	61	52	59	50	-2.1	-1.8
R39	59	50	60	55	61	52	59	50	-2.1	-1.7
R40	57	47	60	55	59	49	57	48	-2.0	-1.6
R41	57	47	60	55	59	50	57	48	-2.0	-1.7
R42	58	48	60	55	60	51	58	49	-1.9	-1.7
R43	58	48	60	55	60	50	58	49	-2.0	-1.6
R44	58	49	60	55	61	51	59	49	-1.9	-1.5
R45	56	47	60	55	58	49	57	48	-1.4	-1.2
R46	56	46	60	55	58	48	56	46	-1.9	-1.6
R47	61	51	60	55	63	53	61	52	-1.8	-1.5
R48	60	51	60	55	63	53	61	52	-1.2	-0.9
R49	57	47	60	55	58	49	58	48	-0.9	-0.6
R50	56	47	60	55	58	48	57	48	-0.6	-0.5
R51	52	43	60	55	54	44	53	44	-0.8	-0.6
R52	53	43	60	55	55	45	54	45	-0.1	0.0
R53	55	45	60	55	57	47	57	47	-0.1	0.0
R54	56	46	60	55	58	48	58	48	0.1	0.0

ID	2019 No Build		Criteria		2029 No Build		2029 Build		Change in Noise Level	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
R55	51	42	60	55	53	44	53	44	0.3	0.3
R56	52	42	60	55	54	44	54	44	0.1	0.0
R57	63	54	60	55	65	56	60	51	-4.7	-5.0
R58	61	52	60	55	63	54	61	52	-2.2	-2.4
R59	64	54	60	55	66	56	66	56	-0.3	-0.3
R60	57	47	60	55	59	50	59	50	0.0	0.0
C01	64	54	60	55	64	54	63	53	-0.5	-0.2
C02	59	49	60	55	60	50	59	50	-0.8	-0.7
C03	59	50	60	55	62	52	60	51	-1.3	-1.4
C04	59	50	60	55	62	52	59	50	-2.4	-2.3
C05	58	48	60	55	60	50	58	48	-1.5	-1.6
C06	57	47	60	55	58	49	57	47	-1.3	-1.3
C07	55	45	60	55	56	46	55	45	-1.1	-1.0

6.8 Maximum Noise Level Assessment

During the entire night time period (22:00 – 07:00), the total number of vehicles along the SFR in 2029 is expected to be as follows:

- Dairy Creek Road – 449 vehicles and 5 heavy vehicles; and
- Blowes Road – 671 vehicles and 7 heavy vehicles.

The L_{Amax} and $L_{Aeq, 9\text{-hour}}$ noise levels during the night-time period are summarised in Table 26 for each sensitive receptor. The maximum noise levels are not predicted to exceed the $L_{Aeq, 9\ hour}$ noise levels by more than 15 dB(A) and are not above 65 dB(A) for any receptors. It should be noted that noise predictions are based on medium and heavy vehicles under full throttle.

Table 26: Maximum Noise Level Assessment (dB(A))

ID	L_{Amax}	$L_{Aeq, 9\ hour}$	L_{Amax} - $L_{Aeq, 9\ hour}$	Number of Events > 65 dB(A) and 15 dB(A) above $L_{Aeq, 9\ hour}$ per night
R01	56	51	5.3	N/A
R02	53	48	4.7	N/A
R03	53	47	5.8	N/A
R04	54	48	5.7	N/A
R05	54	49	5.7	N/A
R06	55	50	5.7	N/A
R07	55	49	5.9	N/A
R08	56	50	5.7	N/A
R09	55	49	5.8	N/A

ID	L_{Amax}	$L_{Aeq,\ 9\ hour}$	L_{Amax} - $L_{Aeq,\ 9\ hour}$	Number of Events > 65 dB(A) and 15 dB(A) above $L_{Aeq,\ 9\ hour}$ per night
R10	55	49	6.1	N/A
R11	55	49	6.0	N/A
R12	56	50	5.6	N/A
R13	55	49	6.1	N/A
R14	56	50	6.1	N/A
R15	55	49	5.9	N/A
R16	55	50	5.3	N/A
R17	55	49	5.3	N/A
R18	54	49	5.3	N/A
R19	57	52	5.3	N/A
R20	55	49	5.2	N/A
R21	54	49	5.1	N/A
R22	58	53	4.6	N/A
R23	54	51	2.4	N/A
R24	52	50	1.7	N/A
R25	57	54	3.3	N/A
R26	54	53	1.2	N/A
R27	55	51	3.4	N/A
R28	54	51	2.9	N/A
R29	52	51	1.6	N/A
R30	52	50	1.8	N/A
R31	48	47	1.4	N/A
R32	49	47	1.6	N/A
R33	52	50	2.9	N/A
R34	55	50	4.6	N/A
R35	55	50	4.9	N/A
R36	55	50	5.1	N/A
R37	56	50	5.7	N/A
R38	55	50	5.6	N/A
R39	56	50	5.9	N/A
R40	54	48	6.1	N/A
R41	52	46	6.0	N/A
R42	54	48	6.3	N/A
R43	55	49	6.3	N/A
R44	55	49	6.2	N/A
R45	56	49	6.3	N/A
R46	53	48	5.4	N/A
R47	57	52	5.5	N/A

ID	L_{Amax}	$L_{Aeq,\ 9\ hour}$	L_{Amax} - $L_{Aeq,\ 9\ hour}$	Number of Events > 65 dB(A) and 15 dB(A) above $L_{Aeq,\ 9\ hour}$ per night
R48	57	52	4.3	N/A
R49	51	49	1.8	N/A
R50	51	49	2.0	N/A
R51	43	45	-1.4	N/A
R52	48	45	2.8	N/A
R53	52	47	5.0	N/A
R54	55	48	6.4	N/A
R55	50	44	5.5	N/A
R56	48	44	3.2	N/A
R57	40	51	-10.7	N/A
R58	39	51	-12.6	N/A
R59	48	56	-8.0	N/A
R60	36	50	-13.3	N/A
C01	46	54	-8.9	N/A
C02	47	51	-3.5	N/A
C03	54	51	2.9	N/A
C04	48	50	-1.4	N/A
C05	46	49	-3.0	N/A
C06	45	48	-2.9	N/A
C07	44	46	-2.3	N/A

7 NOISE MANAGEMENT OPTIONS

The implementation of noise mitigation measures is ultimately a decision for OCC to consider as part of the integrated design process. It is not mandatory via the NMG to implement any measures but consideration must be given to their implementation in certain circumstances, and this must include a decision as to whether the measures considered are reasonable and feasible.

For new and redeveloped roads, the NMG considers that noise mitigation should be considered for receivers where the total noise level for the 'build' year exceeds the controlling criterion established using the NMG and there is an increase of more than 2.0 dB relative to the 'no-build' year. This is noted to include the situation where the 'no-build' noise level is below the criterion value. If either, but not both of these criteria, are satisfied, the implementation of mitigation measures is optional.

Reviewing the noise assessed for the 2029 build options, the following is noted:

- 11 residential receptors exceed the assessment criteria of $L_{Aeq,\ 15\text{-}hour}$ 60 dB(A) during the daytime and one (1) receptor exceeds the $L_{Aeq,\ 9\text{-}hour}$ 55 dB(A) during the night time periods as presented in Table 25. These receptors are R19, R22, R23, R25, R26, R27, R28, R47, R48, R58 and R59;
- 63 receptors are predicted to experience a decrease in predicted noise levels during the daytime and 61 receptors are predicted to experience a decrease in predicted noise levels during the night time period;
- no receptors are predicted to exceed the 2 dB(A) criteria relative to the no build option, where mitigation may be considered; and
- no receptors are predicted to exceed the overall relative increase criteria of 12 dB for the 2029 build option.

Overall, no receptors exceed both the NMG criteria for the 'build' year and experience a 2 dB increase relative to the 'no-build' year, as such noise mitigation does not have to be considered.

8 CONCLUSIONS AND RECOMMENDATIONS

Assured Environmental has undertaken an assessment of the potential noise and vibration impacts from the construction and operation of the Southern Feeder Road Stage 3 project.

Baseline noise monitoring was undertaken to define the existing noise environment and determine the appropriate noise criteria for construction activities. The noise prediction of various construction activities was undertaken in accordance with Construction Noise & Vibration Guideline and is based on distance from the road corridor centreline. The assessment determined the number of receptors within 70 m of the road alignment which may exceed the 'highly affected' assessment criteria of 75 dB(A) during the daytime period.

The predicted vibration levels indicate compliance with the continuous preferred vibration nuisance criteria for locations at a separation distance of 50-60 metres. Compliance with the building damage criteria is predicted at 10 metres from operations for each source.

For intermittent vibration, heavy truck movements (on smooth surfaces) at distances of >10 m is predicted to be within the maximum intermittent criteria of 17 mm/s.

The predicted noise levels for the 2029 'build' option indicate that several residential receivers in the study area exceed the road traffic noise assessment criteria of $L_{Aeq,\ 15\text{-}hour}$ 60 dB(A) during the daytime and $L_{Aeq,\ 9\text{-}hour}$ 55 dB(A) during the night time periods.

Noise modelling indicates the following:

- road traffic noise levels are not predicted to exceed an increase of 12 dB at any receptors modelled for the 2029 build option;
- receptor R60 is predicted to have the same noise level with or without the SFR;
- receptors R54, R55, and R56, are predicted to experience an increase in noise as a result of the SFR, however all increases in noise level are ≤2 dB(A), which is below the criterion where noise mitigation should be considered;
- 63 receptors are predicted to experience a decrease in noise level up to 5 dB. For receptors R01 to R05, this is a result of the northern section of Elsham Avenue changing into a cul-de-sac. Receptors R57, R58 and R59 are predicted to experience decreased noise levels of up to 4.7 dB as a result of the realignment of the Dairy Creek Road motorway junction when compared to the 'no-build' case;
- all other receptors are predicted to experience a decrease in noise level as a result of the road surface changing from the existing 14 mm chip seal to the proposed DGA surface; and
- it is noted that for some receptors, the degraded condition of the existing road surface may also be contributing to higher noise levels. For these receptors, a minor additional benefit may be experienced in the short-term as a result of the resurfacing of the roadway.

Overall, the results of the assessment show that the delivery of Stage 3 of the SFR is predicted to result in decreased noise levels for the majority of sensitive receptors as a result of an improved (DGA instead of 14 mm chip seal) road surface, converting the northern part of Elsham Avenue into a cul-de-sac and realignment of the Dairy Creek Road motorway junction.

APPENDIX A: GLOSSARY OF TERMS

A-Weighting	A response provided by an electronic circuit which modifies sound in such a way that the resulting level is similar to that perceived by the human ear.
dB (decibel)	This is the scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure (0.00002 N/m^2).
dB(A) or dBA	This is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Free-field	Refers to a sound pressure level determined at a point away from reflective surfaces other than the ground with no significant contribution due to sound from other reflective surfaces; generally, as measured outside and away from buildings.
L_{Aeq}	This is the equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over the given period. Noise levels often fluctuate over a wide range with time. Therefore, when a noise varies over time, the L_{Aeq} is the equivalent continuous sound which would contain the same sound energy as the time varying sound. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.
L_{A1}	L_{A1} is the noise level exceeded for 1% of the measurement period, A-weighted and calculated by statistical analysis.
L_{A10}	L_{A10} is the noise level exceeded for 10% of the measurement period, A-weighted and calculated by statistical analysis. L_{A10} is commonly used as a indicator of traffic-related noise.
L_{A90}	L_{A90} is the noise level exceeded for 90% of the measurement period, A-weighted and calculated by statistical analysis.

APPENDIX B: NOISE MONITORING

Table 27: Site Details for Monitoring Location 1

Site Details	
Coordinates:	33°18'25.93"S, 149°06'43.19"E
Start/End Date and Time	15/01/2019 at 10:51 hours to 23/01/2019 at 14:51 hours
Logger Details	Rion NL21 (serial number – 01047100)
Calibration Details	Start / End Calibration Level: 94.0 / 94.0 dB(A)
Microphone Height:	1.2 m / Free field position
Measurement Details:	Fast/ A-weighting / 15-minute duration
Weather Details	Orange Airport (ID: 095726). During the monitoring period 18 hours of data was removed due to either high winds or rainfall.
On-site Observations:	Located in the rear garden of 69 Kurim Avenue, approximately 25 m from the kerb of Blowes Road and 8 m from Kurim Road. Domesticated animal including dogs lived at the property.
Site Photo	

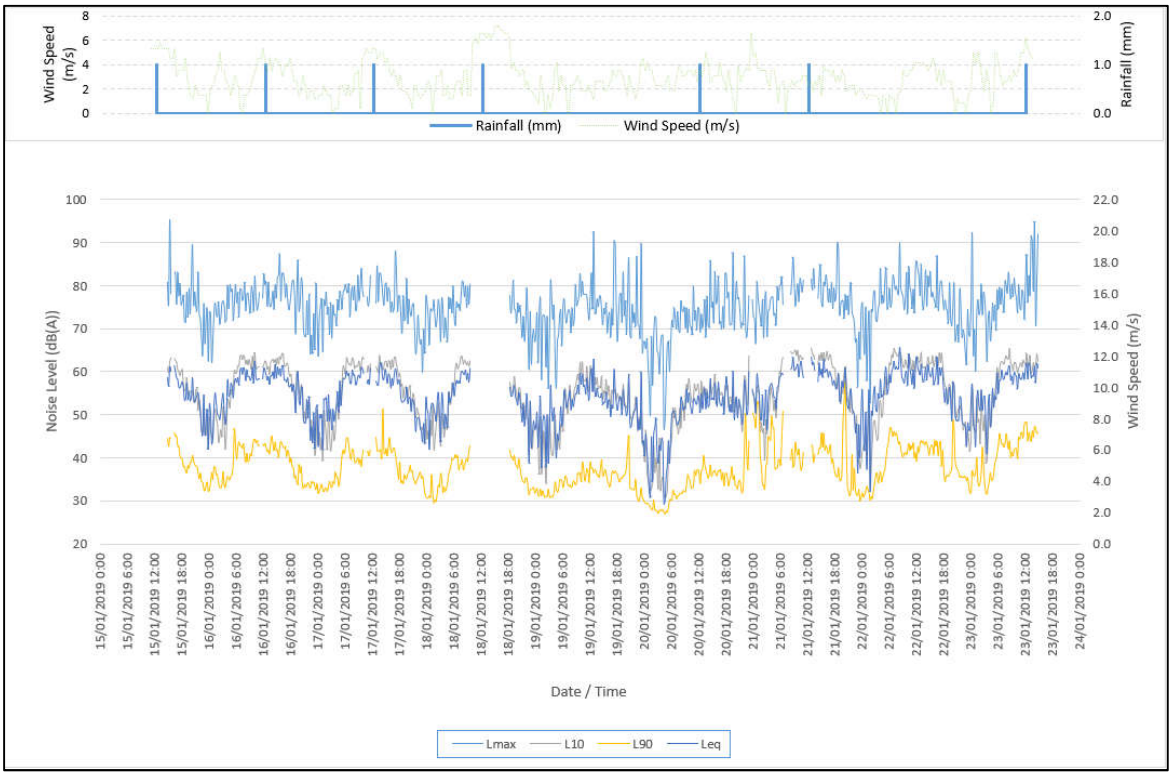


Table 28: Noise Monitoring Data for Location ML1

Date	Period [a]	L_{Amax}	L_{10}	L_{90}	L_{eq}	ABL	Road Traffic	
							L_{Aeq} [b]	$L_{A10,\ 18\ hr}$ [c]
15/01/19 (Tue)	Day	-	-	-	-	-	-	-
	Evening	89.5	55.3	38.1	55.1	36.6		
	Night	80.3	50.5	36.2	54.1	32.9	54.1	
16/01/19 (Wed)	Day	87.2	61.9	42.1	59.3	40.2	58.5	58.4
	Evening	85.8	54.5	35.6	55.1	33.4		
	Night	80.3	49.5	35.5	54.1	32.5	54.1	
17/01/19 (Thu)	Day	87.9	61.5	41.0	58.9	38.8	57.9	58.2
	Evening	81.6	54.8	35.8	53.4	34.2		
	Night	79.8	49.6	34.5	52.6	30.7	52.6	
18/01/19 (Fri)	Day	-	-	-	-	-	56.9	55.5
	Evening	81.0	54.5	37.9	53.7	34.6		
	Night	80.9	45.2	32.7	50.1	31.1	50.1	
19/01/19 (Sat)	Day	92.5	56.6	35.9	56.0	33.7	55.3	54.5
	Evening	86.2	52.6	35.8	52.9	32.7		
	Night	89.7	40.5	29.4	48.3	27.5	48.3	
20/01/19 (Sun)	Day	85.7	54.2	35.2	53.5	31.7	53.6	53.7
	Evening	87.6	52.5	34.5	54.1	33.1		
	Night	86.8	53.4	43.2	55.8	37.4	55.8	
21/01/19 (Mon)	Day	-	-	-	-	-	59.4	58.5
	Evening	89.9	55.7	38.9	56.3	32.5		

Date	Period [a]	L_{Amax}	L_{10}	L_{90}	L_{eq}	ABL	Road Traffic	
							L_{Aeq} [b]	$L_{A10,\ 18\ hr}$ [c]
	Night	84.1	48.6	35.4	54.9	30.9	54.9	
22/01/19 (Tue)	Day	89.8	62.5	42.4	60.4	40.5	59.4	58.7
	Evening	80.6	53.9	37.9	53.8	35.6		
	Night	92.2	49.8	36.6	53.6	32.6	53.6	
23/01/19 (Wed)	Day	94.7	61.9	44.3	59.6	41.5	59.6	-
	Evening	-	-	-	-	-		
	Night	-	-	-	-	-	-	

a) Periods are defined as Day – 7 am to 6 pm; Evening – 6 pm to 10 pm; and Night – 10 pm to 7 am.

b) Road traffic descriptors as defined by Day – 7 am to 10 pm and Night – 10 pm to 7 am.

c) $L_{A10,\ 18hour}$ is defined as 6 am to 12 am

Table 29: Site Details for Monitoring Location 2

Site Details	
Coordinates:	33°18'30.53"S, 149°07'04.85"E
Start/End Date and Time	15/01/2019 at 10:51 hours to 23/01/2019 at 14:51 hours
Logger Details	Norsonic 139 (serial number – 1392800)
Calibration Details	Start / End Calibration Level: 94.0 / 94.0 dB(A)
Microphone Height:	1.2 m / Free field position
Measurement Details:	Fast/ A-weighting / 15-minute duration
Weather Details	Orange Airport (ID: 095726). During the monitoring period 18 hours of data was removed due to either high winds or rainfall.
On-site Observations:	Located in the nature strip along Diary Creek Road approximately 19 m from the kerb opposite the Lone Pine junction.
Site Photo	

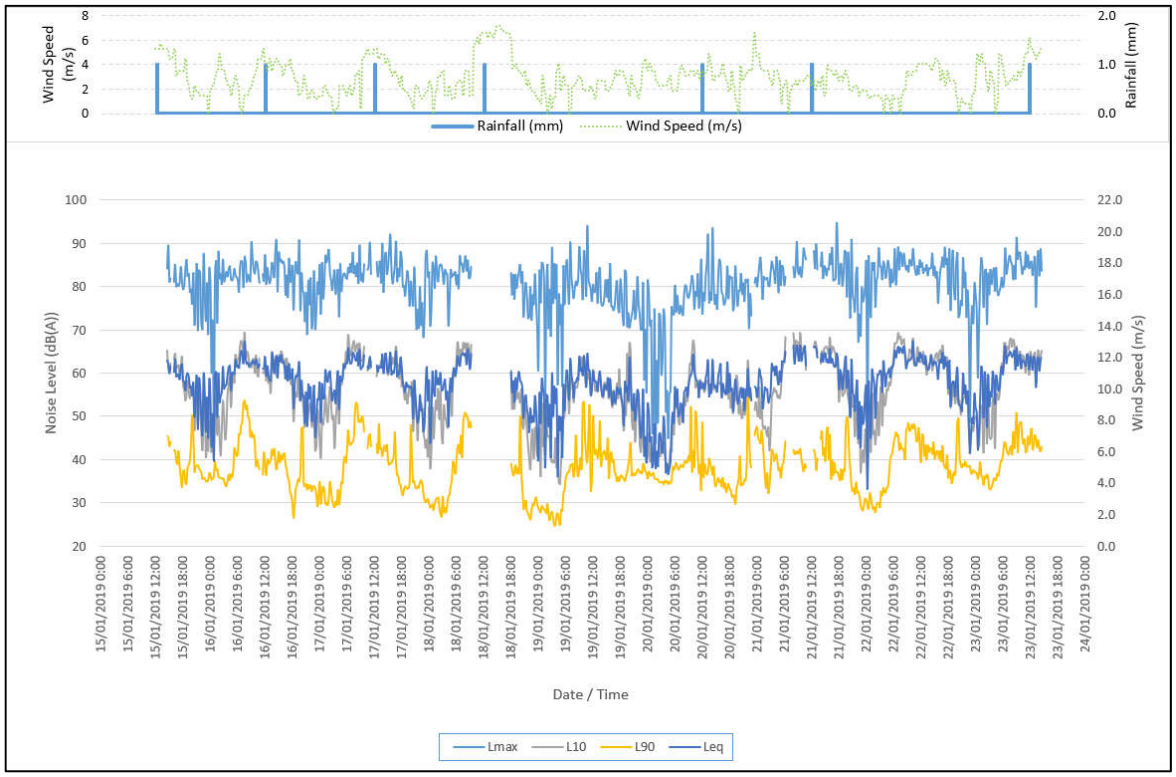


Table 30: Noise Monitoring Data for Location ML2

Date	Period [a]	L_{Amax}	L_{10}	L_{90}	L_{eq}	ABL	Road Traffic	
							L_{Aeq} [b]	$L_{A10,\ 18\ hr}$ [c]
15/01/19 (Tue)	Day	-	-	-	-	-	59.4	55.4
	Evening	86.2	55.2	39.0	57.8	34.6		
	Night	87.9	51.3	37.1	58.5	35.0	58.5	
16/01/19 (Wed)	Day	90.6	62.1	42.0	62.3	36.6	61.5	58.6
	Evening	90.6	53.3	34.8	57.8	29.8		
	Night	88.4	52.6	33.6	58.5	29.6	58.5	
17/01/19 (Thu)	Day	92.0	63.1	43.7	62.4	38.9	61.4	59.3
	Evening	88.0	54.3	34.9	57.6	32.8		
	Night	88.3	51.2	32.3	57.8	28.2	57.8	
18/01/19 (Fri)	Day	-	-	-	-	-	61.1	55.5
	Evening	85.0	53.0	35.8	57.1	29.0		
	Night	89.0	43.9	28.8	54.0	26.1	54.0	
19/01/19 (Sat)	Day	94.1	57.1	40.9	58.9	35.9	58.3	55.2
	Evening	83.7	54.1	37.1	56.2	35.3		
	Night	82.3	43.8	36.3	49.7	34.8	49.7	
20/01/19 (Sun)	Day	93.6	56.7	38.4	58.3	33.8	57.8	55.5
	Evening	84.7	53.2	33.9	55.8	31.4		
	Night	86.8	53.6	40.9	59.2	35.9	59.2	
21/01/19 (Mon)	Day	-	-	-	-	-	63.1	59.7
	Evening	90.9	54.9	38.2	59.5	33.0		

Date	Period [a]	L_{Amax}	L_{10}	L_{90}	L_{eq}	ABL	Road Traffic	
							L_{Aeq} [b]	$L_{A10,\ 18\ hr}$ [c]
	Night	88.9	50.6	33.0	58.9	28.6	58.9	
22/01/19 (Tue)	Day	89.1	64.1	43.2	63.4	39.7	62.5	60.4
	Evening	88.7	55.0	39.3	58.1	35.9		
	Night	88.9	51.3	37.1	57.9	34.4	57.9	
23/01/19 (Wed)	Day	91.3	63.8	44.1	63.2	41.7	63.2	-
	Evening	-	-	-	-	-		
	Night	-	-	-	-	-	-	

a) Periods are defined as Day – 7 am to 6 pm; Evening – 6 pm to 10 pm; and Night – 10 pm to 7 am.

b) Road traffic descriptors as defined by Day – 7 am to 10 pm and Night – 10 pm to 7 am.

c) $L_{A10,\ 18hour}$ is defined as 6 am to 12 am

APPENDIX C: ESTIMATED CONSTRUCTION NOISE LEVELS – DETAILED RESULTS

This Appendix provides the detailed results for each receptor for each construction activity and the associated additional mitigation requirements.

Table 31: Additional Noise Mitigation Requirements for R1

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	74	48	43	26	31	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	79	48	43	31	36	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	81	48	43	33	38	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Paving	76	48	43	28	33	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Compound Establishment	43	48	43	-	-	N, V	-
Road Furniture	68	48	43	20	25	N, V	V, IB, N, R1, DR, PC, SN
Re-surfacing Works	76	48	43	28	33	N, V, PC, RO	V, IB, N, R1, DR, PC, SN

Table 32: Additional Noise Mitigation Requirements for R11

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	69	48	43	21	26	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	70	48	43	22	27	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	75	48	43	27	32	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	77	48	43	29	34	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	69	48	43	21	26	N, V	V, IB, N, R1, DR, PC, SN
Paving	72	48	43	24	29	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	46	48	43	-	3	N, V	N/A
Road Furniture	64	48	43	16	21	N, V	V, IB, N, R1, DR
Re-surfacing Works	72	48	43	24	29	N, V	V, IB, N, R1, DR, PC, SN

Table 33: Additional Noise Mitigation Requirements for R22

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	72	48	43	24	29	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	78	48	43	30	35	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	80	48	43	32	37	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	72	48	43	24	29	N, V	V, IB, N, R1, DR, PC, SN
Paving	75	48	43	27	32	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Compound Establishment	50	48	43	2	7	N, V	N, R1, DR
Road Furniture	67	48	43	19	24	N, V	V, IB, N, R1, DR
Re-surfacing Works	75	48	43	27	32	N, V, PC, RO	V, IB, N, R1, DR, PC, SN

Table 34: Additional Noise Mitigation Requirements for R30

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	72	48	43	24	29	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	77	48	43	29	34	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	79	48	43	31	36	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Paving	74	48	43	26	31	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	54	48	43	6	11	N, V	N, R1, DR
Road Furniture	66	48	43	18	23	N, V	V, IB, N, R1, DR
Re-surfacing Works	74	48	43	26	31	N, V	V, IB, N, R1, DR, PC, SN

Table 35: Additional Noise Mitigation Requirements for R35

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	72	48	43	24	29	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	77	48	43	29	34	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	79	48	43	31	36	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Paving	74	48	43	26	31	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	57	48	43	9	14	N, V	N, R1, DR
Road Furniture	66	48	43	18	23	N, V	V, IB, N, R1, DR
Re-surfacing Works	74	48	43	26	31	N, V	V, IB, N, R1, DR, PC, SN

Table 36: Additional Noise Mitigation Requirements for R43

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	70	48	43	22	27	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	76	48	43	28	33	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	78	48	43	30	35	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	70	48	43	22	27	N, V	V, IB, N, R1, DR, PC, SN
Paving	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	65	48	43	17	22	N, V	V, IB, N, R1, DR
Road Furniture	65	48	43	17	22	N, V	V, IB, N, R1, DR
Re-surfacing Works	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN

Table 37: Additional Noise Mitigation Requirements for R47

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	74	48	43	26	31	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	79	48	43	31	36	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	81	48	43	33	38	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Paving	76	48	43	28	33	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Compound Establishment	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Road Furniture	68	48	43	20	25	N, V	V, IB, N, R1, DR, PC, SN
Re-surfacing Works	76	48	43	28	33	N, V, PC, RO	V, IB, N, R1, DR, PC, SN

Table 38: Additional Noise Mitigation Requirements for R52

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	65	48	43	17	22	N, V	V, IB, N, R1, DR
Utility Adjustment	66	48	43	18	23	N, V	V, IB, N, R1, DR
Corridor Clearing	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	65	48	43	17	22	N, V	V, IB, N, R1, DR
Paving	68	48	43	20	25	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	61	48	43	13	18	N, V	V, IB, N, R1, DR
Road Furniture	60	48	43	12	17	N, V	V, IB, N, R1, DR
Re-surfacing Works	68	48	43	20	25	N, V	V, IB, N, R1, DR, PC, SN

Table 39: Additional Noise Mitigation Requirements for R53

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	68	48	43	20	25	N, V	V, IB, N, R1, DR, PC, SN
Utility Adjustment	69	48	43	21	26	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	74	48	43	26	31	N, V	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	76	48	43	28	33	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	68	48	43	20	25	N, V	V, IB, N, R1, DR, PC, SN
Paving	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	57	48	43	9	14	N, V	N, R1, DR
Road Furniture	63	48	43	15	20	N, V	V, IB, N, R1, DR
Re-surfacing Works	71	48	43	23	28	N, V	V, IB, N, R1, DR, PC, SN

Table 40: Additional Noise Mitigation Requirements for R54

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	67	48	43	19	24	N, V	V, IB, N, R1, DR
Utility Adjustment	68	48	43	20	25	N, V	V, IB, N, R1, DR, PC, SN
Corridor Clearing	73	48	43	25	30	N, V	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	75	48	43	27	32	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	67	48	43	19	24	N, V	V, IB, N, R1, DR
Paving	70	48	43	22	27	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	47	48	43	-	4	N, V	N/A
Road Furniture	62	48	43	14	19	N, V	V, IB, N, R1, DR
Re-surfacing Works	70	48	43	22	27	N, V	V, IB, N, R1, DR, PC, SN

Table 41: Additional Noise Mitigation Requirements for R56

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	59	48	43	11	16	N, V	V, IB, N, R1, DR
Utility Adjustment	60	48	43	12	17	N, V	V, IB, N, R1, DR
Corridor Clearing	65	48	43	17	22	N, V	V, IB, N, R1, DR
Bulk Earthworks	67	48	43	19	24	N, V	V, IB, N, R1, DR
Drainage Infrastructure	59	48	43	11	16	N, V	V, IB, N, R1, DR
Paving	62	48	43	14	19	N, V	V, IB, N, R1, DR
Compound Establishment	42	48	43	-	-	N, V	-
Road Furniture	54	48	43	6	11	N, V	N, R1, DR
Re-surfacing Works	62	48	43	14	19	N, V	V, IB, N, R1, DR

Table 42: Additional Noise Mitigation Requirements for R57

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	55	48	43	7	12	N, V	N, R1, DR
Utility Adjustment	56	48	43	8	13	N, V	N, R1, DR
Corridor Clearing	61	48	43	13	18	N, V	V, IB, N, R1, DR
Bulk Earthworks	63	48	43	15	20	N, V	V, IB, N, R1, DR
Drainage Infrastructure	55	48	43	7	12	N, V	N, R1, DR
Paving	58	48	43	10	15	N, V	V, IB, N, R1, DR
Compound Establishment	38	48	43	-	-	N, V	-
Road Furniture	50	48	43	2	7	N, V	N, R1, DR
Re-surfacing Works	58	48	43	10	15	N, V	V, IB, N, R1, DR

Table 43: Additional Noise Mitigation Requirements for R59

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	66	48	43	18	23	N, V	V, IB, N, R1, DR
Utility Adjustment	67	48	43	19	24	N, V	V, IB, N, R1, DR
Corridor Clearing	72	48	43	24	29	N, V	V, IB, N, R1, DR, PC, SN
Bulk Earthworks	82	48	43	34	39	N, V, PC, RO	V, IB, N, R1, DR, PC, SN
Drainage Infrastructure	66	48	43	18	23	N, V	V, IB, N, R1, DR
Paving	69	48	43	21	26	N, V	V, IB, N, R1, DR, PC, SN
Compound Establishment	41	48	43	-	-	N, V	-
Road Furniture	61	48	43	13	18	N, V	V, IB, N, R1, DR
Re-surfacing Works	69	48	43	21	26	N, V	V, IB, N, R1, DR, PC, SN

Table 44: Additional Noise Mitigation Requirements for C03

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	72	75	75	-	-	-	-
Utility Adjustment	73	75	75	-	-	-	-
Corridor Clearing	78	75	75	3	3	N, V, PC, RO	-
Bulk Earthworks	80	75	75	5	5	N, V, PC, RO	-
Drainage Infrastructure	72	75	75	-	-	-	-
Paving	75	75	75	-	-	N, V, PC, RO	-
Compound Establishment	44	75	75	-	-	-	-
Road Furniture	67	75	75	-	-	-	-
Re-surfacing Works	75	75	75	-	-	N, V, PC, RO	-

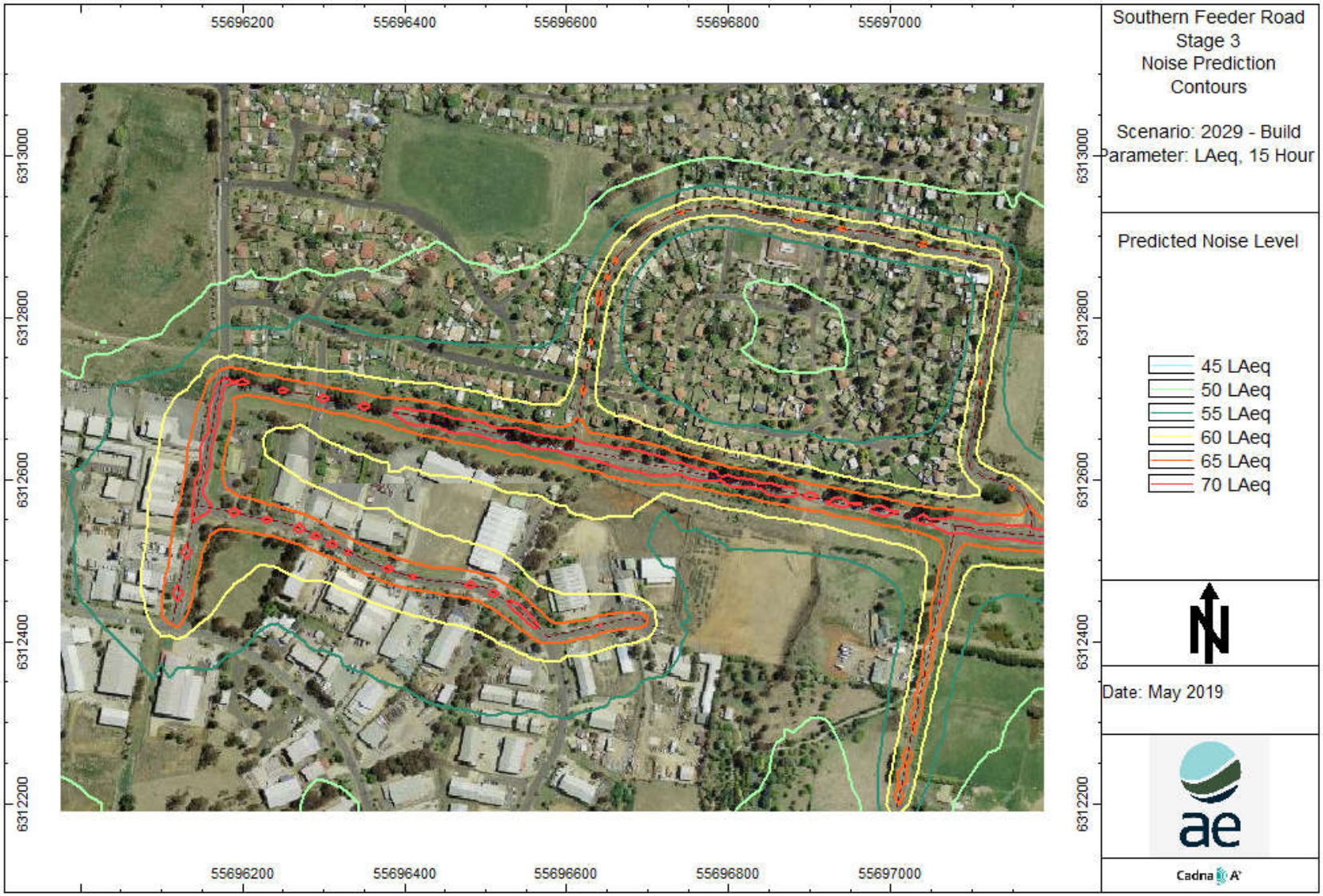
Table 45: Additional Noise Mitigation Requirements for C04

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	65	75	75	-	-	-	-
Utility Adjustment	66	75	75	-	-	-	-
Corridor Clearing	71	75	75	-	-	-	-
Bulk Earthworks	73	75	75	-	-	-	-
Drainage Infrastructure	65	75	75	-	-	-	-
Paving	68	75	75	-	-	-	-
Compound Establishment	49	75	75	-	-	-	-
Road Furniture	60	75	75	-	-	-	-
Re-surfacing Works	68	75	75	-	-	-	-

Table 46: Additional Noise Mitigation Requirements for C07

Activity	Predicted Noise Level, $L_{Aeq, 15min}$	NML (dB(A))		Exceedence of NML (dB(A))		Additional Noise Mitigation	
		Standard Hours	OOHW	Standard Hours	OOHW	Standard Hours	OOHW
Site Establishment	63	75	75	-	-	-	-
Utility Adjustment	64	75	75	-	-	-	-
Corridor Clearing	69	75	75	-	-	-	-
Bulk Earthworks	71	75	75	-	-	-	-
Drainage Infrastructure	63	75	75	-	-	-	-
Paving	66	75	75	-	-	-	-
Compound Establishment	56	75	75	-	-	-	-
Road Furniture	58	75	75	-	-	-	-
Re-surfacing Works	66	75	75	-	-	-	-

APPENDIX D: PREDICTED NOISE CONTOURS

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Noise Prediction
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55 LAeq
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65 LAeq
70 LAeq
N
Date: May 2019
Cadna A


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Southern Feeder Road
Stage 3
Noise Prediction
Contours
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Parameter: LAeq, 9 Hour
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Date: May 2019
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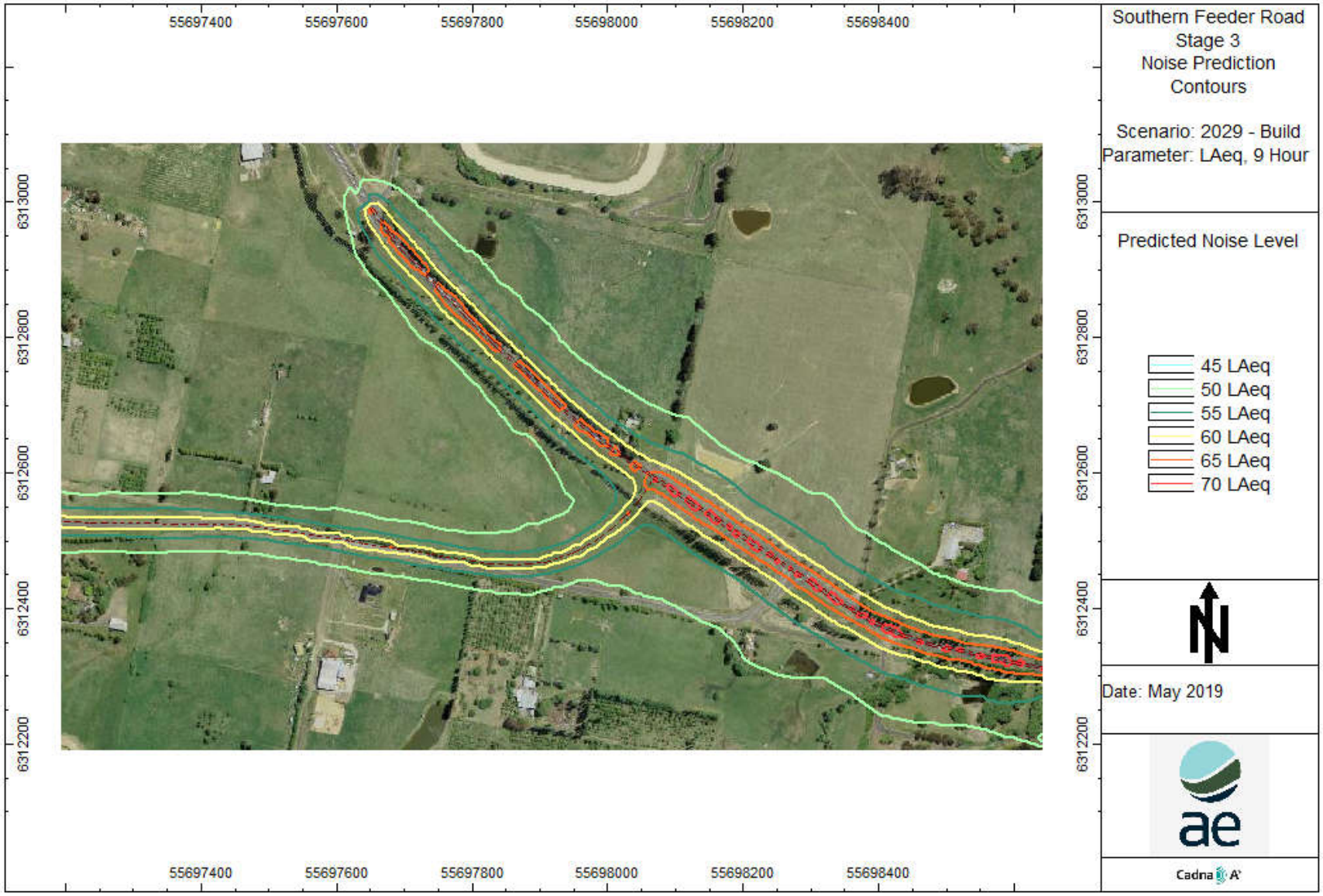
Cadna A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Southern Feeder Road
Stage 3
Noise Prediction
Contours
Scenario: 2029 - Build
Parameter: LAeq, 9 Hour
Predicted Noise Level
45 LAeq
50 LAeq
55 LAeq
60 LAeq
65 LAeq
70 LAeq
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