Parkes Bypass

Operational road traffic noise and construction noise and vibration assessment report

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Roads and Maritime Services

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Executive summary

Introduction

WSP has been engaged to undertake a construction noise and vibration and operational noise assessment for the proposed Parkes Bypass (the proposal). This technical report was prepared to inform the environmental assessment and forms part of the Parkes Bypass review of environmental factors (REF).

Roads and Maritime Services (Roads and Maritime) proposes to build a new 10.5 kilometres bypass about 1.5 to 2.0 kilometres west of the existing Newell Highway in Parkes, NSW (the proposal).

The proposal's key features include:

- A new two-lane bypass (one lane in each direction) with four key intersections comprising:
  - T-intersections where the new bypass connects to the existing highway near Barkers Road (south) and Maguire Road (north)
  - A staggered T-intersection at London Road
  - A four-way roundabout at Condobolin Road
  - A bridge over the Broken Hill and Parkes to Narromine rail lines and Hartigan Avenue and a shared pedestrian/cycleway bridge over the Parkes Bypass connecting Victoria Street and Back Trundle Road
- An extension of Hartigan Avenue that would connect to Brolgan Road (west of the bypass) and Condobolin Road
- Changes to local roads to tie in with the new bypass.

It is anticipated that construction would start in 2020 and would take about three years to complete. This would be subject to funding, weather and access considerations.

Existing environment

The areas surrounding the proposed bypass consist of freestanding residential dwellings, interspersed with other sensitive land use including educational facilities, a child care centre, a place of worship, and outdoor recreational areas. A total of ten noise catchment areas (NCA) have been established to group together dwellings with similar representative land uses, ambient noise environments and potentially similar degree of impacts.

Short-term and long-term ambient noise surveys were undertaken between 7 December 2016 and 15 December 2016 at seven locations within the study area as well as between 29 November 2017 to 17 December 2017 at one additional location. Traffic tube counters were deployed at the same time as the noise monitors were installed to collect concurrent traffic volume, classification and speed data for relevant existing roads in the study area. Representative background noise levels were also measured for the NCAs.

The measured background and ambient noise data have been used for the establishment of construction noise criteria and for the operational noise modelling validation.

The established NCAs are as follows:

- NCA01 and NCA10 are located at both ends of the proposed bypass and are generally being affected by existing road traffic noise from Newell Highway
- NCA02 and NCA03 generally consists of properties considered as isolated and are also affected by existing road traffic noise
- NCA04 and NCA05 generally consists of properties considered closely spaced and are currently affected by existing road traffic noise by road that will cross the proposed bypass
- Road traffic noise is generally not a dominant feature of the existing acoustic environment in NCA06, NCA07, NCA08 and NCA09.

Assessment guidelines

The operational road traffic noise has been assessed in accordance with the Roads and Maritime's guidelines; *Noise Criteria* Guideline (NCG) (2015) and *Noise Mitigation Guideline* (NMG) (2015) to implement the *NSW Road Noise Policy* (RNP) ((NSW) Environment Protection Authority (EPA), 2011).

Construction noise and vibration has been assessed in accordance with the Roads and Maritime's *Construction Noise and Vibration Guideline* (CNVG) (Roads and Maritime, 2016) and the *NSW Interim Construction Noise Guideline* (ICNG) (EPA, 2009).

Operational noise

Three-dimensional noise modelling was undertaken for the proposal utilising the Calculation of Road Traffic Noise (CoRTN) calculation algorithm as implemented in the SoundPLAN software package. The CoRTN method was adapted to account for the Australian heavy vehicle fleet based on current scientific literature to improve the model's prediction performance under Australian conditions.

The noise model was validated using noise monitoring and concurrent traffic count data to account for the relevant roads. The conducted model validation exercise indicated good correlation between predicted and measured noise levels on site.

The alignment of the proposed bypass is currently planned to go through greenfield areas where in the majority of areas there is not a substantial amount of existing traffic noise. The assessment considered the relative increase criteria (RIC) when determining the project controlling criteria in line with the RNP for areas with no substantial existing road traffic noise exposure. Transition zones between new and redeveloped roads were identified where the design meets the existing Newell Highway alignment. The rest of the bypass alignment was considered new road.

The bypass will have a posted speed limit of 110 km/h except between London Road and north of Cookapie Street where it is proposed to be posted at 80 km/h. The design pavement is a 14/7 mm spray seal on the 110 km/h areas with dense graded asphalt proposed for the 80 km/h areas.

The proposal would increase average road traffic noise levels along the new highway at existing properties not currently exposed to road traffic noise. The predicted average noise levels from the new highway were higher during the daytime than at night.

The most stringent assessment criteria triggered by the proposed bypass is the relative increase criteria (RIC) and most of the properties determined to require further consideration of mitigation are due to exceedance of this criteria. The assessment considered both residential and non-residential land uses and identified a total of 36 properties requiring further consideration of mitigation as follows:

- NCA01 – one non-residential property (Parkes Golf Course)
- NCA02, NCA05, NCA10 – no properties identified
- NCA03 – four residential dwellings, all considered isolated
- NCA04 – eleven residential dwellings, four of which are considered isolated
- NCA06 – eleven residential dwellings, three of which are considered isolated
- NCA07 – four residential dwellings, all considered isolated
- NCA08 – two residential dwellings, all considered isolated
- NCA09 – three residential dwellings, all considered isolated.

Operational noise mitigation options

Operational noise mitigation options were considered in line with the NMG in the following order:

- Road design and traffic management
- Quieter road pavement
- Noise mounds or walls
- At-property treatments.

The Parkes Golf Course qualified for further consideration of mitigation however it is not typical for road infrastructure project to provide further mitigation for such land uses.

For qualifying properties considered as isolated or in groups of three or fewer, noise mitigation strategies in the form of quieter road pavement and/or noise barrier are not considered reasonable. These properties would therefore be considered for at-property treatment only as per the NMG. The option of quieter road pavement and/or noise barriers were therefore only considered feasible and reasonable for NCA04 and NCA06.

With the use of a quieter pavement surface such as OGA (open graded asphalt) or Crumb Rubber Asphalt with a 10 mm aggregate pavement, the total number of properties requiring further consideration of treatment reduced from 36 to 25. The use of quieter pavement is however only considered reasonable in line with the NMG for use near eligible properties in NCA04 and NCA06.

In line with the NMG, a barrier (noise mound or wall) was considered for those properties eligible for consideration of additional mitigation in NCA04 and NCA06. The barrier alignments were determined based on the location of the eligible properties relative to the road and the principles in the NMG and *Noise Wall Design Guideline* and is approximately 700 metres and 800 metres in length for NCA04 and NCA06 respectively. The barrier analysis method in the NMG was used to determine the design height for the barrier as 3 metres and 4.5 metres with the design pavement for NCA04 and NCA06 respectively. At the determined barrier design heights, six and five dwellings in NCA04 and NCA06 respectively would still require consideration of at property treatment.

Properties that were identified to be eligible for consideration of mitigation after the implementation of quieter pavements and noise barriers would be considered for at-property treatment.

All noise mitigation options and detailed assessment of combination of mitigation options are subject to further design and consideration during the subsequent design stages.

Maximum noise levels

The following findings were made of potential maximum noise events due to truck passby:

- By considering L_{Amax} > 65 dBA and $L_{Amax} – L_{Aeq(1hr)}$ ≥ 15 dBA, maximum noise events with the potential of causing sleep disturbance are likely to occur at 10 properties. One of these dwellings is located in NCA03, one dwelling in NCA05 and eight dwellings in NCA06.

The following findings were determined where compression braking or trucks operating under full open throttle condition could occur:

- Maximum noise events with the potential of causing sleep disturbance are predicted to occur at the assessed properties in NCA01 and NCA03 to NCA07
- The presence of the roundabout and grades in the vicinity of the bridge has the potential to trigger maximum noise level events.

Construction noise and vibration

The following findings were made of the construction noise and vibration impacts:

- Exceedances of daytime (and subsequent time periods) NMLs were predicted at all NCAs for site establishment, corridor clearing, bulk earthworks, drainage infrastructure and paving/asphalting with exceedances above 30 dB at some NCAs. In some cases exceedances of the highly noise affected level were predicted
- Other exceedances of NMLs were predicted for bridge works and compound establishment at NCAs within close proximity to the respective construction footprints. Impacts due to construction compound site establishment were also predicted at localised areas where properties are in close proximity to the construction footprints. This includes NCA09 and NCA10 for compound 1, NCA03, NCA04, NCA05, and NCA07 for compound 2, NCA01 and NCA02 for compound 3 and NCA03 to NCA07 for compounds a, b and c
- The predicted noise levels at educational institutions within NCA06 during bulk earthworks show exceedance of the respective NML by up to 1 dB. Exceedance of the respective NML at commercial land use and active recreational areas in NCA01 by up to 10 dB and 16 dB respectively are predicted during site establishment, corridor clearing, bulk earthworks, drainage infrastructure and paving/asphalting works. Predicted noise levels at the place of worship in NCA06 show exceedances by up to 18 dB for all types of construction works near the property. Predicted noise levels at industrial land use in NCA04 show exceedances by up to 5 dB for the corridor clearing, bulk earthworks and asphalting scenarios
- Existing roads carrying less than approximately 800 vehicles per day will likely experience a notable increase in road noise level during peak construction period. As the construction traffic routes have not yet been confirmed, further review should be undertaken as more information becomes available to develop specific strategies for management
- A blasting assessment was undertaken to identify ground vibration and over-pressure from blasting associated with the construction of two cuts on the alignment between Condobolin Road and north of Cookapie Street adjacent to NCA05, NCA06, NCA07 and NCA08. The assessment was undertaken with reference to AS 2187.2:2006 *"Explosives – Storage and use Part 2: Use of Explosives"* and identified maximum explosive charge masses in order to meet the blasting limits at the closest sensitive properties
- Noise, vibration and blasting mitigation and management measures have been identified for the project and include development of a Construction Noise and Vibration Management Plan in later project stages.

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1 Introduction

Roads and Maritime Services (Roads and Maritime) proposes to build a new 10.5 kilometres bypass about 1.5 to two kilometres west of the existing Newell Highway in Parkes (the proposal).

Parkes is a town in central-west New South Wales (NSW) located at the intersection of the Newell Highway and two major rail lines that run between Parkes and Perth, via Broken Hill, Adelaide and Darwin. It is located within the Parkes Shire Local Government Area (LGA). The Parkes Bypass is one of several upgrades proposed under the Newell Highway Corridor Strategy.

A key objective of the strategy and proposal is to improve the highway as an inland freight route between Queensland and Victoria via NSW. The proposal would improve freight efficiency around Parkes by avoiding the need for heavy vehicles to travel through the town centre by diverting them onto a bypass. This report has been prepared as a technical paper (noise and vibration) to support the review of environmental factors (REF) for the proposal.

This report:

- Identifies the noise and vibration assessment study area and associated sensitive properties
- Describes the existing noise environment
- Defines the assessment criteria adopted to assess the proposal's noise and vibration impacts
- Presents predicted operational road traffic noise levels at the identified sensitive properties
- Presents predicted construction noise and vibration levels associated with building the proposal
- Presents the feasible and reasonable mitigation and management measures that should be considered for noise and vibration impacts when building and operating the proposal.

The assessment has been prepared with reference to the following guidelines and documentation:

- Noise Policy for Industry (NPfI, EPA, 2017)
- Environmental Noise Management Manual (ENMM, Roads and Maritime, 2001)
- Assessing Vibration, A Technical Guideline (NSW Environment Protection Authority (EPA), 2006)
- Interim Construction Noise Guideline (ICNG, EPA, 2009)
- Construction Noise and Vibration Guidelines (CNVG, Roads and Maritime, 2016)
- NSW Road Noise Policy (RNP, EPA, 2011)
- Procedure – Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report (Roads and Maritime, 2016)
- Noise Criteria Guideline (NCG, Roads and Maritime, 2015)
- Noise Mitigation Guideline (NMG, Roads and Maritime, 2015)
- Noise Model Validation Guideline (NMVG, Roads and Maritime, 2018).

2 Project description

The proposal is situated within the central west region of NSW, within the Parkes Shire LGA. The proposal would primarily divert heavy vehicle traffic out of Parkes town centre as well as a portion of light vehicles. The proposal would depart from the existing Newell Highway to the south of Barkers Road and would re-join the highway to the north of Parkes near Maguire Road.

Figure 2-1 shows the key features of the proposal. Key features of the proposal would include:

- A new two-lane bypass (one lane in each direction) with four key intersections comprising:
  - T-intersections where the new bypass connects to the existing highway near Barkers Road (south) and Maguire Road (north)
  - A staggered T-intersection at London Road
  - A four-way roundabout at Condobolin Road
- A bridge over the Broken Hill and Parkes to Narromine rail lines and Hartigan Avenue and a shared pedestrian/cycleway bridge over the Parkes Bypass connecting Victoria Street and Back Trundle Road
- An extension of Hartigan Avenue that would connect to Brolgan Road (west of the bypass) and Condobolin Road
- Changes to local roads to tie in with the new bypass.

It is anticipated that construction would start in 2020 and would take about three years to complete. The construction work would be largely carried out in accordance with standard construction working hours per the ICNG.

To minimise disruption to daily traffic and disturbance to surrounding land owners and businesses, it would however be necessary to carry out certain work activities outside of standard construction hours, including the following:

- Placement of asphalt
- Intersection and tie-in activities
- Deliveries of oversized materials or equipment
- Installation and delivery of Bridge Girders
- Line marking
- Installation and adjustment of barriers and signage for construction zones during each construction stage
- Work within the rail corridor.

These are expected to be subjected to further specific assessment when triggered.

Figure 2-1 Proposal overview

3 Existing environment

3.1 Existing roads

Table 3-1 describes the characteristics of the significant existing roads within the local area that may be affected under the proposal, principally due to traffic flow, speed and composition changes. The road category is determined based on the descriptions presented in the NCG.

Table 3-1 Relevant roads within the study area

Road name	Section	Category	Posted Speed limit	Pavement surface
Newell Highway south	Between Grey Dove Lane and Parkes	Arterial	110 km/h	14 mm chip seal
Newell Highway	Through Parkes town centre (existing Highway)	Arterial	50 km/h	Dense Graded Asphalt
Newell Highway north	Between Maguire Road and Nock Road	Arterial	80 km/h	14 mm chip seal
Westlime Road	South of Coronation Avenue	Sub-arterial	50 km/h	14 mm chip seal
Hartigan Avenue	South of Billy Mac Place	Arterial	60 km/h	14 mm chip seal
Brolgan Road	West of Friendship Place	Collector	50 km/h	14 mm chip seal
Condobolin Road	Between Westlime Road and Flinders Street	Sub-arterial	80 km/h	7 mm chip seal
Henry Parkes Way / Condobolin Road	West of Westlime Road	Sub-arterial	100 km/h	14 mm chip seal
Thomas Street	East of Reedsdale Road	Collector	50 km/h	14 mm chip seal
Bogan Road	Between Deep Lead Road and Reedsdale Road	Sub-arterial	100 km/h	7 mm chip seal
Bleechmore Road	Between Maguire Road and Nock Road	Sub-arterial	50 km/h	14 mm chip seal

3.2 Noise and vibration sensitive properties

This section provides an overview of properties and land use potentially impacted by the proposal.

3.2.1 Residential noise sensitive properties

Most of the residential properties are located east of the proposal footprint, west of Parkes town centre in medium density suburban developments. West of the proposal footprint, residential properties are typically isolated low-density rural residential dwellings across open farmland.

Most of the residential dwellings near the proposal are single storey with some isolated two storey dwellings. The minimum distance to the nearest residential property has been identified as a dwelling on Hartigan Avenue, located about 20 metres from the nearest trafficked lane.

3.2.2 Non-residential noise sensitive properties

Non-residential noise sensitive properties and land use as described in the RNP, have also been identified in the project area. Table 3-2 presents a summary of these receivers and their respective distance from the proposal.

Table 3-2 Other noise sensitive receivers

Land use	Address	Approximate minimum distance from proposal boundary (metres)
Child care centre Outdoor passive recreational	97-105 Victoria Street	380
Outdoor active recreational	Scoble Place Park	330
Outdoor active recreational related facilities	99 London Road (Parkes Golf Course and Gold Club)	50
Educational	Back Trundle Road (Parkes Christian School)	550
Places of worship	Back Trundle Road (Kingdom Hall of Jehovah's Witnesses)	300

3.2.3 Commercial and industrial noise sensitive properties

Commercial and industrial buildings are not considered sensitive receivers for operational road traffic noise. For construction noise and vibration, commercial and industrial receivers are however classified as being noise sensitive and should be considered.

Commercial and industrial areas closest to the proposed alignment have been identified as follows:

- Commercial buildings east of the proposal on Condobolin Road, Bogan Street
- Country Energy and substation on Brolgan Road east of the proposal.

3.2.4 Vibration sensitive structures

Vibration sensitive structures include all occupied buildings and utilities.

Buildings (such as the residential, non-residential, commercial and industrial buildings identified in the previous sections) are generally assessed according to established assessment standards for cosmetic building damage and human comfort (amenity).

Vibration can also affect sensitive structures, including certain heritage listed buildings. No heritage listed buildings have been identified within the proposal study area.

More stringent vibration assessment goals may also be required for structures and utilities identified to be particularly sensitive to vibration. Examples of such structures and utilities can include tunnels, gas pipelines and fibre optic cables. Specific vibration goals would be determined on a case-by-case for these identified structures.

3.2.5 Property acquisition

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3.3 Noise catchment areas (NCA)

NCA's are groups of sensitive receivers that are likely to experience similar impacts from the proposal. Predicted impacts for each NCA are considered to represent typical noise and vibration impacts at each individual receiver within a NCA. Table 3-4 describes the location of the NCAs adopted for the proposal.

Table 3-4 Noise Catchment Areas (NCAs)

NCA	Representative background monitoring location	Approximate number of receivers in NCA	Description
NCA01	NM01	7	Medium density single and multi-storey residential dwellings east of the proposal. Ambient noise conditions are dominated by road and rail traffic noise from the existing Newell Highway and Narromine railway line. Includes a commercial receiver identified as Parkes Golf Club located on London Road.
NCA02	NM01	3	Three residential dwellings and one shed located west of the proposal on the existing Newell Highway and Barkers Road. Catchment area is predominantly open farmlands.
NCA03	NM03	8	Low density residential dwellings and sheds located west of the proposal on London Road, Ballerdee Lane and Coronation Avenue. Catchment area is predominantly open farmlands.
NCA04	NM02	239	Medium density single and multi-storey residential dwellings east of the proposal. Industrial receiver identified as Country Energy and substations located 60 metres east of the proposal boundary on Brolgan Road.
NCA05	NM03	121	Medium density single and multi-storey residential dwellings east of the proposal. Outdoor passive recreational and child care centre located on Victoria Street.
NCA06	NM04	35	Low density single storey and multi-storey residential dwellings west of the proposal. Educational building, outdoor active recreational and place of worship at Back Trundle Road, Parkes Christian School.
NCA07	NM04	34	Open farmland and low density single storey and multi-storey residential dwellings within 630 metres east of the proposal.

NCA	Representative background monitoring location	Approximate number of receivers in NCA	Description
NCA08	NM06	7	Catchment area is predominantly farmland. Residential dwellings along Heraghty Road, Moulden Street and Noble Road located west of the proposal.
NCA09	NM05	17	Catchment area is predominantly open farmland. Low density one-storey residential dwellings and sheds identified east of the proposal.
NCA10	NM06	1	Catchment area is predominantly open farmland. One one-storey residential dwelling and shed identified on Bogan Road located north west of the proposal boundary.

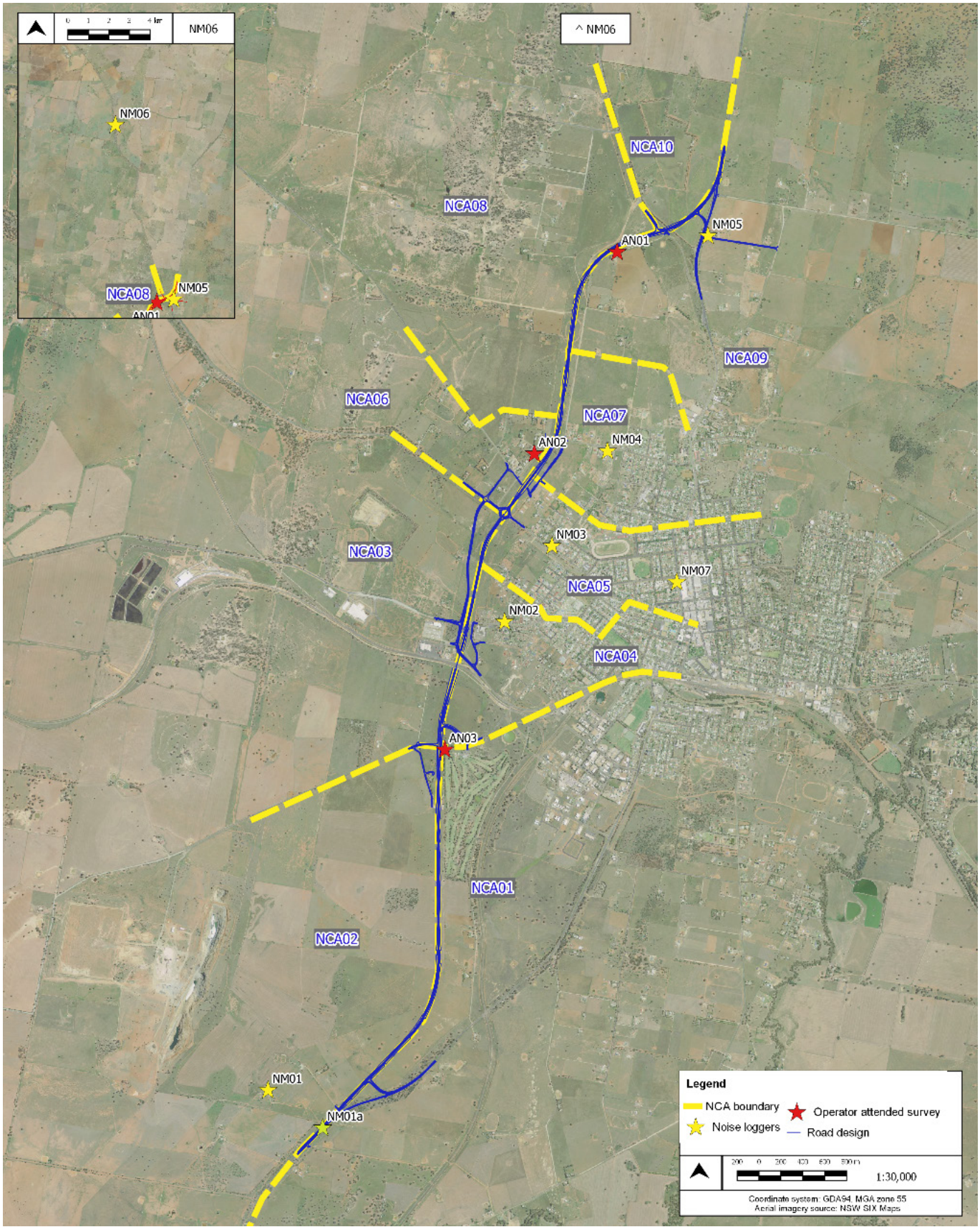


Figure 3-1 Noise catchment areas and noise monitoring locations

4 Noise monitoring and analysis

This section describes the noise monitoring carried out to determine the existing road traffic, ambient and background noise environment in the study area.

4.1 Methodology and monitoring location

Attended and unattended noise measurements were taken in December 2016 and December 2017 to quantify the existing noise environment of the study area. The noise monitoring was carried out in general accordance with Australian Standard AS 1055 Acoustics, Description and Measurement of Environmental Noise (Standards Australia, 1997) and the RNP (EPA, 2011).

Table 4-1 presents the noise monitoring equipment used onsite, with the monitoring locations shown in Figure 3-1.

Noise monitoring was conducted along the western side of Parkes town centre where there are residential properties located close to the proposal footprint. The purpose of the noise monitoring was to establish both the background noise levels and measure existing road traffic noise levels at sensitive properties. As the construction noise management levels at commercial and industrial properties do not depend on the background noise levels, monitoring was not conducted in these areas.

The data was gathered over a period of typical traffic movement, outside of school holidays or major festivities.

Table 4-1 Noise monitoring details

Measurement location	Address	Survey type[1,2]	Monitoring dates	Manufacturer and Type No.	Serial No.
NM01	2683 Newell Hwy, Parkes	LOG / FF	07/12/2016 – 14/12/2016	SVAN 959 Type 1 noise logger	11225
NM01a	Newell Hwy, Parkes	LOG / FF	29/11/2017 – 18/12/2017	ARL EL316	16-707-005
NM02	58 Brolgan Rd, Parkes	LOG / FF	07/12/2016 – 16/12/2016	SVAN 958 Type 1 noise logger	14295
NM03	122 Condobolin Rd, Parkes	LOG / FF	07/12/2016 – 13/12/2016	SVAN 958 Type 1 noise logger	36693
NM04	35 Thomas St, Parkes	LOG / FF	08/12/2016 – 15/12/2016	Norsonic Nor140	1406502
NM05	Lot 784 Newell Hwy, Parkes	LOG / FF	07/12/2016 – 16/12/2016	SVAN 959 Type 1 noise logger	21293
NM06	1178 Bogan Rd, Goonumbla	LOG / FF	09/12/2016 – 13/12/2016	SVAN 958 Type 1 noise logger	36659
NM07	TAFE, Bogan St, Parkes	LOG / FF	07/12/2016 – 17/12/2016	Svan 955 Type 1 noise logger	28808
AN01	‘Lumeah’, Bogan Rd, Parkes	AT / FF	08/12/2016	Norsonic Nor140	1406502
AN02	13 Moulden Rd, Parkes	AT / FF	08/12/2016	Norsonic Nor140	1406502
AN03	‘Balmoral’, 123 London Rd, Parkes	AT / FF	08/12/2016	Norsonic Nor140	1406502

1. Measurement type: LOG – unattended noise logging; AT – operator attended noise survey
2. Reflection Type: FF – free-field; F – façade

4.2 Noise measurement results

The monitoring equipment were fitted with windshields and were field calibrated before and after monitoring. No significant drifts in calibration (± 1.0 dB) were noted. The weather conditions at the time of monitoring were recorded at Parkes Airport automatic weather station (Bureau of Meteorology station number 065068), which is located about eight kilometres east of the proposal.

Monitoring data were excluded during periods of weather that adversely affected the monitoring data; i.e. where wind speeds were greater than five metres per second and during significant rainfall, as recorded at the nearest meteorological station.

4.2.1 Unattended noise monitoring results

Table 4-2 summarises the unattended long-term noise monitoring results. The data are reported as the 15-minute average equivalent continuous average sound levels ($L_{eq(15min)}$) and rating background levels (RBL) as defined in the NPfI (EPA, 2017). Appendix B presents the daily graphs of the noise monitoring.

Table 4-2 Unattended noise monitoring results

Measurement location	Measured noise level, dBA					
	Day		Evening		Night	
	$L_{eq(Day)}$	RBL	$L_{eq(Evening)}$	RBL	$L_{eq(Night)}$	RBL
NM01	52	33	49	31	40	30
NM01a	72	38	70	33	67	30
NM02	54	39	52	37	47	31
NM03	58	41	56	38	50	32
NM04	56	37	48	31	48	30
NM05	61	40	60	32	57	30
NM06	51	31	48	30	47	30
NM07	66	51	65	45	61	35

4.2.2 Operator attended ambient noise monitoring results

Table 4-3 reports the monitoring of ambient road traffic noise at the monitoring locations in the study area.

Table 4-3 Operator attended noise monitoring results

Measurement location	Date	Start time	dBA, $L_{eq(15min)}$	dBA, $L_{90(15min)}$	Comments and observations on existing ambient noise environment
NM01	07/12/2016	11:50 am	43	35	Ambient noise environment dominated by distant trees rustling and birds chirping (38-41 dBA), with the Newell Highway partially audible. Cars did not produce a distinct noise when passing by. Heavier vehicles such as B doubles produced a more noticeable pass-by event when using compression brakes. Intermittent noise from animals such as dogs (45-52 dBA) and horses (50-54 dBA) was also present.
NM01a	18/11/2017	1:30 pm	74	42	Ambient noise environment generally dominated by light and heavy vehicles on Newell Highway.
NM02	07/12/2016	10:15 am	43	35	Ambient noise environment generally dominated by trees rustling and birds chirping. Ambient noise levels were 32-33 dBA during quiet periods. When traffic was present, vehicle noise was the dominant source (42-62 dBA). No heavy vehicles were observed passing the property during the attended measurement. Noise from cement rendering works across the street (primarily scraping of house walls 40-48 dBA) was also audible.
NM03	07/12/2016	5:15 pm	61	40	Ambient noise environment generally dominated by trees rustling and birds chirping. When traffic was present, vehicle noise was the dominant source. Heavy vehicles were observed passing the property. Passby noise levels ranged from 57-70 dBA for light vehicles and from 71-79 dBA for heavy vehicles. A lawnmower in the distance was also heard intermittently (46-51 dBA).
NM04	08/12/2016	12:10 pm	54	47	Ambient noise environment generally dominated by trees rustling and birds chirping. Occasional vehicles on Thomas Street were audible but not common. No other distant traffic could be heard. Heavy vehicles were not observed passing the property.
NM05	07/12/2016	1:50 pm	60	37	Ambient noise environment generally dominated by vehicles on Newell Highway, when vehicles were not on Nock Road. Heavy vehicles were present, trees rustling and birds chirping were audible. No traffic was observed passing the property on Nock Road.

Measurement location	Date	Start time	dBA, $L_{eq(15min)}$	dBA, $L_{90(15min)}$	Comments and observations on existing ambient noise environment
NM06	08/12/2016	10:55 am	51	44	Ambient noise environment generally dominated by trees rustling and birds chirping. Occasional vehicles on Bogan Road were audible. Passby noise levels on Bogan Road ranged from 51-63 dBA for light vehicles, only one heavy vehicle was measured during the site visit, this was measured to 66 dBA. Distant traffic on Newell Highway was audible but only just audible. Heavy vehicles were observed passing the property on Bogan Road.
NM07	07/12/2016	2:40 pm	67	53	Ambient noise environment generally dominated by traffic on Bogan Road. In the absence of traffic, general urban hum and trees rustling were audible. Heavy vehicles on Bogan Road were observed passing the property (65-72 dBA). Light vehicle passby traffic noise levels were between 49 and 54 dBA. Traffic on Bushman Street was not audible.
AN01	08/12/2016	10:20 am	47	41	Ambient noise environment generally dominated by trees rustling and birds chirping (49-54 dBA). Distant traffic on Newell Highway was only just audible, heavy vehicles were occasionally audible. Light aircraft noise was observed at this location (35-37 dBA).
AN02	08/12/2016	1:45 pm	55	43	Ambient noise environment generally dominated by trees rustling and birds chirping. Occasional vehicles on Moulden Street were audible but not common, passby noise levels were measured to between 72-77 dBA.
AN03	08/12/2016	9:15 am	56	46	Ambient noise environment dominated by distant trees rustling and birds chirping. Intermittent noise from traffic was audible. Heavier vehicles produced a more noticeable pass-by event when using compression brakes on London Road (70-75 dBA).

4.2.3 Road traffic noise monitoring results

Table 4-4 reports the monitoring of road traffic noise levels at the monitoring locations where traffic noise was identified to be a dominant noise sources in the study area.

Table 4-4 Unattended traffic noise monitoring results (free-field)

Measurement location	Measured traffic noise level	
	Day (7 am to 10 pm) dBA $L_{eq(15hr)}$	Night (10 pm to 7 am) dBA $L_{eq(9hr)}$
NM01A	71	67
NM02	51	47
NM03	56	50
NM05	61	57
NM06	51	47

It is noted that Brolgan Road (NM02), Condobolin Road (NM03) and Bogan Road (NM06) carry low traffic volumes with minimal heavy vehicles. It is therefore likely that the noise environment is subjected to the influence of other ambient noise sources. This is particularly likely to occur at night where insect noise and rustling leaves can dominate the sound scape during quiet periods. A review of the traffic volumes and noise monitoring data indicates that there are very low traffic volumes (12 cars or less an hour) with essentially no heavy vehicles on these roads. This means that there may not be enough road traffic noise compared to other ambient noises to be able to compare the measured road noise level with a prediction of road noise level.

5 Operational noise criteria and mitigation guidance

Operational road traffic noise has been assessed in line with the RNP. The application of the RNP guidelines, as set out in the NCG, has been used. Properties identified to exceed the NCG criteria have been considered for mitigation in accordance with the NMG. This section outlines the assessment criteria and method used for the operational road traffic noise assessment.

5.1 Road types

The NCG assigns different criteria for each road type. Road project types include new, redeveloped, transition zones or minor works as defined in the NCG. Identification of the road development type is required to determine the relevant criteria at each receiver.

Where different road types meet, a transition zone may be applicable. The NCG defines two types of transition zone:

- Type 1, where a new and redeveloped road meet.
- Type 2, where a road project and an impacted existing road meet.

The project is primarily a new road, as it is either located where no road currently exists, or is upgrading an existing local or collector road to an arterial road. Type 1 transition zones were identified where the proposal meets redeveloped sections of the Newell Highway corridor at either end of the project. Additionally, screening of traffic volumes has identified no increase of more than 2.0 dB in the equivalent continuous noise levels on the local roads connecting the proposed bypass.

Screening for type 2 transition zones indicated that they are not applicable to any existing roads in the proposal area.

5.2 Noise criteria guideline

Noise criteria are assigned to sensitive receivers using Roads and Maritime's NCG. The NCG provides guidance on how the RNP is implemented. The road traffic noise assessment criteria apply at one metre from the façade of buildings and are assessed for each façade. For assessment locations without buildings, such as open space or outdoor play areas, the assessment is taken at 1.5 metres above ground at the worst affected location that is regularly used.

Table 5-1 provides a summary of the applicable criteria for the assessment of residential properties.

Table 5-1 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/land use	Assessment criteria	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/arterial/sub-arterial/collector[1] roads	Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads	60 dBA $L_{eq(15hr)}$	55 dBA $L_{eq(9hr)}$
	Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	55 dBA $L_{eq(15hr)}$	50 dBA $L_{eq(9hr)}$
	Existing residences affected by noise from a **transition zone** between new and redeveloped roads	55–60 dBA $L_{eq(15hr)}$	50–55 dBA $L_{eq(9hr)}$

1. According to the NCG, collector roads are considered the same category as sub-arterial roads.

The RNP also specifies relative increase criteria (RIC) that are intended to protect existing quiet areas from excessive adverse changes in amenity due to traffic noise. Table 5-2 shows the relative increase criteria for residential land uses.

Table 5-2 Relative increase criteria for residential land uses

Road category	Type of project/land use	Total traffic noise level increase	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/arterial/sub-arterial/collector roads	New road corridor/redevelopment of existing road	Existing traffic $L_{Aeq(15hr)}$ +12 dB	Existing traffic $L_{Aeq(9hr)}$ +12 dB

Table 5-3 provides a summary of the criteria used to assess the operational road traffic noise impacts for non-residential noise sensitive receivers. All noise assessment criteria have been presented as external noise levels. Where land uses are assigned internal criteria in the RNP, a factor of +10 dB has been conservatively applied to convert these internal criteria to external criteria. The +10 dB factor approximates the difference between internal and external noise levels, representing the noise reduction of a window partially open for ventilation. This assumption would need to be confirmed during detailed design.

Table 5-3 Road traffic noise assessment criteria for non-residential sensitive land uses

Existing sensitive land use	Assessment criteria dBA ($L_{eq(1hr)}$) (external)	
	Day (7 am – 10 pm)	Night (10 pm – 7 am)
School classrooms	50	–
School play areas	55	–
Places of worship	50	50
Open space (active)	60 $L_{Aeq(15hr)}$	–
Child care facility sleeping rooms	45	–
Child care facility indoor play areas	50	–
Child care facility outdoor play areas	55	–

5.3 Noise mitigation guideline

The NMG outlines the Roads and Maritime's approach for the evaluation, selection and design of feasible and reasonable noise mitigation measures for operational road traffic noise.

When identifying feasible and reasonable noise mitigation the total noise level from all roads is used. This includes when assessing against new road criteria. This means that any noise mitigation that is implemented provides a benefit by reducing the total road noise level at a property rather than just noise levels coming from a single road source.

Properties are eligible for the consideration of mitigation where they qualify under the NMG process (as shown in Figure 5-1) or when the contribution from the proposal is acute.

An acute noise levels is defined as the level of road traffic noise equal to or above 65 dBA $L_{Aeq(15hr)}$ during the day period or 60 dBA $L_{Aeq(9hr)}$ during the night period.

The cumulative limit is defined in the NMG as 5 dB above the NCG controlling criteria, where the road project is a significant contributor to the total noise level. This is intended to prevent properties with existing high noise level exposure from remaining well above the criteria if noise levels do not change sufficiently to trigger consideration of mitigation.

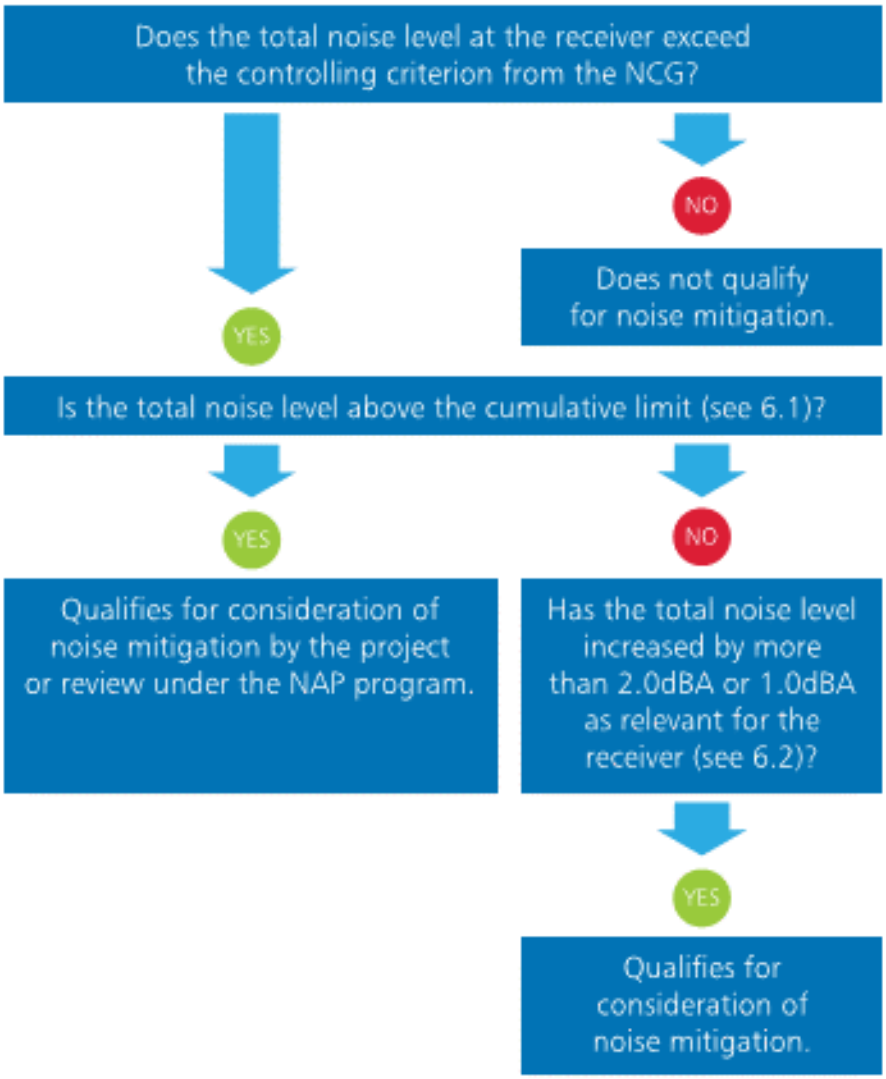


Figure 5-1 Process for determining eligibility for consideration of mitigation (an extract from the NMG)

6 Operational noise assessment

This section describes the predicted noise impacts expected when the proposal is operational. It also considers the impacts on adjacent roads affected by the proposal.

6.1 Noise modelling method

The predicted noise impacts expected once the proposal is in operation are calculated using supplied information on the road alignment, forecast traffic volumes, the existing conditions and a number of conservative assumptions.

An operational noise model was created using the SoundPLAN software package (version 7.4) implementing the Calculation of Road Traffic Noise (CoRTN, UK Department of Transport, 1988) method. The model predicted the road traffic noise generated as a result of changes to traffic volumes and composition (light and heavy vehicle mixture), vehicle speed, road gradient, pavement surface, ground absorption and shielding, and reflections from topography, buildings and barriers.

The assessment covers the following timeframes:

- Year of opening of 2023
- Design year of 2033 (ten years after the project opens).

The design year (2033) was used to determine the requirements for considering mitigation measures as more properties are predicted for consideration of noise mitigation in 2033 compared to 2023. Noise levels are predicted and assessed between the build and no build scenarios as follows:

- No build scenario is where the proposal is not built and where north south traffic on Newell Highway would pass through Parkes town centre
- Build scenarios is where the proposal is built and the bypass provides an alternative route for north-south traffic.

The assessment considers the four scenarios and predicts noise levels at each receiver to enable the assessment, and any mitigation requirements. Table 6-1 summarises the modelling parameters used in the assessment.

Table 6-1 Noise modelling parameters

Item	Assumptions
Calculation method	CoRTN (1988) with variations as described in this report. Low traffic correction not used.
Ground topography	From a combination of supplied 3D drawings and survey data and existing topographical maps provided by NSW Lands and Property Information.
Pavement surfaces	Existing pavement surfaces: cold overlay asphalt, 7 mm chipseal and 14 mm chipseal, as identified on site. A +2 dB correction was added for cold overlay and 7 mm chipseal, a +4 dB correction was added for 14 mm chipseal. (applied correction factors representative of acoustic performance relative to DGA) The proposed surfaces are 14/7 mm spray seal on the new bypass where the posted speed is 110 km/h and DGA between the London Road intersection and Cookapie Street where the posted speed is 80 km/h. The Hartigan Avenue extension and adjustments to local roads to tie into the Bypass are 14/7 mm spray seal. Pavement correction factors for these pavements were applied to light vehicles only.

Item	Assumptions
Traffic volumes and mix	Classified tube counts were conducted for two weeks at 12 locations in and around Parkes. These results were used for the noise model validation. Forecasted total traffic volumes and traffic composition were supplied by the project traffic engineer for all modelled roads, including splits between heavy and medium truck types. Heavy vehicles were classified into six categories defined in “A six category heavy vehicle noise emission model in free-flowing condition” (J. Peng et al, Applied Acoustics, vol 143) from the traffic tube counting. The six categories of heavy vehicles were condensed into two, HV1 and the most dominant category between HV2 and HV6 as defined in the paper. Forecast traffic volumes were categorised into two heavy vehicle categories as instructed by the traffic engineer.
Existing structures	Buildings defined from aerial photography and site surveys.
Sources heights and correction	The noise model assumes three sources heights: • Light vehicles at 0.5 metres with 0 dB correction • Heavy vehicles at 1.5 metres with a -0.6 dB correction and at 3.6 metres with a -8.6 dB correction.
Vehicle speeds	Predictions for existing and proposed designs set at posted speeds. Mean speeds were used for model validation.
Road gradient	Gradient calculated from supplied topographical and road design data
Ground absorption	Set at 75% soft ground for grass, wooded areas and park land Set at 50% soft ground for residential/suburban land use Set at 25% soft ground for commercial and industrial land uses
Receiver locations	Assessed at one metre from the façade at heights of 1.5 metres above ground level for ground floor receivers and 4.5 metres above ground level for first floor receivers. It is noted that no properties of more than two floors are identified in the study area. Free-field receivers set at 1.5 metres height above natural ground level.
Façade reflection correction	+2.5 dB
CoRTN Correction factors	Correction factors were applied to light and heavy vehicle noise emissions based on the approach outlined in “A six category heavy vehicle noise emission model in free-flowing condition” (J. Peng et al, Applied Acoustics vol 143). A three category model was used (one light vehicle and two heavy vehicle categories) to account for differences in the different fleets and traffic compositions between CoRTN and the reference vehicles groups outlined in the paper. The correction factors for heavy vehicles assumed categories of medium (HV1) and heavy trucks (HV2-6), with the category of heavy trucks determined by the dominant category of heavy truck from measured traffic volumes and forecast volumes as supplied by the traffic engineer. An additional correction factor was added to account for additional heavy vehicle noise on down slopes greater than 2%, a correction factor of 5.6 dBA was applied as propulsion correction factor only[1]. The propulsion correction factor was applied to the heavy vehicle noise sources, hence to both the 1.5 and 3.6 metre source heights.

1. Referenced from Acoustic Source Modelling of Nordic Road Vehicles SP Rapport 2006:12.

6.2 Traffic volumes

6.2.1 Existing traffic volumes – 2017

A traffic volume survey was carried out concurrently with the noise monitoring survey on the same road sections as the corresponding noise monitoring locations.

Traffic counters were placed at a distance far enough away from noise monitors to ensure they did not affect the noise measurements. Table C.1 in Appendix C summarises the existing traffic volumes used for model validation purposes.

6.2.2 Forecast traffic Volumes – 2023 and 2033

The traffic volumes provided for the assessment are set out in Appendix C.

6.3 Noise model validation

The noise model was validated using the noise monitoring and concurrently collected traffic volumes. Table 6-2 presents a summary of the measured and predicted noise levels.

Table 6-2 Model validation (free-field noise levels)

Measurement location	Day			Night			Difference between day and night dB		
	Measured	Predicted	Difference	Measured	Predicted	Difference			
	dBA, $L_{Aeq(15hr)}$	dBA, $L_{Aeq(15hr)}$	Day dB	dBA, $L_{Aeq(9hr)}$	dBA, $L_{Aeq(9hr)}$	Night dB	Measured	Predicted	Difference
NM01A	71.3	70.9	-0.4	66.9	65.9	-1.0	4.4	5.0	0.6
NM02	50.8	51.5	0.7	46.9	43.8	-3.1	3.9	7.7	3.8
NM03	55.9	58.1	2.2	49.8	48.7	-1.1	6.1	9.4	3.3
NM05	60.7	62.4	1.7	57.2	57.6	0.4	3.5	4.8	1.3
NM06	50.7	50.9	0.2	46.7	47.0	0.3	4.0	3.9	-0.1

1. Night time noise level at NM02 affected by noise other than road noise.
2. Night time noise level at NM03 affected by noise other than road noise.

The validation takes into consideration different road classes which carry different vehicle fleets and volumes. Newell Highway carries the most traffic with a heavy vehicle percentage greater than 10%, especially at night.

The predictive model shows good agreement with the Newell highway locations (NM01A and NM05) indicating that the model is suitable to use for the prediction of the noise from the bypass that will carry a similar vehicle fleet and have a similar pavement surface.

As previously discussed in Section 4.2.3, the other three noise monitoring locations (Brolgan Road (NM02), Condobolin Road (NM03) and Bogan Road (NM06)) are noted to carry lower traffic volumes with low or minimal heavy vehicles particular during the night time period. The noise measurements were therefore more sensitive to influence of other ambient noise sources. This is considered to be the reasons that NM02 and NM03 show an under prediction and day/night difference outside of acceptable tolerances.

Excluding these results, the median of the day time differences is +0.7 dB with a standard deviation of 1 dB. During the night, the median is -1.0 dB with a standard deviation of 1.3 dB.

The differences in the predicted levels do not show a systematic consistent pattern of difference and as such additional correction factors are not considered necessary for this project.

Based on the predicted results, the noise model generally returned results within ±2 dB of the measured road traffic noise levels and the predicted day and night difference is generally within ±2 dB of the measured levels.

This indicates a reasonable agreement within ±2 dB between the measured and predicted levels and as such the model is considered validated.

6.4 Noise criteria determination

The controlling criteria were determined in line with the NCG for each sensitive property. The proposal has two type-1 transition zones where the road type changes from new to redeveloped. A transition zone criteria contour map is presented in Appendix D.

The controlling criteria for a property was then determined by selecting the most stringent criteria between the new/redeveloped or transition zone criteria, and the RIC.

6.5 Predicted operational road traffic noise

The results of the operational noise assessment are provided in Appendix E and they show the following:

- Appendix E-1:
    - Map indicating receivers eligible for consideration of noise mitigation for the design year (2033)
    - Daytime noise contour map for the opening year (2023) for the no build scenario
    - Night time noise contour map for the opening year (2023) for the no build scenario
    - Daytime noise contour map for the opening year (2023) for the build scenario
    - Night time noise contour map for the opening year (2023) for the build scenario
    - Daytime noise contour map for the design year (2033) for the no build scenario
    - Night time noise contour map for the design year (2033) for the no build scenario
    - Daytime noise contour map for the design year (2033) for the build scenario
    - Night time noise contour map for the design year (2033) for the build scenario
- Appendix E-2, tabulated results of predicted façade noise levels for the both the year of opening (2023) and design year (2033)
- Appendix E-3, map indicating residential receivers eligible for consideration of noise mitigation for the design year (2033).

6.6 Operational noise impact

6.6.1 Parkes bypass

The predicted noise level identified that 35 residential properties, and one non-residential land use would be eligible for consideration of additional mitigation. These identified properties are shown in the aerial maps in Appendix E-3. The below provides a description of the areas along the proposed bypass including predicted noise levels and analysis of the results for the design year of 2033:

- NCA01:
  - This area is located at the southern-most end of the proposed bypass. The proposed bypass would generally divert traffic farther away from most residential properties, which would result in a decrease, or only a minor increase, in road noise levels for these properties
  - Specific properties were located closer to the proposed bypass, with levels of noise increase predicted to be up to 7 dB at residential properties
  - The number of residential properties exceeding the NCG criteria were predicted to decrease because of the proposed bypass. No residential properties were found to qualify for further consideration of mitigation
  - The Parkes Golf Course is located next to the proposed bypass and was found to exceed the relevant criterion for active recreational area and qualified for further consideration of mitigation. It is however noted that it is not typical for road infrastructure project to provide further mitigation for such land uses.
- NCA02:
  - This area has a relatively small number of isolated residential properties
  - Noise levels were predicted to be within the NCG criteria at all assessed properties, with noise level increases of up to 6 dB. No residential properties were found to qualify for further consideration of mitigation.
- NCA03:
  - This area has a relatively small number of isolated residential properties
  - Noise levels were predicted to exceed the NCG criteria at four assessed properties. These exceedances are generally caused by a relative increase of more than 12 dB, apart from one property adjacent to Brolgan Road. All four of these exceeding properties qualify for further consideration of mitigation.
- NCA04:
  - This area has groups of properties considered to be closely spaced together. Most of these properties are currently impacted by existing road noise (Brolgan Road, Coronation Drive)
  - The majority of the properties are impacted by existing roads with some above the NCG criteria in the no build scenario
  - Eleven properties were found to qualify for further consideration of mitigation. These exceedances are generally caused by exceedance of the NCG criteria and an increase of total noise levels of greater than 2 dB.

- NCA05
    - This area has groups of properties considered to be closely spaced together. Most of these properties are currently impacted by existing road noise (Coronation Drive, Condobolin Road, Mitchell Street)
    - The averaged noise level increase across all assessed properties is not higher than 3 dB, and all properties are below the RIC. The largest increase was 10 dB at the property closest to the new highway alignment, however the predicted levels were below the NCG criteria and did not trigger the RIC
        - The number of exceeding of properties decreases from the no-build to build scenario. No properties were found to be eligible for consideration of mitigation.
- NCA06:
    - This area houses groups of properties considered to be closely spaced together. Road traffic noise is generally not a dominant feature of the existing acoustic environment
    - A total of eleven properties primarily along Moulden Street were identified to qualify for further consideration of mitigation. This is primarily due to exceedance of the RIC.
- NCA07:
    - This area houses groups of properties considered to be closely spaced together. Road traffic noise is generally not a dominant feature of the existing acoustic environment
    - A total of four properties were identified to qualify for further consideration of mitigation. This is primarily due to exceedance of the RIC.
- NCA08 and NCA09:
    - This area contains properties generally considered to be isolated. Road traffic noise is generally not a dominant feature of the existing acoustic environment
    - Two properties in NCA08 and three in NCA09 were identified to qualify for further consideration of mitigation. This is primarily due to exceedance of the RIC.
- NCA10:
    - This area contains one isolated dwelling, which is located at the northern-most end of the proposed bypass and currently experiences noise from the existing Newell Highway. Noise levels were predicted to comply with the relevant NCG criteria and no further mitigation consideration is needed.

6.6.2 Parkes town centre

It is understood that up to about 74 per cent of heavy vehicles that currently use the Newell Highway would use the bypass. While this is the case, there was no detailed data available at the road and intersection level to identify how this would affect traffic flow changes on each road in the town centre. Therefore, changes in road traffic noise in the town centre, due to traffic switching onto the bypass, cannot be quantified. Indicatively however, it is expected that the drop in heavy vehicle traffic would reduce road traffic noise levels in the town centre, especially along the route of the existing highway. This would be assessed and quantified during the detailed design stage.

6.7 Possible operational noise mitigation options

This section provides a discussion of possible mitigation measures to control operational noise impact. The mitigation assessment was conducted in the preferred order of mitigation in line with the NMG, for the design year of 2033.

The mitigation options presented in this section are subject to further investigation during detailed design and reasonable and feasible considerations.

6.7.1 Road design and traffic management

The RNP outlines that where any exceedances are identified, the preferred mitigation measure is road design and traffic management.

Where possible, the road design should use shielding provided by the natural landscape. Placing the road in a cut is also typically an effective way to shield road traffic noise. It is understood that the new bypass is generally in a cut between Hartigan Avenue and Cookapie Street, providing some shielding to receivers either side of the alignment. It is also beneficial to design the road in such a way that the need for compression release engine braking is minimised or preferably completely avoided. To reduce potential noise impacts, the road design should avoid features that interrupt free-flowing traffic, bring all lanes of traffic to a stop or significant speed change such as signalised intersections and roundabouts. These types of features increase the risk of noise impacts due to vehicles accelerating and a potential trigger for truck compression breaking.

Traffic management could include signs that discourage inappropriate noisy driving behaviour (e.g. discouraging the use of compression release engine braking).

During the detailed design stage, it is recommended that consideration be provided to road design and traffic management to improve the acoustic outcomes.

6.7.2 Quieter road pavement

The next preferred mitigation measure are quieter pavement surfaces. According to the NMG, quieter pavement surfaces should only be considered where there are four or more closely spaced eligible dwellings. Closely spaced dwellings are defined as dwellings that generally have facades between 20 metres and 100 metres apart and are not isolated as defined by the NMG. As such, quieter road pavement have been considered for the qualifying dwellings in NCA04 and NCA06 only. Qualifying dwellings in the other NCAs will be considered for at-property treatments only, as noise barriers are also not considered reasonable on similar principles.

The design road pavement surface for the section that affects NCA04 and NCA06 is DGA. Therefore, quieter pavement surfaces such as open graded asphalt (OGA) or crumb rubber asphalt (10mm aggregate) should be considered. For the purposes of this assessment, a -2 dB noise reduction compared to DGA for total traffic noise has been considered for a quieter pavement surface.

The findings associated with the assessment of the quieter pavement are summarised in Table 6-3. The use of quieter pavement would reduce the total number of dwellings qualifying for mitigation by eleven. Five of these dwellings (that no longer require consideration of treatment) are in NCA04, three in NCA06 and two in NCA07 which is on the opposite side of the bypass to the affected dwellings in NCA06. The extent, design or implementation of any pavement surface is subject to further consideration during the subsequent design stages. Alternative quieter pavement surfaces may also be considered as part of the subsequent design stages.

Table 6-3 Operational noise assessment – design year 2033, with quieter road pavement

NCA	Total number of assessed residential dwellings	Current design (DGA)		OGA	
		Number of dwellings qualifying for further consideration of mitigation	Qualifying dwellings considered isolated	Number of dwellings qualifying for further consideration of mitigation	Qualifying dwellings considered isolated
NCA04	239	11	4	6	2
NCA06	35	11	3	8	2
NCA07	34	4	4	2	2

6.7.3 Noise barriers

Noise barriers, in the form of noise walls or mounds, should only be considered where there are four or more eligible dwellings in a group of closely spaced dwellings. In accordance with the NMG they are not considered reasonable for situations where there are single isolated residences, or where there are groups of three or fewer eligible closely spaced residences.

Based on the operational assessment results a noise barrier was considered for the qualifying dwellings in both NCA04 and NCA06. It is noted that:

- Seven out of eleven of the qualifying dwellings in NCA04 are considered closely spaced (Mimosa Road and Brolgan Road receivers)
- Eight out of eleven of the qualifying dwellings in NCA06 are considered closely spaced (Moulden Street and Cookapie Street receivers).

The length of the barrier was determined to be approximately 700 metres and 800 metres in length for NCA04 and NCA06 respectively. The location of the barrier was determined in consideration of Roads and Maritime's Noise wall design guideline (2016) and the NMG. The barrier has considered the location of the dwellings relative to the road, the intervening topography, especially where the road is in a cut and the angle of view to the road for the row of qualifying dwellings on Moulden Street in NCA06.

The following figures provide an indication of the modelled noise barriers:

- Figure 6-1 and Figure 6-2 shows the indicative location of the barrier at NCA04 both in plan view and 3-dimensional perspective view respectively
- Figure 6-3 and Figure 6-4 shows the indicative location of the barrier at NCA06 both in plan view and 3-dimensional perspective view respectively.

Figure 6-1 Indicative location of noise barrier – NCA04

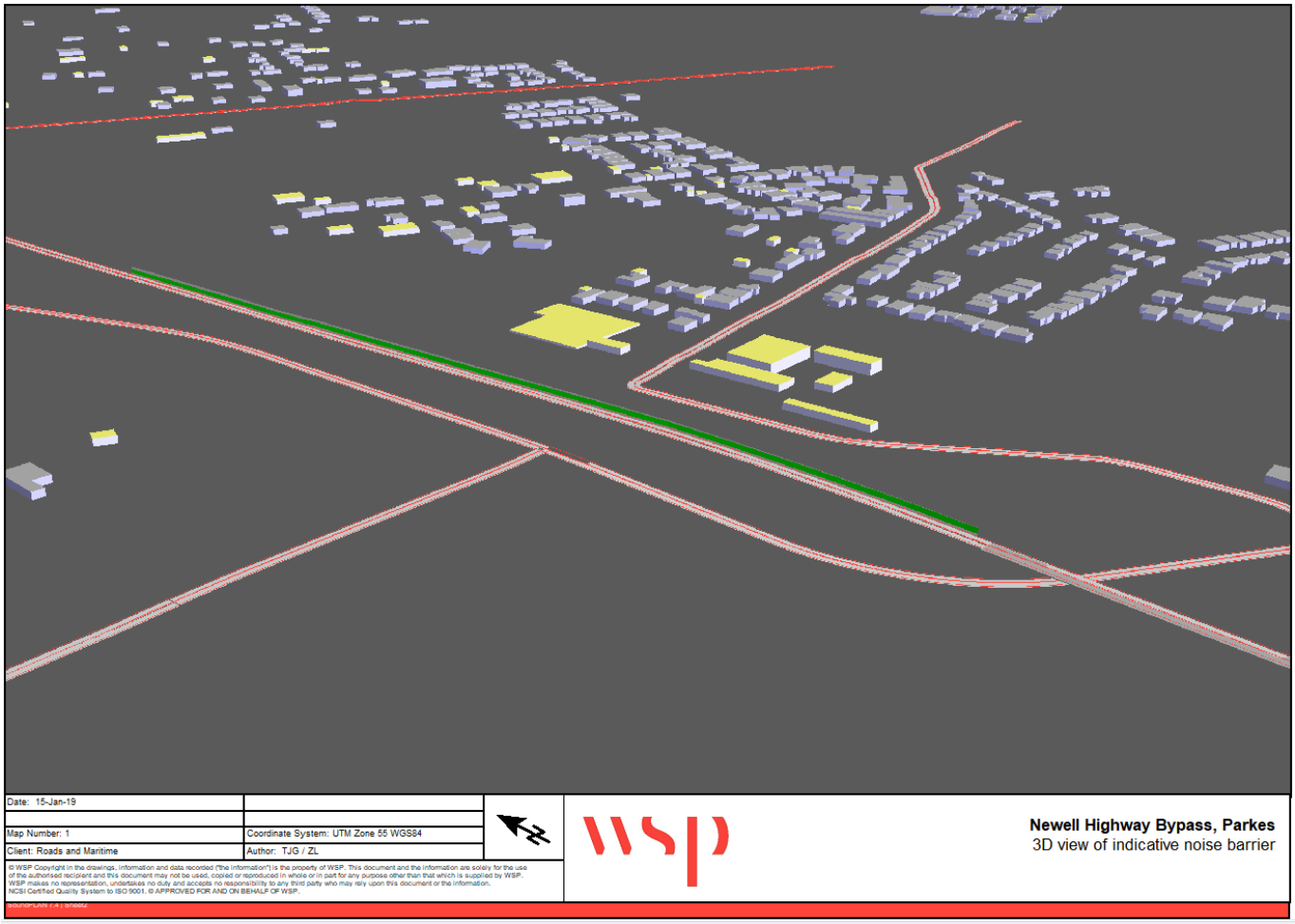


Figure 6-2 3D view of indicative noise barrier – NCA04

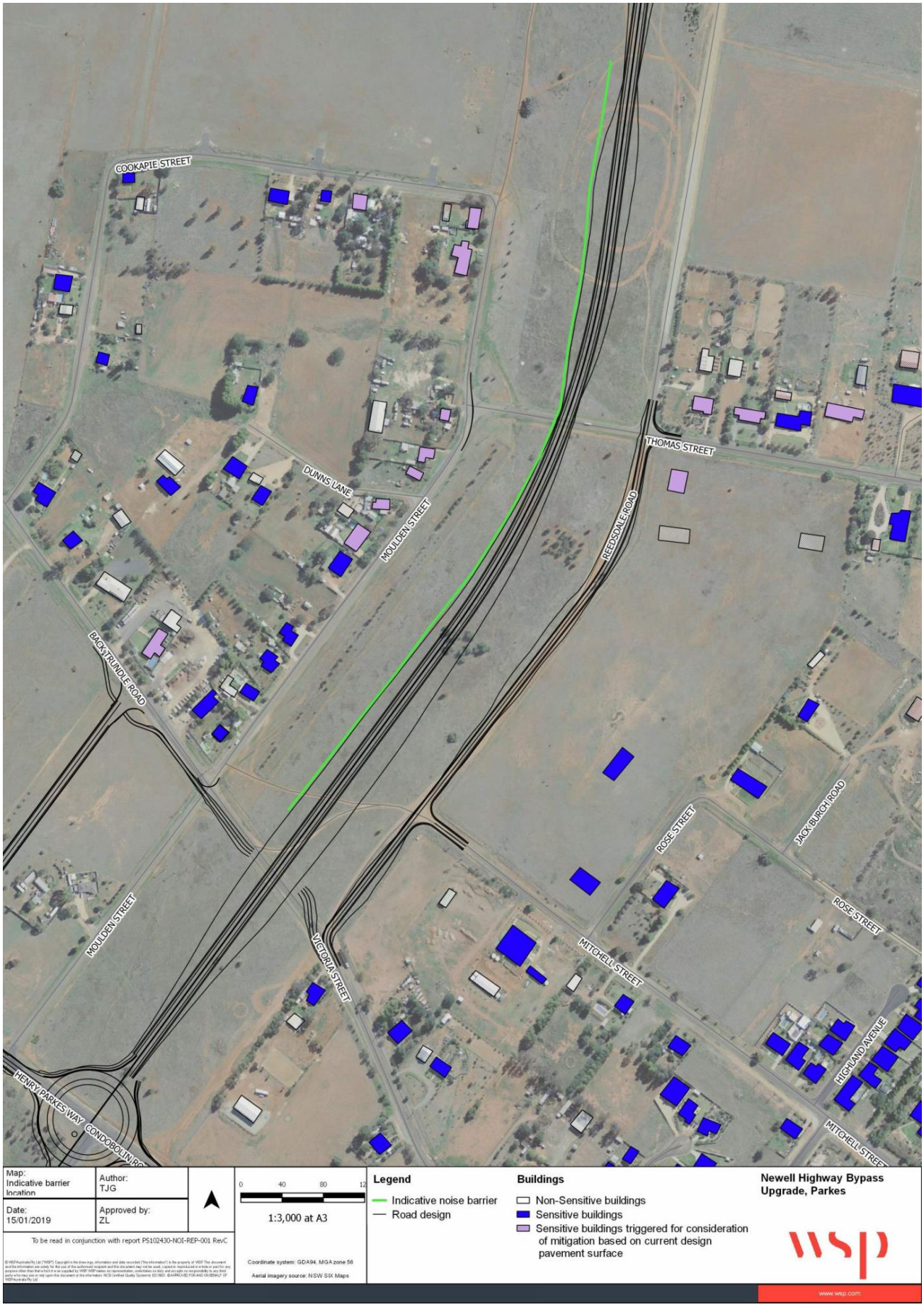


Figure 6-3 Indicative location of noise barrier – NCA06

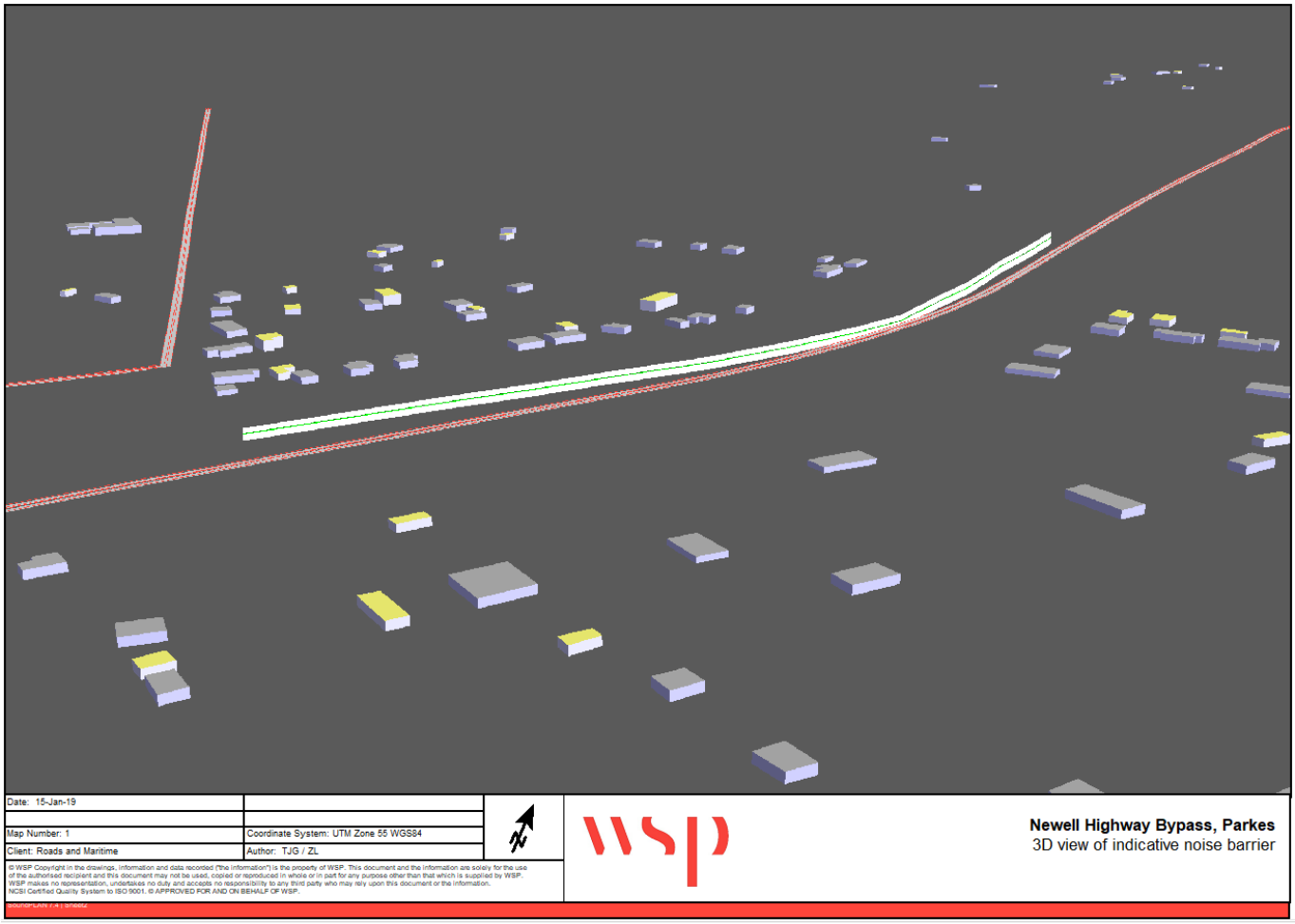


Figure 6-4 3D view of indicative noise barrier – NCA06

NCA04

Following the barrier assessment process in the NMG, the initial barrier height was determined to be 3 metres, while the maximum barrier height was determined to be 5 metres. The design barrier height was subsequently determined to be 3 metres where the height of the barrier provided the most reduction in the number of at-property treatments, with a residual two dwellings (out of seven) still qualifying for further treatment (it is also noted that there is no minimum in the total points weighting between the initial design barrier height and the maximum barrier height). Figure 6-6 presents the barrier analysis.

With this noise barrier at the determined design height for NCA04, a total of six dwellings are still required for further treatment (including the isolated dwellings not eligible for noise barriers).

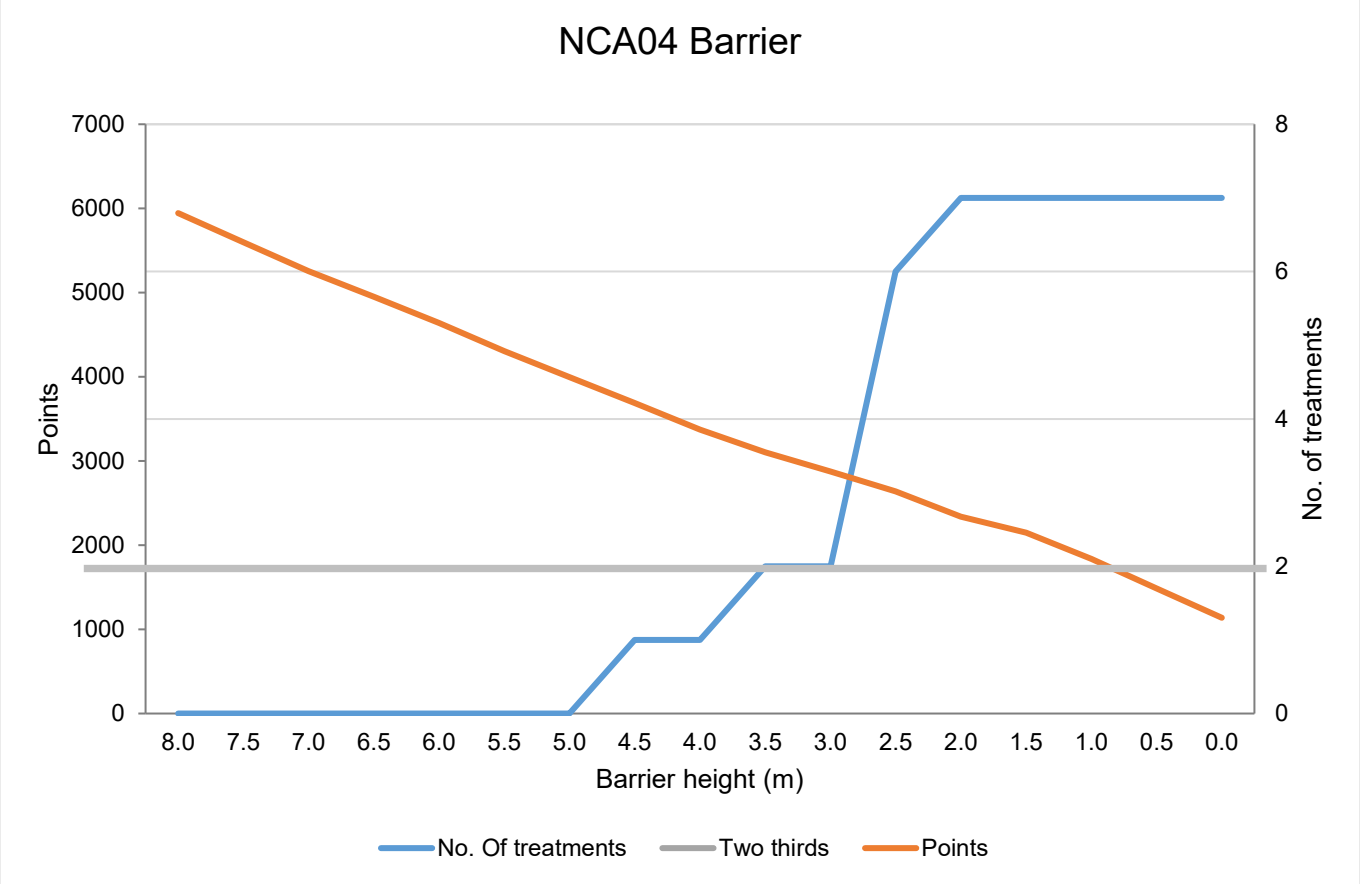


Figure 6-5 Barrier analysis for NCA04 barrier using design pavement

NCA06

Following the barrier assessment process in the NMG, the initial barrier height was determined to be 4.5 metres, while the maximum barrier height was determined to be 6 metres. The design barrier height was subsequently determined to be 4.5 metres where the height of the barrier provided the most reduction in the number of at-property treatments, with a residual two dwellings (out of eight) still qualifying for further treatment (it is also noted that there is no minimum in the total points weighting between the initial design barrier height and the maximum barrier height). Figure 6-6 presents the barrier analysis.

With this noise barrier at the determined design height for NCA06, a total of five dwellings are still required for further treatment (including the isolated dwellings not eligible for noise barriers).

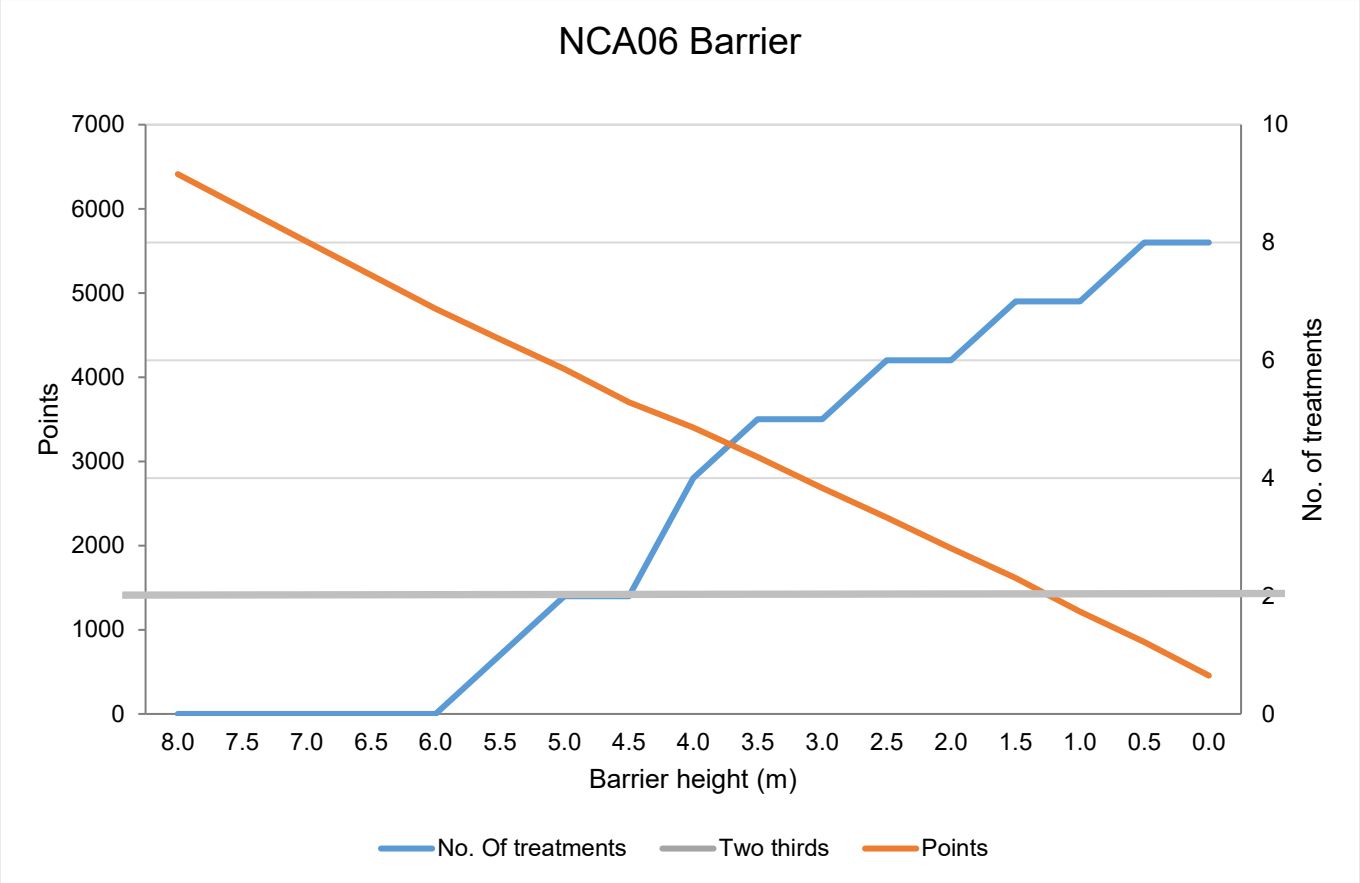


Figure 6-6 Barrier analysis for NCA06 barrier using design pavement

Possible forms of the noise barrier

The barrier may take the form of a wall or mound, given the potentially fewer space constraints in the corridor, a noise mound or reuse of spoil would be preferred over a noise wall, where feasible and reasonable. It is recommended that further barrier assessment and optimisation (refinement of noise barrier location, extent, design and height) per the process in the NMG is conducted during subsequent design stages.

6.7.4 At-property treatments

Under the NMG, at-property treatments may only be considered where all other noise mitigation options have been shown to be not reasonable or feasible or where there are residual impacts. For isolated dwellings not eligible for consideration of quieter pavement or noise barriers, at-property treatment would be the most appropriate mitigation option. At-property treatments are typically limited to architectural upgrades such as sealing windows and providing mechanical ventilation, or localised screening.

The number of at-property treatments depends on the final selection of mitigation options or combination of options (quieter pavement and noise barriers) implemented on the proposal. Detailed assessment and analysis of mitigation option(s) in combination with at-property treatment must be considered as part of the subsequent design stage.

6.8 Maximum noise level assessment

Assessment of maximum noise levels was conducted with reference to the guidelines in ENMM Practice Note (iii). It should however be noted that exceedance of maximum noise assessment guidelines alone does not trigger the need to consider mitigation, but can be used to help prioritise/rank possible mitigation strategies.

6.8.1 Overview

In regard to the assessment of sleep disturbance, guideline in the ENMM Practice Note (iii) suggests that:

- A “maximum noise event” is an event likely to cause sleep disturbance and is defined as any pass-by for which $L_{Amax} – L_{Aeq(1hr)} \geq 15$ dB.

In addition to the guidance above, the following secondary guidelines are also provided:

- Maximum internal noise levels below 50–55 dBA are unlikely to cause awakening reactions
- One or two noise events per night with maximum internal noise levels of 65–70 dBA are not likely to significantly affect health and wellbeing.

The RNP does not specify how an assessment of sleep disturbance should be conducted. It refers to ENMM Practice Note (iii) which outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance.

Based on the above recommended maximum noise levels, and an assumed external to internal noise reduction of 10 dB as well as the recommended approach per the ENMM, the following external noise screening criterion can be derived for the assessment of maximum noise level:

- External noise level of L_{Amax} 65 dBA at any façade where $L_{Amax} – L_{Aeq(1hr)} \geq 15$ dB.

6.8.2 Maximum noise level monitoring results

Noise monitoring data from selected locations (NM02, NM03 and NM05) representative of the potentially affected receivers within the study area were analysed to provide an assessment of the likely potential for maximum noise level impacts. Figure F-1 to Figure F-4 in Appendix F shows the number of 15 minute measurement periods during the night where at least one maximum noise event occurred. These locations were considered to be representative due to the following:

- Location NM02 was considered representative of residential dwellings closest to the proposed bypass in NCA04
- Location NM03 was considered representative of the residential dwellings closest to the proposed bypass in NCA05
- Location NM05 was considered representative of the residential dwellings closest to the current and future alignment of Newell Highway north of Parkes.

In addition, Figure F-1 to Figure F-4 in Appendix F indicate that existing maximum noise events occurred at all three monitoring locations. 3350 maximum noise events occurred next to Newell Highway during the night time period at monitoring location NM05 over the 9 day monitoring period. Site visits indicated that the noise environment at the monitoring locations were generally quiet and that traffic passbys were easily distinguished. It is therefore likely that maximum noise events were a result of traffic passbys but the events may also have occurred due to extraneous noises such a bird chirps near the microphone. However, as NM05 was located next to the existing Newell Highway, it is believed that the maximum noise event measured at this location is a result of traffic passbys. The maximum noise events measured at NM02 and NM03 may be caused by traffic passbys, but could also be a result of other natural noises in the area.

The measured maximum noise events ranged from:

- 65–88 dBA L_{max} for NM02
- 65–83 dBA L_{max} for NM03
- 65–84 dBA L_{max} for NM05.

6.8.3 Assessment of potential sleep disturbance

The typical cause of maximum noise events is from truck passbys or by heavy vehicles applying compression brakes. Two situations were assessed for maximum noise levels:

- Truck passby with an assumed sound power level of 114 dBA L_{Amax}.
- Compression release engine braking with an assumed sound power level of 122 dBA L_{Amax}.

Truck passby

Predicted maximum noise levels for a truck passby on the Parkes Bypass indicate that receivers located closer than 100 metres may experience maximum noise levels above 65 dBA.

The predicted noise levels likewise indicate that receivers located closer than 50 metres from the Parkes Bypass may experience a difference of 15 dB or more between the equivalent noise level ($L_{Aeq(1hr)}$) of the predicted unmitigated night time noise levels for the year 2033 and the maximum noise level (L_{Amax}) of a truck passby.

Maximum noise events that are likely to cause sleep disturbance are defined as events where a receiver is exposed to a maximum noise level above 65 dBA while at the same time exposed to a difference of 15 dB or more between the equivalent noise level ($L_{Aeq(1hr)}$) and the maximum noise level (L_{Amax}).

Table 6-4 shows the number of sensitive residential properties that may experience maximum noise levels that could cause sleep disturbance.

Table 6-4 Sensitive dwellings exceeding the maximum noise screening criteria due to truck passby

NCA	Number of dwellings where predicted maximum noise level exceeds 65 dBA	Range of exceedance above 65 dBA	Number of dwellings where LAmax – LAeq(1hr) ≥ 15 dB	Range of exceedance where LAmax – LAeq(1hr) ≥ 15 dB	Number of dwellings where there is a risk of sleep-disturbing maximum noise events
1	–	–	–	–	–
2	–	–	–	–	–
3	1	4 dB	1	1 dB	1
4	–	–	4	1 dB	–
5	1	4 dB	1	1 dB	1
6	10	1–4 dB	11	1–3 dB	8
7	4	1 dB	2	2–4 dB	–
8	–	–	–	–	–
9	–	–	–	–	–
10	–	–	–	–	–
Total	**16**	**–**	**19**	**–**	**10**

The following findings were made from Table 6-4:

- Maximum noise levels due to truck passby are likely to exceed 65 dBA at 16 dwellings
- Most of the noise sensitive dwellings that may experience maximum noise levels above 65 dBA are in NCA06. In this NCA, maximum noise level are predicted to exceed the 65 dBA screening criteria by between up to 4 dB
- Most of the noise sensitive dwellings predicted to experience a difference in maximum noise levels and equivalent noise levels greater than 15 dB are in NCA06
- By taking into account L_{Amax} > 65 dBA and $L_{Amax} – L_{Aeq(1hr)} \geq 15$ dB, maximum noise events due to truck passbys (with higher potential to disturb sleep) may occur at 10 dwellings, where eight of these are located in NCA06. The eight dwellings in NCA06 predicted to experience maximum noise event are mostly located on Moulden Street. One dwelling in NCA03 and one dwelling in NCA05 are also likely subjected to maximum noise events that are likely to cause sleep disturbance
- The sensitive dwellings predicted to experience maximum noise events due to truck passby (with higher potential to disturb sleep) are dwellings that have been identified as dwellings that qualify for further consideration of noise mitigation.

Heavy vehicle acceleration and compression braking

Compression braking is typically associated with heavy vehicles having to decelerate due to changes in posted speed, intersections, changes in gradients or bends. Compression braking should be avoided near residential dwellings as the sudden onset of engine braking may increase the potential to cause sleep disturbance when occurring near a residential dwelling.

The new bypass includes one roundabout situated approximately 320 metres south of NCA06 and an area of minor gradient changes associated with a new overpass bridge. These areas are at risk of triggering compression braking compared to other areas of the proposal where the road is generally straight and flat. In addition, maximum noise events may be triggered by trucks accelerating from the roundabout. Based on the guidance within *Guide to Road Design part 3: Geometric Design* (AustRoads

AGRD03-16, September 2016), a heavy vehicle may take around 800 metres to accelerate up to the posted speed either side of a traffic interruption, such as the roundabout located on the bypass. This may increase the risk of maximum noise level events at dwellings near to the roundabout.

There is a risk that the noise sensitive dwellings in NCA04, NCA05 and NCA06 could be exposed to engine compression braking noise when trucks approach the roundabout and when accelerating away from the roundabout.

It is understood that the proposed bypass alignment is designed such that trucks using the bypass would not have to slow down when entering the bypass from the south or the north, rather traffic that is bound for Parkes would have to slow down on the highway when arriving from the south to access the existing Newell Highway.

Vehicles arriving at and using the bypass from the north would also not have to slow down, neither would vehicles travelling on the bypass reconnecting back to the existing Newell Highway in the northern part of the proposal. On the other hand, vehicles leaving Parkes travelling north on the existing highway would have to slow down to access Newell Highway, as such compression engine braking may occur at this location.

Noise modelling indicated that the maximum noise level emitted from an engine compression braking event can exceed 65 dBA and $L_{Amax} - L_{Aeq(1hr)} \geq 15$ dB at a distance of up to 220 metres from the event. This indicates that noise sensitive receivers in NCA01 and NCA03 to NCA07 are likely to be exposed to maximum noise levels that could cause awakening reactions when a truck uses engine compression braking to decelerate at either end of the bypass or at the proposed roundabout at Condobolin Road/Henry Parkes Way.

7 Construction noise and vibration criteria

Impacts from construction noise are assessed using the CNVG. The CNVG defines the assessment method, and suggests noise management measures based on the length of the works, the number of people affected and the times the works occur.

As the proposed construction duration would be greater than 6 weeks and there are likely to be many potentially impacted properties, the quantitative assessment method detailed in CNVG has been applied.

The CNVG specifies that construction noise management levels (NMLs, as defined in the CNVG)) are defined using the method specified in the ICNG. They are based on the measured rating background level (RBL) as defined in NPfI plus an additional allowance of 10 dB during standard hours and 5 dB outside of standard hours. The ICNG also states that where construction noise levels are above 75 dBA at residential dwellings during standard hours, they are considered 'highly noise affected' (HA) and require additional considerations to mitigate potential impacts. Table 7-1 presents the CNVG assessment time periods.

Table 7-1 CNVG assessment periods

Name	Time periods	Assessment period
Standard Hours (SH)	Monday to Friday – 7 am to 6 pm Saturday – 8 am to 1 pm Sunday/Public Holiday – Nil	Daytime (D)
Out of Hours Work Period 1 (OOHW 1)	Monday to Friday – 6 pm to 10 pm Saturday – 7 am to 8 am and 1 pm to 10 pm Sunday/Public Holiday – 8 am to 6 pm	Daytime OOHW (DOOH)
		Evening (E)
Out of Hours Work Period 2 (OOHW 2)	Monday to Friday – 10 pm to 7 am Saturday – 10 pm to 8 am Sunday/Public Holiday – 6 pm to 7 am	Evening (E)
		Night-time (N)

7.1 Construction noise criteria

Table 7-2 presents the NMLs for residential dwellings for each assessment period.

Table 7-2 Noise management levels at residential dwellings

NCA	Measurement location	RBL dBA[1]			NML $L_{Aeq(15min)}$ dBA[1]					
					Highly noise affected	SH	OOHW1		OOHW2	
		D	E	N		D	DOOH	E	E	N
NCA01	NM01	33	31	30	75	43	38	36	36	35
NCA02	NM01	33	31	30		43	38	36	36	35
NCA03	NM03	41	38	32		51	46	43	43	37
NCA04	NM02	39	37	31		49	44	42	42	36
NCA05	NM03	41	38	32		51	46	43	43	37
NCA06	NM04	37	31	30		47	42	36	36	35
NCA07	NM04	37	31	30		47	42	36	36	35
NCA08	NM05	40	32	30		50	45	37	37	35
NCA09	NM05	40	32	30		50	45	37	37	35
NCA10	MN05	40	32	30		50	45	37	37	35

1. Daytime (D), Daytime out of hour (DOOH), Evening (E) and Night-time (N). Refer to Table 7-1 and Table 8-3 for detailed time periods.

Table 7-3 lists the NMLs that have been adopted for the other noise sensitive land use. These NMLs apply when the premises are in use during any assessment period.

Table 7-3 Noise management levels at sensitive land uses (other than residences)

Land use	NML $L_{Aeq(15min)}$ dBA
Commercial[1]	70
Industrial[1]	75
Place of worship	55
Child care centre	55[2]
School classrooms	55[2]
Active recreation area	65
Passive recreation area	60

1. The external noise levels should be assessed at the most affected occupied point on the premises
2. A 10 dB correction has been applied to the internal noise levels to reflect external noise levels as detailed in ICNG

7.1.1 Construction traffic noise criteria

Construction activities would result in additional heavy and light vehicle movements on public roads. An initial screening test has been provided in the CNVG which states:

> *For Roads and Maritime projects an initial screening test should first be applied by evaluating whether noise levels will increase by more than 2 dB due to construction traffic or a temporary reroute due to a road closure. Where increases are 2 dB or less then no further assessment is required.*
>
> *Where noise levels increase by more than 2 dB (less than 2.1 dB) further assessment is required using Roads and Maritimes Criteria Guideline.*

Consideration should be given under the direction provided in the NCG to determine whether the construction traffic or temporary reroute triggers the new road criteria due to changes in road category. Where exceedance due to construction traffic has been determined, corresponding noise mitigation as outlined in Appendix B and Appendix C of CNVG and the supporting application notes should be considered.

7.1.2 Sleep disturbance

Work carried out at night has the potential to lower sleep quality of the residents next to the construction footprints due to peak noise events. The potential sleep impacts include decreased ability to fall asleep and possible awakening reactions.

Section 4.3 of the ICNG discusses the method for assessing and managing sleep disturbance. This guidance references further information in the RNP that discusses criteria for the assessment of sleep disturbance, which is discussed in Section 6.8.1.

Feasible and reasonable safeguards should be considered where there are predicted exceedances above this night-time assessment criteria.

It should be noted that this assessment method (sleep disturbance criteria based on guidance for sleep awakening) may not capture the full extent of impacts during the early and later stages of sleep (difficulty falling asleep and waking up early). However, this assessment method would provide an indication of the potential sleep disturbance when work occurs at night. The night-time impacts due to construction are quantified and managed through the $L_{Aeq(15min)}$ assessment.

7.2 Construction vibration criteria

Construction vibration can lead to:

- Cosmetic building damage (and structural damage in extreme cases)
- Loss of amenity due to perceptible vibration, termed human comfort
- Impacts on the condition and structural integrity of key infrastructure.

Importantly, cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building's structural integrity. It is described as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks, and separation of partitions or intermediate walls from load bearing walls. If there is no significant risk of cosmetic building damage then structural damage is not considered a significant risk and is not assessed.

7.2.1 Cosmetic building damage and structural integrity

There is currently no Australian Standard that provides guidance for assessing cosmetic building damage caused by vibration. As such, German Standard DIN 4150 Part 3 Structural Vibration - Effects of Vibration on Structures has been adopted. Table 7-4 presents the guideline levels for structural damage for short term vibration.

Table 7-4 Structural damage guideline levels (DIN 4150-3)

Group	Type of structure	Vibration velocity, mm/s			
		At foundation, frequency of			Plane of floor uppermost storey
		1–10 Hz	10–50 Hz	50–100 Hz[1]	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
3	Structures that because of their sensitivity to vibration, are not like dwellings or commercial buildings and have intrinsic values (e.g. buildings under a preservation order)	3	3 to 8	8 to 10	8

1. Frequencies above 100 Hz, the values given in this column may be used as minimum values.

7.2.2 Human comfort (amenity)

Table 7-5 presents the guideline levels (vibration dose values) above which there is considered to be a risk that the amenity and comfort of people occupying buildings would be affected by construction work. The guideline levels are taken from Assessing Vibration: A Technical Guideline (EPA, 2006) for intermittent vibration.

Table 7-5 Vibration guideline levels for human exposure from intermittent vibration

Location	Assessment period	Vibration dose value, m/s1.75	
		Preferred values	Maximum values
Critical areas	Day or night time	0.10	0.20
Residences	Daytime	0.20	0.40
	Night time	0.13	0.26
Offices, schools, educational institutions, and places of worship	Day or night time	0.40	0.80
Workshops	Day or night time	0.80	1.60

The vibration guideline also specifies guideline levels for continuous and impulsive vibration. These vibration guideline levels are expressed in acceleration (m/s^2) and peak particle velocity (mm/s) as presented in Appendix C of the vibration guideline, reproduced in Table 7-6.

Table 7-6 Preferred and maximum values for continuous and impulsive vibration

Location	Assessment period	RMS acceleration m/s^2				Peak particle velocity mm/s	
		Preferred values		Maximum values		Preferred values	Maximum values
		Z-axis	X and Y axes	Z-axis	X and Y axes		
Continuous vibration							
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072	0.14	0.28
Residences	Daytime	0.010	0.0071	0.020	0.017	0.28	0.56
	Night time	0.007	0.005	0.014	0.010	0.20	0.40
Offices, schools, educational institutions, and places of worship	Day or night time	0.020	0.014	0.040	0.028	0.56	1.1
Workshops	Day or night time	0.04	0.029	0.080	0.058	1.1	2.2

Location	Assessment period	RMS acceleration m/s^2				Peak particle velocity mm/s	
		Preferred values		Maximum values		Preferred values	Maximum values
		Z-axis	X and Y axes	Z-axis	X and Y axes		
Impulsive vibration							
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072	0.14	0.28
Residences	Daytime	0.3	0.21	0.60	0.42	8.6	17.0
	Night time	0.10	0.071	0.20	0.14	2.8	5.6
Offices, schools, educational institutions, and places of worship	Day or night time	0.64	0.46	1.28	0.92	18.0	36.0
Workshops	Day or night time	0.64	0.46	1.28	0.92	18.0	36.0

7.3 Blasting criteria

Ground vibration and overpressure generated by construction blasting are assessed according to the CNVG. The nominated Australian Standard for blasting criteria is AS 2187.2:2006 *"Explosives – Storage and use Part 2: Use of Explosives"*. The recommended limits provided within AS 2187 as well as DIN 4150 which has been used where AS 2187 does not provide a recommendation have been summarised below.

7.3.1 Human comfort limits

The recommendations in AS 2187 in our assessment in accordance with the CNVG for human comfort limits for ground vibration and airblast overpressure.

The human comfort limits for airblast overpressure are summarised in Table 7-7, note that the reference pressure for the pressure has been set as 20 µPa.

Table 7-7 Human comfort limits for airblast overpressure

Category	Type of blasting operations	Peak sound pressure level (dBL)	
		95% of blasts per year	Maximum values
Sensitive Site[1]	Operations lasting longer than 12 months or more than 20 blasts	115	120[2]
Sensitive Site[1]	Operations lasting for less than 12 months or less than 20 blasts	120	125[2]
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	–	125[2,3]

1. A sensitive site includes houses and low rise residential buildings, hospitals, theatres, schools, etc., occupied by people.
2. Unless agreement is reached with occupier that a higher limit may apply.
3. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation.

The AS 2187 human comfort and annoyance limits for blasting induced vibration are outlined in Table 7-8. The more stringent 5 mm/s peak component particle velocity has been adopted for this assessment.

Table 7-8 Human comfort limits for ground-borne vibration due to blasting

Category	Type of blasting operations	Peak component particle velocity (mm/s)	
		95% of blasts	Maximum values
Sensitive site[1]	Operations lasting longer than 12 months or more than 20 blasts	5	10[2]
Sensitive site[1]	Operations lasting for less than 12 months or less than 20 blasts	–	10[2]
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	–	25[2,3]

1. A sensitive site includes houses and low rise residential buildings, hospitals, theatres, schools, etc., occupied by people.
2. Unless agreement is reached with occupier that a higher limit may apply.
3. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation.

7.3.2 Structural damage limits

In addition to the provided more stringent human comfort limits, AS 2187 provides the following structural damage limits due to blasting. The limits for airblast overpressure are shown in Table 7-9.

Table 7-9 Structural damage limits due to airblast overpressure from blasting

Category	Type of blasting operations	Peak sound pressure level (dBL)
Structures that include masonry, plaster and plasterboard in their construction and also unoccupied structures of reinforced concrete or steel construction	All blasting	133[1]
Service structures, such as pipelines, powerlines and cables located above the ground	All blasting	Limit to be determined by structural design methodology

1. Unless agreement is reached with the owner that a higher limit may apply

The limits for cosmetic structural damage due to ground-borne vibration are as per Table 7-10. A damage limit of 100 mm/s peak particle velocity has been adopted for unoccupied reinforced structures. Limits for other structures such as power lines above ground are dependent on their structural design methodology.

Table 7-10 Ground-borne vibration limits for cosmetic damage from vibration due to blasting

Type of building	Peak component particle velocity in frequency range of predominant pulse[3]	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings[1]	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
Unreinforced or light framed structure. Residential or light commercial type buildings[2]	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz[4]	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

1. Refer to Line 1 in Figure 7-1
2. Refer to Line 2 in Figure 7-1
3. Values referred to are at the base of the building.
4. For unreinforced or light framed structures, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

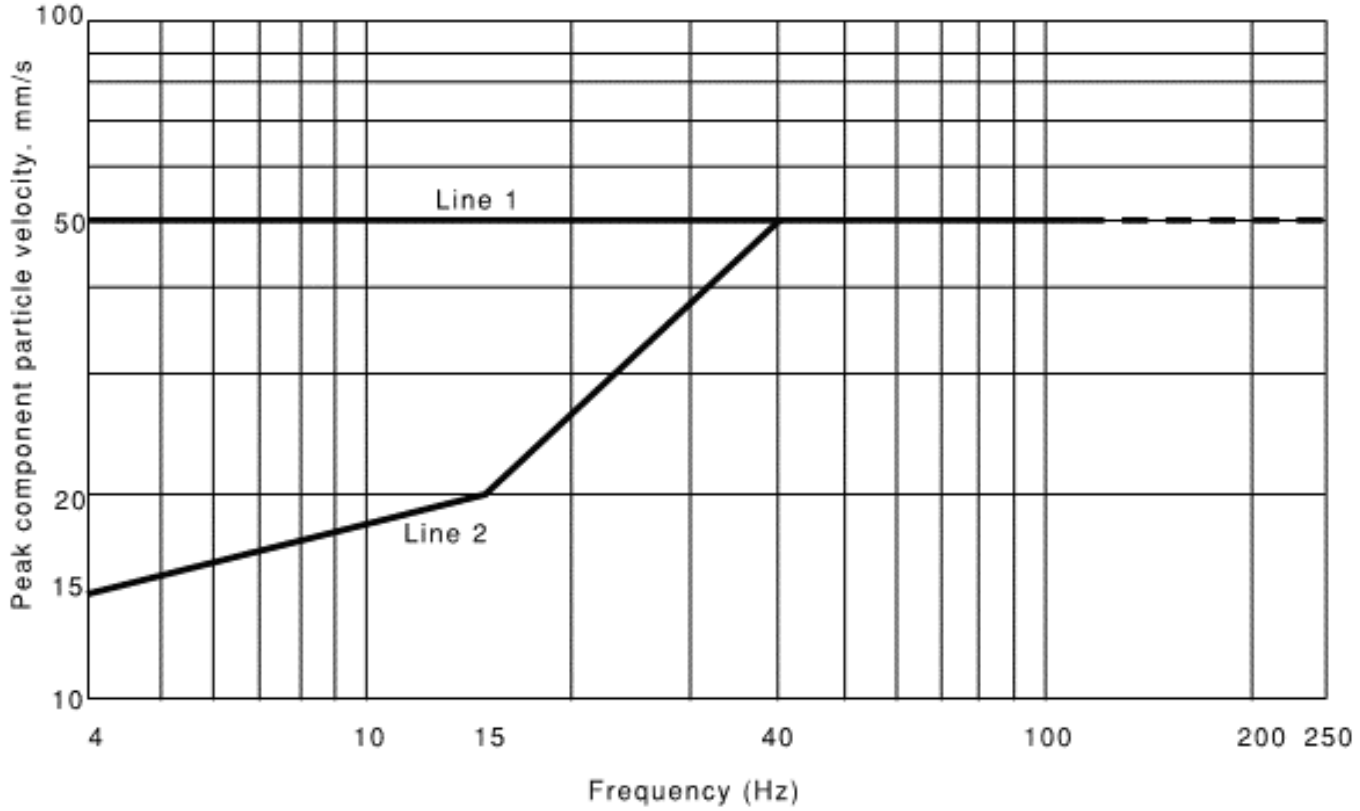


Figure 7-1 Reproduction of Figure J4.4.2.1 from AS 2187 for transient vibration guide values for cosmetic damage

For buried pipework, the limits within German Standard DIN 4150-3 Effects of vibration on structures have been adopted.

Table 7-11 DIN 4150 guideline values for short-term vibration on buried pipework

Pipe material	Guideline values for velocity measured on the pipe in mm/s
Steel (including welded pipe)	100
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plastic	50

8 Construction noise assessment

8.1 Noise modelling method

Noise predictions were conducted using SoundPLAN implementing the CONCAWE (calm condition) algorithm. Modelled equipment and associated sound power levels as well as construction scenarios were based on typical construction activities associated with this type of road project based on information from the road designer, Roads and Maritime, and previous assessments undertaken. The model considered noise sources, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings.

8.2 Construction scenarios

The proposed construction work activities and the associated total sound power level (SWL) and proposed working hours have been categorised into 12 construction scenarios as described in Table 8-1, determined based on the type and location of construction work. The estimated total SWLs are based on the assumed list of equipment for each scenario as further discussed in Section 8.3.

Most construction works are generally carried out during standard hours per the ICNG. Construction works on the bridges near the rail line and on the existing Newell Highway are however required to be undertaken outside of standard hours to minimise disruption on these transport corridors and to improve worker safety.

Table 8-1 Summary of work activities and construction scenarios

Scenario reference	Work activity	Location	Scenario noise levels SWL, dBA		Proposed work period			
			15-minute equivalent (L_{Aeq})	Instantaneous maximum noise level (L_{Amax})[1]	D	DOOH	E	N
SC01	Site establishment	Main alignment	115	116	x			
SC02	Corridor Clearing	Main alignment	121	122	x			
SC03	Bulk earthworks	Main alignment	123	130	x			
SC04	Drainage infrastructure	Main alignment	115	117	x			
SC05	Paving/ asphalting (including concrete sawing)	Main alignment	120	130	x	x	x	x
SC06A	Bridge works (Rail)	Bridge A	120	124	x	x	x	x
SC06B	Bridge works Main (Local)	Bridge B	120	124	x	x	x	x
SC07A	Construction Compound Site Establishment (1)	Compound 1	122	123	x			
SC07B	Construction Compound Site Establishment (2)	Compound 2	122	123	x			
SC07C	Construction Compound Site Establishment (3)	Compound 3	122	123	x			

Scenario reference	Work activity	Location	Scenario noise levels SWL, dBA		Proposed work period			
			15-minute equivalent (L_{Aeq})	Instantaneous maximum noise level (L_{Amax})[1]	D	DOOH	E	N
SC07D	Construction Compound Site Establishment (a&b)	Compound (a&b)	122	123	x			
SC07E	Construction Compound Site Establishment (c)	Compound (c)	122	123	x			

1. The presented L_{Amax} parameter is referring to the instantaneous maximum produced by the loudest plant equipment within the proposed scenario.

8.3 Construction equipment

Typical plant and equipment used in a road construction and demolition project have been used to predict the likely level of construction noise for the proposal. The type of plant and equipment used at each stage of construction would vary depending on the construction activity being undertaken. Table 8-2 presents the equipment, sound power levels and applicable construction assessment scenarios. Sound power levels were primarily taken from the CNVG. Where the CNVG did not have a suitable item of plant, other published sources were used including the DEFRA construction noise database (UK Department of Environmental and Rural Affairs, 2006) and TfNSW Construction Noise and Vibration Strategy (TfNSW, 2018).

Table 8-2 Construction activity and plant equipment

Equipment / construction area and activity	SWL	Usage factor (within 15min)	Main corridor/intersection works					Bridge construction	Site compounds
			Site establishment	Corridor clearing	Bulk earthworks	Drainage infrastructure	Paving/ asphalting	Bridge works	Construction compound site establishment
			SC01	SC02	SC03	SC04	SC05	SC06	SC07
Air track drill[1]	124	7.5	–	–	–	–	–	–	–
Asphalt truck and sprayer[1]	106	15	–	–	–	–	1	–	–
Backhoe	111	10	–	–	–	1	–	–	–
Bulldozer D9	116	15	–	1	1	–	–	–	–
Chainsaw 4-5 HP[1]	114	7.5	–	1	–	–	–	–	1
Compactor	106	15	–	–	1	–	–	–	–
Compressor	109	15	–	–	–	–	–	1	–
Concrete pump	109	15	–	–	–	–	–	1	1
Concrete saw[1]	118	15	–	–	–	–	1	–	–
Concrete truck	109	5	–	–	–	1	1	1	1
Concrete vibrator	113	15	–	–	–	–	–	–	1
Dump truck	110	7.5	–	1	1	–	1	–	–
Excavator (tracked) 35t	112	7.5	–	2	1	1	–	–	1
Excavator (tracked) 35t + hydraulic hammer[1]	122	7.5	–	–	–	–	–	–	–
Fixed crane	113	15	–	–	–	–	–	–	1
Franna crane 20t	98	15	–	–	–	–	–	1	–
Front end loader 23t	112	15	–	–	–	–	–	–	1
Grader	113	15	–	–	–	–	–	–	1

Equipment / construction area and activity	SWL	Usage factor (within 15min)	Main corridor/intersection works					Bridge construction	Site compounds
			Site establishment	Corridor clearing	Bulk earthworks	Drainage infrastructure	Paving/ asphalting	Bridge works	Construction compound site establishment
			SC01	SC02	SC03	SC04	SC05	SC06	SC07
Mobile crane	113	15	–	–	–	–	–	–	–
Pavement laying machine	114	15	–	–	–	–	–	–	–
Piling rig - bored	112	7.5	–	–	–	–	–	1	1
Piling rig - driven[1]	116	7.5	–	–	–	–	–	1	-
Pneumatic hammer[1]	115	15	–	–	–	–	–	1	1
Power generator	103	15	–	–	–	–	–	1	1
Road truck	108	15	1	–	–	1	–	–	–
Roller (large pad foot)	109	15	–	–	1	–	–	–	–
Scissor Lift	98	15	1	–	1	–	–	–	–
Smooth drum roller[1]	107	15	–	–	–	–	1	–	–
Truck (medium rigid)	103	15	1	–	1	–	–	1	–
Truck compressor	75	15	–	–	–	1	–	–	–
Tub grinder/ mulcher 40-50 HP	116	15	–	1	–	–	–	–	–
Vibratory roller[1]	109	15	–	–	–	1	–	–	1
Water cart	107	15	–	–	1	–	–	–	1
Welding equipment	105	7.5	–	–		–	–	1	–
Total Scenario SWL, $L_{Aeq(15min)}$ (dBA)			115	121	123	115	120	120	122
Total Scenario SWL, L_{Amax} (dBA)			116	122	130	117	130	124	123

1. A 5 dBA penalty have been added to the noise source level to account for tonal or impulsive characteristics.

8.4 Predicted noise levels

The noise model was used to predict noise levels within each NCA for each construction activity. The predicted levels were compared with the NMLs for each NCA. To assist with visualization of any predicted exceedances of the NMLs, the formatting styles as described in Table 8-3 are adopted in the reported construction noise predictions in Table 8-4.

The predicted construction noise levels are intended to be conservative and represent a worst case noise level where the equipment within the nominated work activity are simultaneously operating at full capacity for the majority of the 15 minute assessment period.

Table 8-3 Exceedance time periods

CNVG period name	**Time periods**	**Assessment period**	**Exceedance indication/formatting in** Table 8-4
Standard Hours (SH)	Monday to Friday – 7 am to 6 pm Saturday – 8 am to 1 pm Sunday/Public Holiday – Nil	Daytime (D)	Orange shaded cells
Out of Hours Work Period 1 (OOHW 1)	Saturday – 7 am to 8 am and 1 pm to 6 pm Sunday/Public Holiday – 8 am to 6 pm	Daytime OOHW (DOOH)	Yellow shaded cells
	Monday to Friday – 6 pm to 10 pm Saturday – 6 pm to 10 pm	Evening (E)	Green shaded cells
Out of Hours Work Period 2 (OOHW 2)	Sunday/Public Holiday – 6 pm to 10 pm	Evening (E)	Green shaded cells
	Monday to Friday – 10 pm to 7 am Saturday – 10 pm to 8 am Sunday/Public Holiday – 10 pm to 7 am	Night-time (N)	Blue shaded cells
Highly noise affected	All periods	–	***Italicised and bolded red text***

Table 8-4 Predicted construction noise levels

NCA	NML															
	HNA[1]	D[1]	D	E[1]	N[1]	SC01	SC02	SC03	SC04	SC05	SC06A	SC06B	SC07A	SC07B	SC07C	SC07D	SC07E
Residential dwellings																	
NCA01	75	43	38	36	35	<30 to 61	36 to 67	38 to 69	30 to 61	35 to 66	<30	up to 20	<30	<30 to 33	<30 to 67	<30	<30
NCA02	75	43	38	36	35	38 to 45	44 to 51	46 to 53	39 to 45	44 to 50	<30		<30	<30	<30 to 38	<30	<30
NCA03	75	51	46	43	37	45 to 64	51 to 70	53 to 72	46 to 64	51 to 69	43 to 61	<30 to 45	<30	39 to 60	<30	40 to 55	***34 to 86***
NCA04	75	49	44	42	36	***35 to 81***	***41 to 87***	***43 to 89***	***35 to 81***	***40 to 86***	39 to 62	30 to 45	<30	39 to 62	<30	35 to 75	36 to 62
NCA05	75	51	46	43	37	***38 to 79***	***44 to 85***	***46 to 87***	***38 to 79***	***43 to 84***	<30 to 47	***38 to 85***	<30	<30 to 43	<30	31 to 48	33 to 61
NCA06	75	47	42	36	35	***41 to 79***	***47 to 85***	***49 to 87***	***41 to 79***	***46 to 84***	30 to 36	39 to 66	<30 to 32	<30 to 34	<30	30 to 37	41 to 58
NCA07	75	47	42	36	35	40 to 67	46 to 73	48 to 75	40 to 67	45 to 72	<30 to 38	40 to 56	<30 to 33	<30 to 36	<30	30 to 40	37 to 48
NCA08	75	50	45	37	35	40 to 60	46 to 66	48 to 68	41 to 61	46 to 66	<30	<30 to 43	35 to 40	<30	<30	<30	<30 to 39
NCA09	75	50	45	37	35	41 to 57	47 to 63	49 to 65	42 to 57	47 to 62	<30	<30 to 35	39 to 50	<30	<30	<30	<30 to 33
NCA10	75	50	45	37	35	up to 60	up to 66	up to 68	up to 61	up to 66	-	up to 24	up to 51	<30	<30	<30	<30
Educational institution																	
NCA06	-	55	55	-	-	up to 48	up to 54	up to 56	up to 48	up to 53	up to 34	up to 49	<30	up to 33	<30	up to 35	up to 46
Child Care Centre																	
NCA05	-	55	55	-	-	up to 45	up to 51	up to 53	up to 45	up to 50	up to 37	up to 48	<30	up to 35	<30	up to 38	up to 47
Place of Worship																	
NCA06	-	55	55	-	-	up to 65	up to 71	up to 73	up to 65	up to 70	up to 33	up to 58	<30	up to 31	<30	up to 34	up to 48

NCA	NML															
	HNA[1]	D[1]	D	E[1]	N[1]	SC01	SC02	SC03	SC04	SC05	SC06A	SC06B	SC07A	SC07B	SC07C	SC07D	SC07E
Commercial properties																	
NCA01	-	70	70	-	-	up to 72	up to 78	up to 80	up to 73	up to 78	up to 55	up to 30	<30	up to 65	up to 31	up to 49	up to 36
NCA05	-	70	70	-	-	46 to 53	52 to 59	54 to 61	46 to 53	51 to 58	39 to 41	47 to 51	<30	31 to 37	<30	32 to 40	35 to 53
Active recreational areas																	
NCA01	-	65	65	-	-	up to 73	up to 79	up to 81	up to 73	up to 78	up to 45	<30	<30	up to 54	up to 45	up to 48	up to 36
NCA04	-	65	65	-	-	up to 48	up to 54	up to 56	up to 48	up to 53	up to 50	up to 38	<30	up to 48	<30	up to 53	up to 47
NCA06	-	65	65	-	-	up to 44	up to 50	up to 52	up to 44	up to 49	up to 32	up to 46	<30	up to 31	<30	up to 33	up to 45
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passive recreational areas																	
NCA05	-	60	60	-	-	up to 43	up to 49	up to 51	up to 43	up to 48	up to 40	up to 46	<30	up to 38	<30	up to 41	up to 48
Industrial receivers																	
NCA04	-	75	75	-	-	66 to 72	72 to 78	74 to 80	66 to 72	71 to 77	57 to 68	36 to 42	<30	46 to 53	<30	54 to 67	54 to 59

1. HNA - Highly noise affected, D – daytime standard hours (SH), DOOH – Daytime (OOHW1), E – Evening (OOHW1 and OOHW2), N – Night-time (OOHW2)
2. Where predicted noise level is 30 dBA or less, noise level of <30 dBA is shown as the predicted noise level.

In addition to the tabulated results, the results of the construction noise assessment are presented graphically in Appendix G for the bulk earthworks (SC03), which represents the typical worst case construction scenario over 15 minutes with all equipment near to the receiver. The actual noise levels would not be continuously at this level and the predictions present the worst case 15 minutes during that scenario occurring. The maps provide the following:

- Appendix G-1 – predicted night-time $L_{Aeq(15min)}$, dB noise levels at receivers including outline of receiver buildings exceeding the highly noise affected NML
- Appendix G-2 – predicted exceedances based on the level of exceedance of the night-time NMLs ($L_{Aeq(15min)}$, dB) and exceedance of sleep disturbance screening criterion (65 dB $L_{Amax,}$) per receiver building (highest noise level within the building) for each construction scenario.

The findings from the construction noise assessment are summarised below:

SC01 – Site establishment

NCA04, NCA05 and NCA06 exceed the highly noise affected level by up to 6 dB. All NCAs exceed the daytime NMLs and night-time NMLs by more than 30 dB for both time periods.

SC02 – Corridor clearing

NCA04, NCA05 and NCA06 exceeded the highly noise affected level by up 12 dB. All NCAs exceed the NMLs during all periods with the maximum exceedance being 43 dB and 51 dB during the day and night respectively.

SC03 – Bulk earthworks

NCA04, NCA05 and NCA06 exceeded the highly noise affected level by up to a 14 dB exceedance. All NCAs exceed the NMLs during all periods with the maximum exceedance being 45 dB and 53 dB during the day and night respectively.

SC04 – Drainage infrastructure

NCA04, NCA05 and NCA06 exceeded the highly noise affected level by up to a 6 dB. All NCAs exceed the NMLs during all periods with the maximum exceedance being 37 dB and 45 dB during the day and night respectively

SC05 – Paving/asphalting

NCA04, NCA05 and NCA06 exceeded the highly noise affected level by up 11 dB. All NCAs exceeded the NMLs during all periods with the maximum exceedance being up to 50 dB during the night.

SC06 – Bridge works construction

NCA05 triggered the highly noise affected level by up to 10 dB. NCA04, NCA05, NCA06 and NCA07 were predicted to exceed the standard hours NML during either SC06A or SC06B.

SC07 – Construction compound site establishment

NCA03 triggered the highly noise affected level by up to 11 dB. NCA01, NCA03, NCA04, NCA05, NCA06, NCA09, NCA10 all triggered the standard hours NML with the maximum exceedance being 35 dB. NCA03 exceeded the NMLs by 40 dB and 49 dB during the day and night respectively.

Potential cumulative construction noise impact

This assessment has not considered the potential cumulative impact between the general construction scenarios (along the main alignment) and establishment of construction compound scenarios, as information was not available for the staging of these works. Based on the assessment of individual activities, as summarised in Table 8-4, the most onerous management measures relating to construction noise have been triggered. Therefore, it is expected that the potential cumulative impact due to the possible concurrent scenarios would not change the outcome of this assessment. During further stages of the project, it is recommended that further assessment of the construction noise impact, with

consideration for possible staging of works, should be carried out. This would help to avoid noisy construction scenarios being conducted concurrently to minimise construction noise impact.

8.5 Sleep disturbance

The construction activities that are required to occur outside of standard hours during the night period are detailed in Table 8-1. The work areas for these scenarios includes active road and rail corridors and work outside of standard hours is required to minimise disruption to these transport links.

An assessment for sleep disturbance has been carried out based on the maximum noise (dBA L_{Amax}) from the construction plant in the scenarios that occur during the night period. The predicted maximum noise events with the potential to cause sleep disturbance are presented in Table 8-5. The Potential sleep disturbance have been identified with:

- Blue shaded cells show locations exceeding the 65 dBA L_{Amax} sleep disturbance screening criteria
- **Bold text** show locations exceeding the sleep awakening screening criteria (night RBL + 15 dB).

Some activities may not take place at night, however all activities have been reported below for completeness.

Table 8-5 Predicted sleep disturbance noise impacts

Nca	Sleep disturbance screening	Sleep awakening screening	Predicted highest noise level range per scenario (dBA L_{Amax})											
			SC01	SC02	SC03	SC04	SC05	SC06A	SC06B	SC07A	SC07B	SC07C	SC07D	SC07E
Residential dwellings														
NCA01	65	50	**<30 to 62**	**36 to 68**	**38 to 76**	**30 to 63**	**35 to 76**	<30 to 34	<30	<30	<30 to 34	**<30 to 68**	<30	<30
NCA02		50	38 to 46	**44 to 52**	**46 to 60**	39 to 47	**44 to 60**	<30		<30	<30	30 to 39	<30	<30
NCA03		52	**45 to 65**	**51 to 71**	**53 to 79**	**46 to 66**	**51 to 79**	**43 to 65**	<30 to 49	<30	**40 to 61**	<30 to 31	**41 to 56**	**35 to 87**
NCA04		51	**35 to 82**	**41 to 88**	**43 to 96**	**35 to 83**	**40 to 96**	**39 to 66**	30 to 49	<30	**40 to 63**	<30	**36 to 76**	**37 to 63**
NCA05		52	**38 to 80**	**44 to 86**	**46 to 94**	**38 to 81**	**43 to 94**	<30 to 51	**38 to 89**	<30	30 to 44	<30	32 to 49	**34 to 62**
NCA06		50	**41 to 80**	**47 to 86**	**49 to 94**	**41 to 81**	**46 to 94**	30 to 40	**39 to 70**	<30 to 33	<30 to 35	<30	31 to 38	**42 to 59**
NCA07		50	**40 to 68**	**46 to 74**	**48 to 82**	**40 to 69**	**45 to 82**	<30 to 42	**40 to 60**	<30 to 34	<30 to 37	<30	31 to 41	38 to 49
NCA08		50	**40 to 61**	**46 to 67**	**48 to 75**	**41 to 62**	**46 to 75**	<30 to 32	<30 to 47	36 to 41	<30	<30	<30	<30 to 40
NCA09		50	**41 to 58**	**47 to 64**	**49 to 72**	**42 to 59**	**47 to 72**	<30	<30 to 39	**40 to 51**	<30	<30	<30	<30 to 34
NCA10		50	**60 to 61**	**66 to 67**	**68 to 75**	**61 to 62**	**66 to 75**	<30	<30	**up to 52**	<30	<30	<30	<30

8.6 Construction traffic noise assessment

Additional road traffic generated on existing roads due to the construction of the proposal has the potential to cause adverse road noise impacts at receivers.

8.6.1 Methodology

The additional road traffic generated by vehicles accessing the construction site locations has been assessed in accordance with the CNVG and RNP.

As stated Section 7.1.1, further noise assessment and consideration of mitigation would only be required where additional traffic on existing roads creates an increase of more than 2 dBA at existing sensitive properties. This corresponds to a minimum traffic volume increase of 60 per cent assuming the mix of light and heavy vehicle traffic is similar.

8.6.2 Construction traffic volume

Currently available information for potential construction traffic is described below. It should however be noted that this is indicative only and subject to change during detailed design and/or determination by the construction contractor.

- Likely haul routes for heavy vehicles (e.g. delivery of construction material, disposal of construction waste/rubble):
  - Newell Highway and London Road
- Likely traffic routes for general construction traffic (e.g. lighter vehicles used by construction personnel):
  - Existing roads such as Hartigan Avenue, Bogan Road, Barkers Road, Hideaway Lane, Moulden Street
- Indicative traffic generation as summarised in Table 8-6.

Table 8-6 Indicative construction traffic movements

Vehicle types and association	Use	Vehicle daily numbers		Typical movement pattern
		Average	Maximum	
Heavy vehicles				
Rigid trucks 12.5 metres 30 tonnes general mass limit (GMS)	• Earthworks (cut and fill) • Aggregate delivery • Road base delivery • Sand delivery • Asphalt delivery • Cement delivery • Fly ash delivery • Precast concrete delivery	95	130	Spaced throughout the day
Semi-trailers 19 metres 42 tonnes GML	• Steel • Pre-fabricated units • Oversized units	Occasional: potentially up to 50 over the course of the construction program.		
Incidental deliveries	Various	2	5	

Vehicle types and association	Use	Vehicle daily numbers		Typical movement pattern
		Average	Maximum	
Light vehicles				
Workforce	N/A	100	300	Typically, at the start and end of the end of the working day between 6 am and 7 am, and 6 pm and 7 pm
Incidental deliveries	Various	2	5	Spaced throughout the day
Total	Various	199	440	Not including semi-trailers

8.6.3 Construction traffic noise assessment

Existing traffic volumes on identified construction routes is an important factor for determining the level of noise impact due to additional traffic. Table C.1 and Table C.2 summarises the traffic volumes on existing roads expected to be used by construction vehicles.

Based on the preliminary traffic forecast associated with the construction as presented in Table 8-6, the following findings are made:

- The existing roads carrying less than about 800 vehicles per day would likely experience a notable increase in road noise level (of 2 dB or more) during the peak construction period. From the roads potentially used as construction traffic routes, this includes Hartigan Avenue, Bogan Road, Barkers Road, Hideaway Lane, London Street and Moulden Street that would potentially be impacted by construction traffic
- As more detailed information becomes available, it is recommended that the potential construction traffic noise impact on the existing road network is reviewed further as part of the Construction Noise Management Plan prepared prior to construction. Additional information may include expected haulage and traffic routes, designated parking area locations, construction compound locations, expected distribution of construction traffic throughout the road network etc.

9 Construction vibration assessment

9.1 Vibration generating equipment and associated work activities

Certain construction scenarios discussed in Section 8.3 would require the use of vibration-generating equipment that may affect the range of receivers discussed in Section 3.2. Table 9-1 presents the proposed vibration-generating equipment for each construction scenario.

Table 9-1 Vibration generating equipment used onsite

Scenario ref	SC01	SC02	SC03	SC04	SC05	SC06	SC07
Plant item							
Excavator mounted hydraulic hammer	–	–	X	–	–	–	–
Piling rig – driven	–	–	–	–	–	X	–
Pneumatic hammer	–	–	–	–	–	X	X
Smooth drum roller	–	–	–	–	X	–	–
Vibratory roller	–	–	–	X	–	–	X

9.2 Minimum working distances for vibration intensive plant

Table 9-2 presents the indicative minimum working distances for the nominated construction plant, adopted from the CNVG, to minimise the risk of cosmetic damage and human comfort for residential residences. Compliance with the minimum working distances would minimise the risk of damage and disturbance.

The minimum working distances are indicative only and are based on continuous vibration generated by typical equipment use in typical geotechnical conditions. The distances may vary, depending on the actual site ground and receiver conditions, equipment used and the activity being undertaken.

Table 9-2 Recommended minimum working distances for vibration intensive plant

Plant item	Rating/description	Minimum working distance	
		Cosmetic damage[1,3,4]	Human response[2]
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 metres	15 to 20 metres
	< 100 kN (Typically 2-4 tonnes)	6 metres	20 metres
	< 200 kN (Typically 4-6 tonnes)	12 metres	40 metres
	< 300 kN (Typically 7-13 tonnes)	15 metres	100 metres
	> 300 kN (Typically 13-18 tonnes)	20 metres	100 metres
	> 300 kN (> 18 tonnes)	25 metres	100 metres
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	2 metres	7 metres
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 metres	23 metres

Plant item	Rating/description	Minimum working distance	
		Cosmetic damage[1,3,4]	Human response[2]
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 metres	73 metres
Vibratory Pile Driver	Sheet piles	2 to 20 metres	20 metres
Pile Boring	≤ 800 mm	2 metres (nominal)	4 metres

1. Referenced from British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2
2. Referenced from EPA's Assessing Vibration: a technical guideline (EPA, 2006)
3. Referred to 15 mm/s vibration guideline level
4. More stringent conditions may apply to vibration sensitive structures

9.3 Construction vibration assessment

It is noted that some of the potentially impacted properties would be approximately 10 metres from the proposal. Figure 9-1 shows the distances of the properties from the proposal.

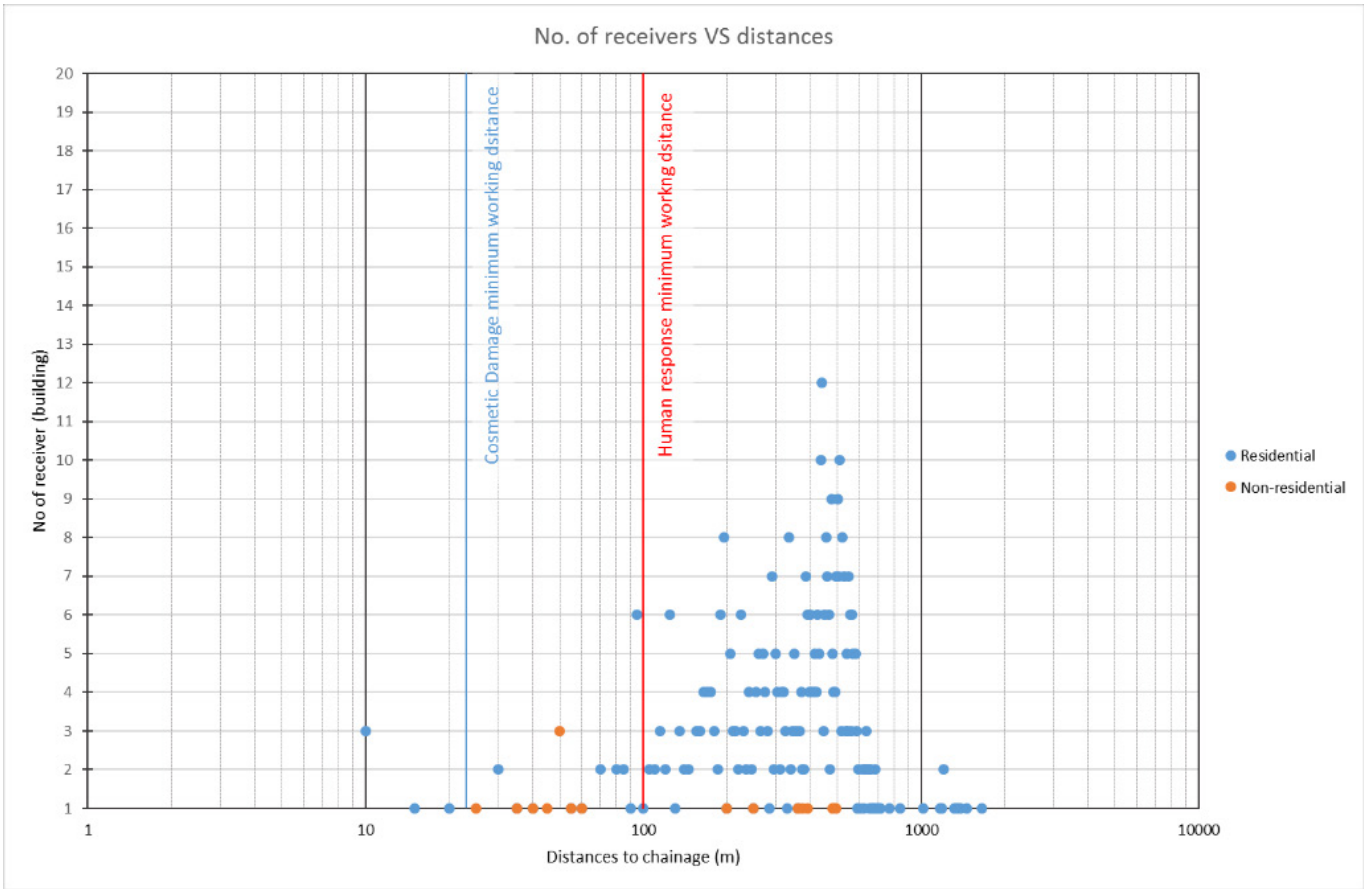


Figure 9-1 Distances of properties along the project footprints

9.3.1 Discussion of assessment

The minimum working distances reported in Table 9-2 indicate the largest distances for compliance with the human comfort guideline and cosmetic damage guideline are 100 metres and 22 metres, respectively, for typical construction equipment associated with the proposal.

Based on a review of the offset distance between the proposal and receivers, the size or power of the vibration generating equipment can be controlled to minimise impacts. The following equipment size/power ratings would allow for the risk of impacts to be minimised and compliant with the minimum working distance in Table 9-2:

- Vibratory rollers < 50 kN (typically 1–2 tonnes)
- Small hydraulic hammers 300 kg (5–12 tonne excavator).

Vibration monitoring should take place to confirm vibration levels and establish a baseline for any potential impacts. By selecting a lower powered/smaller machine and restricting when the machine is used, particularly when near the minimum working distances of the nominated sensitive receivers, the vibration impacts can be reduced.

10 Blasting assessment

It is proposed to use blasting at two locations along the alignment for the purpose of excavating a cut for the bypass. These potential locations are:

- Cut 1: chainage 34045 to 34475
- Cut 2: chainage 32920 to 33700.

A preliminary blasting assessment has been undertaken based on the guidance in the CNVG. As details of the proposed blasting parameters are not available at this stage of the project, the assessment has calculated the highest mass of explosive that would be able to be used and still meet the blasting overpressure or vibration limits at the nearest sensitive receivers for each cut.

10.1.1 Ground-borne vibration assessment

Calculations have been carried out in accordance with AS 2187 in order to determine the likely levels of ground-borne vibration and airblast overpressures from the proposed blasting as follows:

$$V = K_g \left(\frac{R}{Q^{1/2}} \right)^{-B}$$

Where

- V = ground vibration as vector peak particle velocity, in mm/s
- R = distance between charge and point of measurement, in m
- Q = maximum instantaneous charge (MIC) (effective charge mass per delay), in kg
- K_g, B = constants related to site and rock properties for estimation purposes.

As site specific information is not available, average conditions under AS 2187 have been assumed. In the case of a free face in average field conditions, it is assumed that K_g = 1140, B = 1.6, which result in:

$$V = 1140 \left(\frac{R}{Q^{1/2}} \right)^{-1.6}$$

The calculated maximum charge in order to meet the ground-borne vibration limits for the closest receivers is presented in Table 10-1 for cut 1 and Table 10-2 for cut 2. The most onerous vibration limit has been used for each receiver.

Table 10-1 Ground-borne vibration maximum MIC for cut 1 chainage 34045 to 34475

Nearest receiver	Receiver type	Distance to receiver (metres)	Vibration limit (mm/s)	Ground vibration max MIC (kg)
447	Shed	220	5	54
525	Residential	125	5	17

Table 10-2 Ground-borne vibration maximum MIC for cut 2 chainage 32920 to 33700

Nearest receiver	Receiver type	Distance to receiver (metres)	Vibration limit (mm/s)	Ground vibration max MIC (kg)
406	Shed	75	5	6.3
405	Residential	80	5	7.2

10.1.2 Overpressure assessment

Airblast overpressure limits was calculated according to the method in AS 2187 as follows:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^{-a}$$

Where

- P = pressure, in kPa
- R = distance between charge and point of measurement, in metres
- Q = explosives charge mass, in kg
- K_a, a = site constants.

Recommended confined blasthole constants per AS 2187 of a = -1.45, K_a = 100 have been used for the assessment. For a surface charge, a K_a of 516 is used. However, as this K_a value would provide a much smaller permissible MIC, the use of confined blasthole charges to minimise annoyance and structural damage is recommended.

The calculated maximum charge in order to meet the airblast limits for the closest receivers is presented in Table 10-3 for cut 1 and Table 10-4 for cut 2.

Table 10-3 Airblast overpressure maximum explosive charge mass for cut 1 chainage 34045 to 34475

Nearest receiver	Receiver type	Distance to receiver (metres)	Airblast limit (dB)	Airblast max. mass (kg)
447	Shed	220	133	5.2
525	Residential	125	115	0.01

Table 10-4 Airblast overpressure maximum explosive charge mass C for cut 2 chainage 32920 to 33700

Nearest receiver	Receiver type	Distance to receiver (metres)	Airblast limit (dB)	Airblast max. mass (kg)
406	Shed	75	133	0.2
405	Residential	80	115	0.003

Given that the maximum explosive mass for airblast overpressure are substantially lower than those for ground-borne vibration, we recommend that the airblast overpressure limits be used to limit the explosive mass.

The calculations are considered conservative, with the use typical blasting factors and do not account for any topographical shielding or other blast controls. It is recommended that further blast design and assessment, including refinement of the site law is carried out when further details relevant to the blasting program is known.

11 Construction safeguards and management measures

This section describes the noise and vibration safeguards and management measures that should be considered for to address potential impacts from the construction of the proposal. The construction noise, vibration and blasting impact assessment and mitigation should be reviewed as the proposal progresses and more construction information becomes available.

At this stage, the construction program and duration of each construction activity is not available. However, due to the large number of exceedances predicted at residential dwellings, the construction program should be developed in consultation with the surrounding residents. This would increase the effectiveness of the additional mitigation measures outlined in Section 11.4.

11.1 Construction noise and vibration management plan

A Construction Noise, Vibration and Blasting Management Plan (CNVBMP) will be prepared and implemented as part of the CEMP. The CNVBMP will generally follow the approach in the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009), and AS 2187 which should identify:

- All potential significant noise and vibration generating activities associated with the proposal
- Feasible and reasonable mitigation measures to be implemented
- A monitoring program to assess performance against relevant noise, vibration and blasting criteria
- Arrangements for consultation with affected neighbours and property owners, including notification and complaint handling procedures
- Contingency measures to be implemented in the event of non-compliance with noise , vibration and blasting criteria.

11.2 Recommended site specific controls

Due to the predicted exceedance of the NMLs, reasonable and feasible mitigation measures to minimise construction noise, vibration and blasting levels have been investigated. In addition to the mitigation measures outlined in Section 11.2.1 and Section 11.4, the measures in Table 11-1 should be considered to minimise the predicted construction noise, vibration and blasting impacts.

Table 11-1 Recommended controls

Equipment/process	Description	Potential benefits
Noise control		
All plant	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of CNVG.	Lower likelihood of construction noise to be higher than predicted levels.

Equipment/process	Description	Potential benefits
All plant	Limiting number of plant and use of alternative equipment and /or using a different, quieter method to carry out the work during night-time period. For this project: • Using electric hand tools instead of pneumatic • Where feasible, limited number of plant to no more than 1 item of equipment operating at any one time.	Up to 3 dB or more reduction of scenario noise level.
Site design	Where feasible and practicable, any site hording or fences erected should be constructed with thick plywood or fitted with temporary acoustic barriers to provide additional noise reduction at the immediate receivers.	Reduction of 5 dB to 10 dB at the nearest receivers.
Simultaneous works	Potential noise impacts have been predicted for the proposal based on all equipment for each construction scenario operating simultaneously. Where feasible, try to limit the simultaneous use of high noise plant and equipment.	Increased likelihood that actual construction noise levels will be lower than predicted.
High noise level equipment	Where feasible, the use of these plant/equipment should be confined to standard hours or should be scheduled to be carried out early in the evening or early morning period from 5 am to 7 am when ambient noise is likely to increase (therefore lower degree of impacts). For scenarios with predicted exceedance of the highly noise affected level of 75 dBA and scenarios with high noise equipment, respite periods should be considered during the evening, overnight and on weekends. 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.	Lower impacts in the critical periods (evening and night-time).
Stationary plant, equipment and activities	Consider implementation of temporary barriers around stationary sources or use of alternative quieter equipment. Where temporary noise barriers are used to block line of sight between stationary works and equipment (road cutting, jackhammering, compressor and generator) and the receivers, a reduction of approximately 5 dB to 10 dB could be expected. For receivers with clear line of sight (overlooking the works) a shielding benefit lower than 5 dB can be expected.	Reduction of 5 dB to 10 dB at the nearest receivers
Mobile plant	Mobile plant and vehicles onsite should be switched off when not in use. Plant should be operated in a manner that reduces the chance of increased noise emissions.	Lower likelihood of construction noise higher than predicted the levels.

Equipment/process	Description	Potential benefits
Materials and equipment handling	Plant, tools and equipment should be operated such that they reduce the likelihood of generating maximum noise level events. This includes: • Not dragging or dropping materials or tools • Avoidance of striking items with excavator buckets • Controlling rear gates on material handling trucks so that they do not slam shut • Avoid loud radios, shouting, horn beeps and other loud communications on site • Consider lining truck trays with matting to reduce the impact noise when material is deposited.	Reduction in the frequency and noise level of maximum noise level events.
Noisy work activities	Very noisy activities should be scheduled for normal working hours. If the work cannot be undertaken during the day, it should be completed before 12 am (midnight). Where feasible, periods where high noise work is required up to midnight, such activities should be scheduled to restart after 7 am the next morning. Where practicable and feasible, provide respite period for receivers.	Lower impacts of sleep disturbance for sleeping residential receivers. Limiting high impact work activities to provide respite for receivers.
Vibration control		
All vibration emitting plant	The required locations for vibration intensive equipment should be reviewed during construction planning when more specific information is available.	Ensure that vibration impacts are addressed, assessed and controlled effectively.
	Where feasible and reasonable, lower powered equipment should be used when working near vibration sensitive receivers.	
	Building condition/dilapidation surveys should be completed both before and after the works on all buildings/structures likely to be impacted by construction vibration to identify existing damage and any proposal related damage. The exact receivers should be identified once detailed construction planning has occurred and during the preparation of the CNVMP.	
Work required within minimum working distances	Where work is required within the nominated minimum working distances of the nominated receiver structures, implementation of additional vibration mitigation measures as outlined in Appendix H should be considered.	Ensure that the vibration impacts are minimised and monitored.
	Attended vibration monitoring or vibration trials should be undertaken when proposed works are within the minimum working distances to ensure that the levels remain below the criterion.	

Equipment/process	Description	Potential benefits
Blasting control		
Blasting times	Blasting should be restricted to the times nominated in the CNVG	Minimise times of impact on residents
Building condition surveys	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage	Reduce chance of unforeseen impacts occurring to property
Blasting regime	The noise and vibration impacts of blasting operations can be minimised by: • Choosing the appropriate blast charge configurations • Ensuring appropriate blast-hole preparation • Optimising blast design, location, orientation and spacing • Selecting appropriate blast times, and utilising knowledge of prevailing meteorological conditions • AS 2187.2 Explosives-Storage, transport and use, Part 2: Use of Explosives provides more detailed advice on ground vibration and airblast overpressure impact minimisation options.	Reduce blasting impacts

11.2.1 Standard airborne mitigation measures (CNVG)

The CNVG provides standard actions and mitigation measures for implementation on road construction proposals. Table 11-2 and Appendix H outlines the relevant measures from the CNVG for the proposal.

Table 11-2 Selected standard mitigation measures CNVG (airborne)

Action required	Applies to	Details
Management measures		
Implement any project specific mitigation measures required	Airborne noise	In addition to the measures set out in this table, any proposal specific mitigation measures identified in this report.
Implement community consultation or notification measures	Airborne noise Ground-borne noise and vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of seven calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. • Website (If required) • Contact telephone number for community • Email distribution list (if required) • Community drop in session (if required by approval conditions).

Action required	Applies to	Details
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All project specific and relevant standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on high noise generating activities • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise and vibration	Where specified under Appendix C (of the CNVG) a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise and vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise and vibration. Airborne noise	Please refer to Appendix C (of the CNVG) for more details on the following respite measures: • Respite offers (RO) • Respite period 1 (R1) • Respite period 2 (R2) • Duration respite (DR).

Action required	Applies to	Details
Equipment selection	Ground-borne noise and vibration Airborne noise	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels	Airborne-noise	The noise levels of plant and equipment must have operating sound power levels (SWLs) or sound pressure levels (SPLs) compliant with the criteria in Appendix H (of the CNVG). Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H (of the CNVG).
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and cannot be used on site unless compliant with the noise level criteria.
Use and siting of plant	Airborne-noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan works site and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.

Action required	Applies to	Details
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading / unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement, earth bunds, fencing, erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor controls		
Structural surveys and vibration monitoring	Ground borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
Additional measures applied at the receiver as specified by Appendix C of the CNVG.	Airborne noise Ground borne vibration	In some instances, additional mitigation measures may be required.

11.3 Construction traffic

Whilst the traffic assessment indicated that noise levels would be compliant with the assessment criteria, the CNVMP should include provisions to reduce the potential impact of construction traffic noise including:

- Restricting travel routes to and from the proposal to main roads (e.g. arterial roads) and avoid using local roads or roads where residential dwellings are potentially impacted
- As far as practicable, restrict construction vehicle movements during the night-time along local roads to light vehicles only, subject to further investigation of potential night-time maximum noise events during detailed design
- Prohibiting the use of engine/compression brakes in or near residential areas
- Promoting driving behaviour that reduces potential noise impacts
- Prohibiting idling of plant and equipment engines near residential dwellings when not in use
- Strategic positioning of site accesses to minimise the chance of trucks passing by residential dwellings, especially at night.

11.4 Additional mitigation measures

Additional mitigation measures should be considered if the NML is exceeded after the application of reasonable and feasible noise mitigation measures. In accordance with the CNVG, the following additional mitigation measures should also be considered where exceedance of construction noise levels would be present after implementation of the standard measures outlined in Section 11.1.

Additional mitigation measures triggers for airborne noise and ground-borne vibration are presented in Table 11-3 and Table 11-4 respectively. Table 11-5 provides the meaning of the abbreviations for measures, with detail explanations of each measure in Appendix H.

Table 11-3 Triggers for additional mitigation measures – air-borne noise

Predicted air-borne dBA, $L_{Aeq(15min)}$	**Exceedance, dB**		**Additional mitigation measures**	
Perception	**Above RBL**	**Above NML**	**Type[1]**	**Mitigation levels[2]**
All hours				
75 dBA or greater			N, V, PC, RO	HA
Standard hours				
Noticeable	5 to 10	0	–	NML
Clearly noticeable	10 to 20	< 10	–	NML
Moderately intrusive	20 to 30	10 to 20	N, V	NML + 10
Highly intrusive	> 30	> 20	N, V	NML + 20
OOHW Period 1				
Noticeable	5 to 10	0	–	NML
Clearly noticeable	10 to 20	< 10	N, R1, DR	NML + 5
Moderately intrusive	20 to 30	10 to 20	V, N, R1, DR	NML + 15
Highly intrusive	> 30	> 20	V, IB, N, R1, DR, PC, SN	NML + 25
OOHW Period 2				
Noticeable	5 to 10	0	N	NML
Clearly noticeable	10 to 20	< 10	V, N, R2, DR	NML + 5
Moderately intrusive	20 to 30	10 to 20	V, IB, N, PC, SN, R2, DR	NML + 15
Highly intrusive	> 30	> 20	AA, V, IB, N, PC, SN, R2, DR	NML + 25

1. Full Abbreviations outlined in Table 11-5 and H2.

Additional mitigation measures should be considered if the predicted vibration level exceeds the maximum vibration levels after the application of reasonable and feasible mitigation measures.

Table 11-4 Triggers for additional mitigation measures – vibration

Triggers	Additional mitigation measures	
	Type[1]	Apply to[2]
Standard hours		
Predicted Vibration Exceeds Maximum Levels	V, N, RP	All
OOHW Period 1		
Predicted Vibration Exceeds Maximum Levels	V, IB, N, RO, PC, RP, SN	All
OOHW Period 2:		
Predicted Vibration Exceeds Maximum Levels	AA, V, IB, N, PC, RP, SN	All

1. Full abbreviation outlined in Table 11-5 and H2.
2. All affected receivers

Table 11-5 Additional mitigation measures abbreviation

Abbreviation	Measure
N	Notification (letterbox drop or equivalent)
SN	Specific notifications
PC	Phone calls
IB	Individual briefings
RO	Respite offer
R1	Respite period 1
R2	Respite period 2
DR	Duration respite
AA	Alternative accommodation
V	Verification

12 Summary of safeguards and management measures

The following table provides a summary of the mitigation measures or environmental safeguards currently identified to be required for the proposal based on the operational noise assessment (Section 6) and construction noise and vibration assessment (Section 7 to Section 11).

Table 12-1 Noise and vibration safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	A Construction Noise, Vibration and Blasting Management Plan (CNVBMP) will be prepared and implemented as part of the CEMP. The CNVBMP will generally follow the approach in the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) and AS 2187 identify: • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented • A monitoring program to assess performance against relevant noise, vibration and blasting criteria • Arrangements for consultation with affected neighbours and property owners, including notification and complaint handling procedures • Contingency measures to be implemented in the event of non-compliance with noise, vibration and blasting criteria.	Contractor	Detailed design / pre-construction
Noise and vibration	All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least 7 days prior to commencement of any works associated with the activity that may have an adverse noise, vibration or blasting impact. The notification will provide details of: • The project • The construction period and construction hours • Contact information for project management staff • Complaint and incident reporting • How to obtain further information.	Contractor	Detailed design / pre-construction
Operational noise impact	Further assessment of the following possible noise mitigation strategies to address the receivers identified to qualify for consideration of mitigation (strategies listed in the order of decreasing preference): • Road design and traffic management • Quieter road pavement • Noise barriers • At-property treatments.	Roads and Maritime	Detailed design
Construction traffic noise	When further information becomes available, a review should be undertaken of the potential road traffic noise impact on the existing road network from construction vehicles or changes to the road network during construction.	Roads and Maritime	Pre-construction

13 Conclusion

WSP has been engaged to undertake a construction noise and vibration and operational noise assessment for the proposed Parkes Bypass. This technical report was prepared to inform the environmental assessment and forms part of the Parkes Bypass Review of Environmental Factors (REF). Information used within this report was supplied by the proposal team and was current at the time of the assessment.

The operational noise assessment found that:

- With the current design pavement surface, a total of 35 residential dwellings and one non-residential property would qualify for further consideration of mitigation. Quieter pavement and/or noise barriers can be considered for the eligible closely spaced dwellings in NCA04 and NCA06. The remaining dwellings in NCA03, NCA04, NCA07, NCA08 and NCA09 are limited to at property treatment only
- A quieter pavement surface such as OGA or Crumb Asphalt (10 mm aggregate) with a correction of –2 dB compared to DGA for NCA06, would reduce the total number of dwellings eligible for consideration of further mitigation by eleven, to a total of 25 dwellings across all the assessed NCAs
- A noise barrier (mound or wall) was considered for eligible dwellings in NCA04 and NCA06. The barrier design heights were determined to be 3 metres and 4.5 metres with the DGA design pavement. At the determined barrier design heights, six and five dwellings in NCA04 and NCA06 respectively would still require at consideration of property treatment
- Mitigation measures to be considered further at the detailed design stage
- No non-residential properties or land use were predicted to qualify for further consideration of mitigation, apart from the Parkes Golf Course. No specific consideration of mitigation is recommended for the Parkes Golf Course, as it is typically not considered reasonable to provide mitigation for this type of land use
- By taking into account L_{Amax} > 65 dBA and $L_{Amax} – L_{Aeq(1hr)} \geq 15$ dB, maximum noise events (with higher potential to disturb sleep) may occur at 10 properties. One of these dwellings is located in NCA03, one dwelling in NCA05 and eight dwellings in NCA06
- The presence of gradients and features that interrupt traffic flow, such as the roundabout may increase the likelihood of maximum noise level events from heavy vehicles through engine breaking and acceleration.

The construction noise and vibration assessment found that:

- Exceedances of daytime (and subsequent time periods) NMLs were predicted at all NCAs for site establishment, corridor clearing, bulk earthworks, drainage infrastructure and paving/ asphalting with exceedances above 30 dB at some NCAs
- Other exceedances of NMLs were predicted for bridge works and compound establishment at NCAs close to the construction footprint. Impacts due to construction compound site establishment were also predicted at localised areas where properties are close to the construction footprints. This includes NCA09 and NCA10 for compound 1, NCA03, NCA04, NCA05, and NCA07 for compound 2, NCA01 and NCA02 for compound 3 and NCA03 to NCA07 for compounds a, b and c

- The predicted noise level at Parkes Christian School during bulk earthworks exceeded the daytime NML by up to 1 dB. Exceedances of the daytime NML at commercial properties and active recreational areas in NCA01, by up to 10 dB and 16 dB respectively, are predicted during site establishment, corridor clearing, bulk earthworks, drainage infrastructure and paving/asphalting works. Noise levels predicted at the place of worship in NCA06 show exceedances by up to 18 dB for all construction scenarios near the property. The predicted noise levels at industrial land use in NCA04 show exceedances by up to 5 dB for the corridor clearing, bulk earthworks and asphalting scenarios
- Limiting the equipment size/power ratings as follows would minimise the risk of vibration impacts and be compliant with the relevant safe working distance: vibratory rollers of < 50 kN (typically 1-2 tonnes) and small hydraulic hammers 300 kg (5–12 tonne excavator) for works within 100 metres from sensitive land use
- Existing roads carrying less than approximately 800 vehicles per day would likely experience a notable increase in road noise levels during the peak construction period
- The preliminary construction blasting assessment identified residential dwellings at least 70 metres from the proposed blasting locations. Indicative maximum explosive masses were identified in order for the blasting to meet overpressure and ground vibration limits at the nearest property.

Appendix A

Proposal overview

Map: Receiver maps	Author: TJG		
Date: 25/09/2018	Approved by: CXM		

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 1 of 10

wsp

HIDEAWAY LANE

NEWELL HIGHWAY

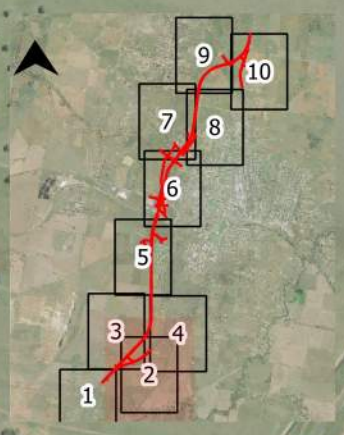
BARKERS ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD



Map: Receiver maps	Author: TJG
Date: 25/09/2018	Approved by: CXM

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 2 of 10

NCA02

BARKERS ROAD

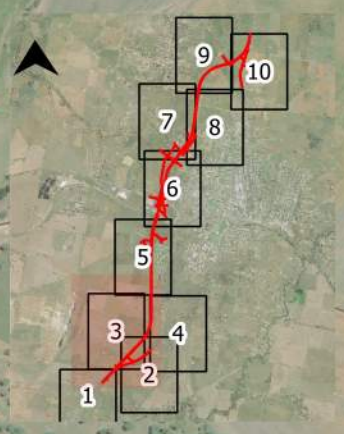
NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD



Map: Receiver maps	Author: TJG
Date: 25/09/2018	Approved by: CXM

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 3 of 10

wsp

NCA01

BOYD CIRCUIT

HENDERSON STREET

HIDEAWAY LANE

NEWELL HIGHWAY

CONS LANE

CONS LANE

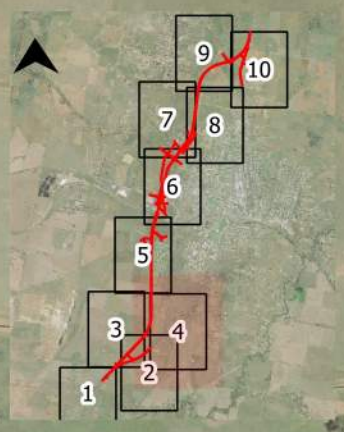
CONS LANE

AITKEN LANE

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD

PARKESBOROUGH RO



Map: Receiver maps	Author: TJG
Date: 25/09/2018	Approved by: CXM

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 4 of 10

wsp

HARTIGAN AVENUE

HARTIGAN AVENUE

ROSEWOOD AVENUE

ALDER AVENUE

BLAXLAND STREET

WARRAGRAH PLACE

BALLERDEE LANE

LONDON ROAD

LONDON ROAD

LONDON ROAD

LONDON ROAD

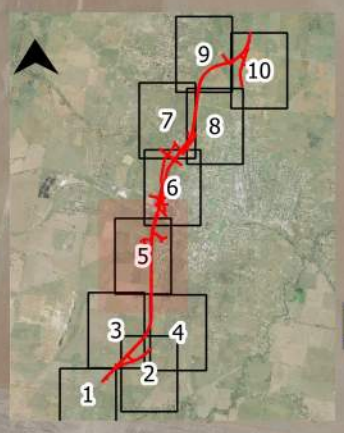
AGKROYD STREET

SALEYARDS ROAD

HIDEAWAY LANE

NCA01

NCA02



Map: Receiver maps	Author: TJG
Date: 25/09/2018	Approved by: CXM

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 5 of 10

Map: Receiver maps	Author: TJG		
Date: 25/09/2018	Approved by: CXM		

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 6 of 10

wsp

Map: Receiver maps	Author: TJG	
Date: 25/09/2018	Approved by: CXM	

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

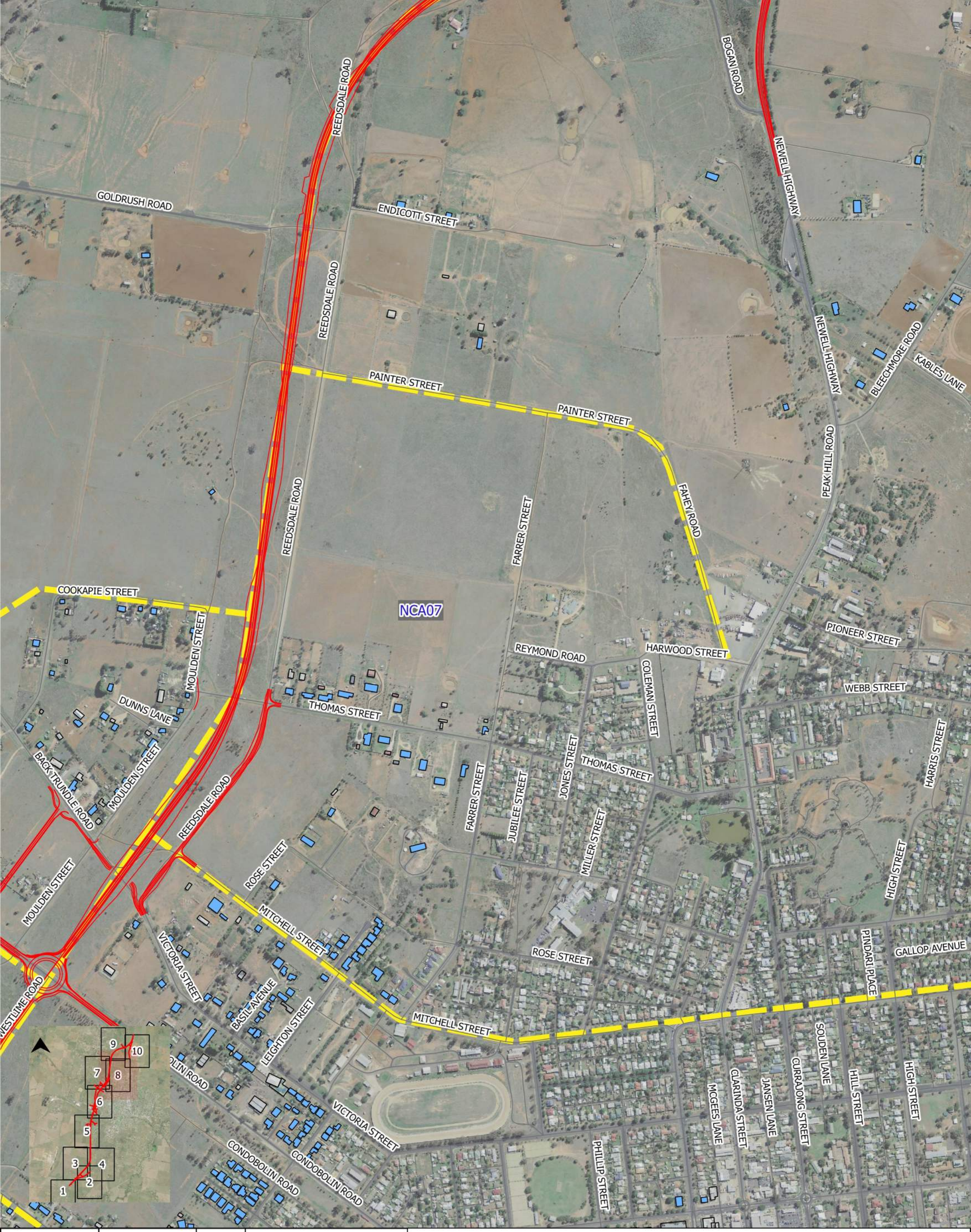
Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 7 of 10

wsp



Map: Receiver maps	Author: TJG
Date: 25/09/2018	Approved by: CXM

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 8 of 10

wsp

DEEP LEAD ROAD
DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NCA10
HERAGHTY ROAD
NCA08
NEWELL HIGHWAY
NEWELL HIGHWAY
REEDSDALE ROAD
BOGAN ROAD
NEWELL HIGHWAY
GOLDRUSH ROAD
ENDICOTT STREET
REEDSDALE ROAD
PAINTER STREET
PAINTER STREET
NEWELL HIGHWAY
1
2
3
4
5
6
7
8
9
10

Map: Receiver maps	Author: TJG	
Date: 25/09/2018	Approved by: CXM	

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 9 of 10

wsp

NCA10

NEWELL HIGHWAY

BOGAN ROAD

REEDSDALE ROAD

MAGUIRE ROAD

NOCK ROAD

BLEECHMORE ROAD

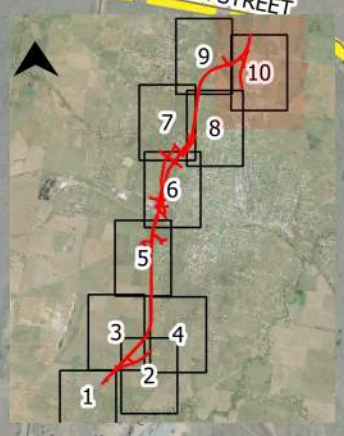
NOBLE ROAD

KABLES LANE

PEAK HILL ROAD

PAINTER STREET

FAHEY ROAD



Map: Receiver maps	Author: TJG
Date: 25/09/2018	Approved by: CXM

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Receiver type

- Residential
- Commercial
- Child Care Centre
- Education
- Place of Worship
- Industrial
- Outdoor Passive recreational Area
- Outdoor Active Recreational Area

Newell Highway Bypass Upgrade, Parkes

Receiver maps
Map 10 of 10

wsp

Appendix B

Ambient noise monitoring

B1 Ambient noise monitoring results – NM01

Noise monitoring location no:		NM01		Noise monitoring map
Noise monitoring address:		2683 Newell Highway Parkes		
Logger type:	SVAN 959	Logger serial number:	11225	

Description of ambient

Ambient noise logger deployed in the front garden of residential address 2683 Newell Highway, Parkes. Logger located next to a tree on the northern boundary of the property.

Attended noise measurements indicate that the ambient noise environment at this location is dominated by distant trees rustling and birds chirping, with the Newell Highway partially audible. Cars did not produce a distinct noise when passing by. Heavier vehicles such as B doubles produced a more noticeable pass-by event when using compression brakes. Intermittent noise from animals such as dogs and horses was also present.

Ambient Noise Logging Results – NPfI Defined Time Periods

Monitoring period	Noise level (dBA)			
	RBL	L_{Aeq}	L_{10}	L_{Amax}
Daytime	36	54	58	73
Evening	32	49	54	67
Night-time	30	48	53	66

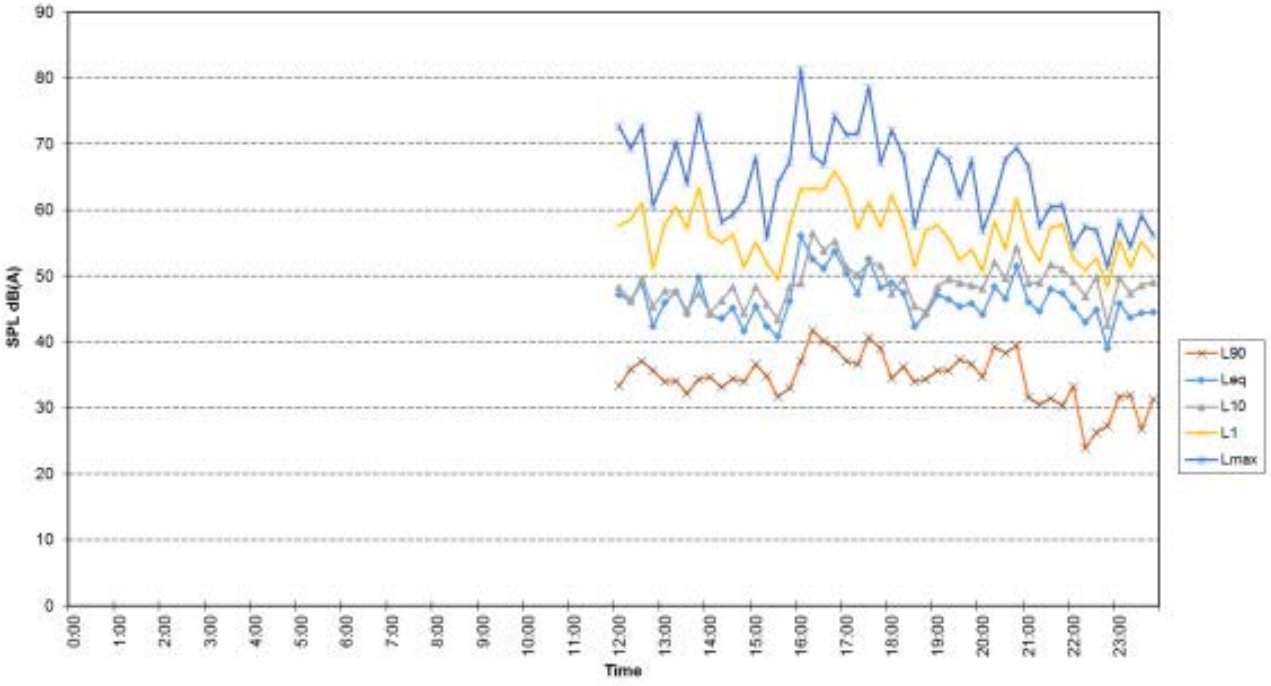
Ambient Noise Logging Results – NPfI Defined Time Periods

Monitoring period	$L_{Aeq, period}$	Max $L_{Aeq(1hr)}$	10% $L_{Aeq(1hr)}$
Daytime	53	60	59
Night-time	48	50	50

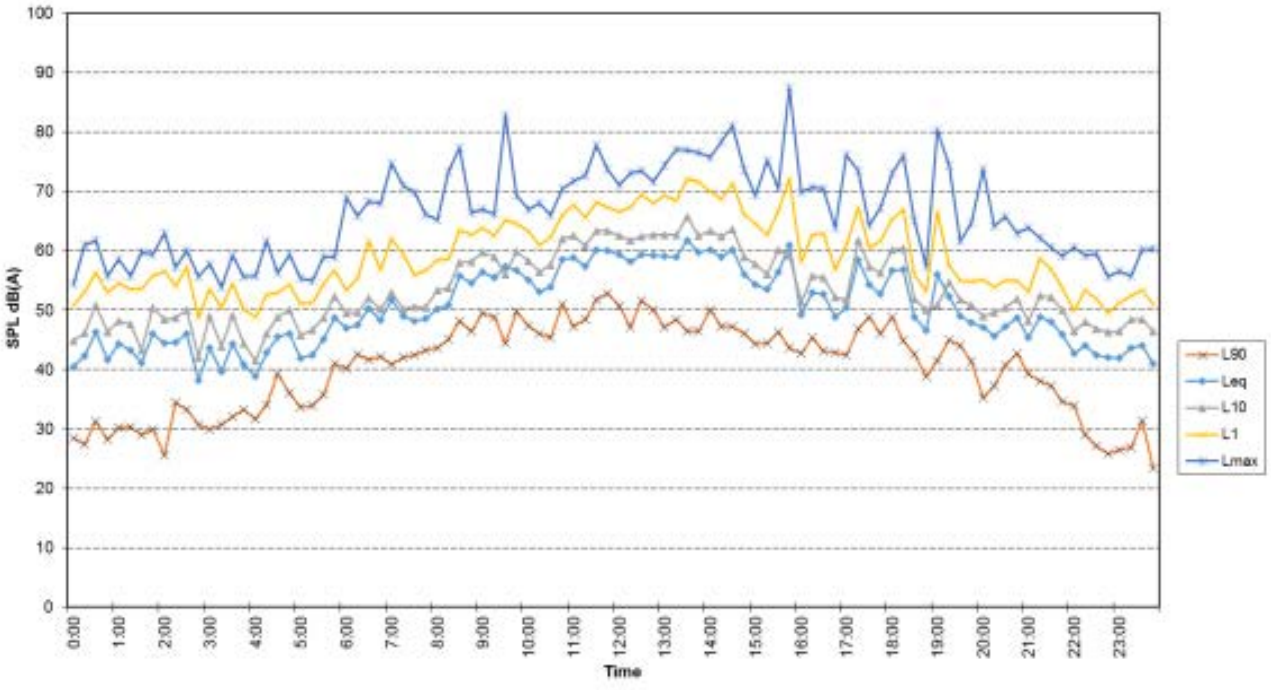
Operator attended noise measurement results

Date	Start time	Measured noise level (dBA)		
		L_{90}	L_{Aeq}	L_{Amax}
07/12/2016	1150	35	43	71

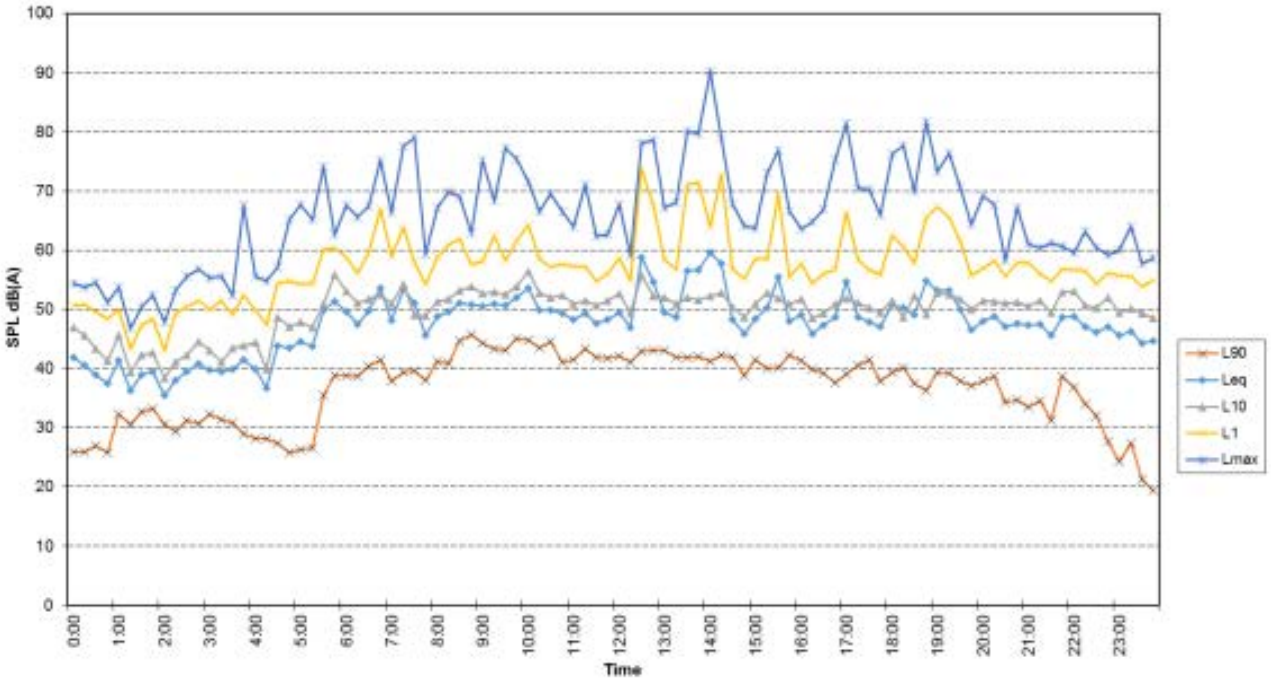
Location - NM01
Measured Noise Levels - Wednesday 07/12/2016



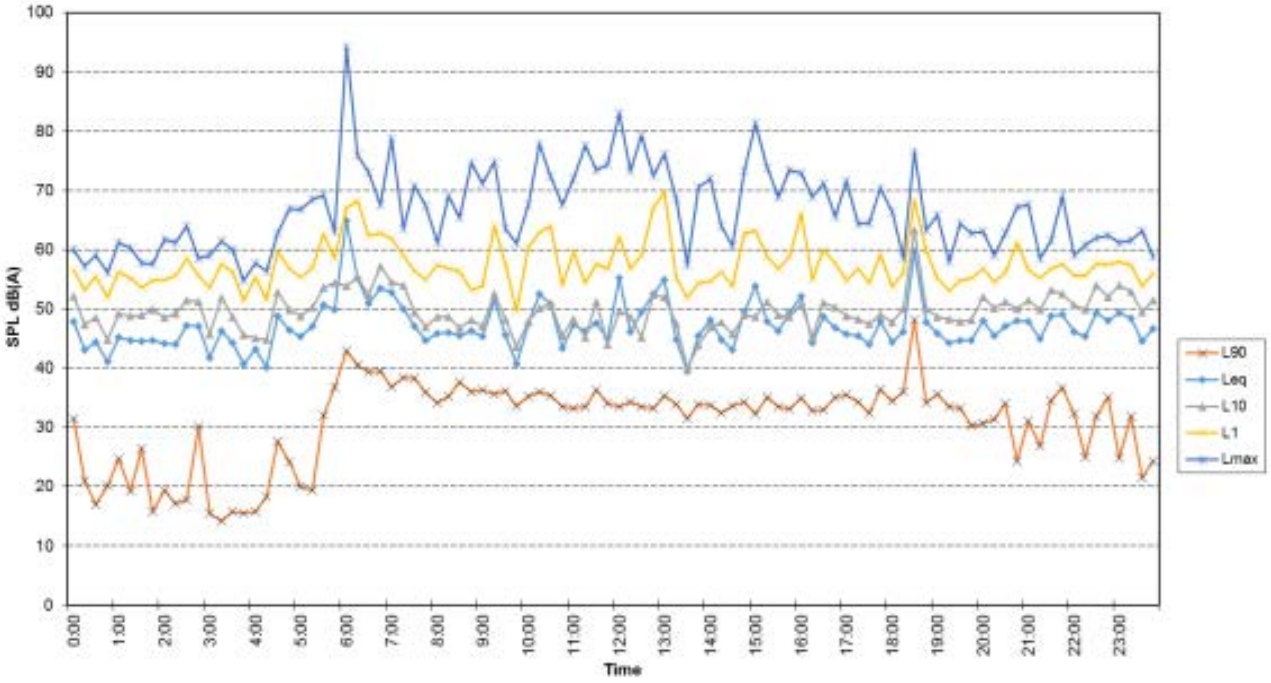
Location - NM01
Measured Noise Levels - Thursday 08/12/2016



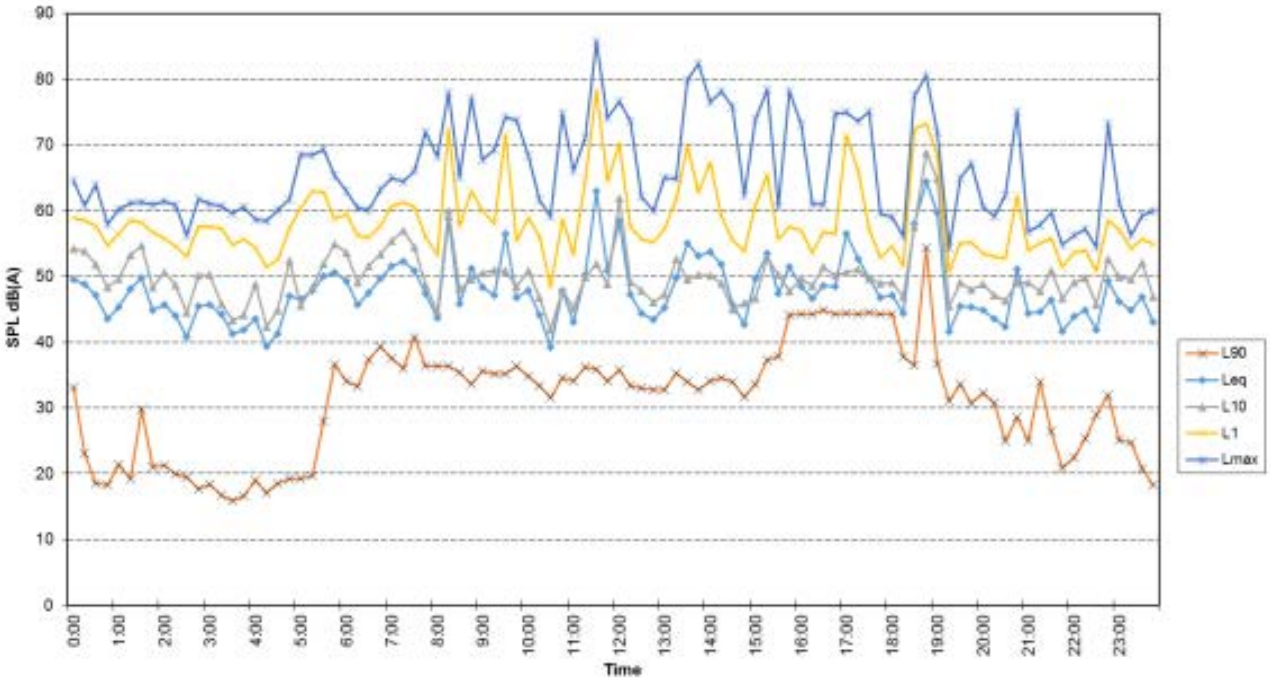
Location - NM01
Measured Noise Levels - Friday 09/12/2016



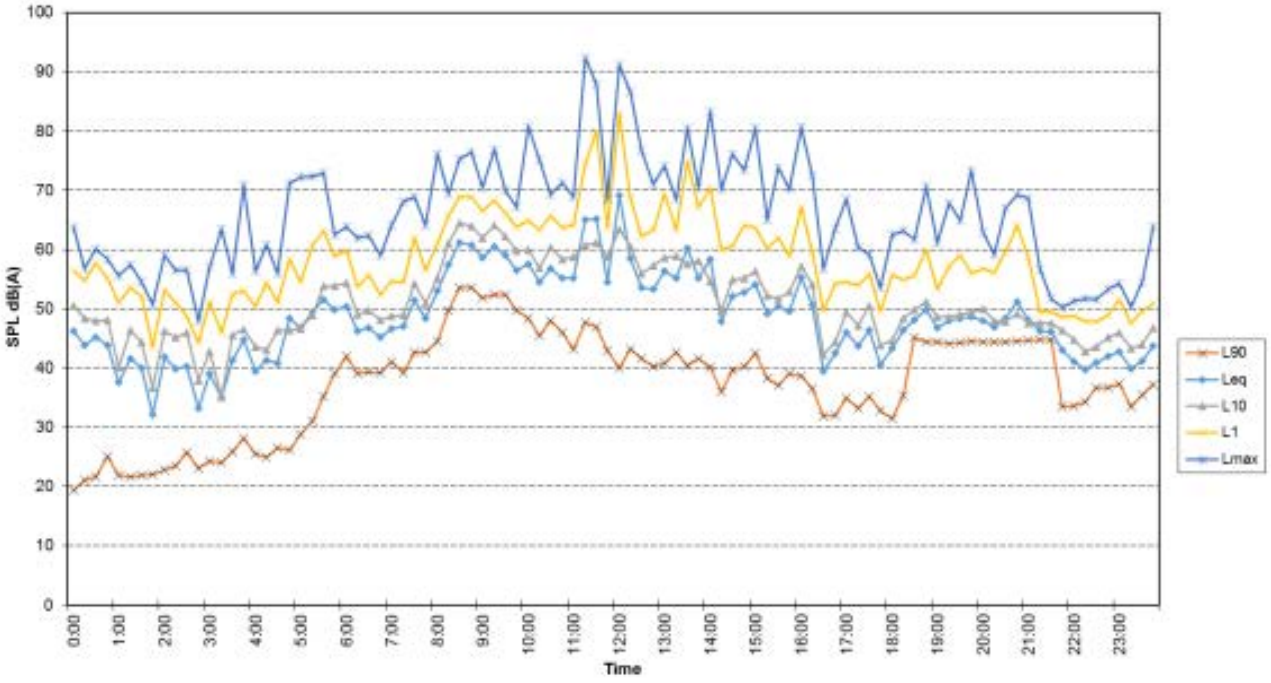
Location - NM01
Measured Noise Levels - Saturday 10/12/2016



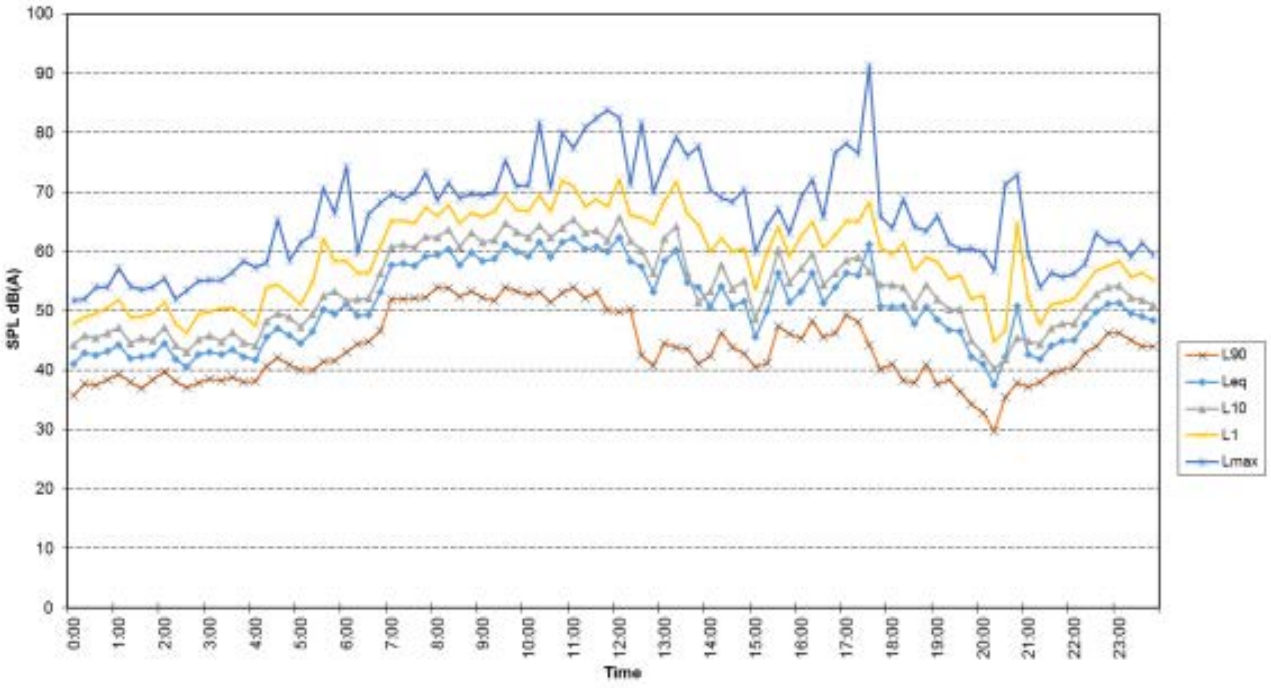
Location - NM01
Measured Noise Levels - Sunday 11/12/2016



Location - NM01
Measured Noise Levels - Monday 12/12/2016



Location - NM01
Measured Noise Levels - Tuesday 13/12/2016



Location - NM01
Measured Noise Levels - Wednesday 14/12/2016

B2 Ambient noise monitoring results – NM02

Noise monitoring location no:		NM02		Noise monitoring map
Noise monitoring address:		58 Brolgan Road, Parkes		
Logger Type:	SVAN 958	Logger Serial number:	14295	

Description of ambient

Ambient noise logger deployed in the front garden of residential address 58 Brolgan Road, Parkes. Logger located next to a tree approximately 5 m from building façade.

Attended noise measurements indicate that the ambient noise environment at this location is generally dominated by trees rustling and birds chirping. When traffic was present, vehicle noise was the dominant source. No heavy vehicles were observed passing the property during the attended measurement. Noise from cement rendering works across the street (primarily scraping of house walls) was also audible.

Ambient Noise Logging Results – NPfl Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	L_{Aeq}	L_{10}	L_{Amax}
Daytime	39	55	58	73
Evening	37	52	58	72
Night-time	31	48	53	65

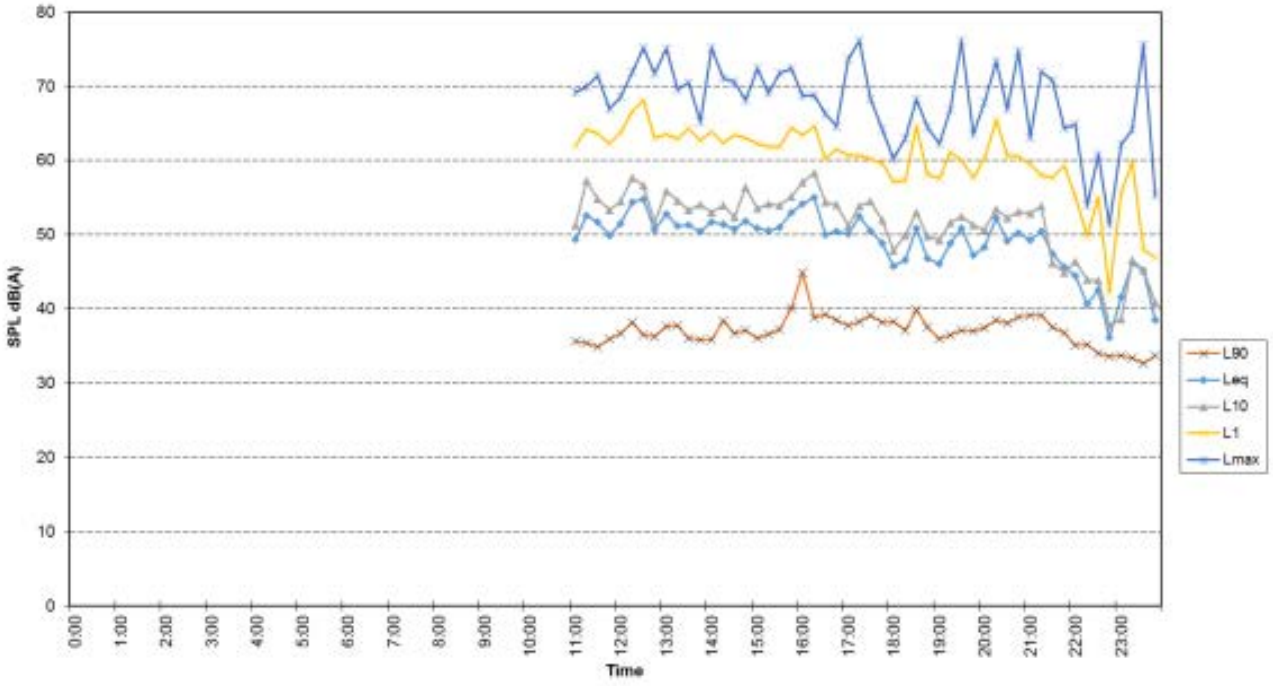
Ambient Noise Logging Results – NPfl Defined Time Periods

Monitoring period	$L_{Aeq, period}$	Max $L_{Aeq(1hr)}$	10% $L_{Aeq(1hr)}$
Daytime	54	57	57
Night-time	48	53	52

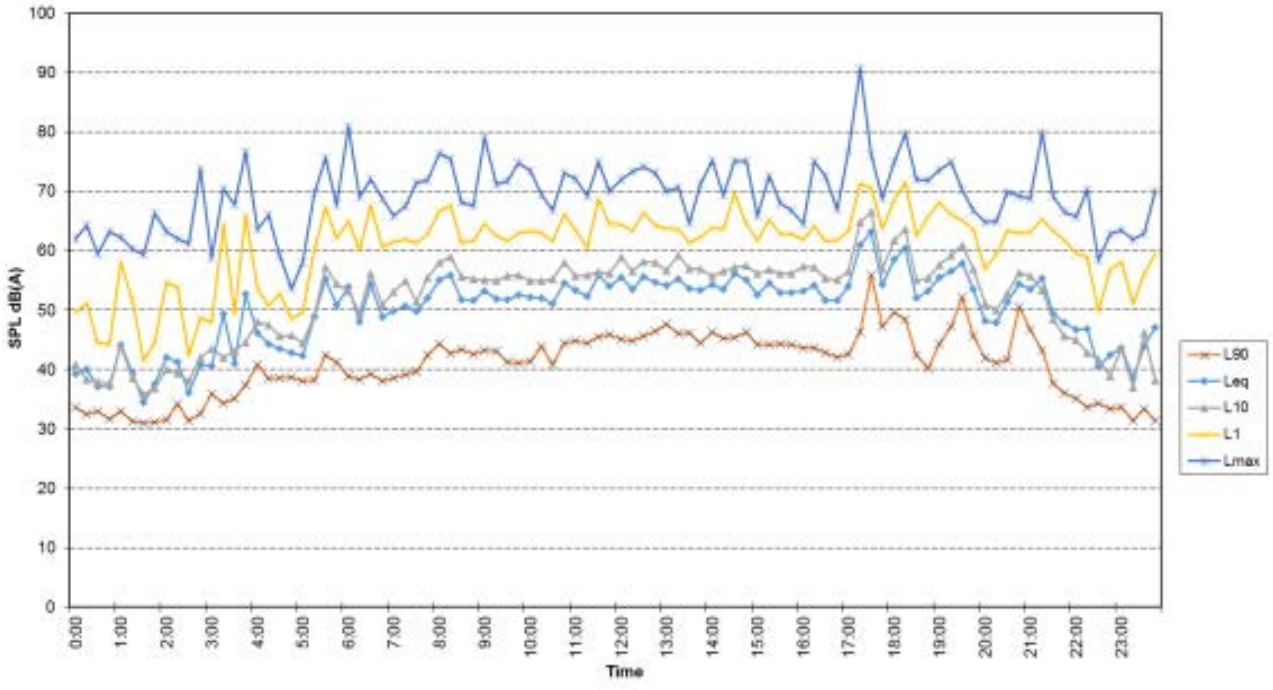
Operator attended noise measurement results

Date	Start time	Measured noise level (dBA)		
		L_{90}	L_{Aeq}	L_{Amax}
07/12/2016	1015	35	43	71

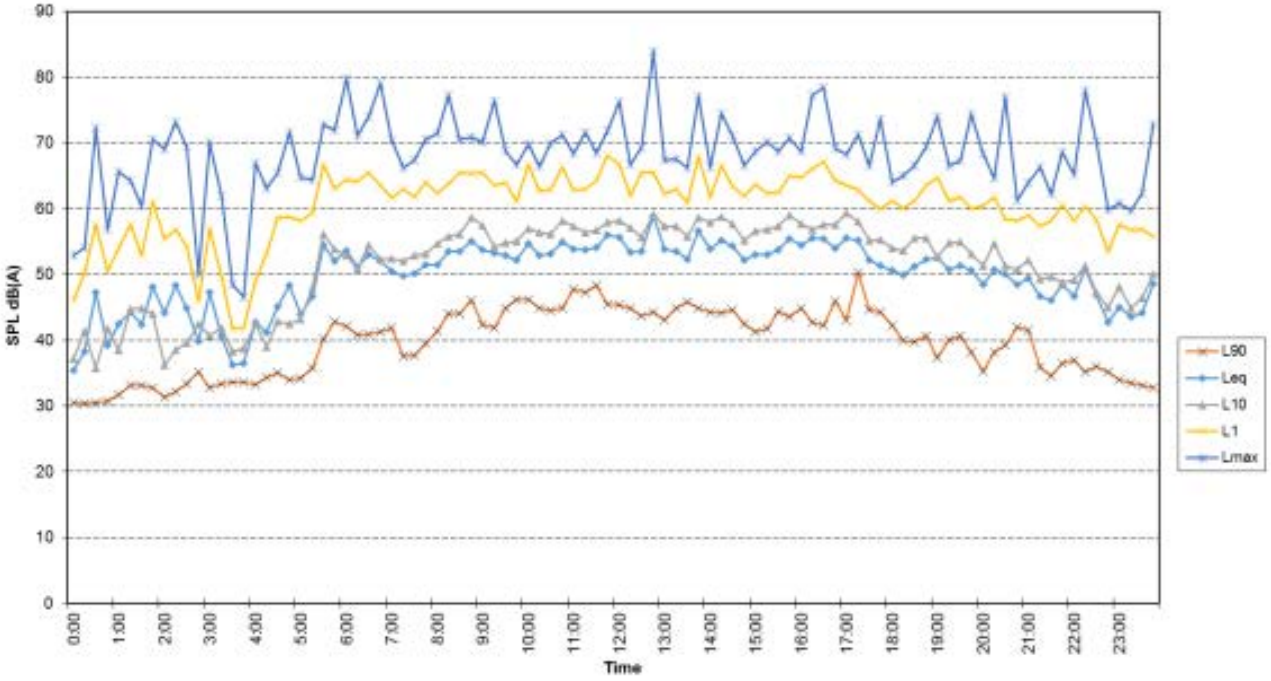
Location - NM02
Measured Noise Levels - Wednesday 07/12/2016



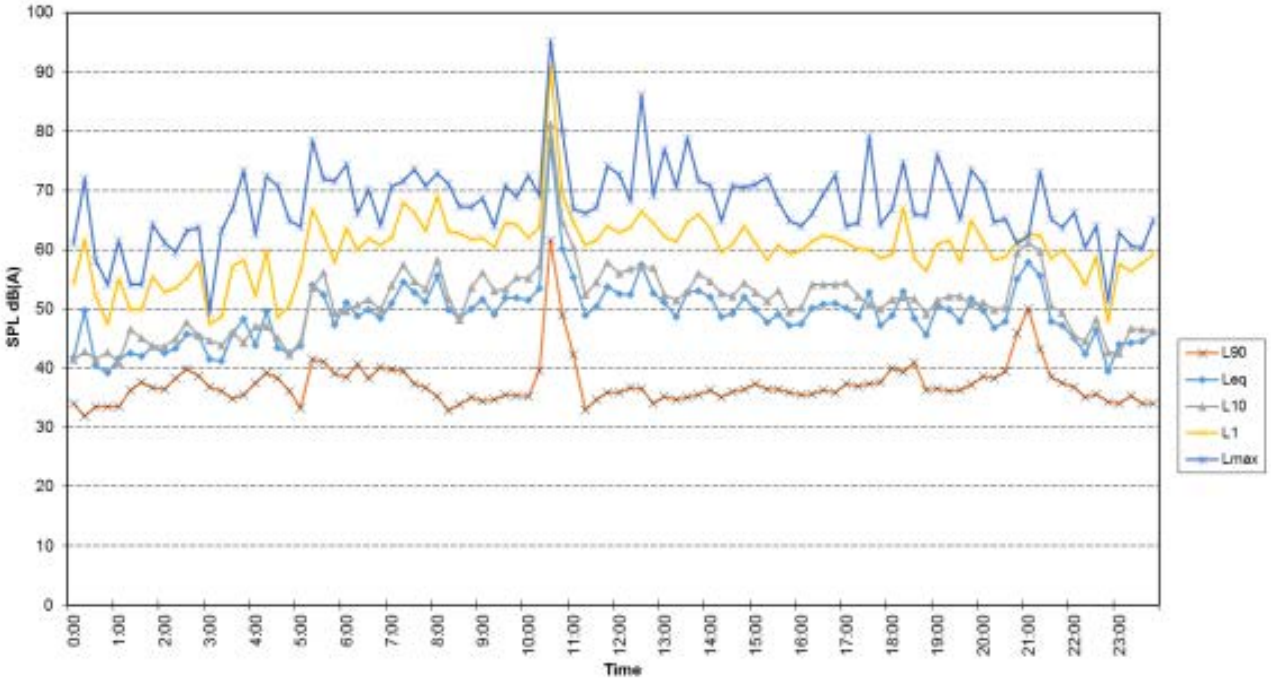
Location - NM02
Measured Noise Levels - Thursday 08/12/2016



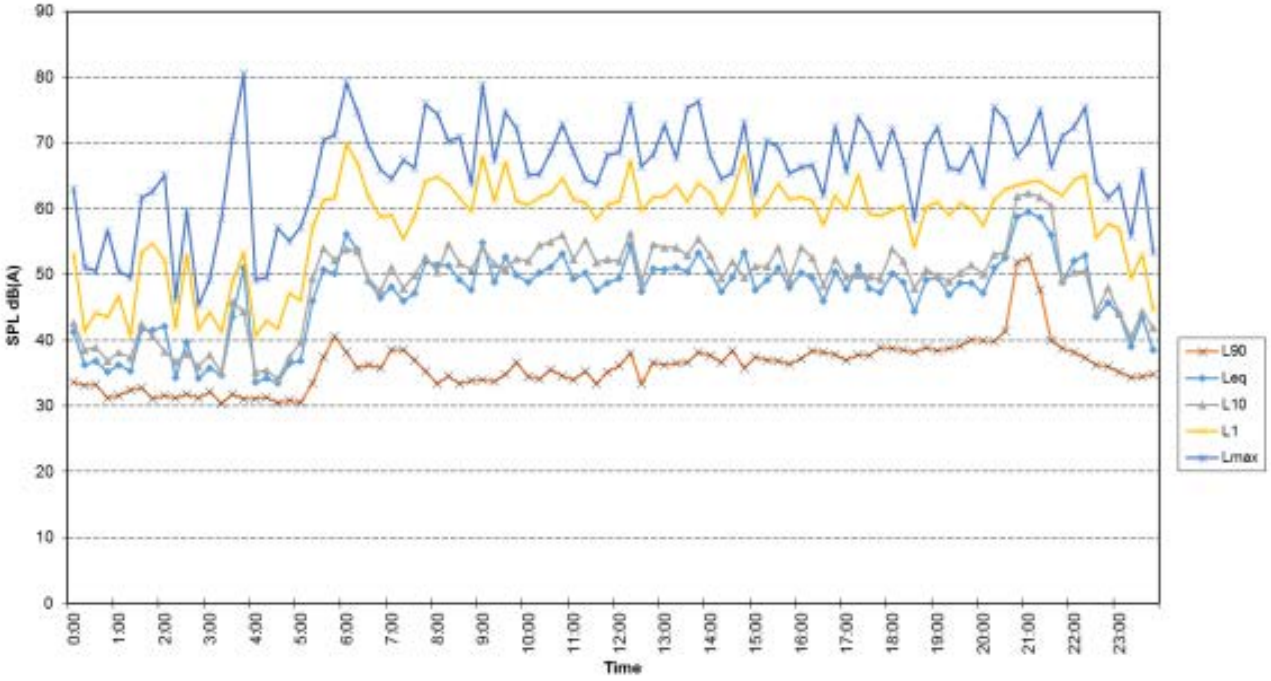
Location - NM02
Measured Noise Levels - Friday 09/12/2016



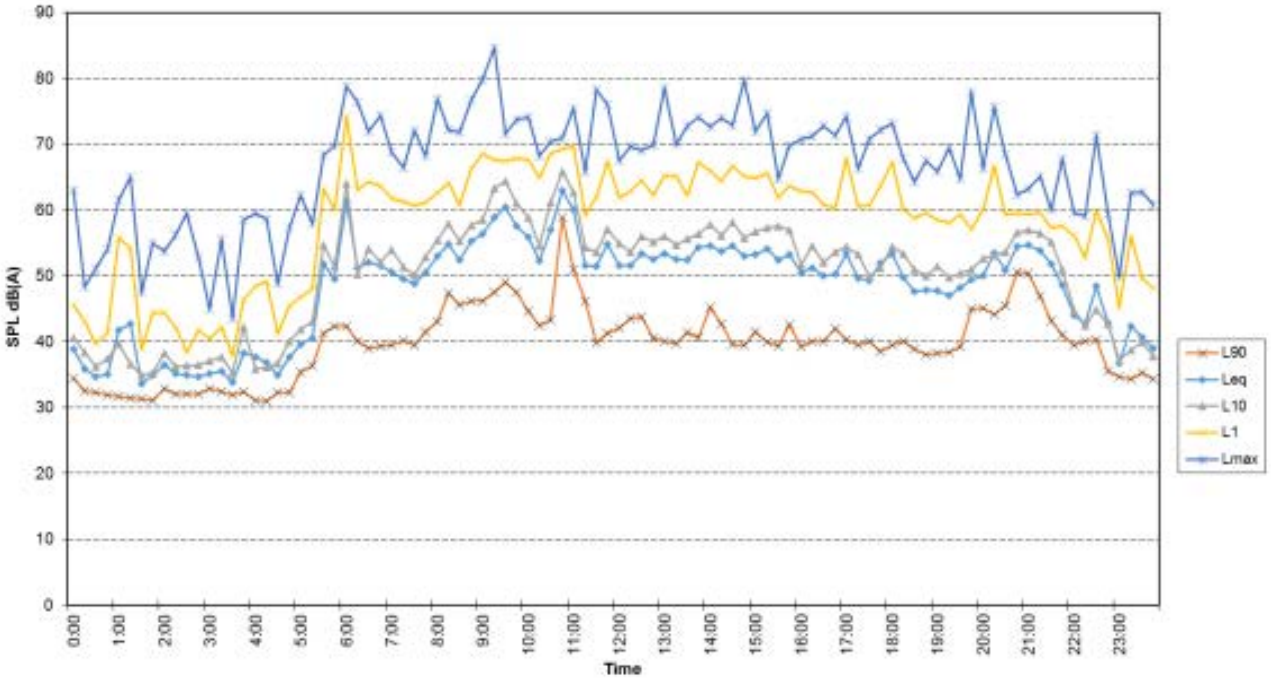
Location - NM02
Measured Noise Levels - Saturday 10/12/2016



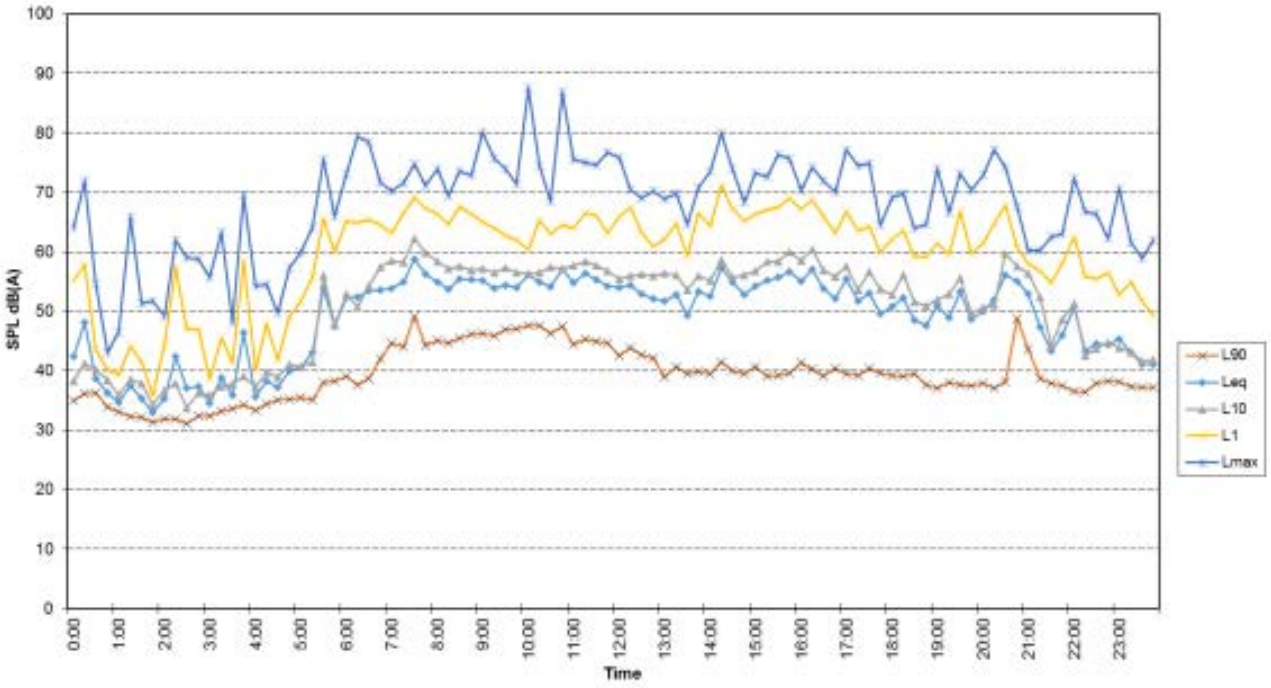
Location - NM02
Measured Noise Levels - Sunday 11/12/2016



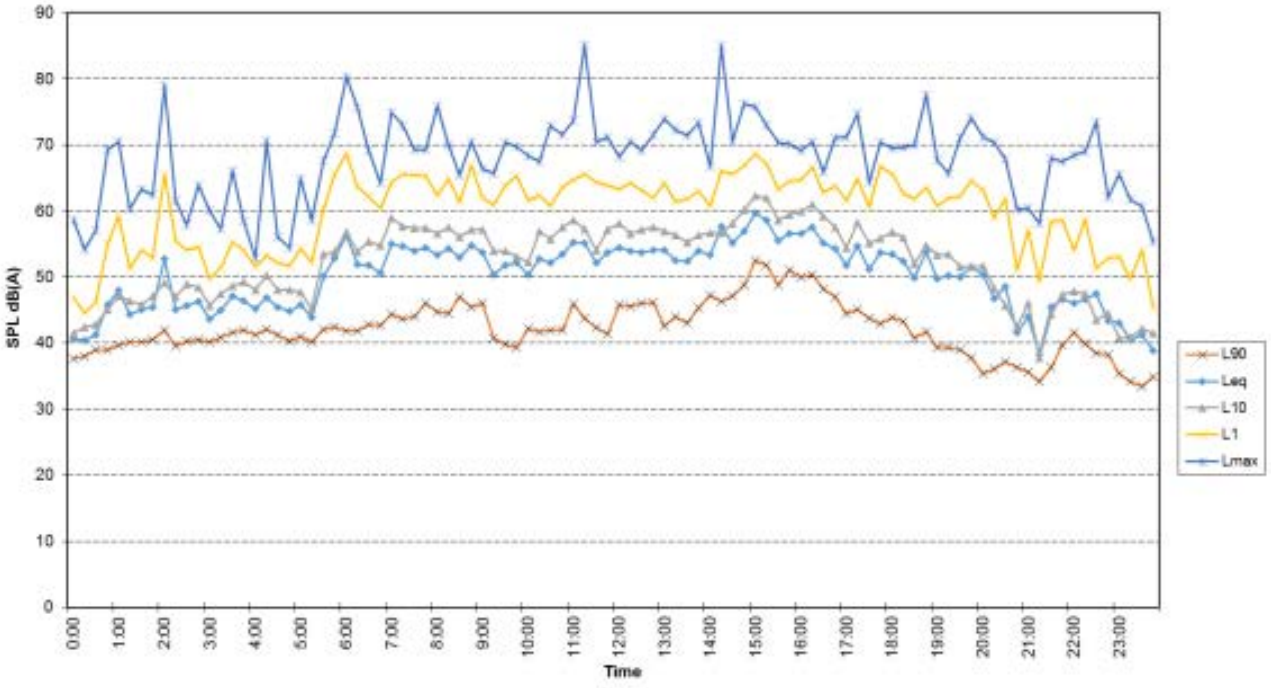
Location - NM02
Measured Noise Levels - Monday 12/12/2016



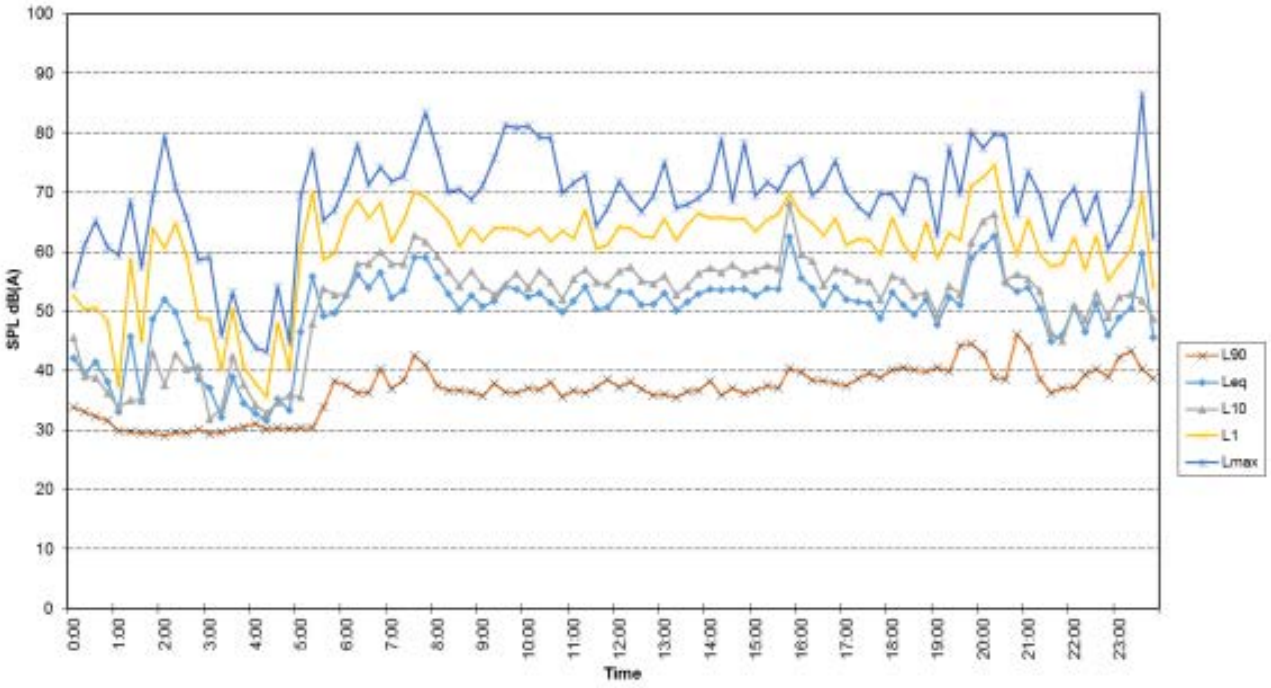
Location - NM02
Measured Noise Levels - Tuesday 13/12/2016



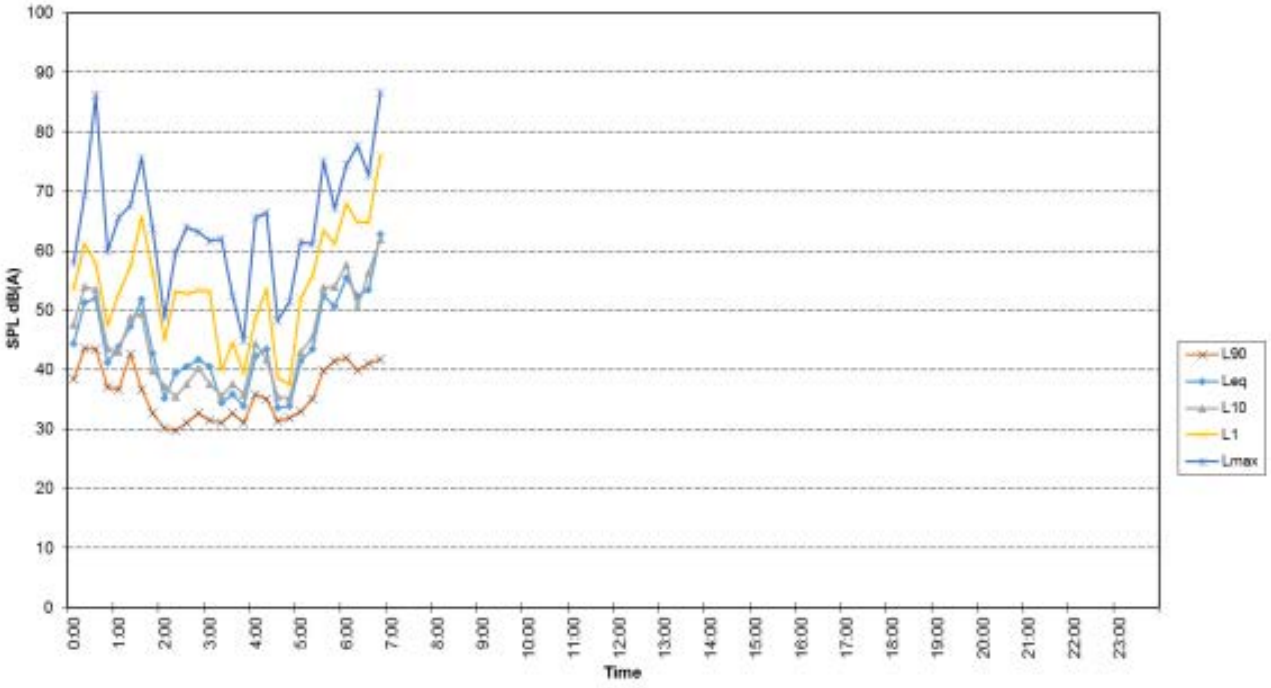
Location - NM02
Measured Noise Levels - Wednesday 14/12/2016



Location - NM02
Measured Noise Levels - Thursday 15/12/2016



Location - NM02
Measured Noise Levels - Friday 16/12/2016



B3 Ambient noise monitoring results – NM03

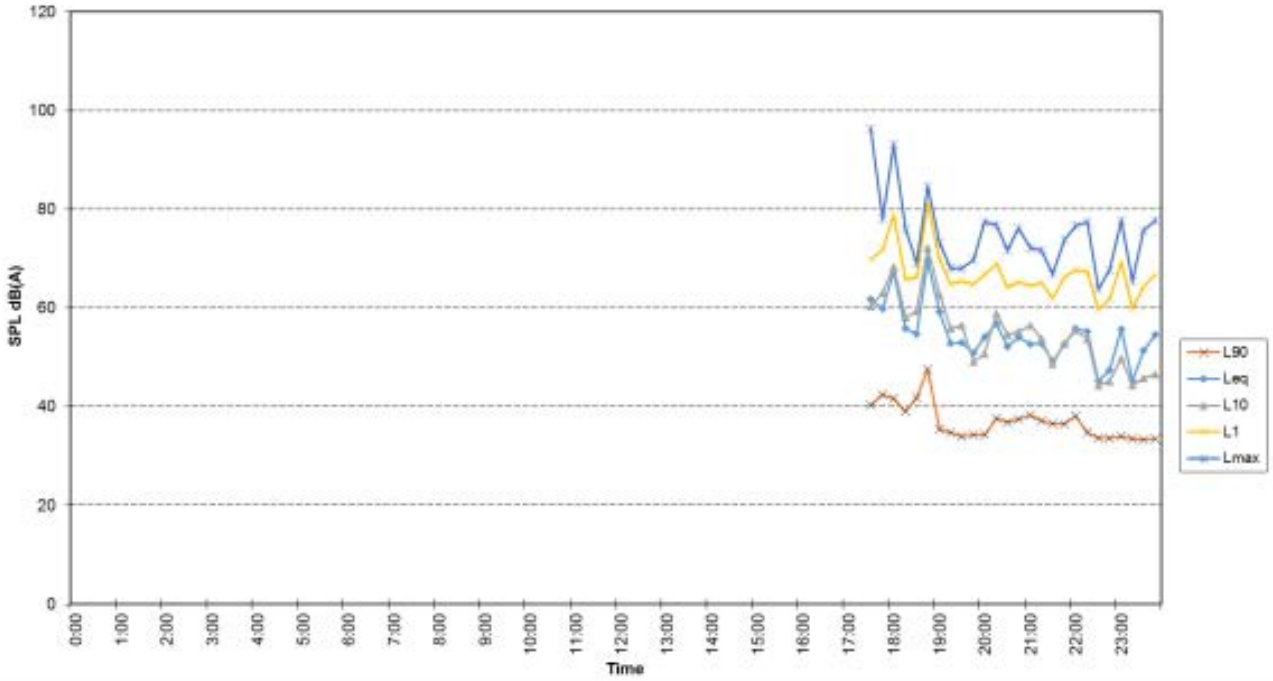
Noise monitoring location no:		NM03		Noise monitoring map
Noise monitoring address:		122 Condobolin Road, Parkes		
Logger Type:	SVAN 958	Logger Serial number:	36693	
Description of ambient				
Ambient noise logger deployed in the front garden of residential address 122 Condobolin Road, Parkes. Logger located next to a telegraph pole approximately 12 m from road edge. Attended noise measurements indicate that the ambient noise environment at this location is generally dominated by trees rustling and birds chirping. When traffic was present, vehicle noise was the dominant source. Heavy vehicles were observed passing the property. A lawnmower in the distance was also heard intermittently.				

Ambient Noise Logging Results – NPfl Defined Time Periods				
Monitoring period	Noise level (dBA)			
	RBL	L_{Aeq}	L_{10}	L_{Amax}
Daytime	41	58	62	78
Evening	38	56	59	77
Night-time	32	50	52	70

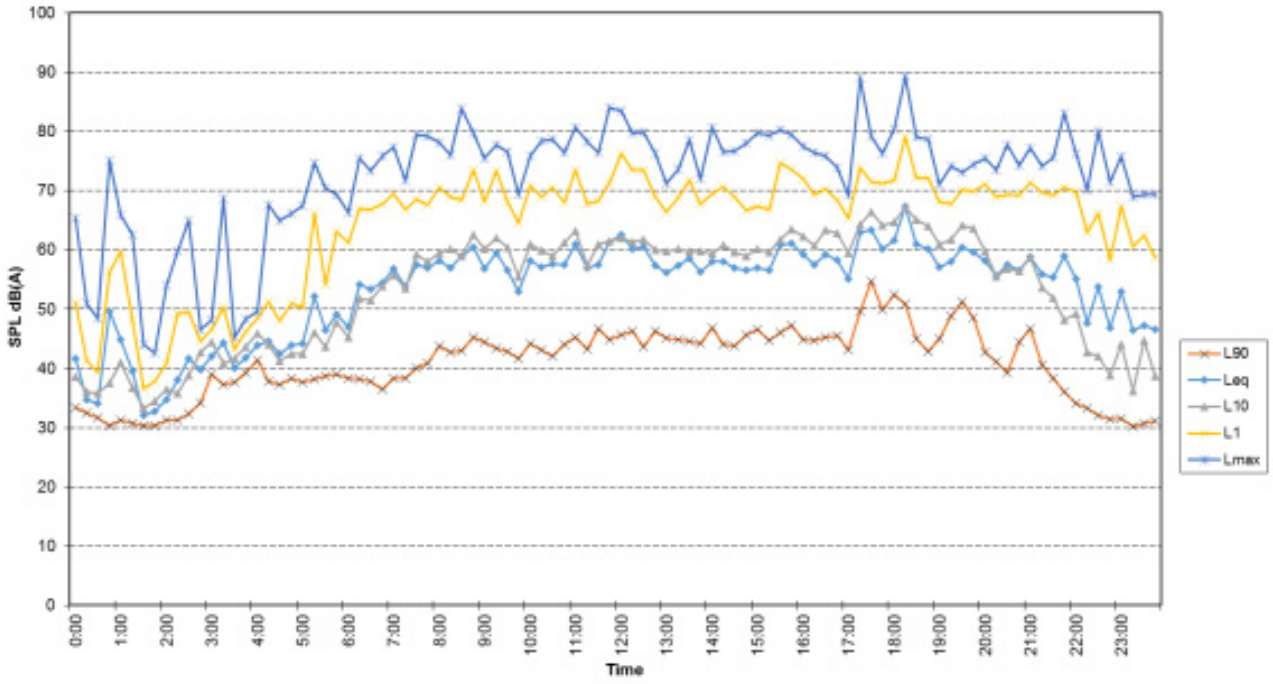
Ambient Noise Logging Results – NPfl Defined Time Periods			
Monitoring period	$L_{Aeq, period}$	Max $L_{Aeq(1hr)}$	10% $L_{Aeq(1hr)}$
Daytime	57	59	59
Night-time	50	54	53

Operator attended noise measurement results				
Date	Start time	Measured noise level (dBA)		
		L_{90}	L_{Aeq}	L_{Amax}
07/12/2016	1715	40	61	80

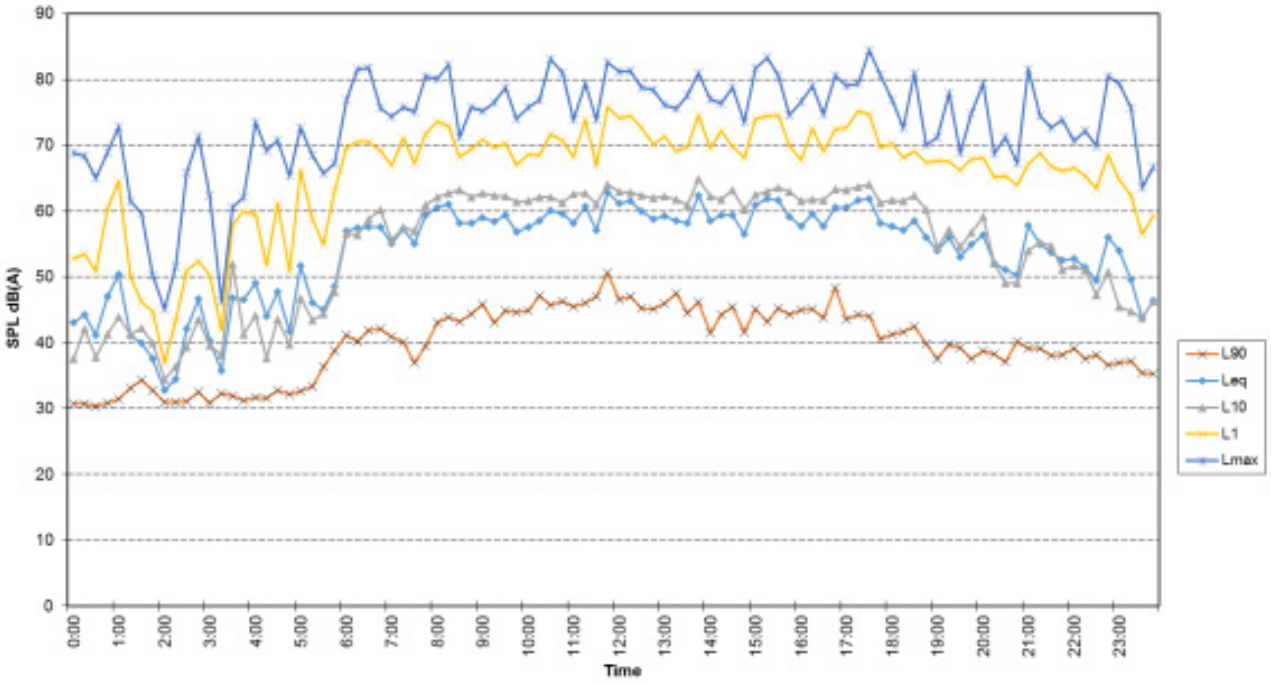
Location - NM03
Measured Noise Levels - Wednesday 07/12/2016



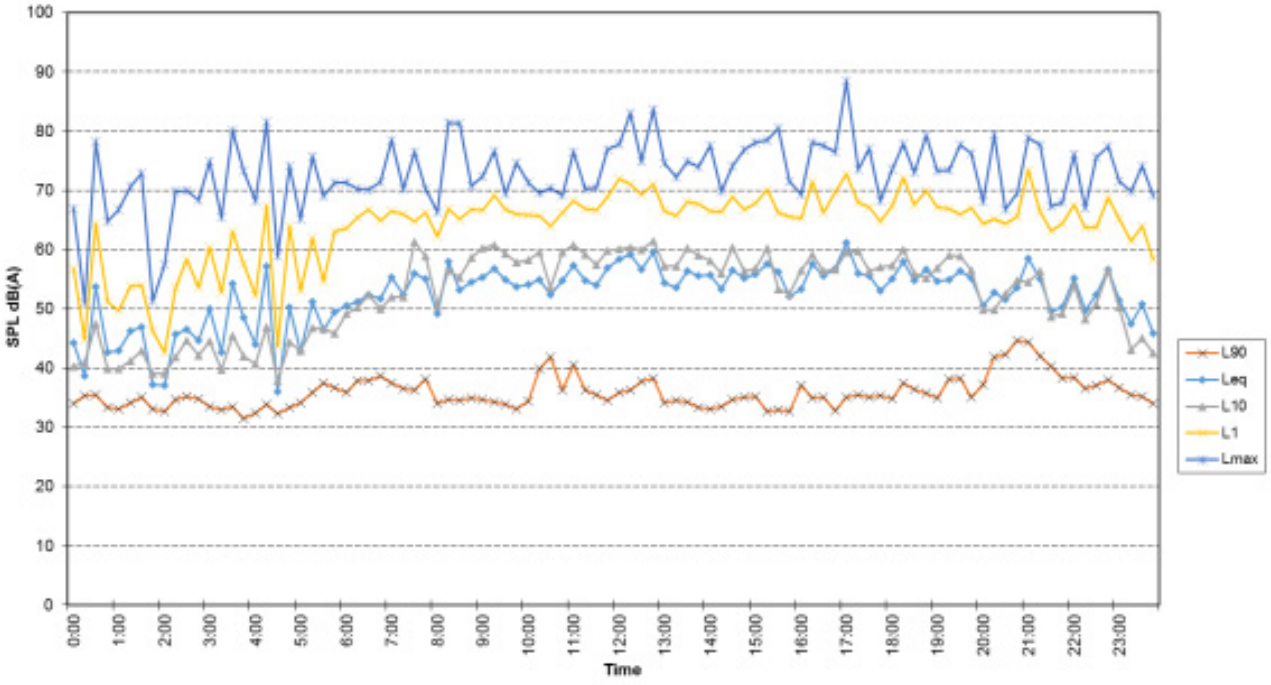
Location - NM03
Measured Noise Levels - Thursday 08/12/2016



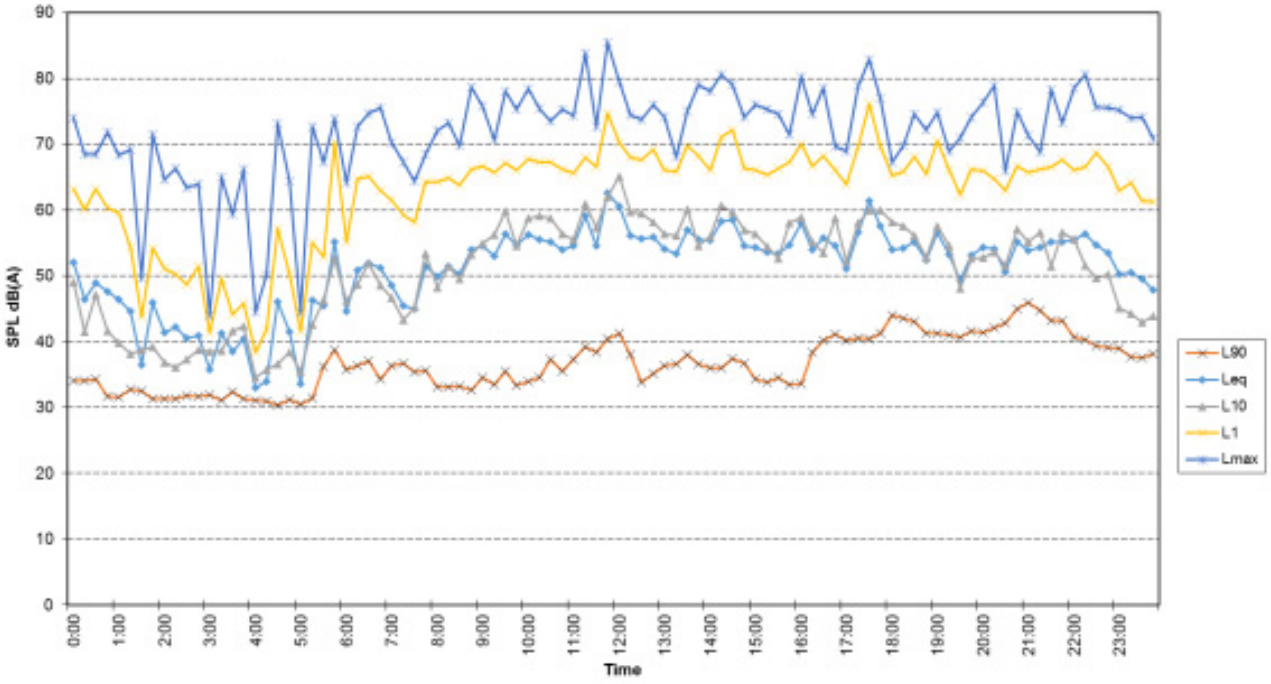
Location - NM03
Measured Noise Levels - Friday 09/12/2016



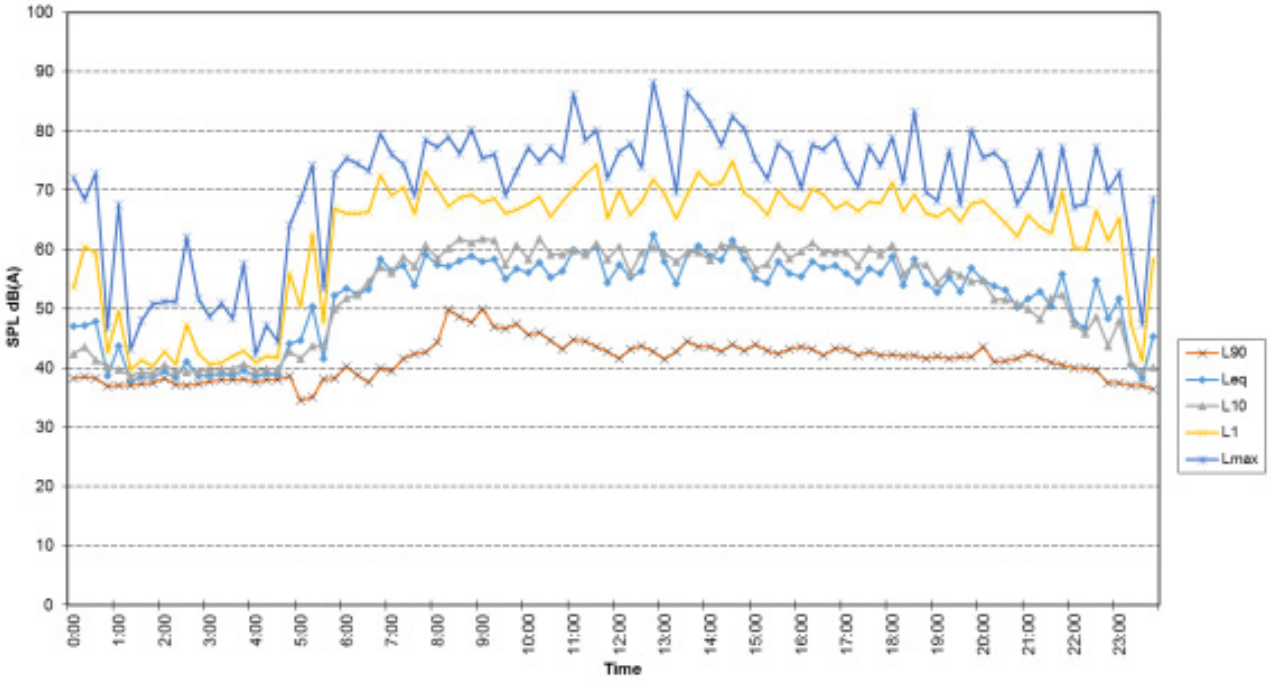
Location - NM03
Measured Noise Levels - Saturday 10/12/2016

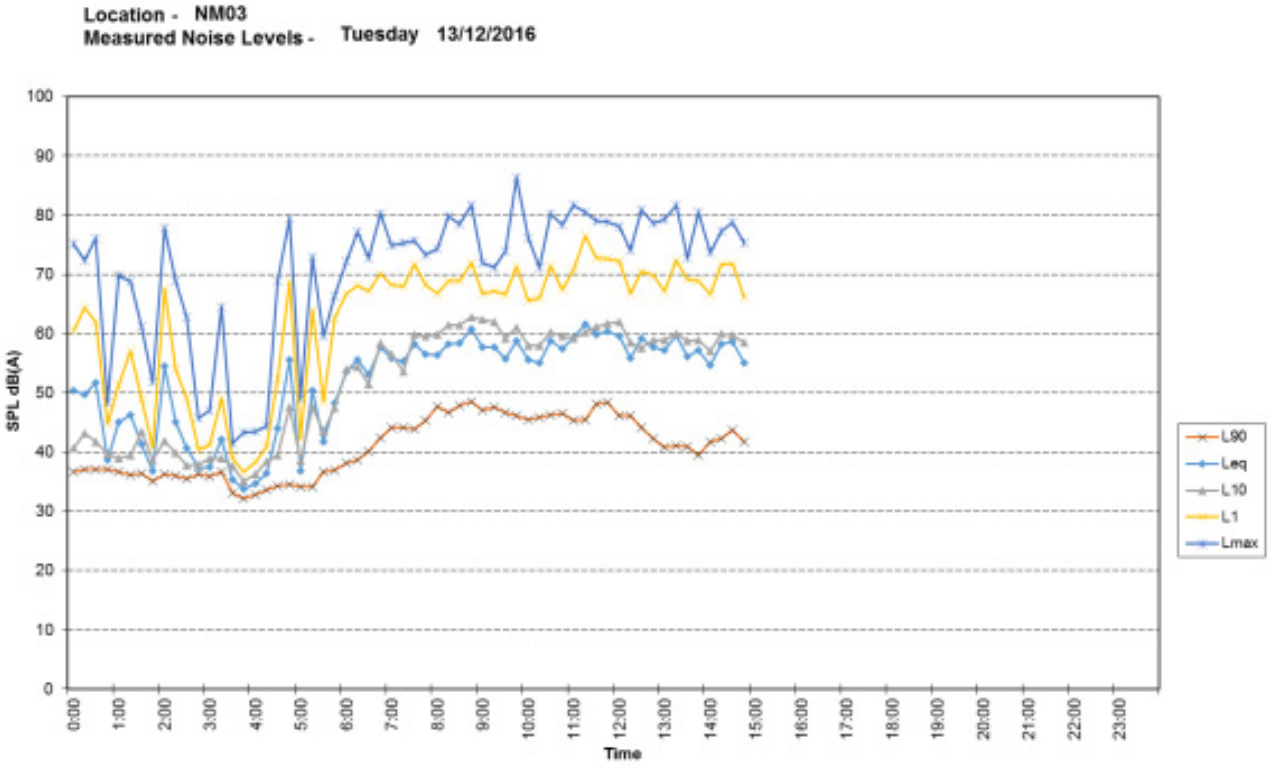


Location - NM03
Measured Noise Levels - Sunday 11/12/2016



Location - NM03
Measured Noise Levels - Monday 12/12/2016




Location - NM03
Measured Noise Levels - Tuesday 13/12/2016
SPL dB(A)
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
L90
Leq
L10
L1
Lmax

B4 Ambient noise monitoring results – NM04

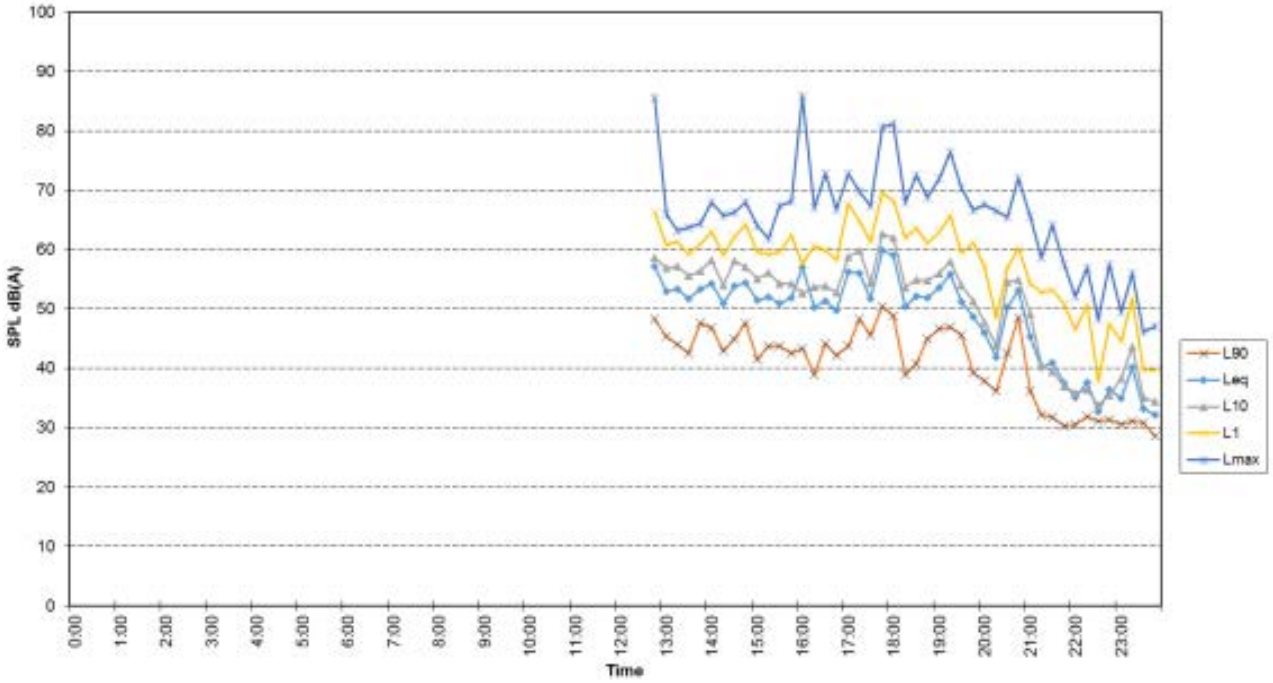
Noise monitoring location no:		NM04		Noise monitoring map
Noise monitoring address:		35 Thomas St, Parkes		
Logger type:	Norsonic Nor140	**Logger serial number:**	1406502	
Description of ambient				
Ambient noise logger deployed in the front garden of residential address 35 Thomas Street, Parkes. Logger located next to a tree approximately 35 m from road edge. Attended noise measurements indicate that the ambient noise environment at this location is generally dominated by trees rustling and birds chirping. Occasional vehicles on Thomas Street were audible but not common. No other distant traffic could be heard. Heavy vehicles were not observed passing the property.				

Ambient Noise Logging Results – NPfI Defined Time Periods				
Monitoring period	**Noise level (dBA)**			
	RBL	**L_{Aeq}**	**L_{10}**	**L_{Amax}**
Daytime	38	56	60	82
Evening	31	48	51	72
Night-time	30	48	52	73

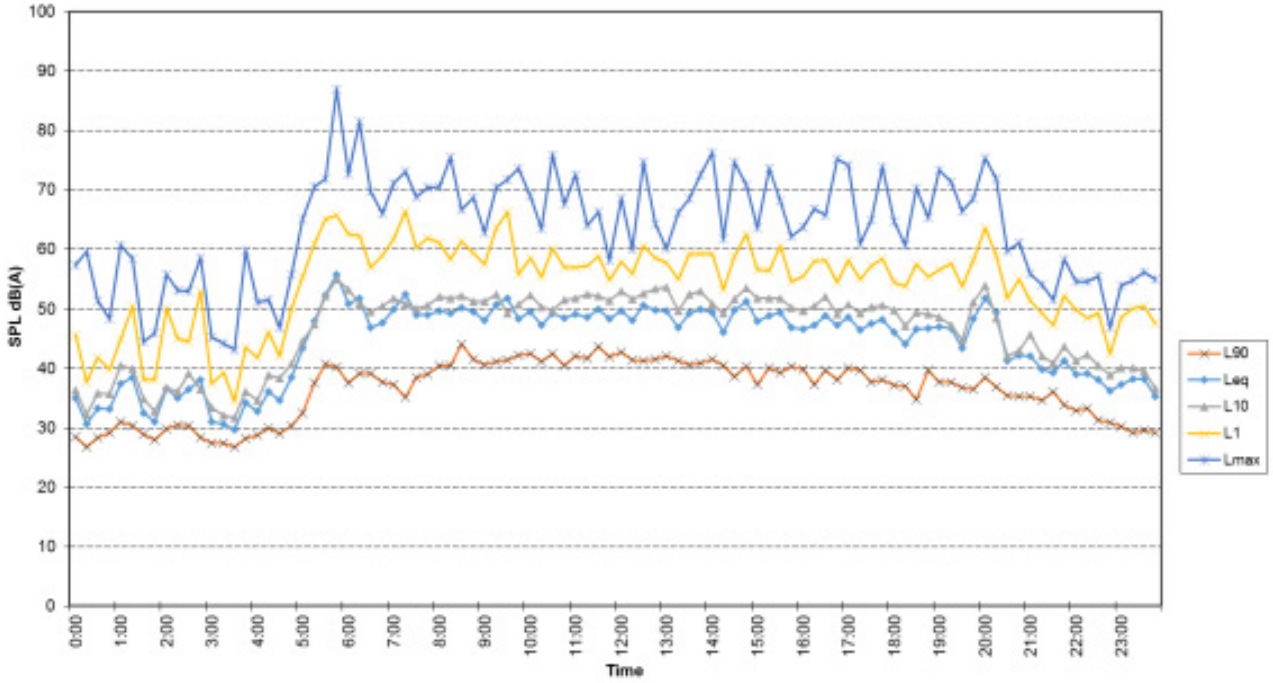
Ambient Noise Logging Results – NPfI Defined Time Periods			
Monitoring period	**$L_{Aeq, period}$**	**Max $L_{Aeq(1hr)}$**	**10% $L_{Aeq(1hr)}$**
Daytime	54	58	58
Night-time	48	54	50

Operator attended noise measurement results				
Date	**Start time**	**Measured noise level (dBA)**		
		L_{90}	**L_{Aeq}**	**L_{Amax}**
08/12/2016	**1210**	47	54	71

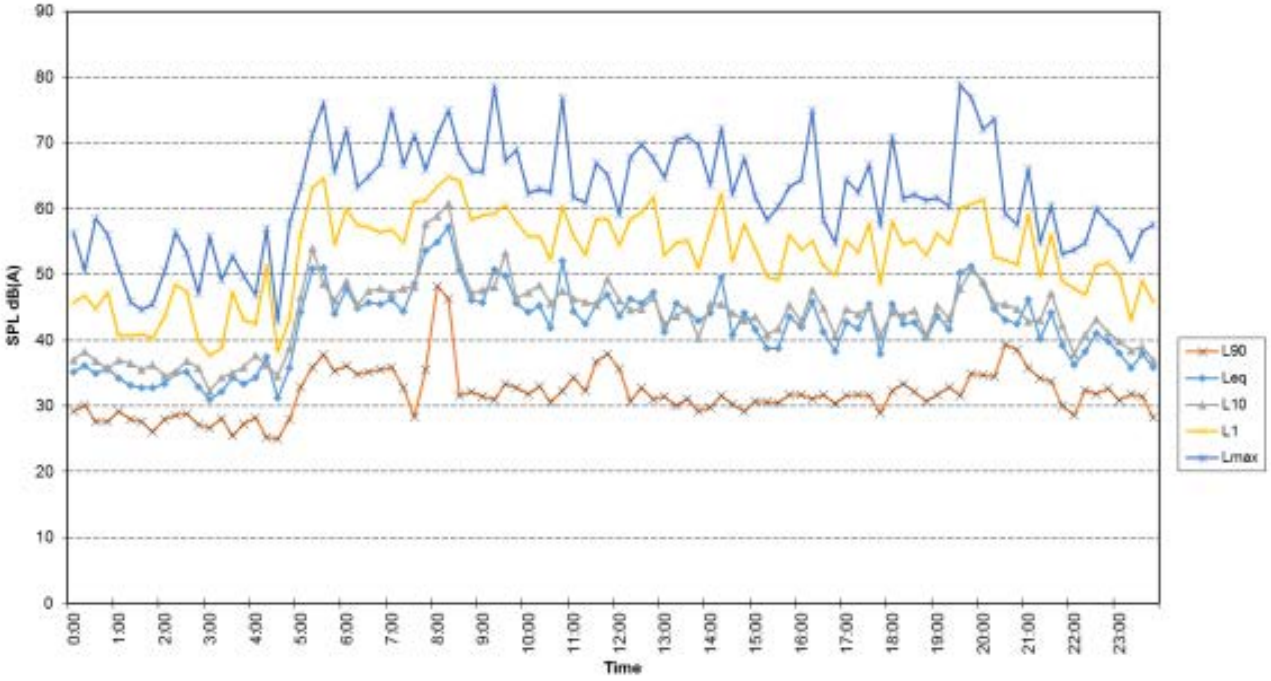
Location - NM04
Measured Noise Levels - Thursday 08/12/2016



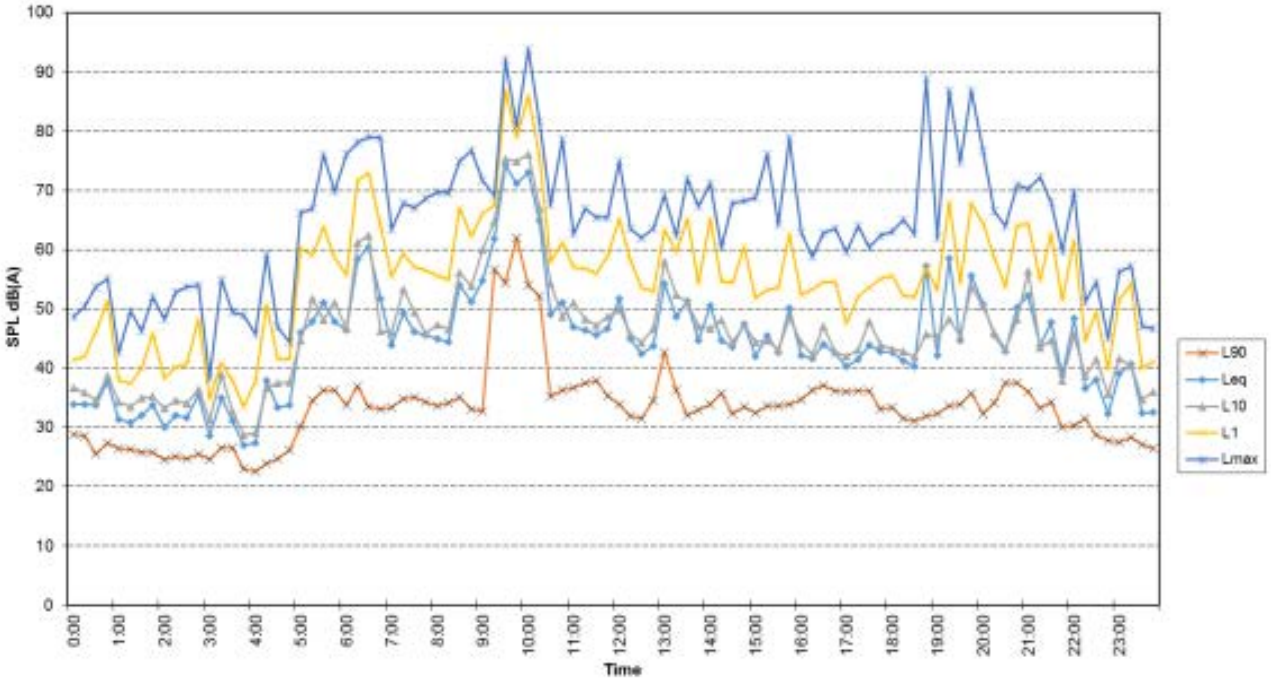
Location - NM04
Measured Noise Levels - Friday 09/12/2016



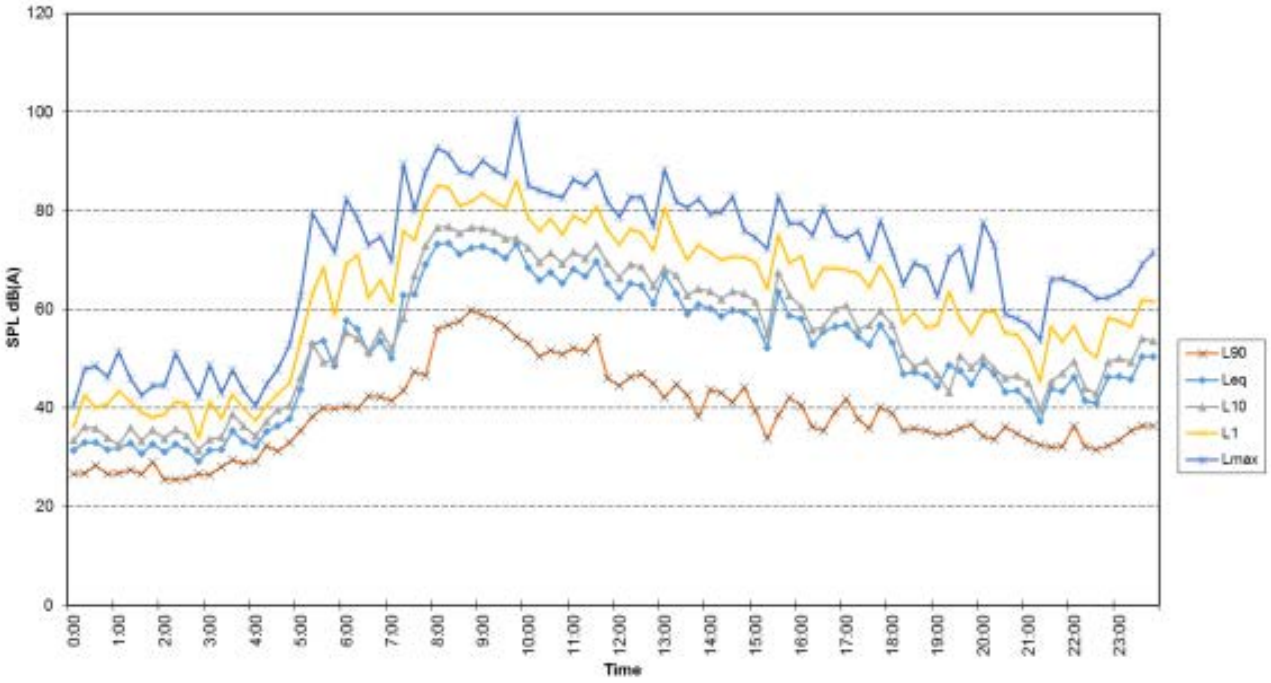
Location - NM04
Measured Noise Levels - Saturday 10/12/2016



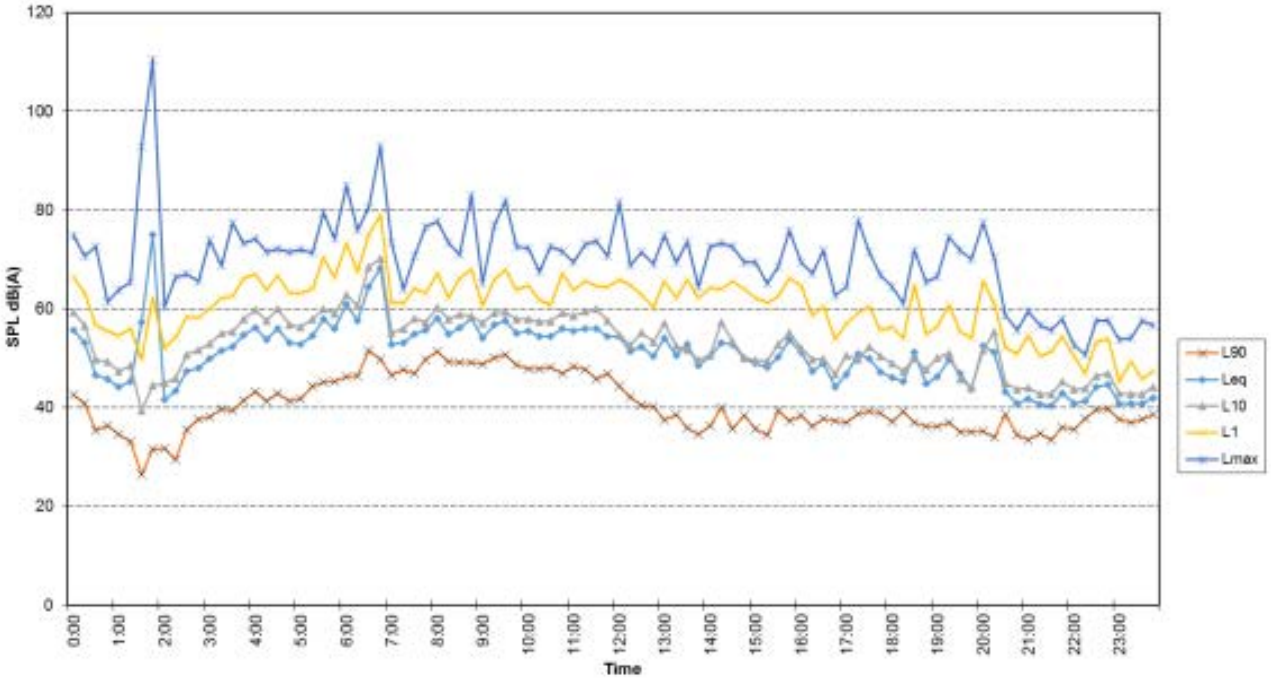
Location - NM04
Measured Noise Levels - Sunday 11/12/2016



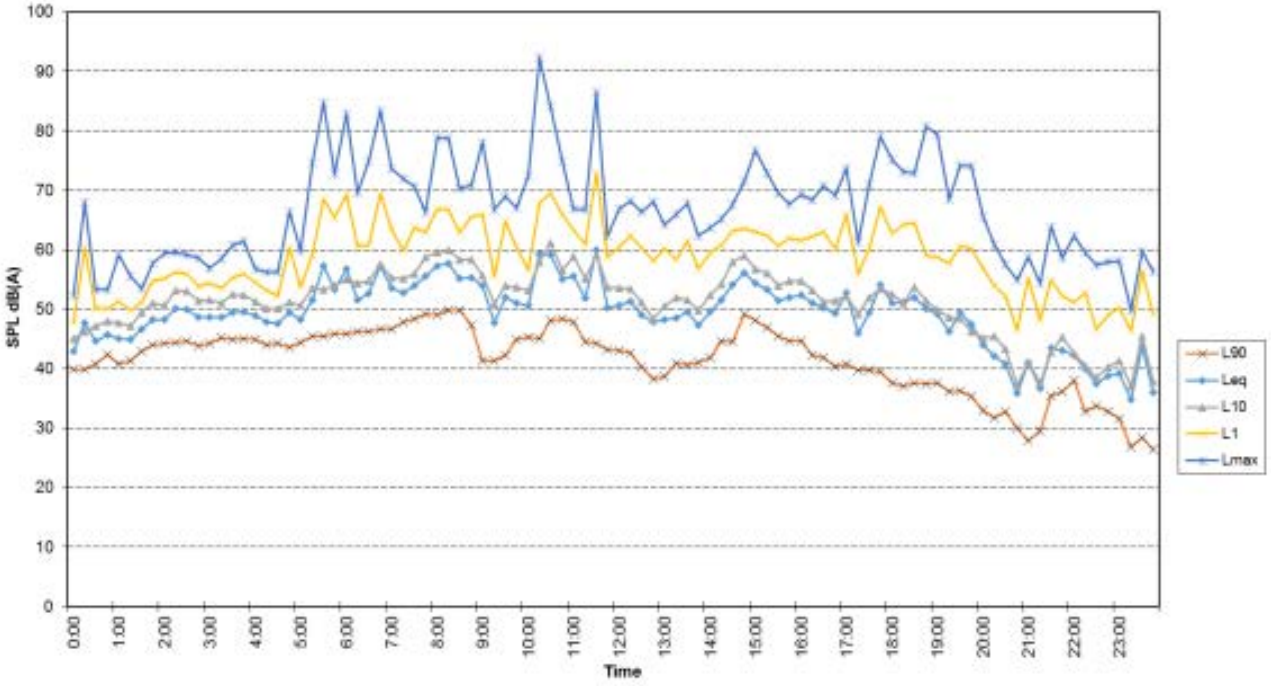
Location - NM04
Measured Noise Levels - Monday 12/12/2016



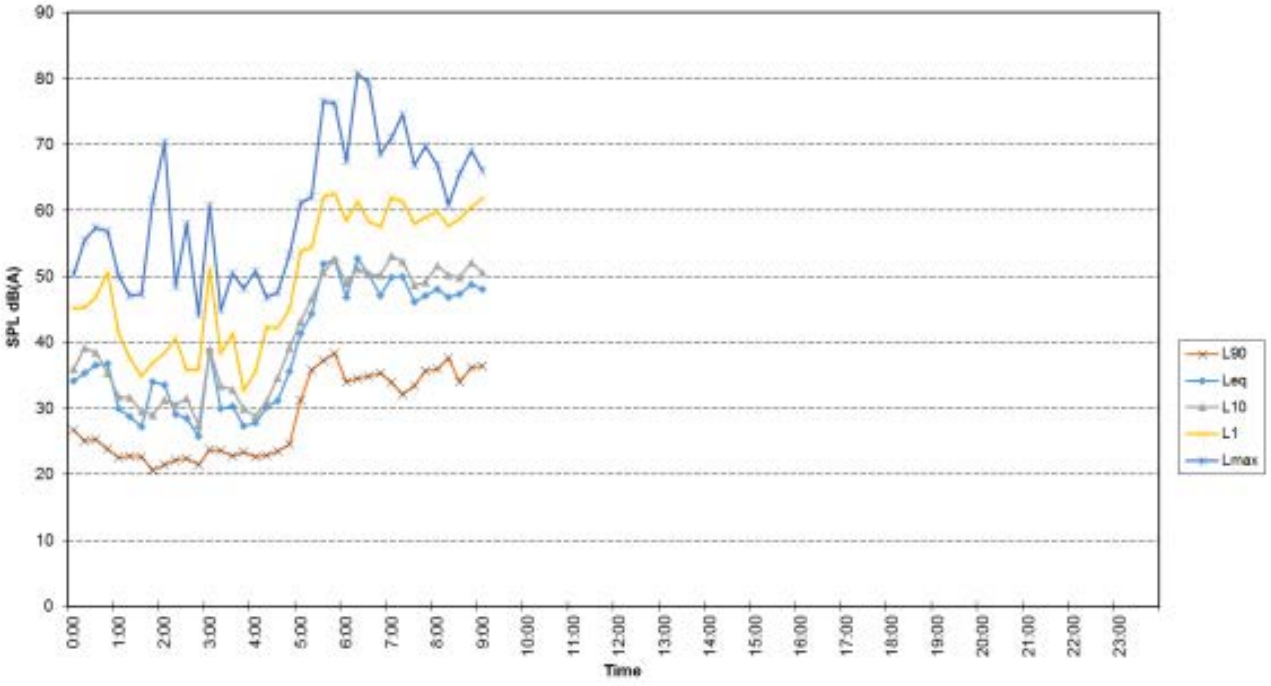
Location - NM04
Measured Noise Levels - Tuesday 13/12/2016



Location - NM04
Measured Noise Levels - Wednesday 14/12/2016



Location - NM04
Measured Noise Levels - Thursday 15/12/2016



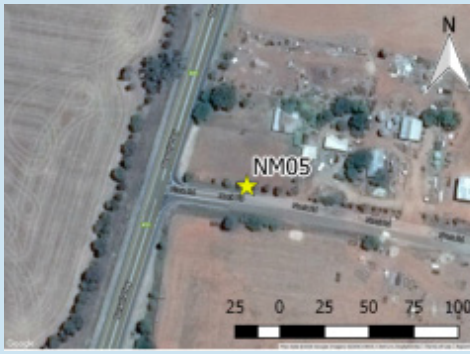
B5 Ambient noise monitoring results – NM05

Noise monitoring location no:		NM05		Noise monitoring map
Noise monitoring address:		Lot 784 Newell Highway, Parkes		
Logger Type:	Svan 959	Logger Serial number:	21293	

Description of ambient

Ambient noise logger deployed in the front garden of residential address Lot 784 Newell Highway, Parkes. Logger located next to a tree approximately 42 m from road edge.

Attended noise measurements indicate that the ambient noise environment at this location is generally dominated by vehicles on Newell Highway. When vehicles were not present, trees rustling and birds chirping were audible. No traffic was observed on Nock Road. Heavy vehicles were observed passing the property on Newell Highway.



Ambient Noise Logging Results – NPfI Defined Time Periods

Monitoring period	Noise level (dBA)			
	RBL	L_{Aeq}	L_{10}	L_{Amax}
Daytime	40	62	66	78
Evening	32	60	65	78
Night-time	30	57	62	77

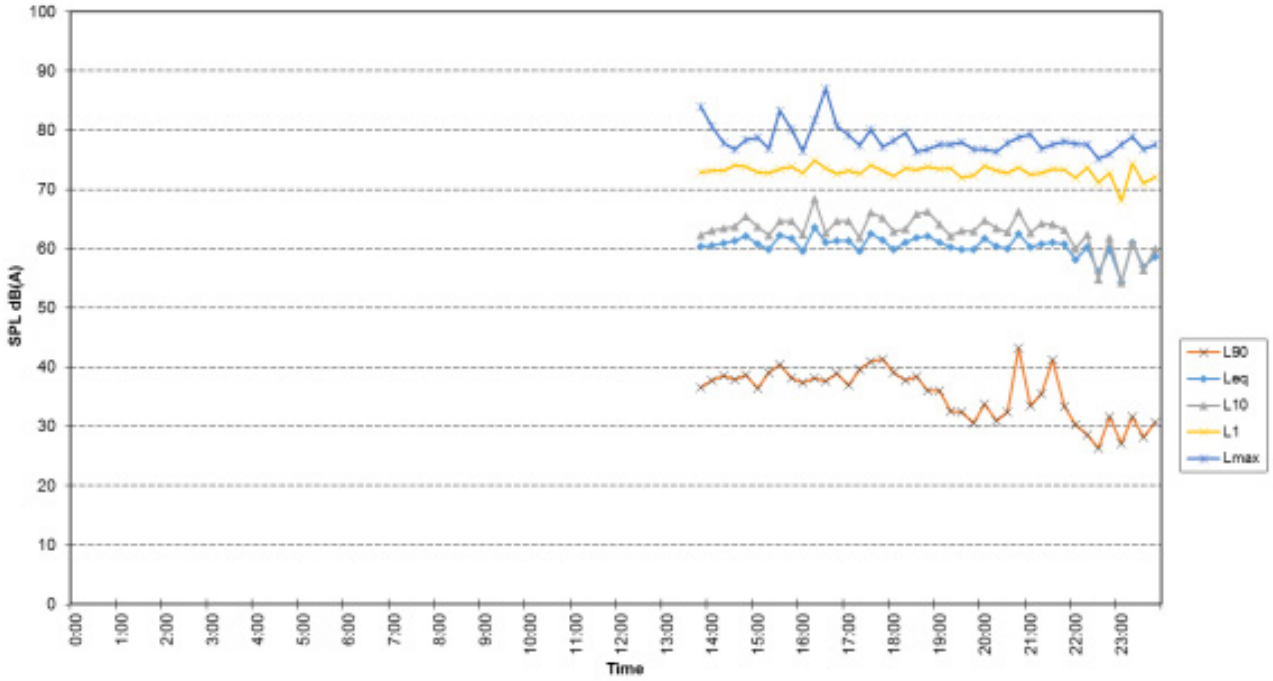
Ambient Noise Logging Results – NPfI Defined Time Periods

Monitoring period	$L_{Aeq, period}$	Max $L_{Aeq(1hr)}$	10% $L_{Aeq(1hr)}$
Daytime	61	63	62
Night-time	57	60	59

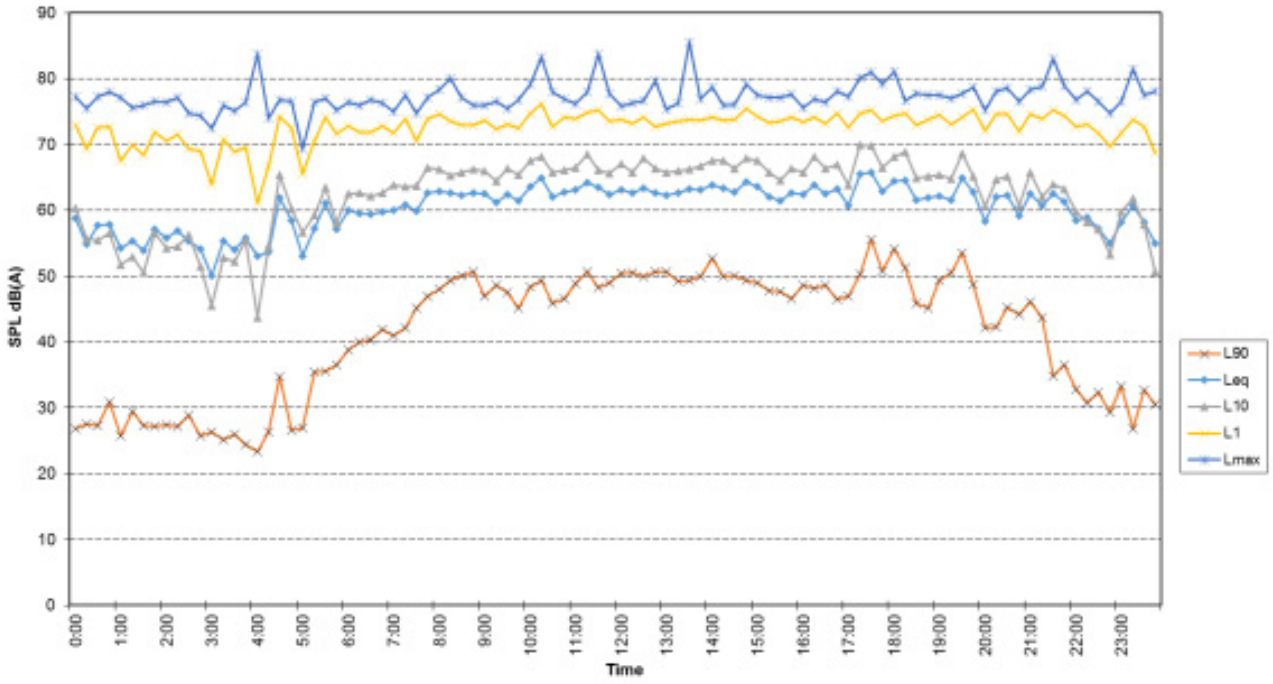
Operator attended noise measurement results

Date	Start time	Measured noise level (dBA)		
		L_{90}	L_{Aeq}	L_{Amax}
07/12/2016	1350	37	60	77

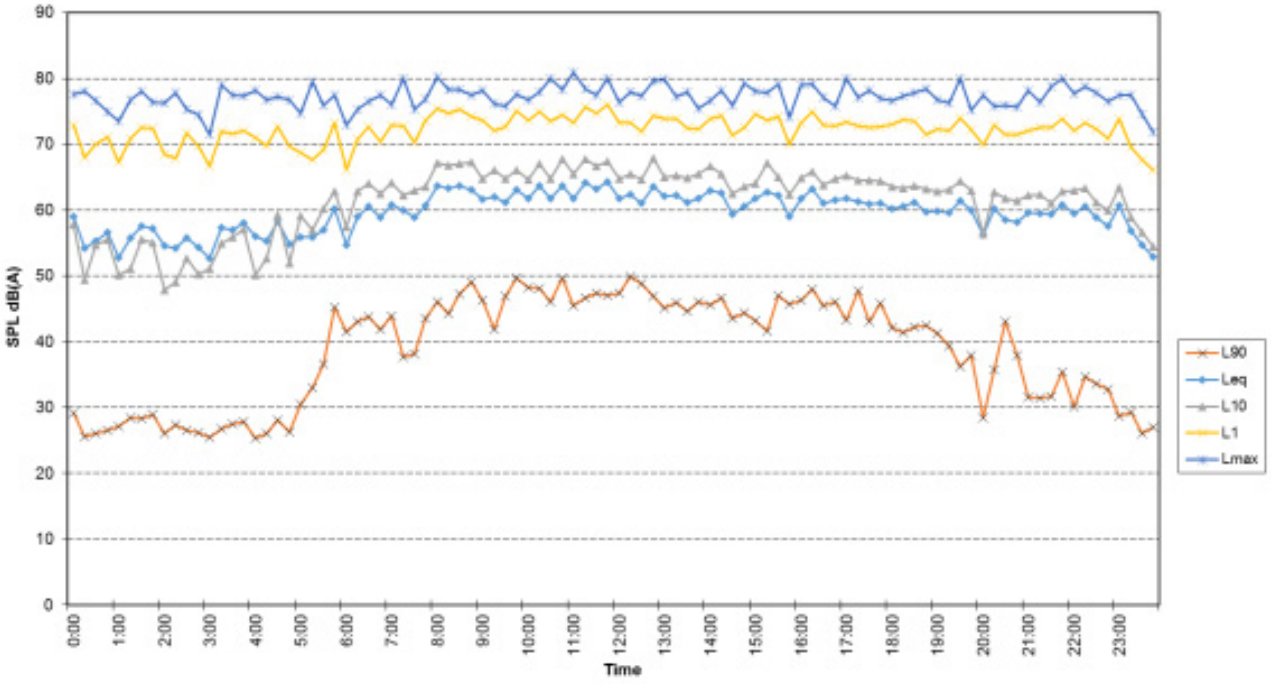
Location - NM05
Measured Noise Levels - Wednesday 07/12/2016



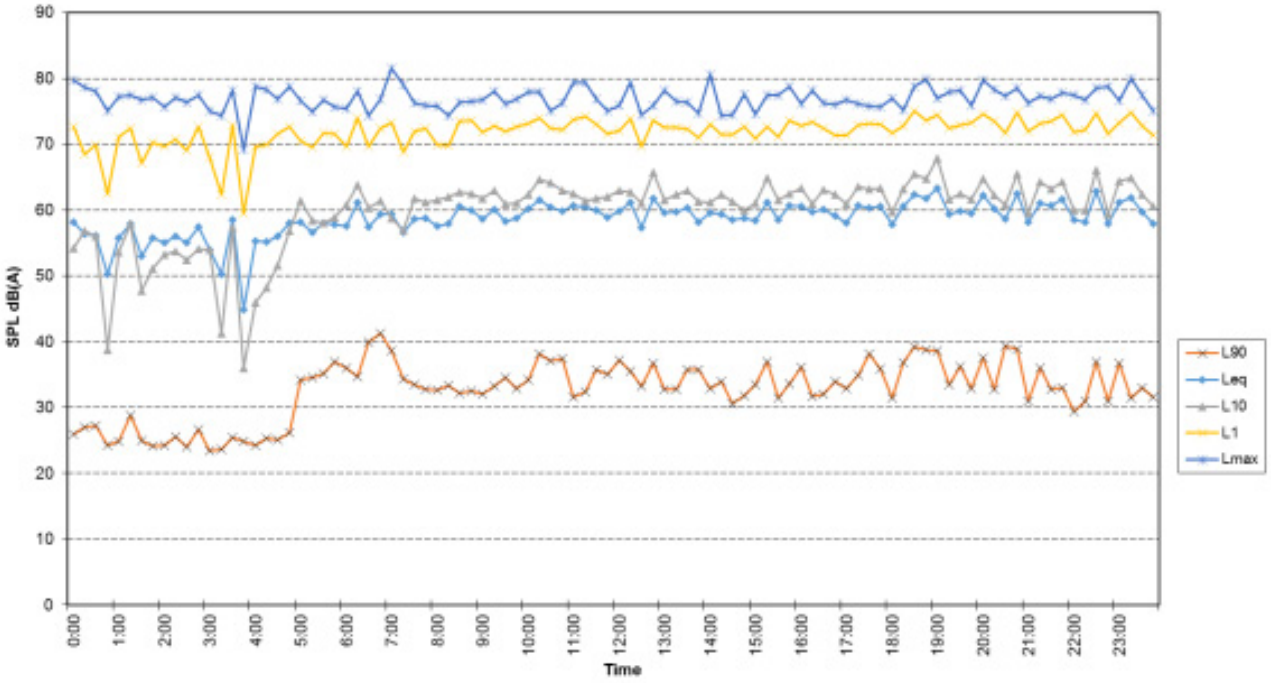
Location - NM05
Measured Noise Levels - Thursday 08/12/2016



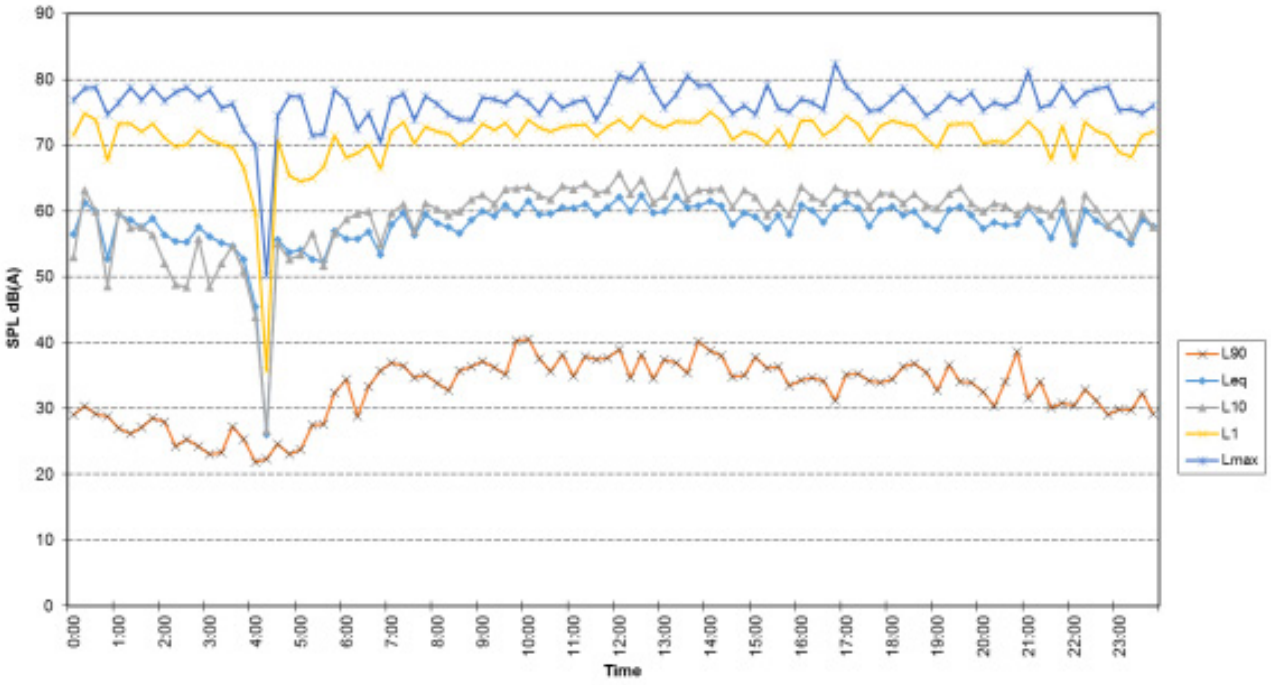
Location - NM05
Measured Noise Levels - Friday 09/12/2016



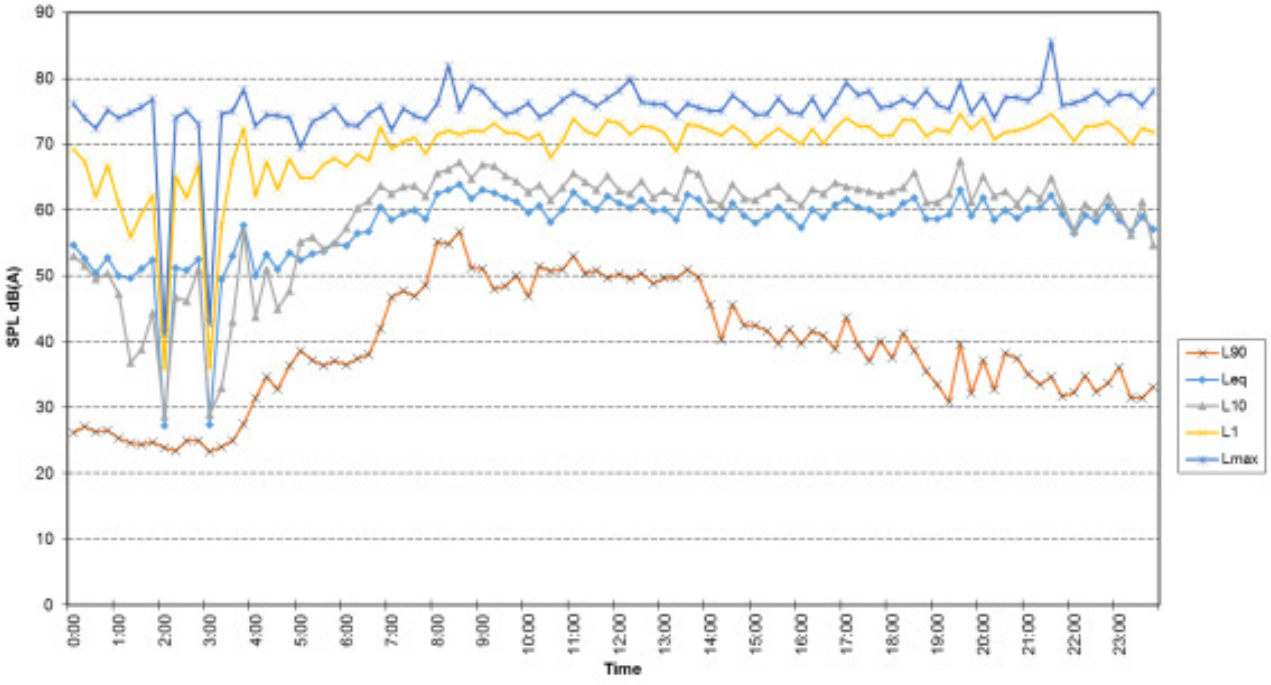
Location - NM05
Measured Noise Levels - Saturday 10/12/2016



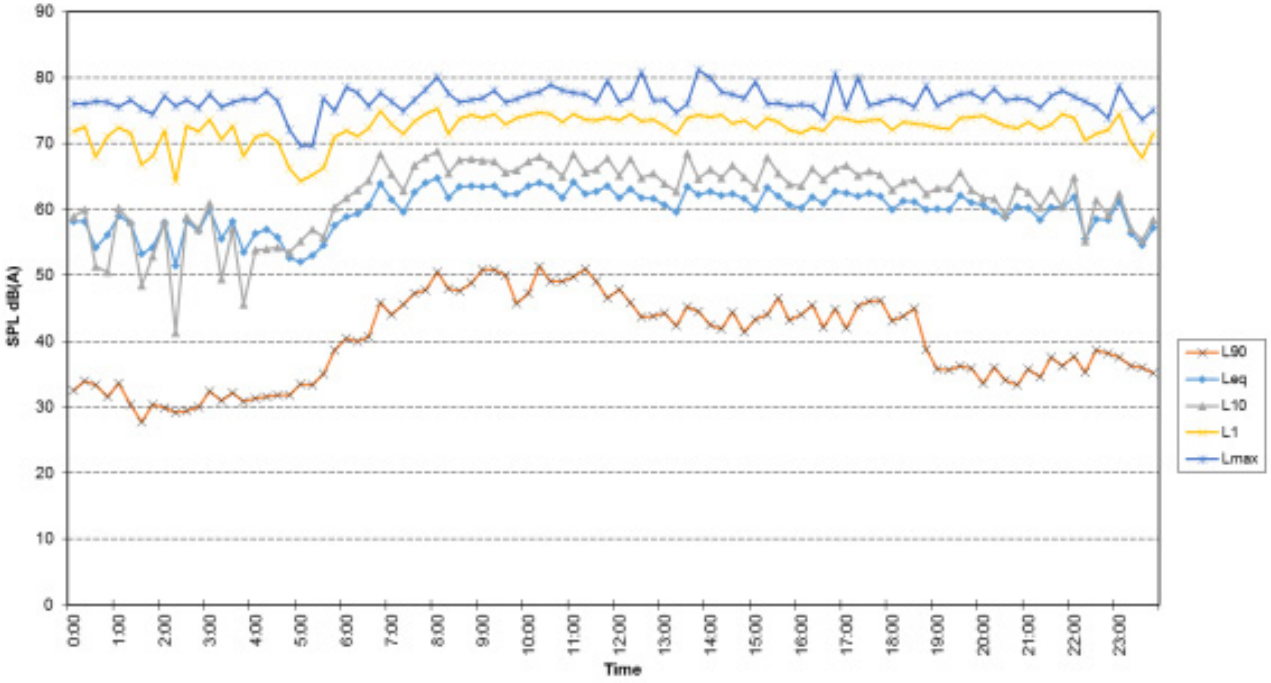
Location - NM05
Measured Noise Levels - Sunday 11/12/2016



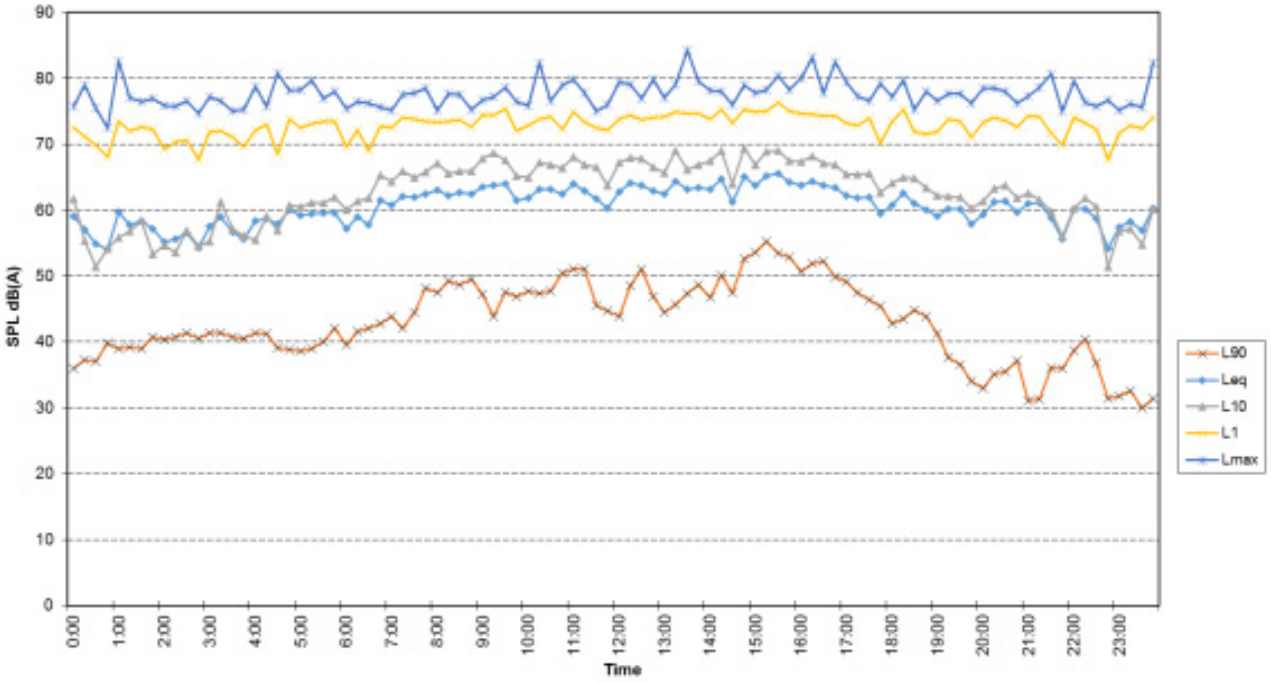
Location - NM05
Measured Noise Levels - Monday 12/12/2016



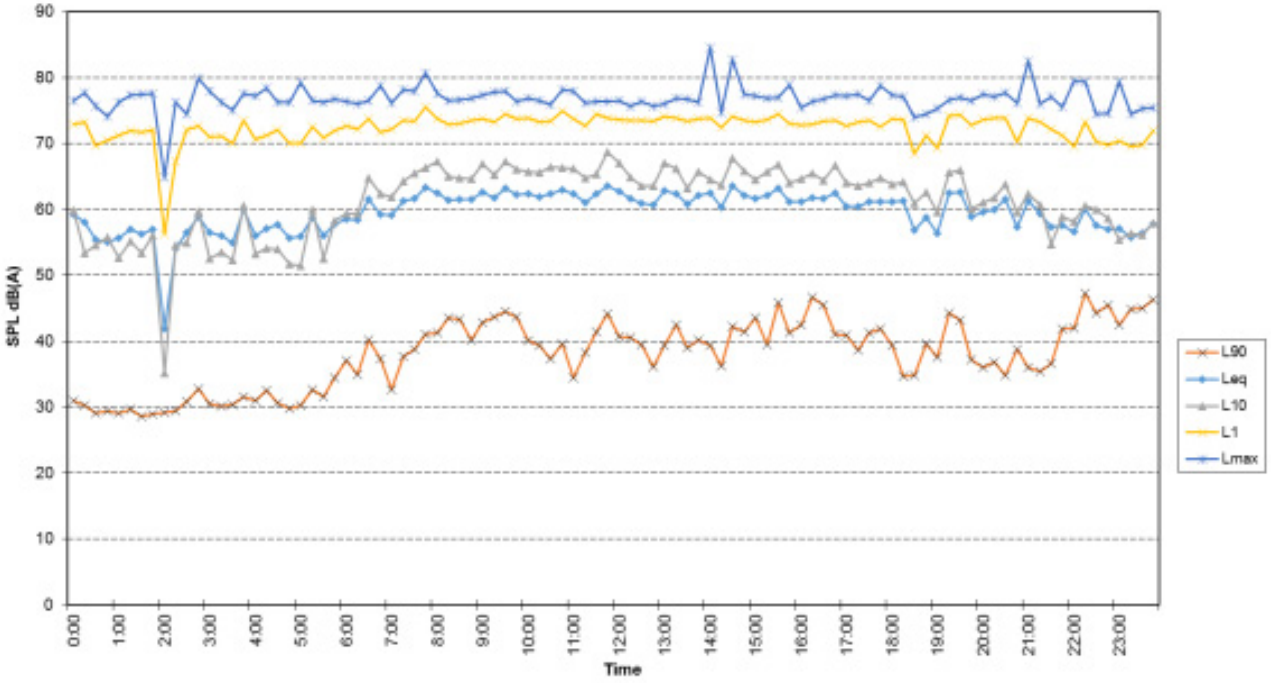
Location - NM05
Measured Noise Levels - Tuesday 13/12/2016



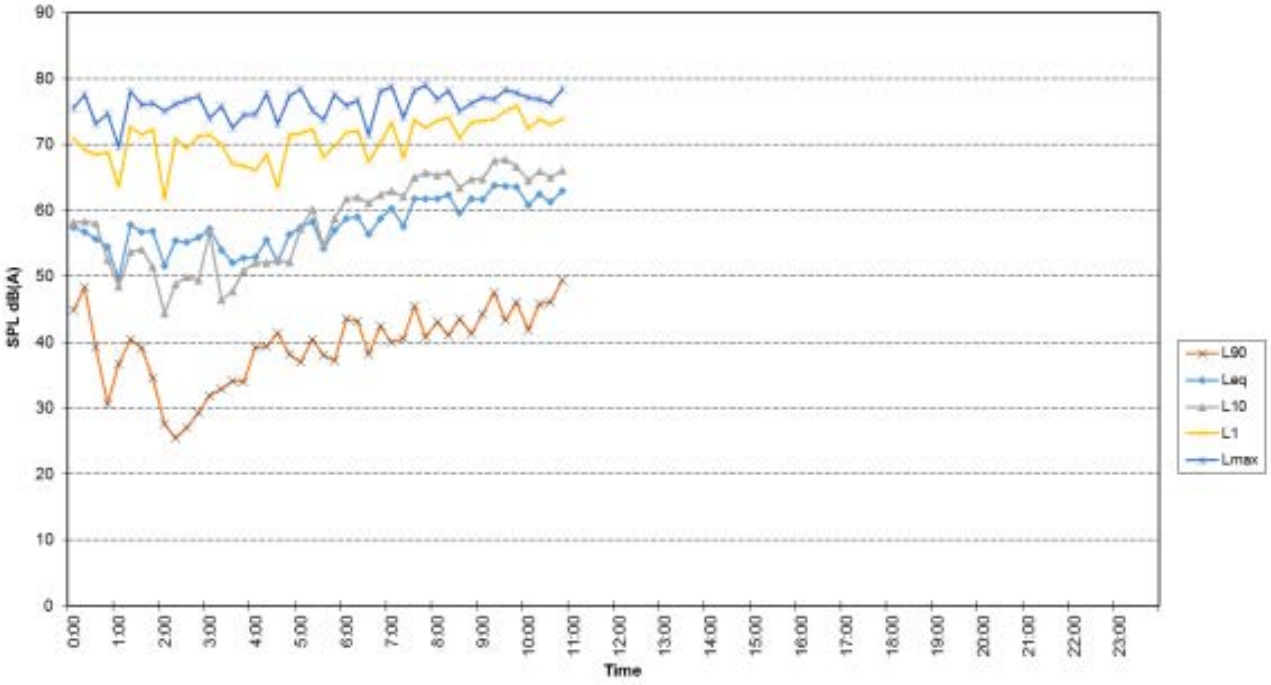
Location - NM05
Measured Noise Levels - Wednesday 14/12/2016



Location - NM05
Measured Noise Levels - Thursday 15/12/2016



Location - NM05
Measured Noise Levels - Friday 16/12/2016



B6 Ambient noise monitoring results – NM06

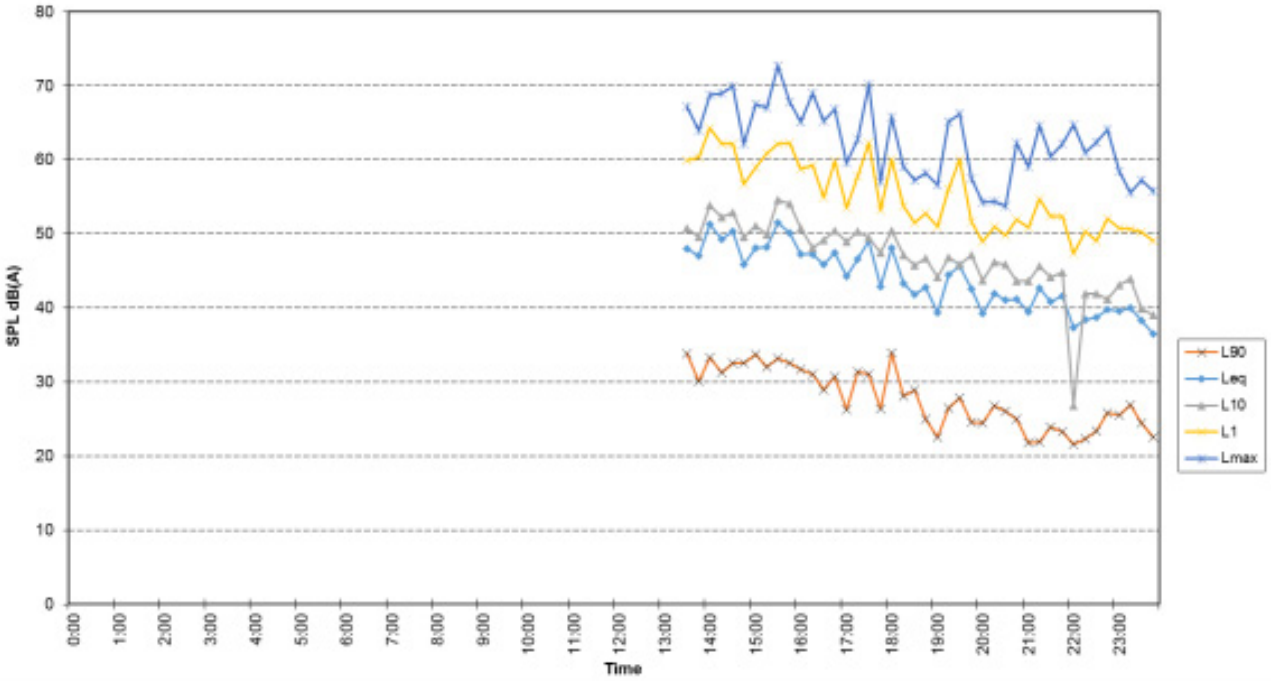
Noise monitoring location no:		NM06		Noise monitoring map
Noise monitoring address:		98 Bogan Road, Parkes / 1178 Bogan Road, Goonumbla		
Logger Type:	Svan 958	Logger Serial number:	36659	
Description of ambient				
Ambient noise logger deployed in the front garden of residential address 98 Bogan Road, Parkes. Logger located next to a tree approximately 70 m from road edge. Relocated to 1178 Bogan Road, Goonumbla by RMS (on advice from WSP | Parsons Brinckerhoff) on 09/12/2016 to avoid nearby road repair works commenced after initial logger deployment. Attended noise measurements indicate that the ambient noise environment at this location is generally dominated by trees rustling and birds chirping. Occasional vehicles on Bogan Road were audible. Distant traffic on Newell Highway was audible but difficult to hear. Heavy vehicles were observed passing the property on Bogan Road.				

Ambient Noise Logging Results – NPfl Defined Time Periods				
Monitoring period	Noise level (dBA)			
	RBL	L_{Aeq}	L_{10}	L_{Amax}
Daytime	32	52	56	
Evening	30	45	46	
Night-time	30	49	53	

Ambient Noise Logging Results – NPfl Defined Time Periods			
Monitoring period	$L_{Aeq, period}$	Max $L_{Aeq(1hr)}$	10% $L_{Aeq(1hr)}$
Daytime	51	56	56
Night-time	50	55	52

Operator attended noise measurement results				
Date	Start time	Measured noise level (dBA)		
		L_{90}	L_{Aeq}	L_{Amax}
08/12/2016	1055	44	51	71

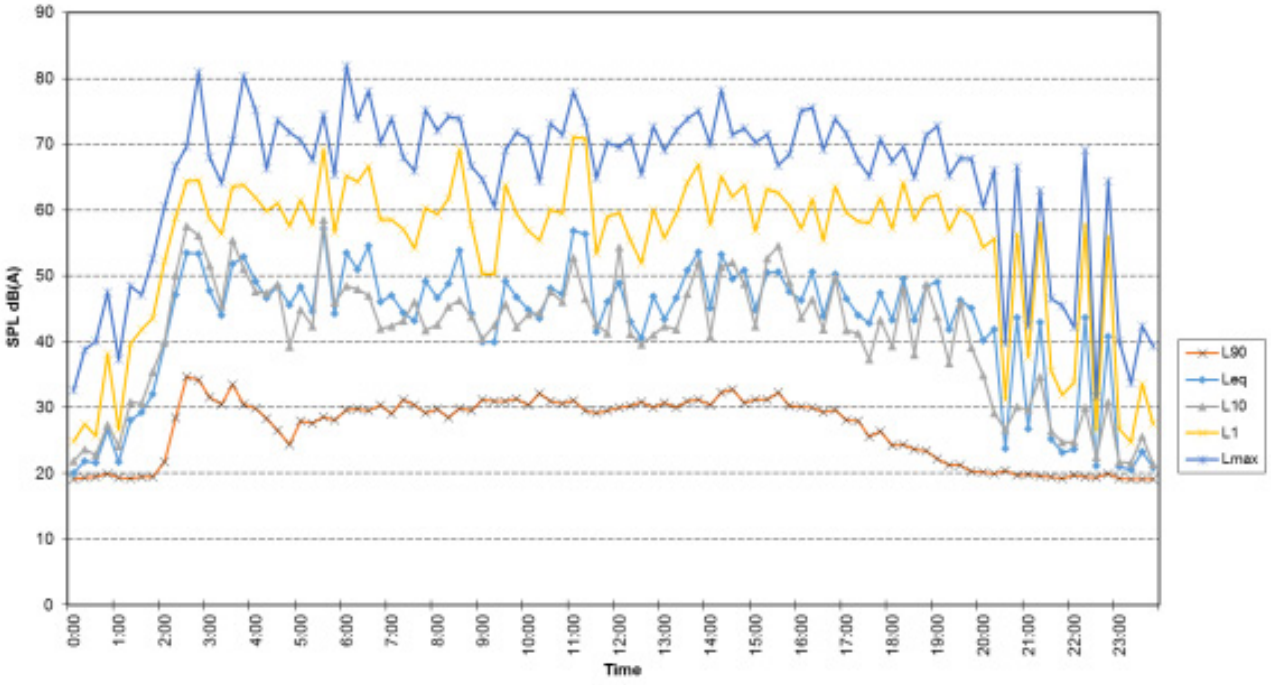
Location - NM06
Measured Noise Levels - Wednesday 07/12/2016



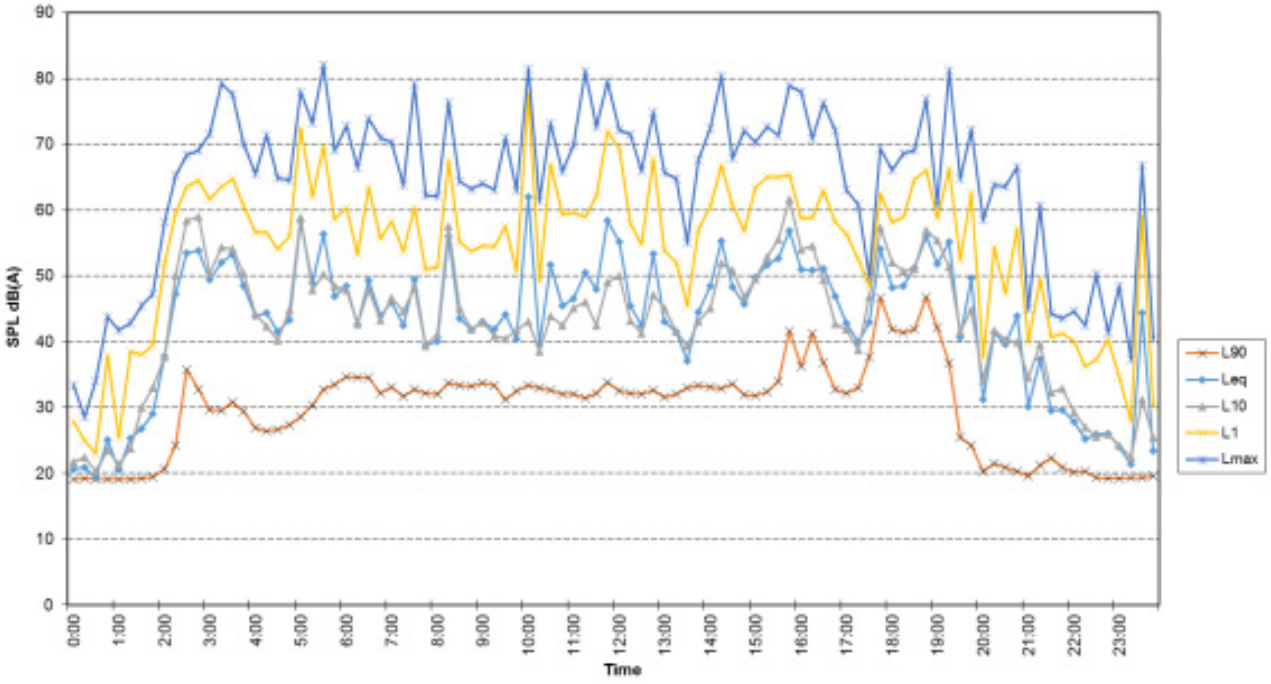
Location - NM06
Measured Noise Levels - Thursday 08/12/2016

Location - NM06
Measured Noise Levels - Friday 09/12/2016

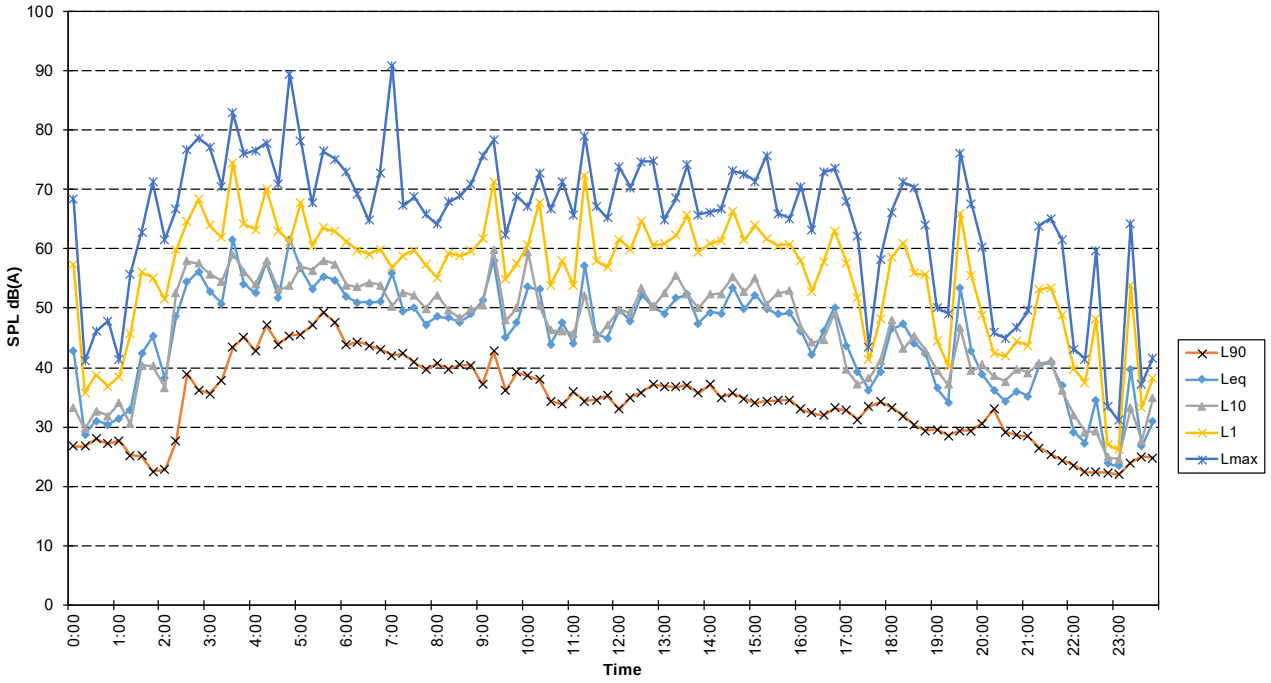
Location - NM06
Measured Noise Levels - Saturday 10/12/2016



Location - NM06
Measured Noise Levels - Sunday 11/12/2016

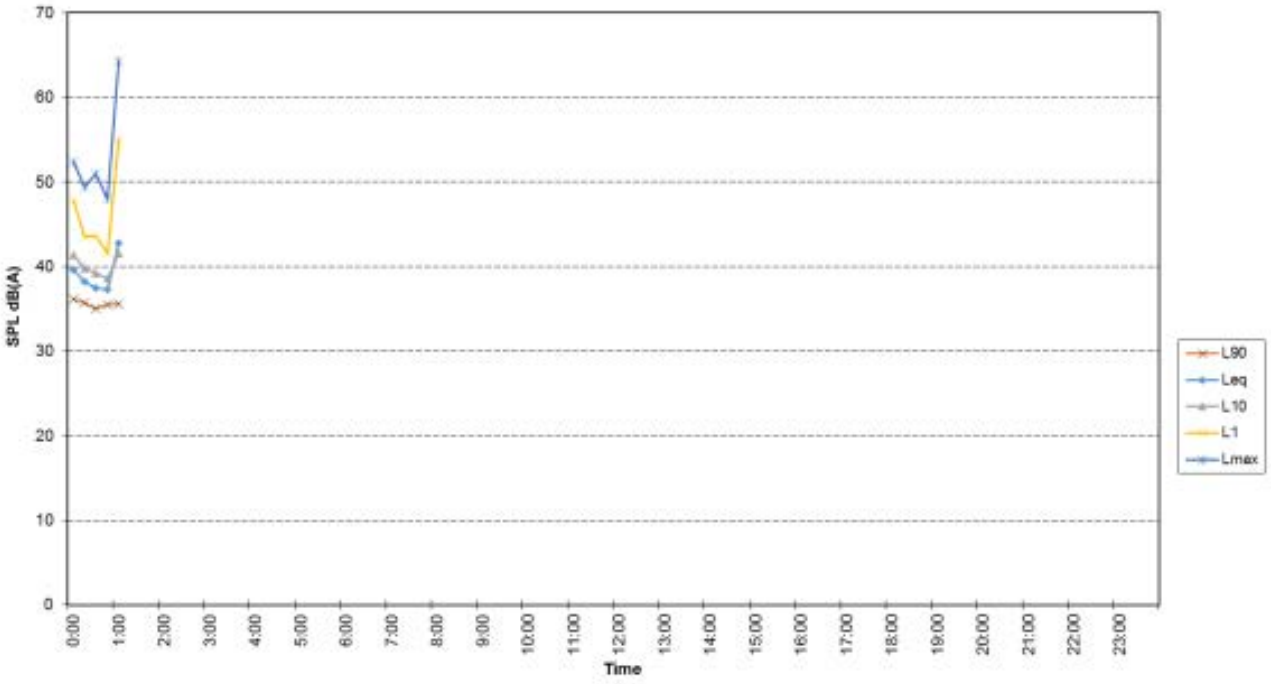


Location - NM06
Measured Noise Levels - Monday 12/12/2016



Location - NM06
Measured Noise Levels - Tuesday 13/12/2016

Location - NM06
Measured Noise Levels - Wednesday 14/12/2016



B7 Ambient noise monitoring results – NM07

Noise monitoring location no:		NM07		Noise monitoring map
Noise monitoring address:		25 Bushman Street, Parkes		
Logger Type:	Svan 955	Logger Serial number:	28808	

Description of ambient

Ambient noise logger deployed in the front garden of TAFE Western - Parkes College, 25 Bushman Street, Parkes. Logger located next to a fence on Bogan Street approximately 15 m from road lane edge.

Attended noise measurements indicate that the ambient noise environment at this location is generally dominated by traffic on Bogan Street. In the absence of traffic, general urban hum and trees rustling were audible. Traffic on Bushman Street was not audible. Heavy vehicles were observed passing the property.

Ambient Noise Logging Results – NPfl Defined Time Periods

Monitoring period	Noise level (dBA)			
	RBL	L_{Aeq}	L_{10}	L_{Amax}
Daytime	51	66	70	84
Evening	45	65	69	84
Night-time	35	61	66	82

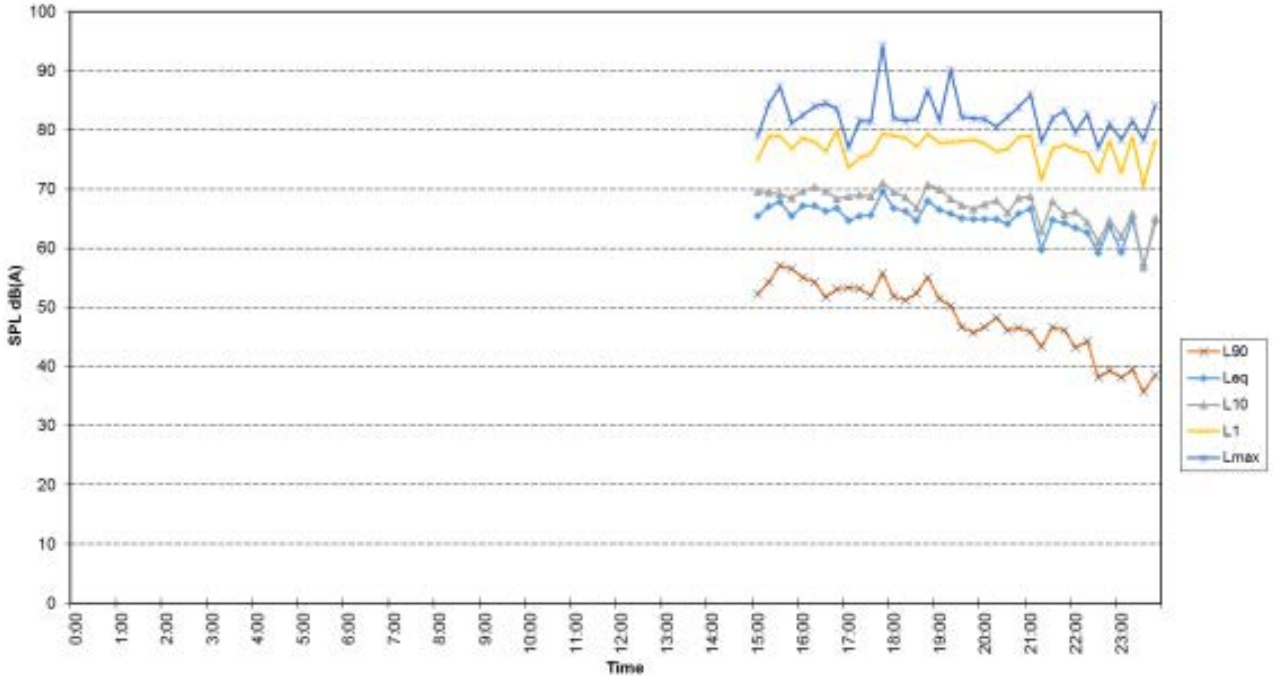
Ambient Noise Logging Results – NPfl Defined Time Periods

Monitoring period	$L_{Aeq, period}$	Max $L_{Aeq(1hr)}$	10% $L_{Aeq(1hr)}$
Daytime	66	68	68
Night-time	61	64	63

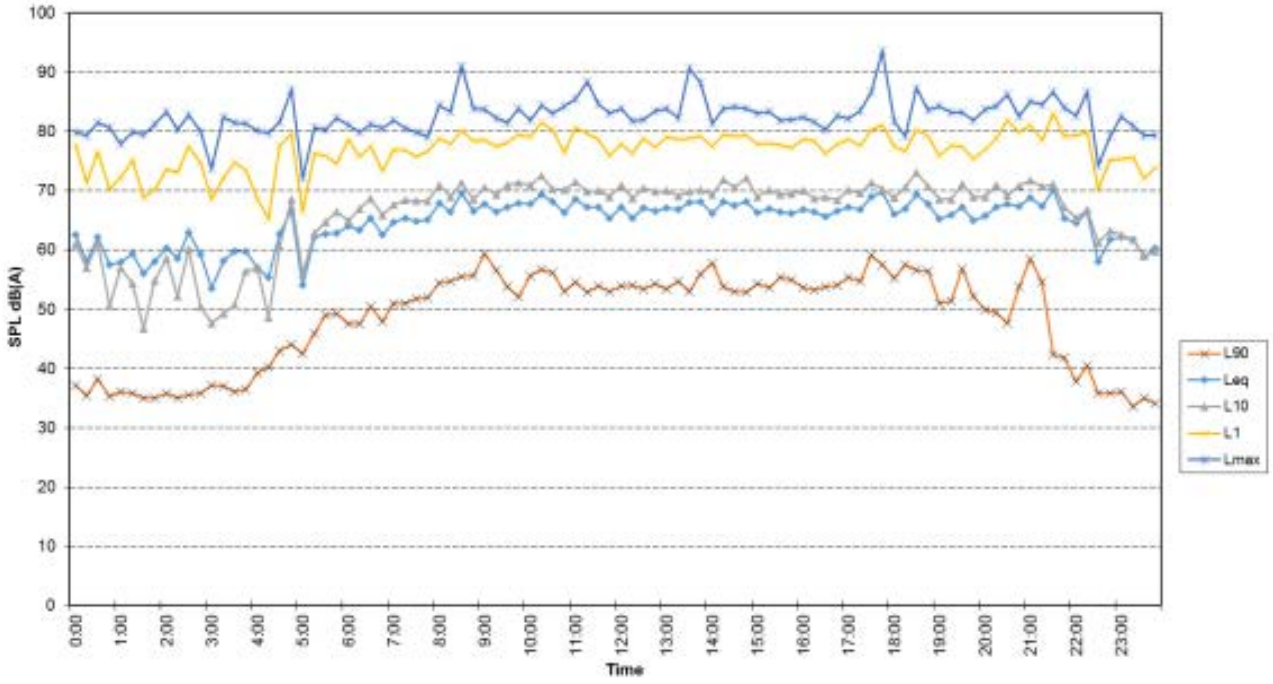
Operator attended noise measurement results

Date	Start time	Measured noise level (dBA)		
		L_{90}	L_{Aeq}	L_{Amax}
07/12/2016	1440	53	67	85

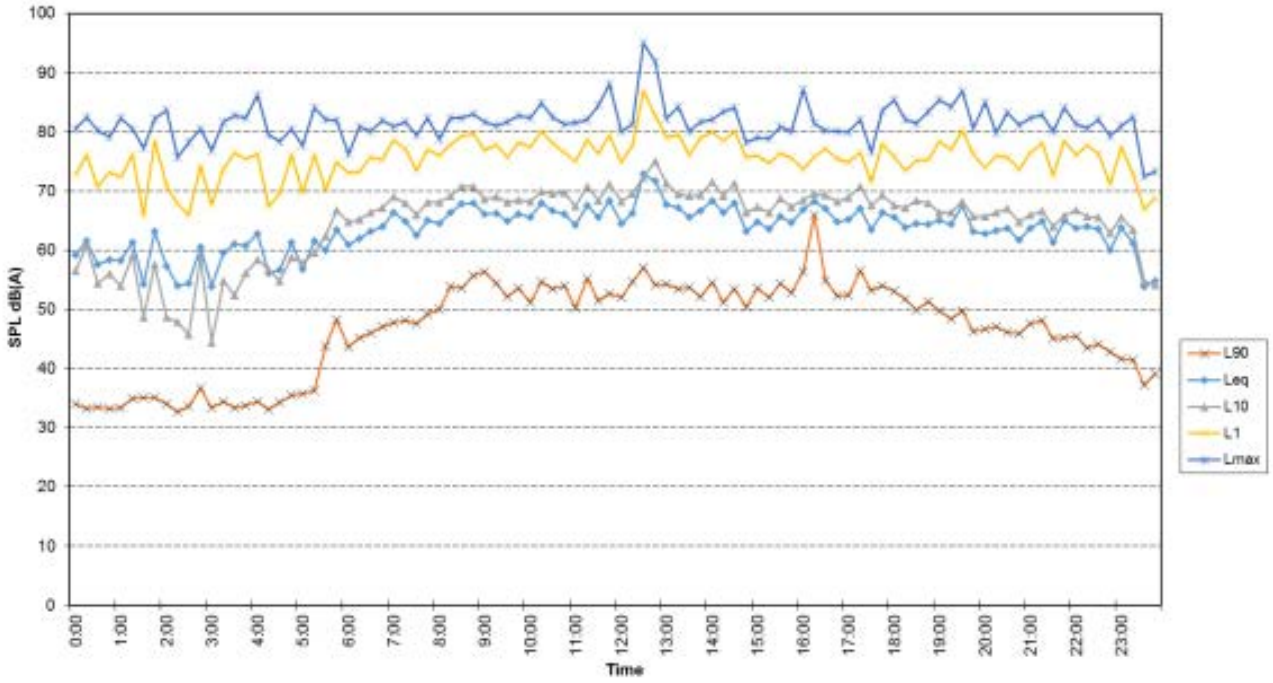
Location - NM07
Measured Noise Levels - Wednesday 07/12/2016



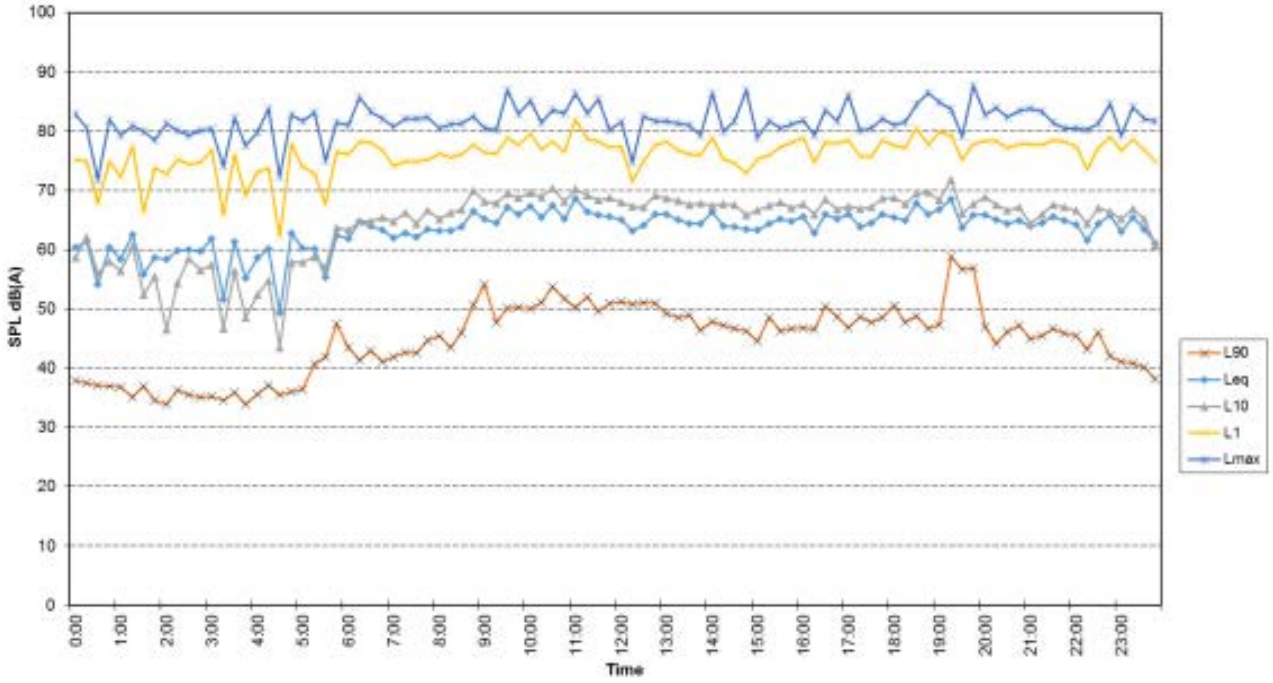
Location - NM07
Measured Noise Levels - Thursday 08/12/2016



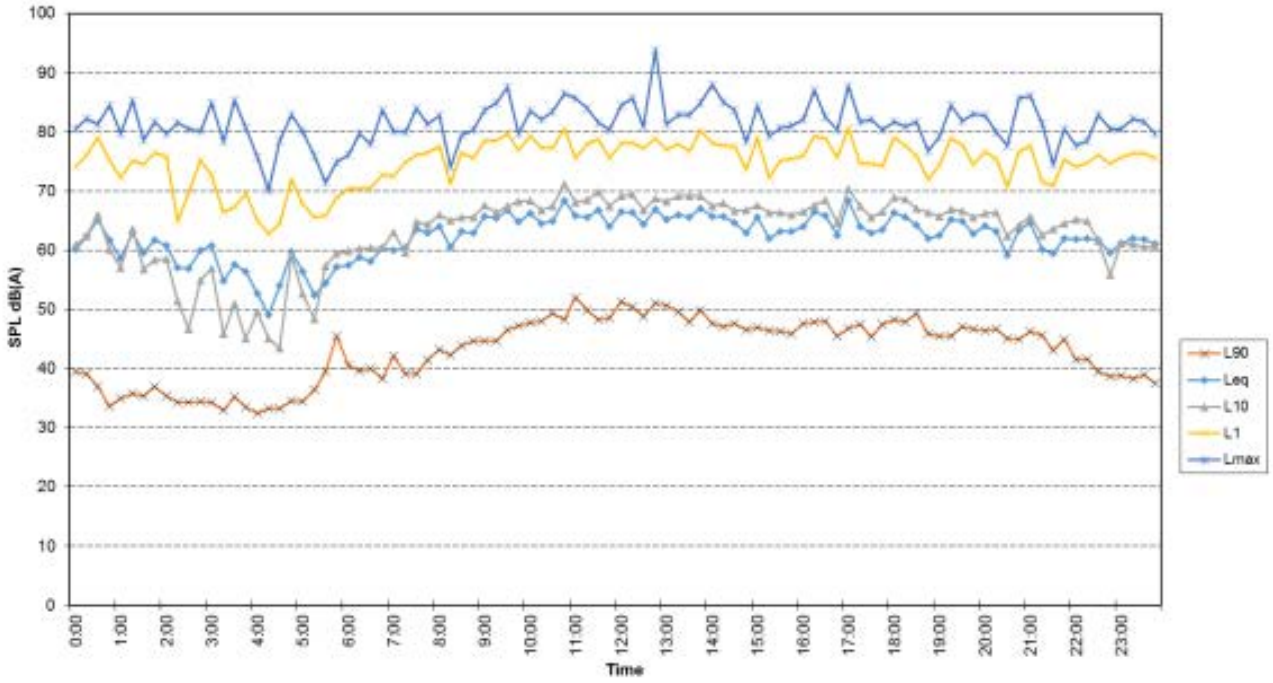
Location - NM07
Measured Noise Levels - Friday 09/12/2016



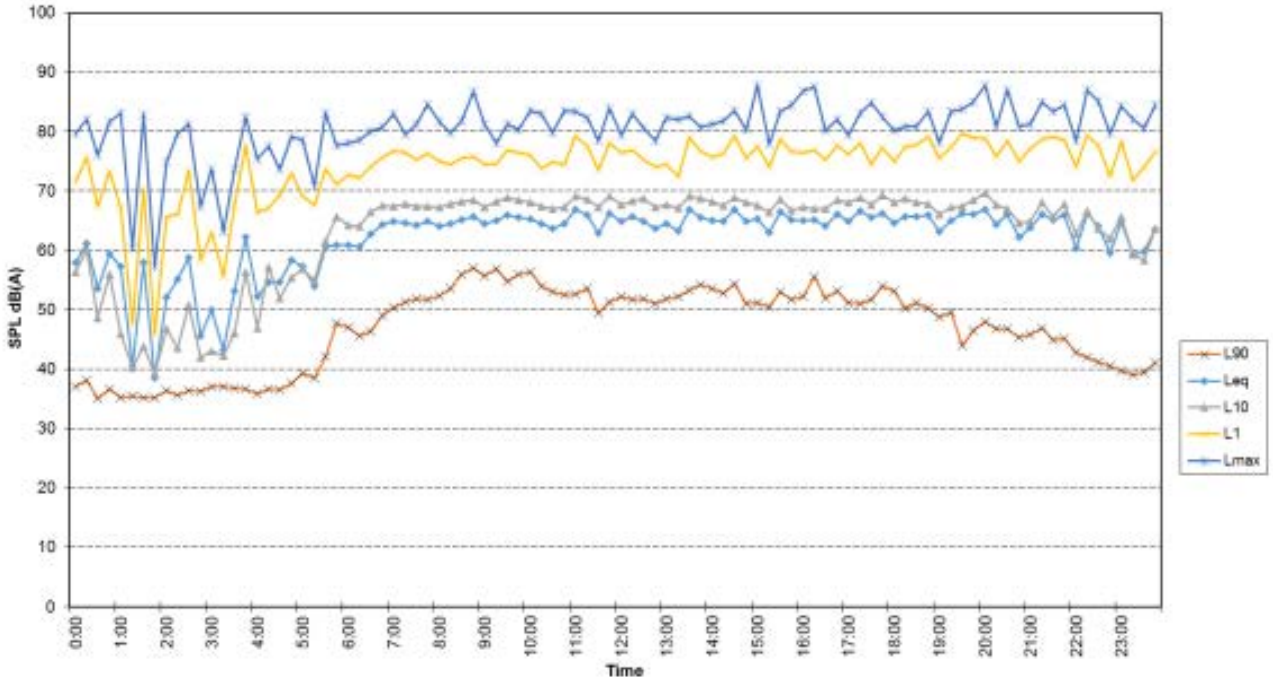
Location - NM07
Measured Noise Levels - Saturday 10/12/2016



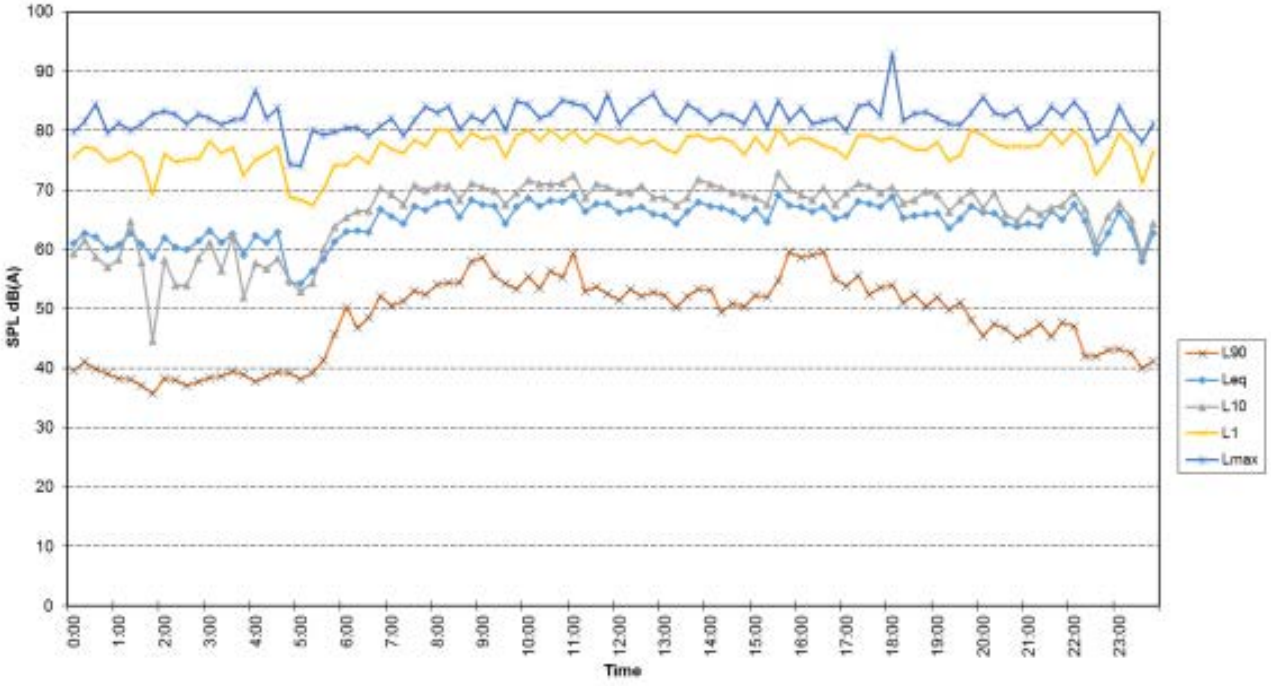
Location - NM07
Measured Noise Levels - Sunday 11/12/2016



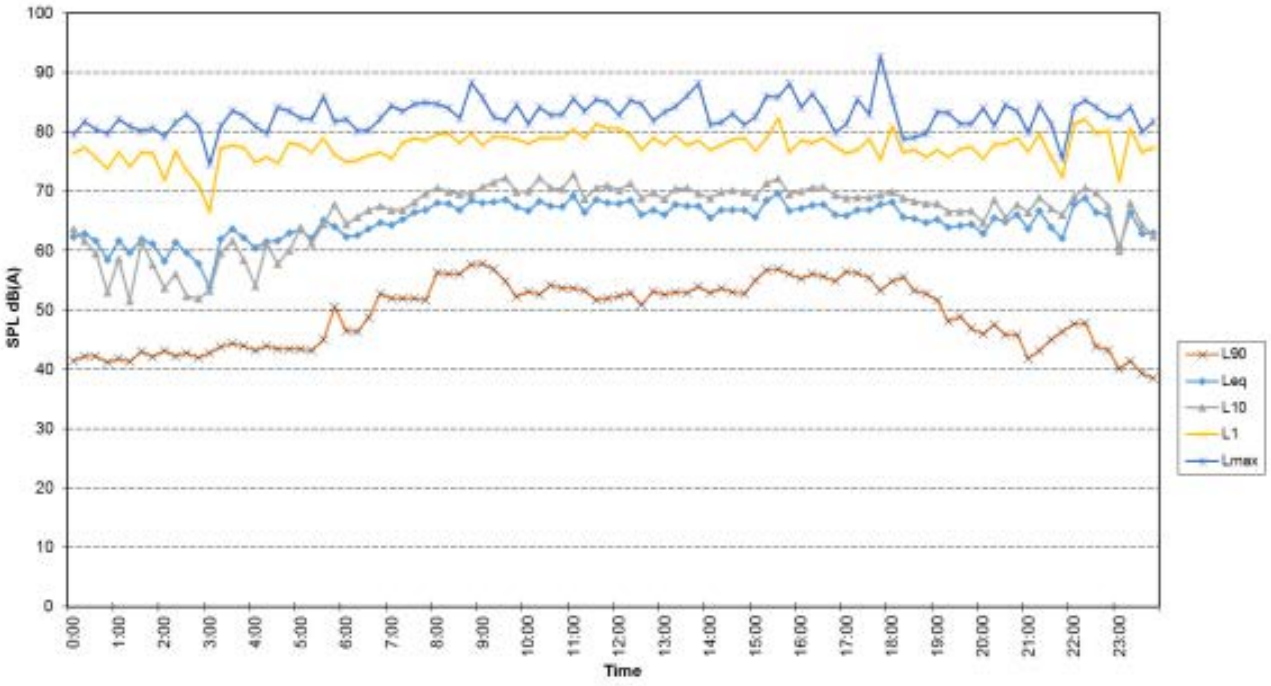
Location - NM07
Measured Noise Levels - Monday 12/12/2016



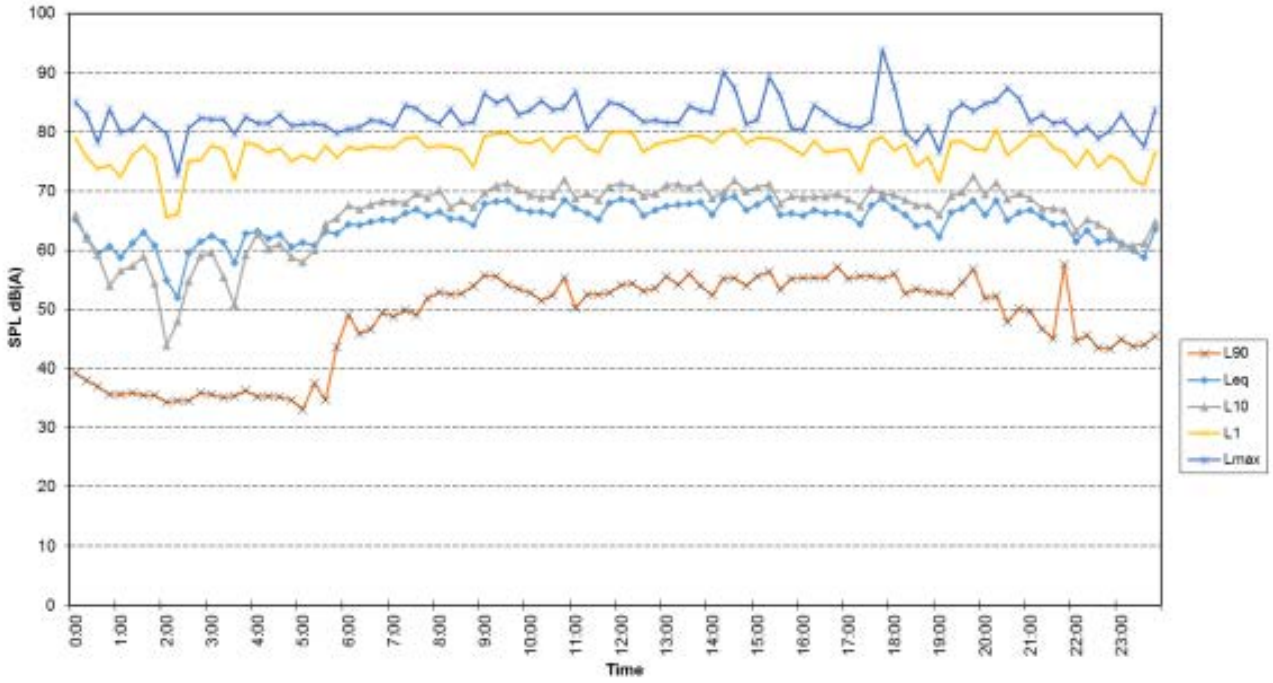
Location - NM07
Measured Noise Levels - Tuesday 13/12/2016



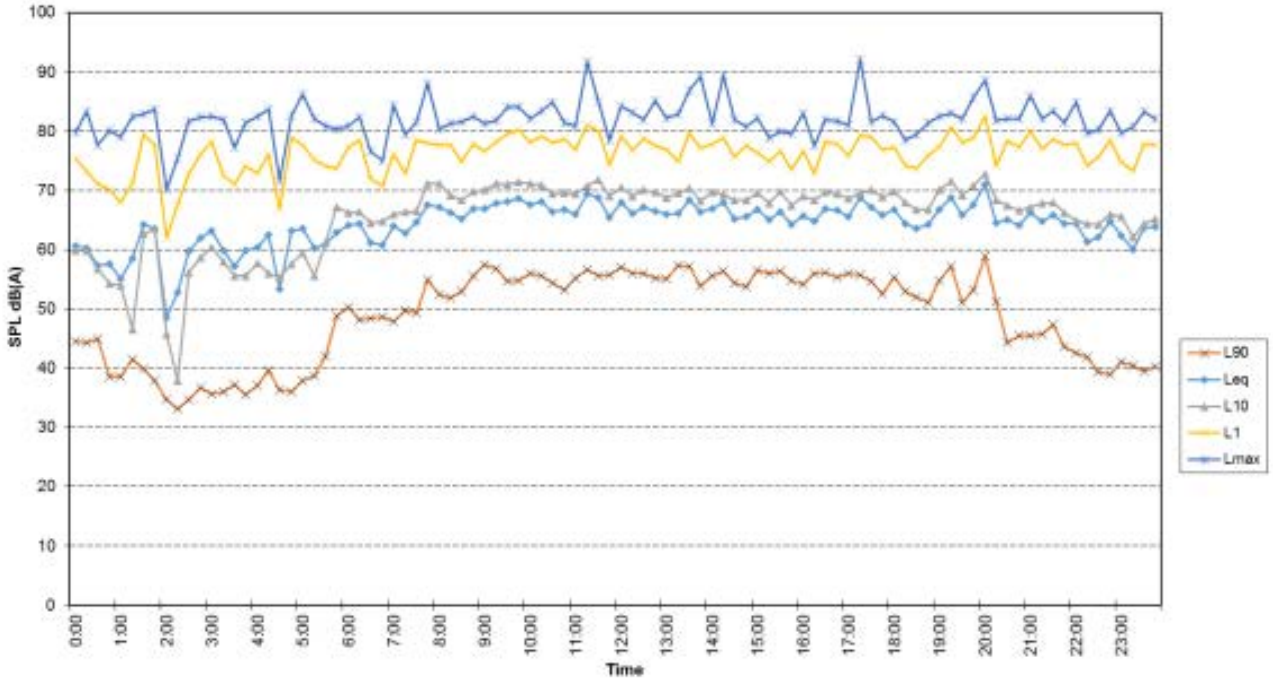
Location - NM07
Measured Noise Levels - Wednesday 14/12/2016

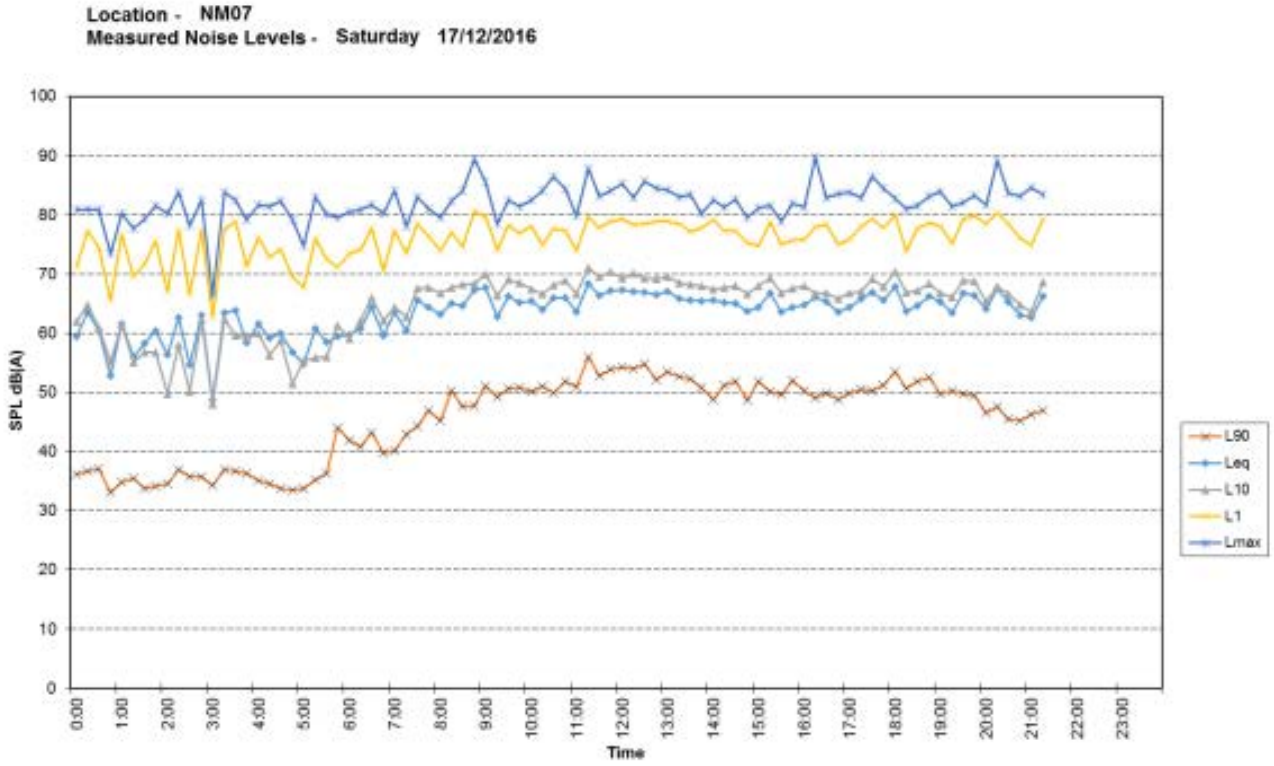


Location - NM07
Measured Noise Levels - Thursday 15/12/2016



Location - NM07
Measured Noise Levels - Friday 16/12/2016




Location - NM07
Measured Noise Levels - Saturday 17/12/2016
SPL dB(A)
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
L90
Leq
L10
L1
Lmax

B8 Attended noise monitoring results

B8.1 Location AN01

Noise monitoring location no:		AN01		Noise monitoring map
Noise monitoring address:		'Lumeah', Bogan Road, Parkes		
Sound level meter type:	Norsonic Nor140	**Serial number:**	1406502	
Description of ambient				
Attended noise measurement conducted at the front gate of 'Lumeah', Bogan Road, Parkes. Measurement taken approximately 525 m from Bogan Road lane edge. Attended noise measurement indicates that the ambient noise environment at this location is generally dominated by grass rustling and trees rustling in the distance. Heavy vehicles travelling on Bogan Road were audible when passing the property but were not a dominant source. Light vehicles could be seen passing on Bogan Road but were not audible. Traffic noise from Newell Highway could not be identified.				
Operator attended noise measurement results				
Date	**Start time**	**Measured Noise Level (dBA)**		
		L_{90}	**L_{Aeq}**	**L_{Amax}**
08/12/2016	**1020**	41	47	64

B8.2 Location AN02

Noise monitoring location no:		AN02		Noise monitoring map
Noise monitoring address:		13 Moulden Road, Parkes		
Sound level meter type:	Norsonic Nor140	**Serial number:**	1406502	
Description of ambient				
Attended noise measurement conducted in front of 13 Moulden Street, Parkes. Measurement taken at north eastern corner of the property. Attended noise measurement indicates that the ambient noise environment at this location is generally dominated by grass and trees rustling. Chickens could also be heard intermittently from a property to the south west. A water cart and a ute was observed passing the property during the 15 minute measurement. Traffic on other nearby roads was not audible.				

Operator attended noise measurement results				
Date	**Start time**	**Measured Noise Level (dBA)**		
		L_{90}	**L_{Aeq}**	**L_{Amax}**
08/12/2016	**1145**	43	55	78

B8.3 Location AN03

Noise monitoring location no:		AN03		Noise monitoring map
Noise monitoring address:		‘Balmoral’, 123 London Road, Parkes		
Sound level meter type:	Norsonic Nor140	**Serial number:**	1406502	
Description of ambient				
Attended noise measurement conducted in front of ‘Balmoral’, 123 London Road, Parkes. Measurement taken at the north eastern corner of the property approximately 20 m from road lane edge. Attended noise measurement indicates that the ambient noise environment at this location is generally dominated by trees rustling and birds chirping. Heavy vehicles were observed passing the property. Compression brakes from trucks on roads further to the north could also be heard.				
Operator attended noise measurement results				
Date	**Start time**	**Measured Noise Level (dBA)**		
		L_{90}	**L_{Aeq}**	**L_{Amax}**
08/12/2016	**0915**	46	56	79

Appendix C

Traffic volumes

C1 Traffic volumes

Table C.1 Existing Traffic Volumes (2016) – for validation of operational noise model

Road	Direction	Existing traffic volumes 2017					
		15 hour (day)			9 hour (night)		
		Total volume	Heavy vehicle	Mean speed (km/h)	Total volume	Heavy vehicle	Mean speed (km/h)
Newell Highway							
North of Grey Dove Lane (South of Parkes)	NB	2,069	211	85.6	255	50	83.7
	SB	2,124	257	88.2	219	27	85.9
Between Maguire Road & Nock Road (North of Parkes)	NB	1,701	306	91.9	247	70	90.1
	SB	1,754	331	88.3	197	52	88.2
Brolgan Road							
West of Friendship Place	EB	615	49	46.8	49	0.3	47.2
	WB	572	37	46.9	52	6.5	44.7
Condobolin Road							
Between Westlime Road & Flinders Street	EB	717	69	61.9	40	1.8	62.8
	WB	738	69	65.9	61	5.1	65.6
Thomas Street							
East of Reedsdale Road	EB	226	36	53.3	13	1.1	54.2
	WB	207	32	56.9	15	2.8	56.7
Bogan Road							
Goonumbla Lane	NB	206	41	87.3	163	21	80.4
	SB	309	55	82.8	41	3.5	83.1
Bogan Street							
At 60 Bogan Street (Within the Parkes Township)	NB	4,058	353	44.6	431	78	45.9
	SB	4,512	374	42.9	376	53	46.2

Table C.2 Existing Traffic Volumes (2012 – 2017) – additional traffic data for construction traffic noise assessment

Road	Location	Average weekday traffic volume (veh/day)			Average weekly traffic volume (veh/day)		
		All vehicles	Heavy vehicles	Heavy vehicle%	All vehicles	Heavy vehicles	Heavy vehicle%
Newell Highway	North of Grey Dove Lane	5,042	982	19%	4,792	918	19%
Westlime Road	South of Coronation Avenue	943	194	21%	846	160	19%
Hartigan Avenue	South of Billy Mac Place	1,182	205	17%	1,032	175	17%
Brolgan Road	West of Friendship Place	1,369	115	8%	1,289	97	8%
Condobolin Road	Between Westlime Road and Flinders Street	1,684	182	11%	1,559	155	10%
Thomas Street	East of Reedsdale Road	497	78	16%	459	71	16%
Newell Highway	Between Maguire Road and Nock Road	4,020	818	20%	3,892	753	19%
Bogan Road	Between Deep Lead Road and Reedsdale Road	1,294	261	20%	1,117	213	19%
Bogan Street	Outside Property 60	10,132	926	9%	9,364	848	9%
Bleechmore Road	Between Maguire Road and Nock Road	173	11	7%	164	10	6%
Henry Parkes Way	10 m west of Billabong Creek, east Parkes	2,175	413	19%	1,998	336	17%
Newell Highway	Forbes/Parkes LGA Boundary	4,004	1,039	26%	3,689	923	25%
Newell Highway	Narromine/Parkes LGA Boundary	2,902	949	33%	2,731	857	31%
Brolgan Road	East of Westlime Road	737	106	14%	696	90	13%
Brolgan Road	West of Westlime Road	833	190	23%	791	155	20%
Westlime Road	North of Brolgan Road	556	139	25%	510	112	22%
Westlime Road	South of Brolgan Road	652	231	35%	564	184	33%
Newell Highway	100 m north of Cecile Street	9,286	1,275	14%	8,446	1,127	13%
Newell Highway	5 km north of Parkes	3,782	899	24%	3,608	837	23%
Henry Parkes Way	West of Russell Street	5,440	767	14%	5,260	656	12%
Condobolin Road	West of Moulden Street	1,334	233	17%	1,274	214	17%

Road	Location	Average weekday traffic volume (veh/day)			Average weekly traffic volume (veh/day)		
		All vehicles	Heavy vehicles	Heavy vehicle%	All vehicles	Heavy vehicles	Heavy vehicle%
Back Trundle Rd	Eastern 40 km/h school zone approach to Christian School	810	70	9%	695	60	9%
Condobolin Road	East of Moulden Street	1,493	283	19%	1,387	230	17%

Table C.3 Traffic Volumes for No Build scenario

Road	Direction	Forecast Traffic Opening Year 2023 - No Build					Forecast Traffic Design Year 2033 - No Build				
		15 hour (day)		9 hour (night)		Speed	15 hour (day)		9 hour (night)		Speed
		Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)	Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)
Newell Hwy											
South of Parkes	NB	2,017	484	224	54	100	2,378	585	264	65	100
	SB	2,088	515	232	57	100	2,461	623	273	69	100
North of Parkes	NB	1,612	420	179	47	80	1,899	509	211	57	80
	SB	1,616	422	180	47	80	1,904	510	212	57	80
Westlime Road											
Between Condobolin Road and Brolgan Road	NB	359	95	40	11	50	423	114	47	13	50
	SB	396	105	44	12	50	467	127	52	14	50
Hartigan Avenue											
Between London Road and Brolgan Road	NB	434	87	48	10	80	510	106	57	12	80
	SB	434	87	48	10	80	510	106	57	12	80
Brolgan Road											
East of Westlime Road	EB	667	150	74	17	50	781	254	87	28	50
	WB	616	58	68	6	50	725	70	81	8	50
West of Westlime Road	EB	667	150	74	17	50	781	254	87	28	50
	WB	616	58	68	6	50	725	70	81	8	50
Condobolin Road											
East of Westlime Road	EB	779	95	87	11	80	917	116	102	13	80
	WB	779	95	87	11	80	917	116	102	13	80

Road	Direction	Forecast Traffic Opening Year 2023 - No Build					Forecast Traffic Design Year 2033 - No Build				
		15 hour (day)		9 hour (night)		Speed	15 hour (day)		9 hour (night)		Speed
		Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)	Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)
West of Westlime Road	EB	779	95	87	11	100	917	116	102	13	100
	WB	779	95	87	11	100	917	116	102	13	100
London Road											
East of Haritgan Avenue	EB	132	77	15	9	100	156	94	17	10	100
	WB	132	77	15	9	100	156	94	17	10	100
Bogan Road											
North of Parkes	NB	512	133	57	15	100	596	161	66	18	100
	SB	529	136	59	15	100	616	165	68	18	100
Back Trundle Road											
West of Moulden Street	EB	387	37	43	4	80	456	45	51	5	80
	WB	359	35	40	4	80	423	42	47	5	80
East of Moulden Street	EB	387	37	43	4	80	456	45	51	5	80
	WB	359	35	40	4	80	423	42	47	5	80

Table C.4 Traffic Volumes for Build scenario

Road	Direction	Forecast Traffic Opening Year 2023 - Build					Forecast Traffic Design Year 2033 - Build				
		15 hour (day)		9 hour (night)		Speed	15 hour (day)		9 hour (night)		Speed
		Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)	Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)
Bypass											
Bypass between Newell Hwy off ramp (south) to link (south)	NB	1,159	121	204	21	110	1,365	146	241	26	110
	SB	1,092	45	193	8	110	1,283	44	226	8	110
Bypass between link (south) to London Rd	NB	1,159	121	204	21	110	1,365	146	241	26	110
	SB	1,092	45	193	8	110	1,283	44	226	8	110
Bypass link (south) with existing Newell Hwy (south of Parkes)	EB	746	337	132	59	110	880	407	155	72	110
	WB	880	441	155	78	110	1,041	544	184	96	110
Bypass London Rd to Bypass roundabout	NB	746	337	132	59	80	880	407	155	72	80
	SB	880	441	155	78	80	1,041	544	184	96	80
Bypass roundabout to Bogan Rd intersection	NB	548	338	97	60	80	647	415	114	73	80
	SB	1,002	293	177	52	80	1,080	466	191	82	80
Bypass Bogan Rd to existing Newell Hwy	EB	484	126	85	22	110	1,077	469	190	83	110
	WB	500	128	88	23	110	1,124	469	198	83	110
Bypass link with existing Newell Hwy (north of Parkes)	EB	375	96	66	17	80	436	116	77	21	80
	WB	362	94	64	17	80	422	114	75	20	80
Newell Hwy											
Newell Hwy south of Bypass	NB	1,905	457	336	81	110	2,246	553	396	98	110
	SB	1,972	486	348	86	110	2,324	588	410	104	110

Road	Direction	Forecast Traffic Opening Year 2023 - Build					Forecast Traffic Design Year 2033 - Build				
		15 hour (day)		9 hour (night)		Speed	15 hour (day)		9 hour (night)		Speed
		Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)	Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)
Existing Newell Hwy between south of Parkes and Bypass	NB	1,098	265	114	28	110	1,266	341	135	36	110
	SB	1,004	281	41	12	110	1,144	364	40	13	110
Existing Newell Hwy between north of Parkes and Bypass	NB	974	59	172	10	110	1,147	65	202	12	110
	SB	936	105	165	19	110	1,103	127	195	22	110
Newell Hwy north of Bypass	NB	375	96	66	17	110	1,653	442	292	78	110
	SB	362	94	64	17	110	1,799	482	317	85	110
Hartigan Avenue											
South of Best St intersection	NB	666	130	118	23	50	842	100	149	18	50
	SB	410	82	72	15	50	482	100	85	18	50
Between Best St intersection and Brolgan Rd intersection	NB	836	188	147	33	50	983	261	173	46	50
	SB	1,160	195	205	34	50	1,366	269	241	48	50
Extension - between Brolgan Rd intersection and intersection with Condobolin St	NB	654	161	115	28	50	768	228	136	40	50
	SB	748	179	132	32	50	880	251	155	44	50
Brolgan Road											
West of Bypass/Hartigan Ave	EB	630	142	111	25	80	738	240	130	42	80
	WB	453	126	80	22	80	531	219	94	39	80
East of Bypass	EB	581	54	103	10	50	685	66	121	12	50
	WB	581	54	103	10	50	685	66	121	12	50
Condobolin Road											

Road	Direction	Forecast Traffic Opening Year 2023 - Build					Forecast Traffic Design Year 2033 - Build				
		15 hour (day)		9 hour (night)		Speed	15 hour (day)		9 hour (night)		Speed
		Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)	Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)
West of Moulden Street	EB	660	154	116	27	80	796	196	140	35	80
	WB	649	161	114	28	80	780	203	138	36	80
Between Moulden St and Bypass roundabout	EB	974	59	172	10	50	1,445	304	255	54	50
	WB	936	105	165	19	50	1,455	320	257	57	50
East of Bypass roundabout	EB	735	90	130	16	50	866	110	153	19	50
	WB	735	90	130	16	50	866	110	153	19	50
London Road											
West of Bypass	NB	125	73	22	13	100	147	88	26	16	100
	SB	125	73	22	13	100	147	88	26	16	100
East of the Bypass	EB	125	73	22	13	80	147	88	26	16	80
	WB	125	73	22	13	80	147	88	26	16	80
Bogan Road											
From intersection of the Bypass and north of Parkes	NB	484	126	85	22	100	563	152	99	27	100
	SB	500	128	88	23	100	581	156	103	27	100
Back Trundle Road											
East of Moulden Street	EB	0	0	0	0	0	0	0	0	0	0
	WB	0	0	0	0	0	0	0	0	0	0
West of Moulden Street	EB	366	35	65	6	50	431	43	76	8	50
	WB	339	33	60	6	50	400	40	71	7	50

Road	Direction	Forecast Traffic Opening Year 2023 - Build					Forecast Traffic Design Year 2033 - Build				
		15 hour (day)		9 hour (night)		Speed	15 hour (day)		9 hour (night)		Speed
		Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)	Total volume	Heavy vehicle	Total volume	Heavy vehicle	(km/h)
New local road joining Hartigan Ave to Best Street											
North of Hartigan Avenue	NB	581	54	103	10	50	685	66	121	12	50
	SB	581	54	103	10	50	685	66	121	12	50
Moulden St											
North of Condobolin Rd	NB	366	35	65	6	50	431	43	76	8	50
	SB	339	33	60	6	50	400	40	71	7	50

Appendix D

Noise criteria – transition zone

DEEP LEAD ROAD
HERAGHTY ROAD
BOGAN ROAD
NEWELL HIGHWAY
HERAGHTY ROAD
MAGUIRE ROAD
NEWELL HIGHWAY
BOGAN ROAD
REEDSDALE ROAD
NOCK ROAD
NEWELL HIGHWAY
BLEECHMORE ROAD
GOLDRUSH ROAD
ENDICOTT STREET
REEDSDALE ROAD
NOBLE ROAD
NEWELL HIGHWAY
KABLES LANE
PAINTER STREET
PAINTER STREET
FARRER STREET
FAHEY ROAD
PEAK HILL ROAD

Map: Transition Zone Calculations Map 1 of 2	Author: TJG	
Date: 25/09/2018	Approved by: CXM	

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Buildings

Sensitive — Non-Sensitive

Criteria (dBA, Leq)

- Day 60dBA / Night 55dBA
- Day 59dBA / Night 54dBA
- Day 58dBA / Night 53dBA
- Day 57dBA / Night 52dBA
- Day 56dBA / Night 51dBA
- Day 55dBA / Night 50dBA

Newell Highway Bypass Upgrade, Parkes

Transition Zone Calculations
Map 1 of 2

wsp

HIDEAWAY LANE

NEWELL HIGHWAY

BARKERS ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD

1

2

Map: Transition Zone Calculations Map 2 of 2	Author: TJG	
Date: 25/09/2018	Approved by: CXM	

To be read in conjunction with report PS102430-NOI-REP-001 RevB

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Buildings

Project roads — Existing roads — Sensitive — Non-Sensitive

Criteria (dBA, Leq)

- Day 60dBA / Night 55dBA
- Day 59dBA / Night 54dBA
- Day 58dBA / Night 53dBA
- Day 57dBA / Night 52dBA
- Day 56dBA / Night 51dBA
- Day 55dBA / Night 50dBA

Newell Highway Bypass Upgrade, Parkes

Transition Zone Calculations
Map 2 of 2

wsp

Appendix E

Operational noise predictions

Appendix E-1
Noise contour maps

Predicted day time noise levels for 2023 for the no build scenario

HIDEAWAY LANE

NEWELL HIGHWAY

BARKERS ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD

NEWELL HIGHWAY

1

2

3

4

Map: Predicted Day Noise Levels 2023 Map 1 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
- > 42 <= 47
- > 47 <= 52
- > 52 <= 57
- > 57 <= 62
- > 62 <= 67
- > 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 1 of 4

wsp

BROLGAN ROAD
WOOLSTORE PLACE
BROLGAN ROAD
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
WESTLIME ROAD
CONDOBOLIN ROAD
CONDOBOLIN ROAD
CORONATION AVENUE
EBELINA CRESCENT
BROLGAN ROAD
BROLGAN ROAD
HARTIGAN AVENUE
MIDDLETON STREET
ALDER AVENUE
ROSEWOOD AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
LYNCH STREET
WARRAGRAH PLACE
HARTIGAN AVENUE
BALLERDEE LANE
CLARKE STREET
LONDON ROAD
LONDON ROAD
ACKROYD STREET
MATTHEWS STREET
LONDON ROAD
SALEYARDS ROAD
HIDEAWAY LANE
SALEYARDS ROAD
BOYD CIRCUIT

Map: Predicted Day Noise Levels 2023 Map 2 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
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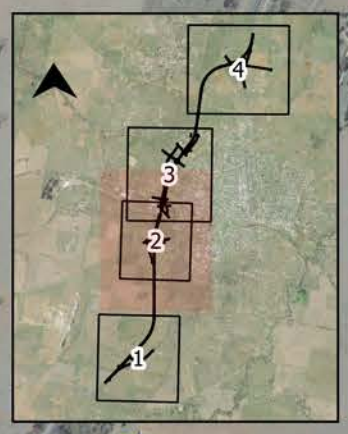
Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 2 of 4



BACK TRUNDLE ROAD
PAINTER STREET
REEDSDALE ROAD
FARRER STREET
COOKAPIE STREET
HENRY PARKES WAY
THOMAS STREET
MOULDEN STREET
JUBILEE STREET
ROSE STREET
MITCHELL STREET
VICTORIA STREET
CONDOBOLIN ROAD
WESTLIME ROAD
BROLGAN ROAD
KING MERINO ROAD
CORONATION AVENUE
EBELINA CRESCENT
HARTIGAN AVENUE
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GRENFELL STREET
LYNCH STREET
JUNCTION STREET
ALDER AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
ROSEWOOD AVENUE
WARRAGRAH PLACE
BALLERDEE LANE
LONDON ROAD
CLARKE STREET
ACKROYD STREET
WOOLSTORE PLACE

Map: Predicted Day Noise Levels 2023 Map 3 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

<= 37	> 52 <= 57
> 37 <= 42	> 57 <= 62
> 42 <= 47	> 62 <= 67
> 47 <= 52	> 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 3 of 4

wsp

DEEP LEAD ROAD
DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NEWELL HIGHWAY
HERAGHTY ROAD
MAGUIRE ROAD
MAGUIRE ROAD
REEDSDALE ROAD
BOGAN ROAD
NEWELL HIGHWAY
NOCK ROAD
BLEECHMORE ROAD
GOLDRUSH ROAD
ENDICOTT STREET
REEDSDALE ROAD
NEWELL HIGHWAY
NOBLE ROAD
PAINTER STREET
PAINTER STREET
REEDSDALE ROAD
FARRER STREET
FAHEY ROAD
COOKAPIE STREET
PIONEER STREET
COLEMAN STREET
JONES STREET
WEBB STREET
THOMAS STREET
WEBB STREET

Map: Predicted Day Noise Levels 2023 Map 4 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

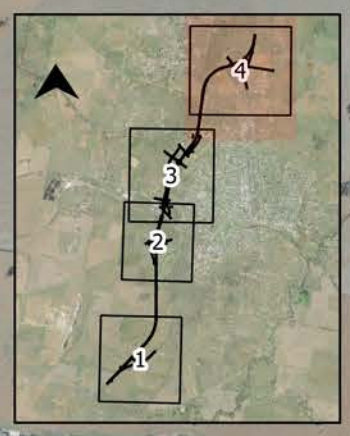
<= 37	> 52 <= 57
> 37 <= 42	> 57 <= 62
> 42 <= 47	> 62 <= 67
> 47 <= 52	> 67

Buildings

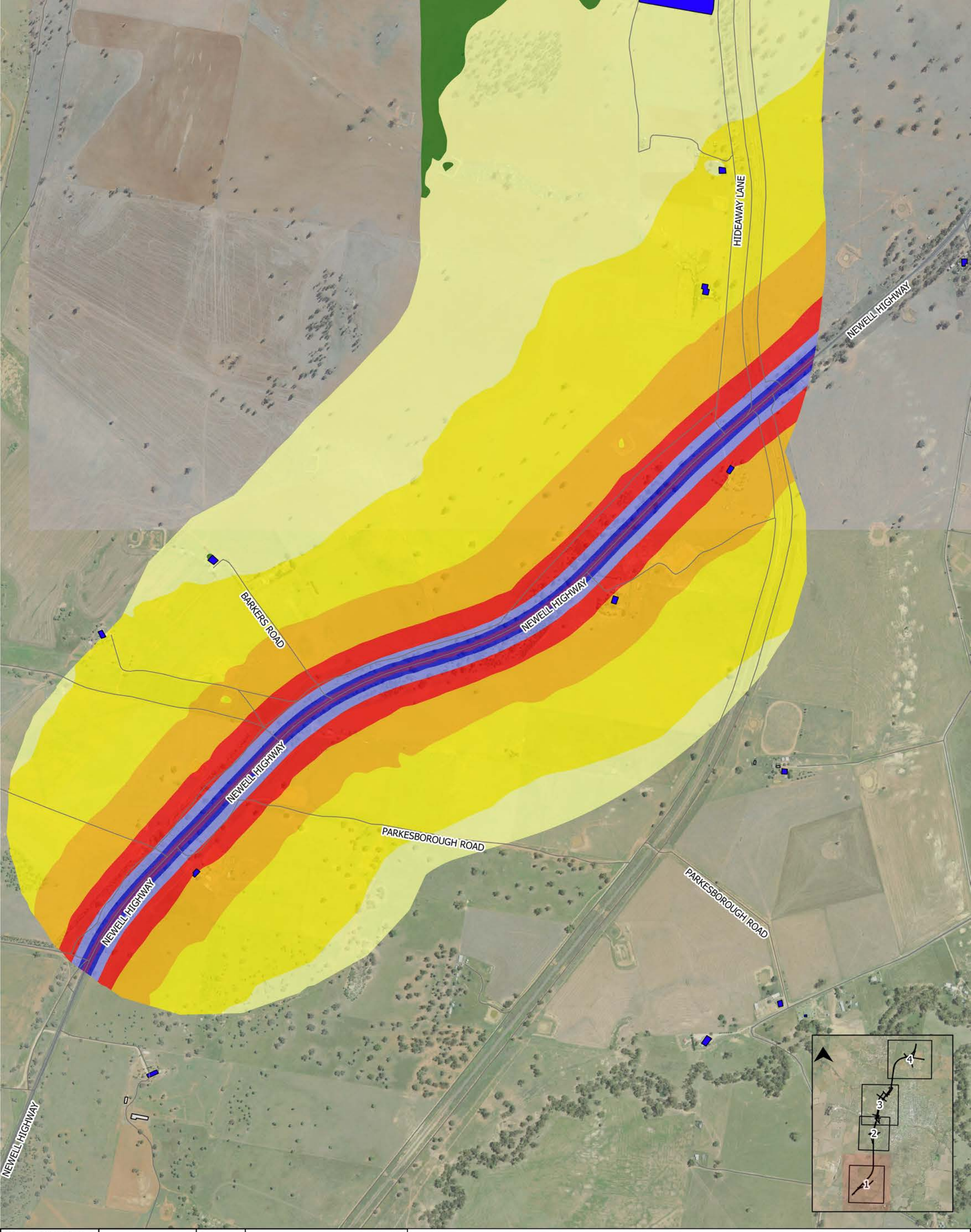
Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 4 of 4



Predicted night time noise levels for 2023 for the no build scenario



Map: Predicted Night Noise Levels 2023 Map 1 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

<= 37	> 52 <= 57
> 37 <= 42	> 57 <= 62
> 42 <= 47	> 62 <= 67
> 47 <= 52	> 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 1 of 4

wsp

BROLGAN ROAD
WOOLSTORE PLACE
BROLGAN ROAD
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
WESTLIME ROAD
CONDOBOLIN ROAD
CONDOBOLIN ROAD
CORONATION AVENUE
EBELINA CRESCENT
BROLGAN ROAD
BROLGAN ROAD
HARTIGAN AVENUE
MIDDLETON STREET
ALDER AVENUE
ROSEWOOD AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
WARRAGRAH PLACE
HARTIGAN AVENUE
BALLERDEE LANE
LONDON ROAD
LONDON ROAD
CLARKE STREET
ACKROYD STREET
MATTHEWS STREET
LONDON ROAD
SALEYARDS ROAD
HIDEAWAY LANE
BOYD CIRCUIT
SALEYARDS ROAD
1
2
3
4

Map: Predicted Night Noise Levels 2023 Map 2 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

<= 37	> 52 <= 57
> 37 <= 42	> 57 <= 62
> 42 <= 47	> 62 <= 67
> 47 <= 52	> 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 2 of 4

wsp

BACK TRUNDLE ROAD
PAINTER STREET
REEDSDALE ROAD
FARRER STREET
COOKAPIE STREET
HENRY PARKES WAY
BACK TRUNDLE ROAD
THOMAS STREET
HENRY PARKES WAY
BACK TRUNDLE ROAD
MOULDEN STREET
REEDSDALE ROAD
FARRER STREET
JUBILEE STREET
ROSE STREET
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VICTORIA STREET
MOULDEN STREET
WESTLIME ROAD
CONDOBOLIN ROAD
MITCHELL STREET
CONDOBOLIN ROAD
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BROLGAN ROAD
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GRENFELL STREET
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LYNCH STREET
JUNCTION STREET
ROSEWOOD AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
WARRAGRAH PLACE
HARTIGAN AVENUE
BALLERDEE LANE
CLARKE STREET
ACKROYD STREET
LONDON ROAD
LONDON ROAD

Map: Predicted Night Noise Levels 2023 Map 3 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

— Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
- > 42 <= 47
- > 47 <= 52
- > 52 <= 57
- > 57 <= 62
- > 62 <= 67
- > 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 3 of 4

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DEEP LEAD ROAD
DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NEWELL HIGHWAY
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REEDSDALE ROAD
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FAHEY ROAD
COOKAPIE STREET
PIONEER STREET
JONES STREET
COLEMAN STREET
WEBB STREET
THOMAS STREET
WEBB STREET
1
2
3
4

Map: Predicted Night Noise Levels 2023 Map 4 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

<= 37	> 52 <= 57
> 37 <= 42	> 57 <= 62
> 42 <= 47	> 62 <= 67
> 47 <= 52	> 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
No Build Scenario
Map 4 of 4

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Predicted day time noise levels for 2023 for the build scenario

HIDEAWAY LANE

NEWELL HIGHWAY

BARKERS ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD

NEWELL HIGHWAY

1

2

3

4

Map: Predicted Day Noise Levels 2023 Map 1 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

— Project roads — Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
- > 42 <= 47
- > 47 <= 52
- > 52 <= 57
- > 57 <= 62
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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 1 of 4

wsp

BROLGAN ROAD
WOOLSTORE PLACE
BROLGAN ROAD
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
WESTLIME ROAD
HARTIGAN AVENUE
CONDOBOLIN ROAD
CONDOBOLIN ROAD
CORONATION AVENUE
EBELINA CRESCENT
BROLGAN ROAD
BROLGAN ROAD
MIDDLETON STREET
ALDER AVENUE
ROSEWOOD AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
WARRAGRAH PLACE
HARTIGAN AVENUE
BALLERDEE LANE
LONDON ROAD
LONDON ROAD
CLARKE STREET
AGKROYD STREET
MATTHEWS STREET
LONDON ROAD
SALEYARDS ROAD
HIDEAWAY LANE
SALEYARDS ROAD
BOYD CIRCUIT
LYNCH STREET
1
2
3
4

Map: Predicted Day Noise Levels 2023 Map 2 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

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Project roads — Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
- > 42 <= 47
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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 2 of 4

wsp

BACK TRUNDLE ROAD
PAINTER STREET
REEDSDALE ROAD
FARRER STREET
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HENRY PARKES WAY
MOULDEN STREET
REEDSDALE ROAD
THOMAS STREET
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ROSE STREET
MITCHELL STREET
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CORONATION AVENUE
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WOOLSTORE PLACE
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
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GRENFELL STREET
ALDER AVENUE
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WARRAGRAH PLACE
HARTIGAN AVENUE
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CLARKE STREET
ACKROYD STREET
LONDON ROAD
LONDON ROAD

Map: Predicted Day Noise Levels 2023 Map 3 of 4	Author: TJG
Date: 14/01/2019	Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

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Legend

Project roads — Existing roads

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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 3 of 4

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DEEP LEAD ROAD
DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NEWELL HIGHWAY
HERAGHTY ROAD
MAGUIRE ROAD
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PIONEER STREET
COLEMAN STREET
WEBB STREET
JONES STREET
THOMAS STREET
WEBB STREET

Map: Predicted Day Noise Levels 2023 Map 4 of 4	Author: TJG	
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To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

— Project roads — Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
- > 42 <= 47
- > 47 <= 52
- > 52 <= 57
- > 57 <= 62
- > 62 <= 67
- > 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 4 of 4

wsp

Predicted night time noise levels for 2023 for the build scenario

HIDEAWAY LANE

NEWELL HIGHWAY

BARKERS ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

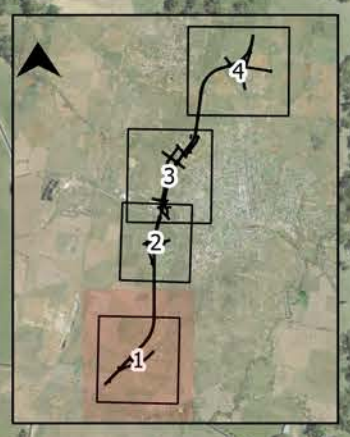
NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD

NEWELL HIGHWAY

1



Map: Predicted Night Noise Levels 2023 Map 1 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

— Project roads — Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 1 of 4

wsp

BROLGAN ROAD
WOOLSTORE PLACE
BROLGAN ROAD
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
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CONDOBOLIN ROAD
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BROLGAN ROAD
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ROSEWOOD AVENUE
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WESTCOTT CRESCENT
LYNCH STREET
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HARTIGAN AVENUE
BALLERDEE LANE
LONDON ROAD
LONDON ROAD
LONDON ROAD
CLARKE STREET
ACKROYD STREET
MATTHEWS STREET
SALEYARDS ROAD
HIDEAWAY LANE
SALEYARDS ROAD
BOYD CIRCUIT

Map: Predicted Night Noise Levels 2023 Map 2 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

— Project roads — Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
- > 42 <= 47
- > 47 <= 52
- > 52 <= 57
- > 57 <= 62
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- > 67

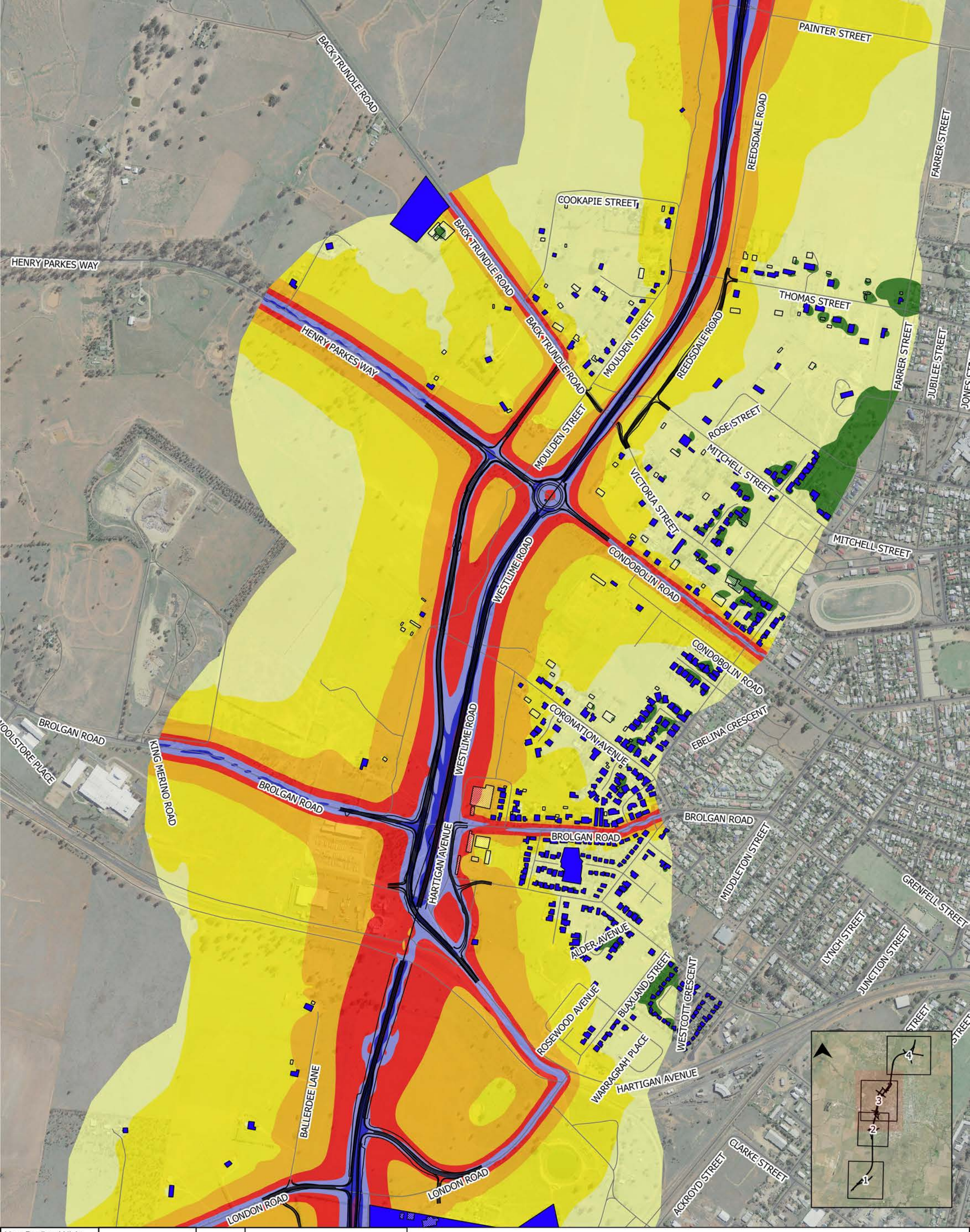
Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 2 of 4

wsp



Map: Predicted Night Noise Levels 2023 Map 3 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

— Project roads — Existing roads

Noise Level (dBA, Leq)

<= 37	> 52 <= 57
> 37 <= 42	> 57 <= 62
> 42 <= 47	> 62 <= 67
> 47 <= 52	> 67

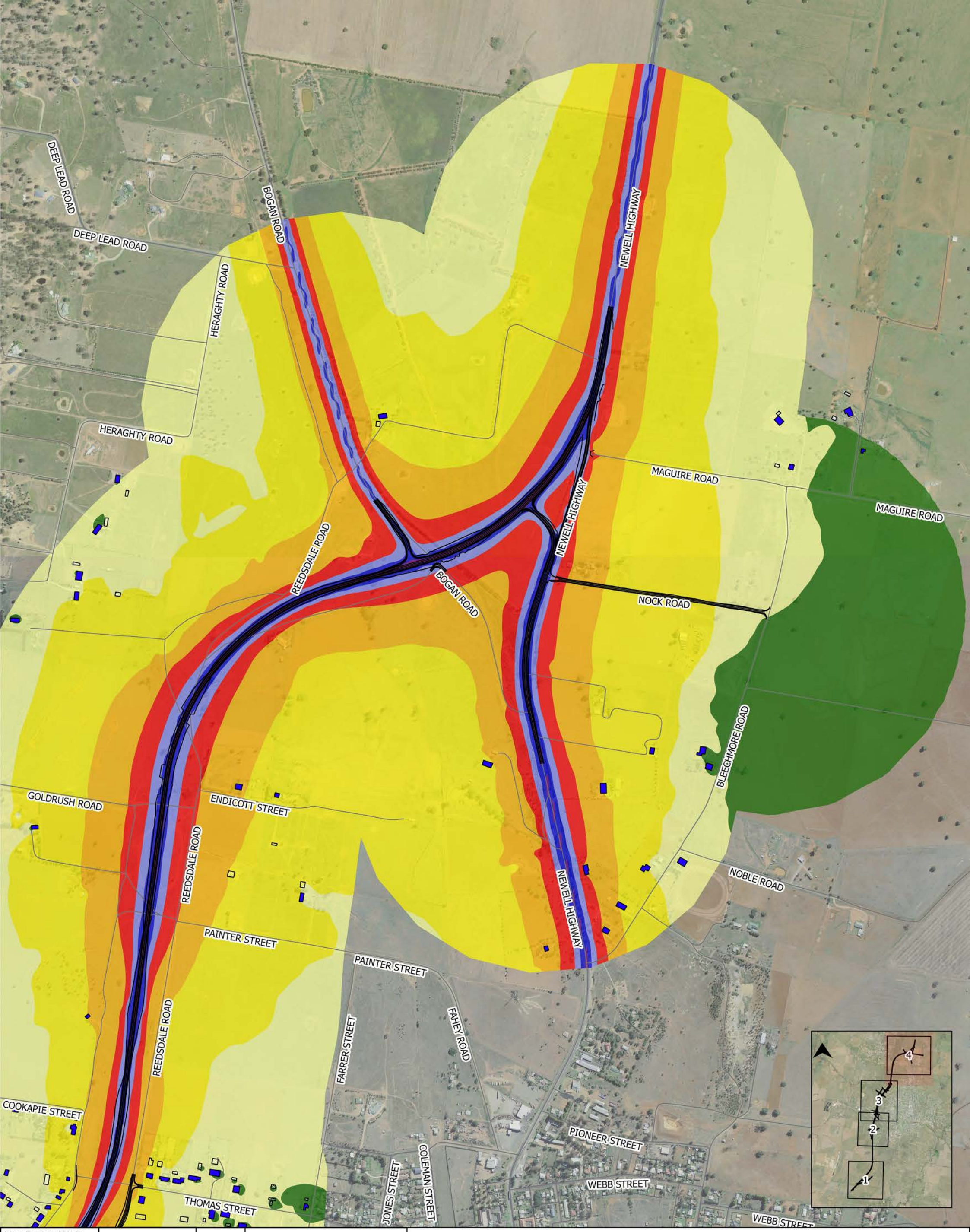
Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 3 of 4

wsp



Map: Predicted Night Noise Levels 2023 Map 4 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

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Noise Level (dBA, Leq)

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- > 52 <= 57
- > 57 <= 62
- > 62 <= 67
- > 67

Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2023
Facade Corrected Noise Levels
Build Scenario
Map 4 of 4

wsp

Predicted daytime noise levels for 2033 for the no build scenario

HIDEAWAY LANE

NEWELL HIGHWAY

BARKERS ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD

NEWELL HIGHWAY

1

2

3

4

Map: Predicted Day Noise Levels 2033 Map 1 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

Noise Level (dBA, Leq)

- <= 37
- > 37 <= 42
- > 42 <= 47
- > 47 <= 52
- > 52 <= 57
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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 1 of 4

wsp

BROLGAN ROAD
WOOLSTORE PLACE
BROLGAN ROAD
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
WESTLIME ROAD
CONDOBOLIN ROAD
CONDOBOLIN ROAD
CORONATION AVENUE
EBELINA CRESCENT
BROLGAN ROAD
BROLGAN ROAD
HARTIGAN AVENUE
MIDDLETON STREET
ALDER AVENUE
ROSEWOOD AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
WARRAGRAH PLACE
HARTIGAN AVENUE
BALLERDEE LANE
LONDON ROAD
LONDON ROAD
CLARKE STREET
ACKROYD STREET
MATTHEWS STREET
LONDON ROAD
SALEYARDS ROAD
HIDEAWAY LANE
SALEYARDS ROAD
BOYD CIRCUIT
LYNCH STREET
1
2
3
4

Map: Predicted Day Noise Levels 2033 Map 2 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

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Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Existing roads

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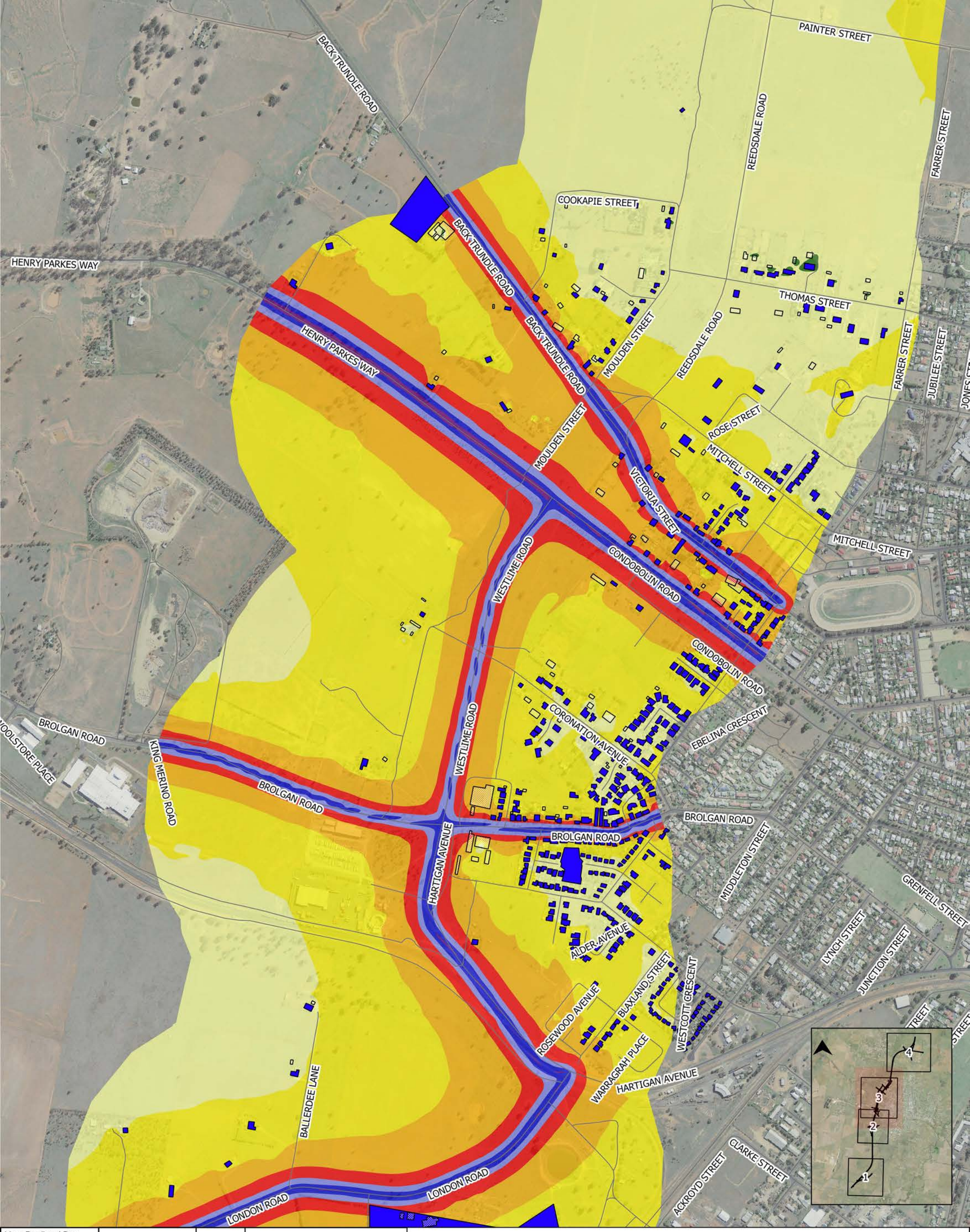
Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 2 of 4

wsp



Map: Predicted Day Noise Levels 2033 Map 3 of 4	Author: TJG	
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Existing roads

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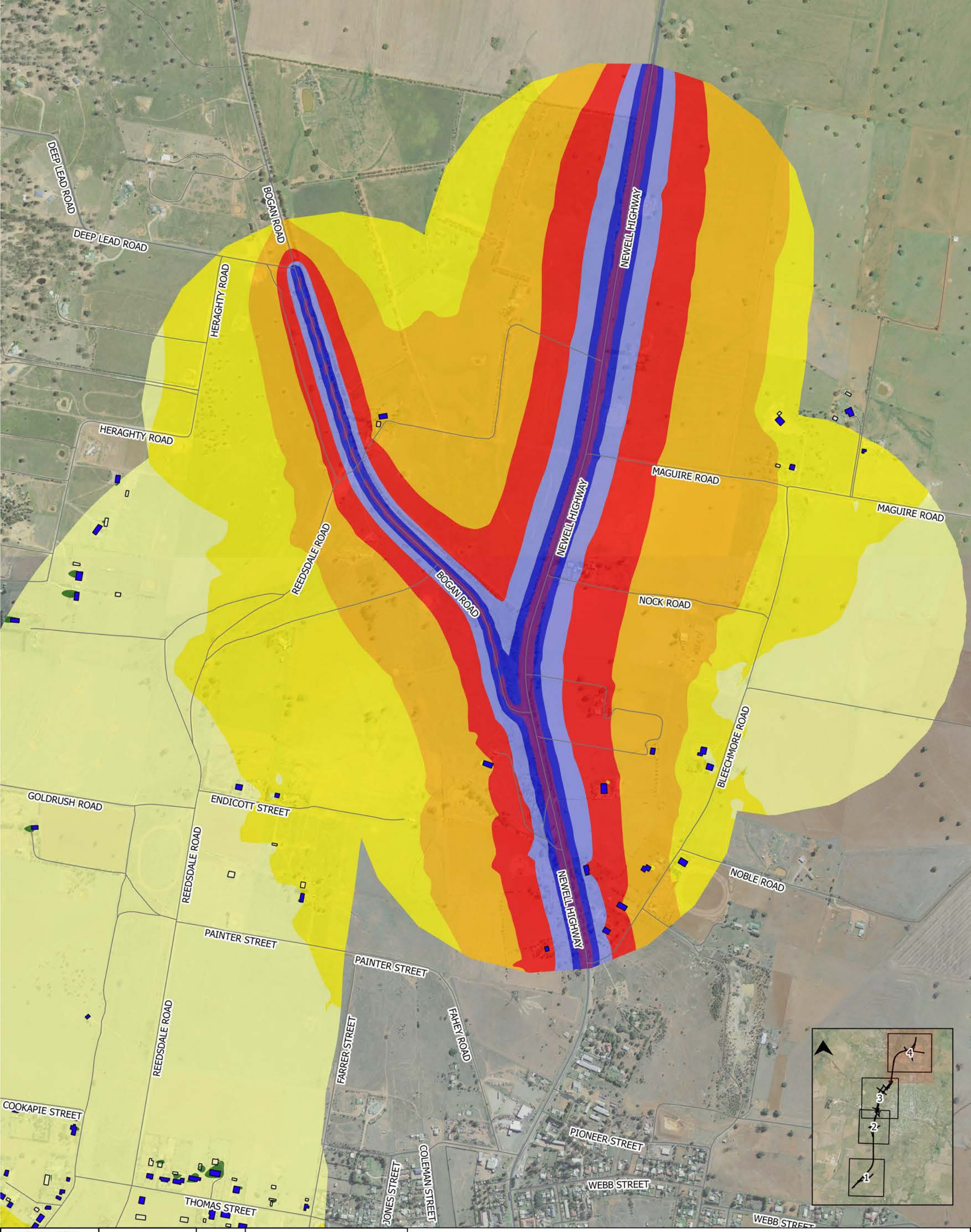
Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 3 of 4

wsp



Map: Predicted Day Noise Levels 2033 Map 4 of 4	Author: TJG	
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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 4 of 4

wsp

Predicted night time noise levels for 2033 for the no build scenario

HIDEAWAY LANE

NEWELL HIGHWAY

BARKERS ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD

NEWELL HIGHWAY

1

2

3

4

Map: Predicted Night Noise Levels 2033 Map 1 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 1 of 4

BROLGAN ROAD
WOOLSTORE PLACE
BROLGAN ROAD
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
WESTLIME ROAD
CONDOBOLIN ROAD
CONDOBOLIN ROAD
CORONATION AVENUE
EBELINA CRESCENT
BROLGAN ROAD
BROLGAN ROAD
HARTIGAN AVENUE
MIDDLETON STREET
ALDER AVENUE
ROSEWOOD AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
LYNCH STREET
WARRAGRAH PLACE
HARTIGAN AVENUE
BALLERDEE LANE
CLARKE STREET
LONDON ROAD
LONDON ROAD
ACKROYD STREET
MATTHEWS STREET
LONDON ROAD
SALEYARDS ROAD
SALEYARDS ROAD
HIDEAWAY LANE
BOYD CIRCUIT

Map: Predicted Night Noise Levels 2033 Map 2 of 4	Author: TJG	
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To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

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Legend

— Existing roads

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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 2 of 4

wsp

BACK TRUNDLE ROAD
PAINTER STREET
REEDSDALE ROAD
FARRER STREET
COOKAPIE STREET
HENRY PARKES WAY
BACK TRUNDLE ROAD
THOMAS STREET
MOULDEN STREET
REEDSDALE ROAD
FARRER STREET
JUBILEE STREET
HENRY PARKES WAY
BACK TRUNDLE ROAD
MOULDEN STREET
ROSE STREET
MITCHELL STREET
VICTORIA STREET
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CORONATION AVENUE
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MIDDLETON STREET
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LYNCH STREET
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ROSEWOOD AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
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HARTIGAN AVENUE
BALLERDEE LANE
CLARKE STREET
ACKROYD STREET
LONDON ROAD
LONDON ROAD

Map: Predicted Night Noise Levels 2033 Map 3 of 4	Author: TJG	
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0 100 200 300 m

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Aerial imagery source: NSW SIX Maps

Legend

Existing roads

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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 3 of 4

wsp

DEEP LEAD ROAD
DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NEWELL HIGHWAY
HERAGHTY ROAD
REEDSDALE ROAD
BOGAN ROAD
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MAGUIRE ROAD
MAGUIRE ROAD
NOCK ROAD
BLEECHMORE ROAD
GOLDRUSH ROAD
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REEDSDALE ROAD
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FAHEY ROAD
COOKAPIE STREET
PIONEER STREET
JONES STREET
COLEMAN STREET
WEBB STREET
THOMAS STREET
WEBB STREET
1
2
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Map: Predicted Night Noise Levels 2033
Map 4 of 4

Author: TJG

Date: 14/01/2019

Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

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Buildings

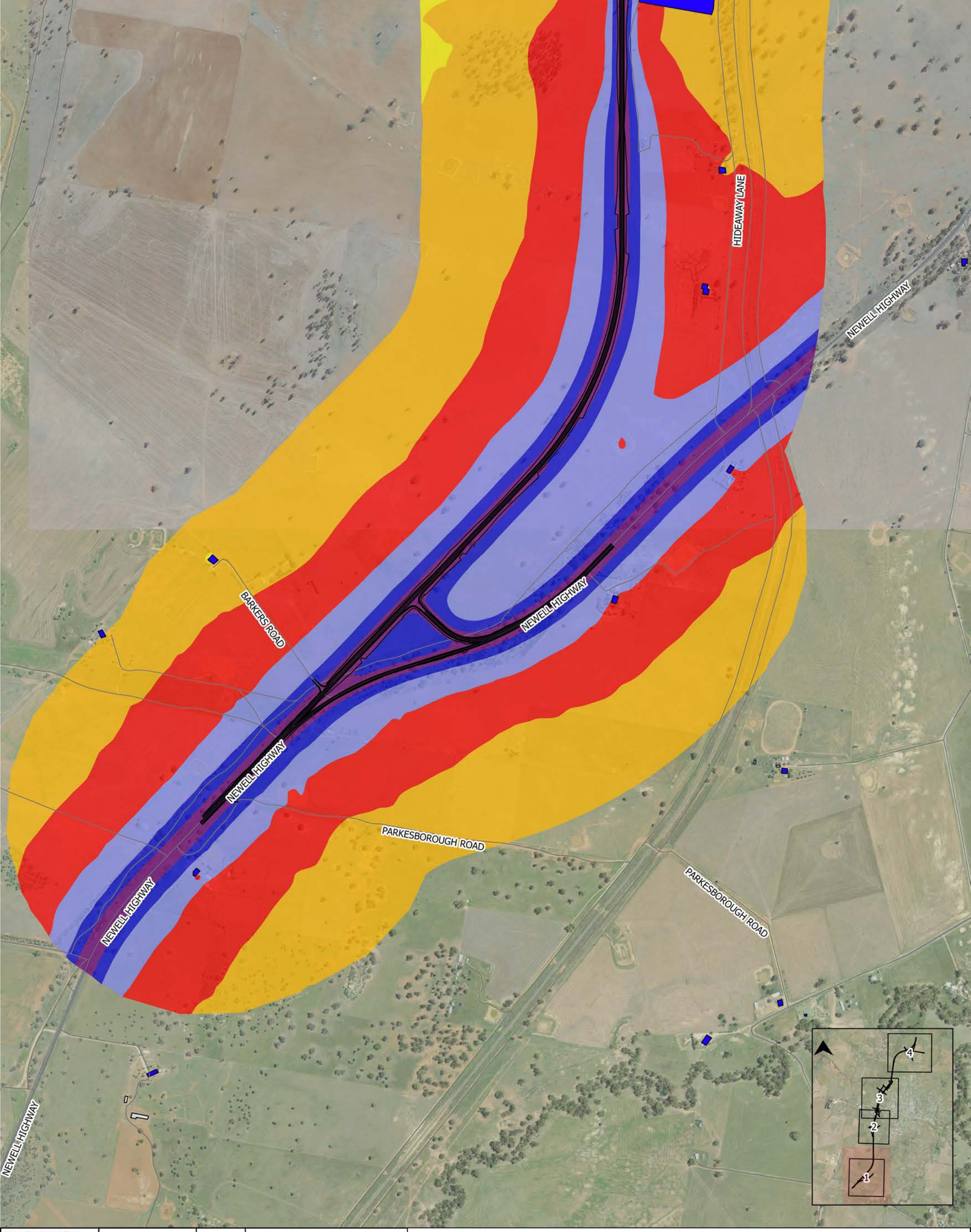
Sensitive
Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
No Build Scenario
Map 4 of 4

wsp

Predicted daytime noise levels for 2033 for the build scenario



Map: Predicted Day Noise Levels 2033 Map 1 of 4	Author: TJG	
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To be read in conjunction with report PS102430-NOI-REP-001 RevD

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Legend

Project roads — Existing roads

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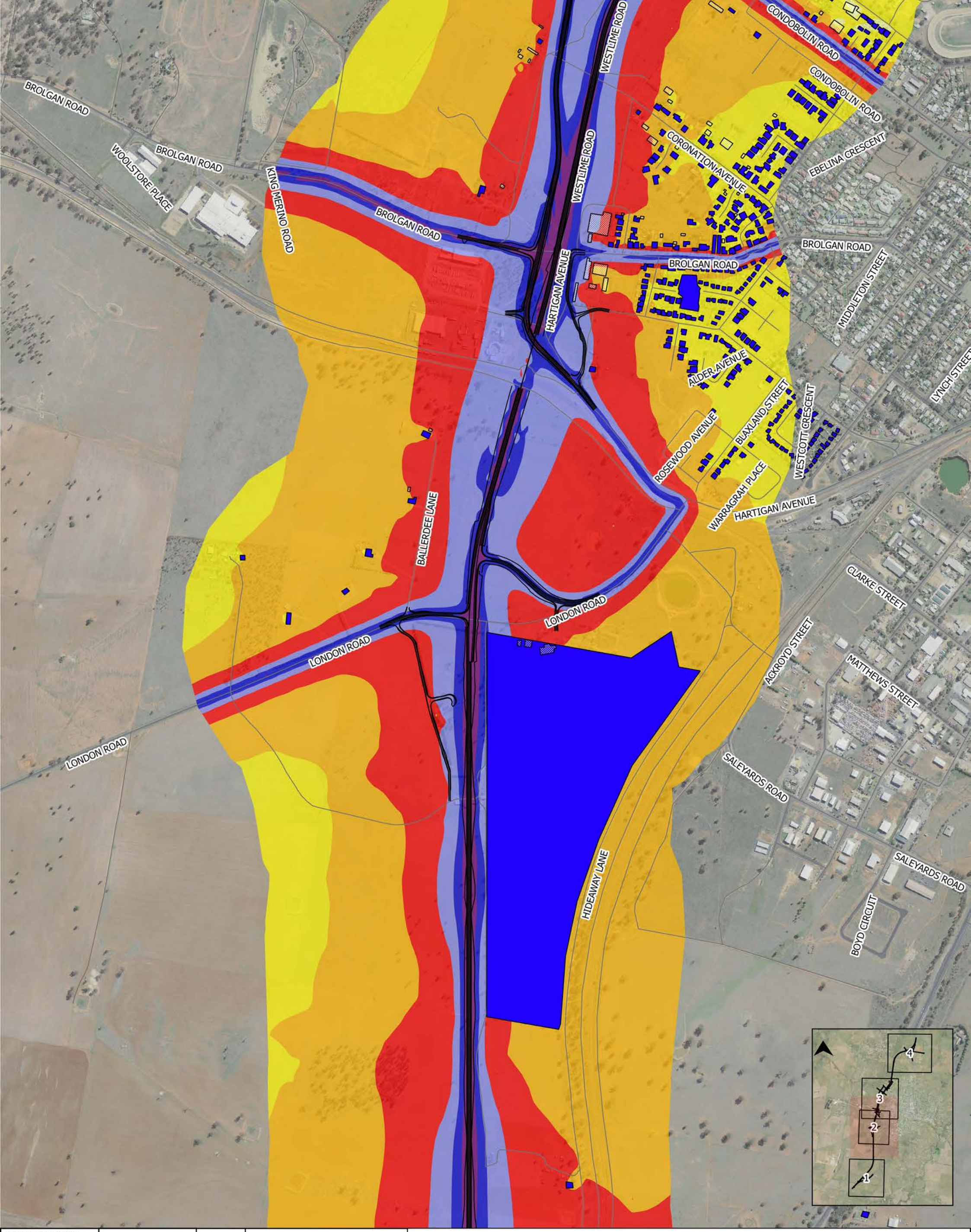
Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 1 of 4

wsp



Map: Predicted Day Noise Levels 2033 Map 2 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 2 of 4

wsp

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GRENFELL STREET
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LYNCH STREET
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BLAXLAND STREET
WESTCOTT CRESCENT
ROSEWOOD AVENUE
WARRAGRAH PLACE
HARTIGAN AVENUE
BALLERDEE LANE
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LONDON ROAD
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Map: Predicted Day Noise Levels 2033 Map 3 of 4	Author: TJG	
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Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 3 of 4

wsp

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WEBB STREET
THOMAS STREET
WEBB STREET
1
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Map: Predicted Day Noise Levels 2033 Map 4 of 4	Author: TJG	
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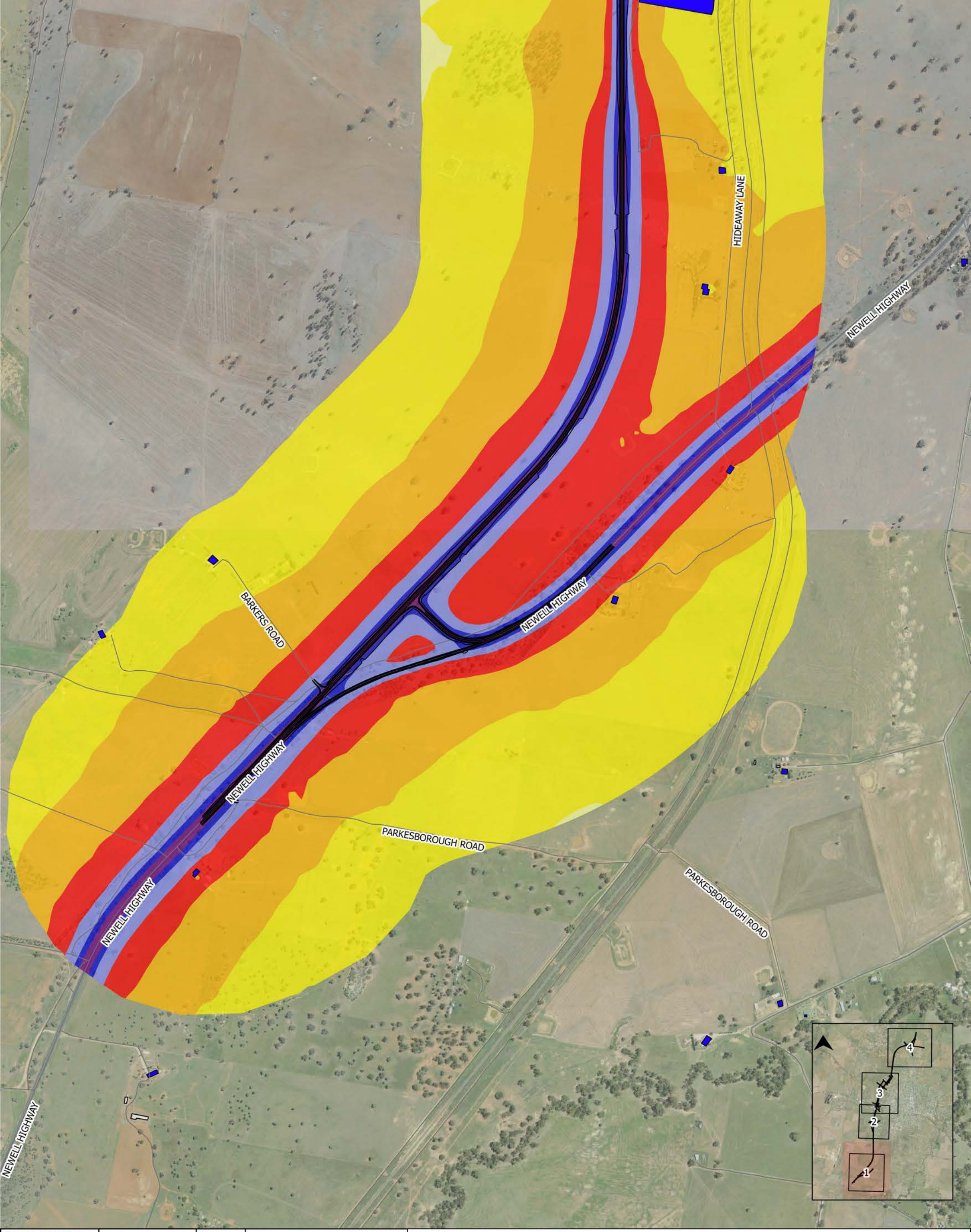
Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Day Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 4 of 4

Predicted night time noise levels for 2033 for the build scenario



Map: Predicted Night Noise Levels 2033 Map 1 of 4	Author: TJG	
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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 1 of 4

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BROLGAN ROAD
WOOLSTORE PLACE
BROLGAN ROAD
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
WESTLIME ROAD
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LONDON ROAD
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ACKROYD STREET
MATTHEWS STREET
SALEYARDS ROAD
HIDEAWAY LANE
SALEYARDS ROAD
BOYD CIRCUIT

Map: Predicted Night Noise Levels 2033 Map 2 of 4	Author: TJG	
Date: 14/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Noise Level (dBA, Leq)

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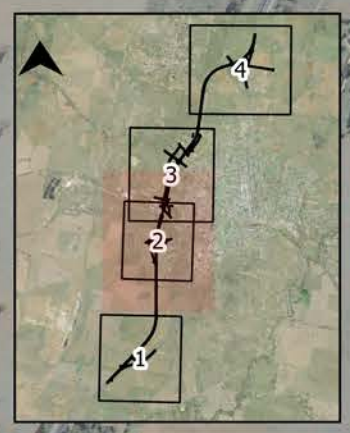
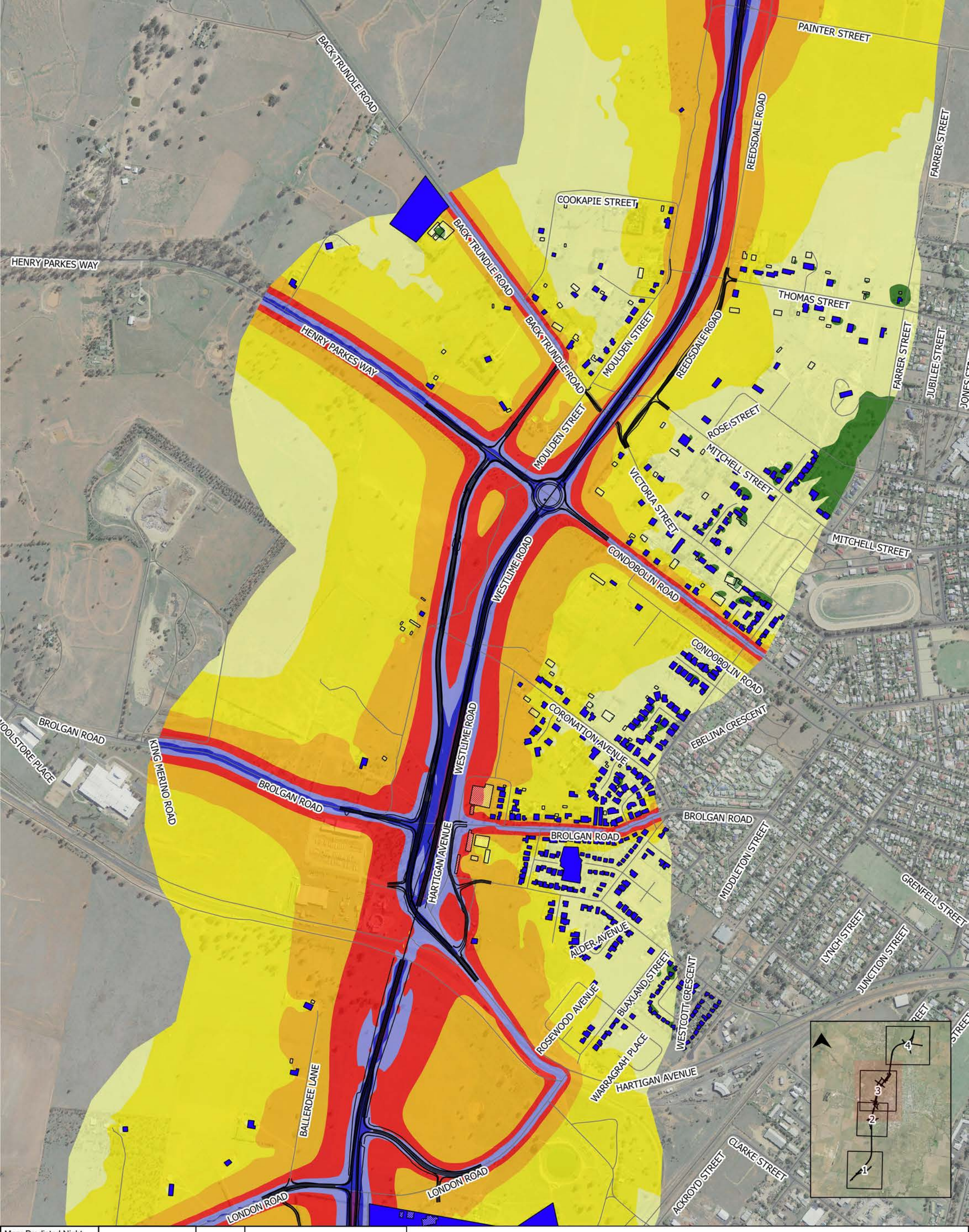
Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 2 of 4





Map: Predicted Night Noise Levels 2033 Map 3 of 4	Author: TJG	
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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 3 of 4

wsp

DEEP LEAD ROAD
DEEP LEAD ROAD
BOGAN ROAD
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COLEMAN STREET
JONES STREET
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THOMAS STREET
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Map: Predicted Night Noise Levels 2033 Map 4 of 4	Author: TJG
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0 100 200 300 m

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Legend

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Buildings

Sensitive Non-Sensitive

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Facade Corrected Noise Levels
Build Scenario
Map 4 of 4

Appendix E-2
Tabulated results of predicted façade noise levels

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Appendix E-3

Map indicating residential receivers eligible for consideration of noise mitigation for the design year (2033)

HIDEAWAY LANE
NEWELL HIGHWAY
BARKERS ROAD
NEWELL HIGHWAY
NEWELL HIGHWAY
PARKESBOROUGH ROAD
NEWELL HIGHWAY
PARKESBOROUGH ROAD
NEWELL HIGHWAY
1
2
3
4

Map: Predicted Night Noise Levels 2033 Mitigation Add. Rec	Author: TJG	
Date: 14/01/19	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Buildings

Receiver

Receivers for consideration of mitigation

Non-Sensitive

Noise Mitigation Triggers

NCG Night Criteria	Relative Increase Criteria	Significant change in noise level
Greater than 50 dBA	Increase greater than 12 dB	Increase greater than 2 dB

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Mitigation Triggers
Facade Corrected Noise Levels
Map 1 of 4

wsp

BROLGAN ROAD
BROLGAN ROAD
WOOLSTORE PLACE
KING MERINO ROAD
BROLGAN ROAD
WESTLIME ROAD
WESTLIME ROAD
HARTIGAN AVENUE
CONDOBOLIN ROAD
CONDOBOLIN ROAD
CORONATION AVENUE
EBELINA CRESCENT
BROLGAN ROAD
BROLGAN ROAD
THOMAS TOM CRESCENT
MIDDLETON STREET
ALDER AVENUE
BLAXLAND STREET
WESTCOTT CRESCENT
WARRAGRAH PLACE
ROSEWOOD AVENUE
LYNCH STREET
HARTIGAN AVENUE
BALLERDEE LANE
LONDON ROAD
LONDON ROAD
CLARKE STREET
ACKROYD STREET
MATTHEWS STREET
LONDON ROAD
SALEYARDS ROAD
SALEYARDS ROAD
HIDEAWAY LANE
BOYD CIRCUIT
4
3
2
1

Map: Predicted Night Noise Levels 2033 Mitigation Add. Rec	Author: TJG	
Date: 14/01/19	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Buildings

- Receiver
- Receivers for consideration of mitigation
- Non-Sensitive

Noise Mitigation Triggers

NCG Night Criteria	Relative Increase Criteria	Significant change in noise level
Greater than 50 dBA	Increase greater than 12 dB	Increase greater than 2 dB

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Mitigation Triggers
Facade Corrected Noise Levels
Map 2 of 4

wsp

BACK TRUNDLE ROAD
PAINTER STREET
REEDSDALE ROAD
FARRER STREET
COOKAPIE STREET
HENRY PARKES WAY
BACK TRUNDLE ROAD
THOMAS STREET
MOULDEN STREET
REEDSDALE ROAD
FARRER STREET
JUBILEE STREET
JONES STREET
ROSE STREET
MITCHELL STREET
VICTORIA STREET
WESTLIME ROAD
CONDOBOLIN ROAD
CONDOBOLIN ROAD
BROLGAN ROAD
CORONATION AVENUE
EBELINA CRESCENT
KING MERINO ROAD
BROLGAN ROAD
BROLGAN ROAD
THOMAS TOM CRESCENT
MIDDLETON STREET
HARTIGAN AVENUE
ALDER AVENUE
LYNCH STREET
JUNCTION STREET
BLAXLAND STREET
WESTCOTT CRESCENT
WARRAGRAH PLACE
ROSEWOOD AVENUE
HARTIGAN AVENUE
CLARKE STREET
ACKROYD STREET
BALLERDEE LANE
LONDON ROAD
LONDON ROAD

Map: Predicted Night Noise Levels 2033 Mitigation Add. Rec

Author: TJG

Date: 14/01/19

Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Buildings

Receiver

Receivers for consideration of mitigation

Non-Sensitive

Noise Mitigation Triggers

NCG Night Criteria	Relative Increase Criteria	Significant change in noise level
Greater than 50 dBA	Increase greater than 12 dB	Increase greater than 2 dB

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Mitigation Triggers
Facade Corrected Noise Levels
Map 3 of 4

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DEEP LEAD ROAD
DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NEWELL HIGHWAY
HERAGHTY ROAD
MAGUIRE ROAD
MAGUIRE ROAD
NEWELL HIGHWAY
BOGAN ROAD
REEDSDALE ROAD
NOCK ROAD
BLEECHMORE ROAD
GOLDRUSH ROAD
ENDICOTT STREET
REEDSDALE ROAD
NOBLE ROAD
NEWELL HIGHWAY
PAINTER STREET
PAINTER STREET
FARRER STREET
FAHEY ROAD
COOKAPIE STREET
REYMOND ROAD
HARWOOD STREET
PIONEER STREET
JONES STREET
COLEMAN STREET
WEBB STREET
THOMAS STREET
WEBB STREET

Map: Predicted Night Noise Levels 2033 Mitigation Add. Rec	Author: TJG
Date: 14/01/19	Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:10,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project roads — Existing roads

Buildings

- Receiver
- Receivers for consideration of mitigation
- Non-Sensitive

Noise Mitigation Triggers

NCG Night Criteria	Relative Increase Criteria	Significant change in noise level
Greater than 50 dBA	Increase greater than 12 dB	Increase greater than 2 dB

Newell Highway Bypass Upgrade, Parkes

Predicted Night Noise Levels 2033
Mitigation Triggers
Facade Corrected Noise Levels
Map 4 of 4

Appendix F

Operational maximum noise level analysis

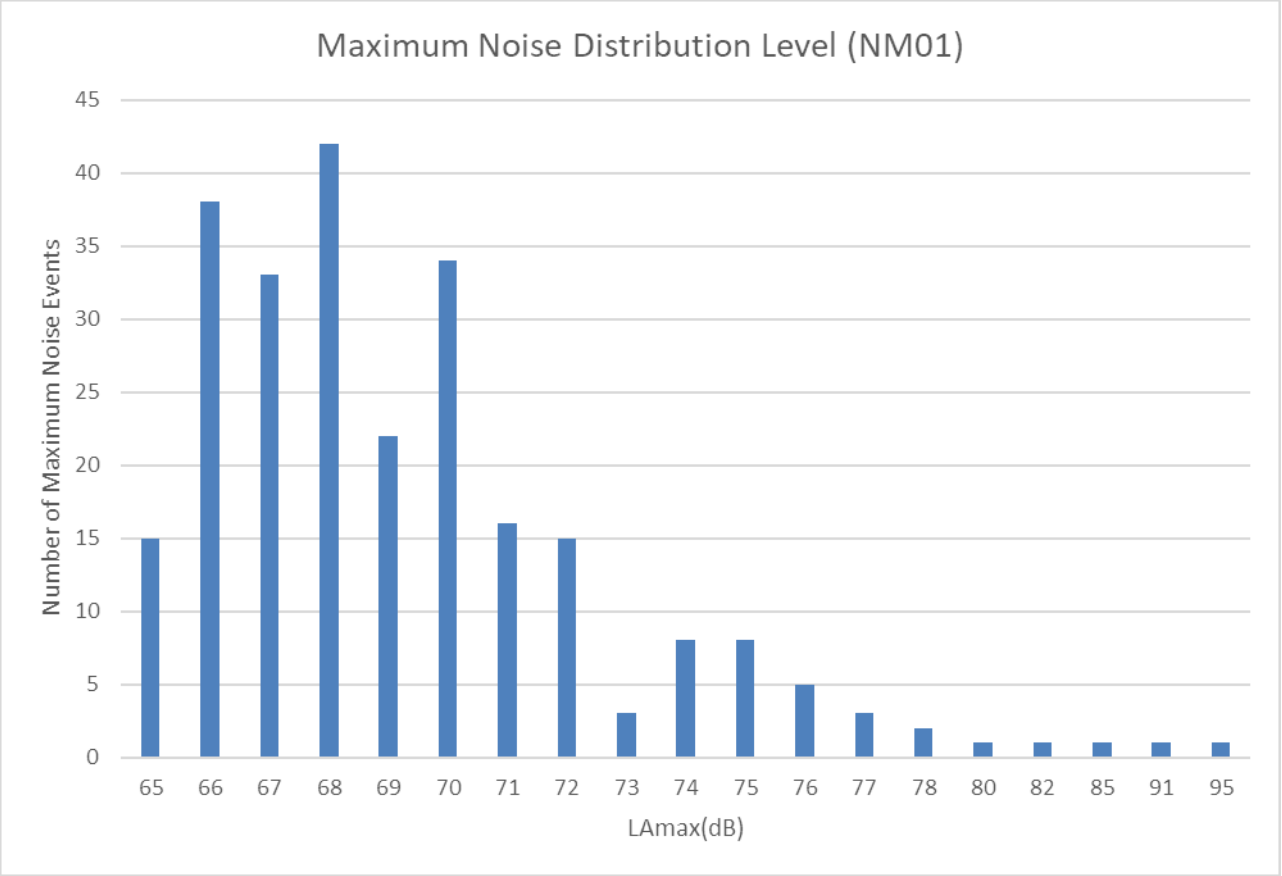


Figure F-1 Location NM01 – Maximum Night Time Noise Distribution Level Over Seven Days of Monitoring

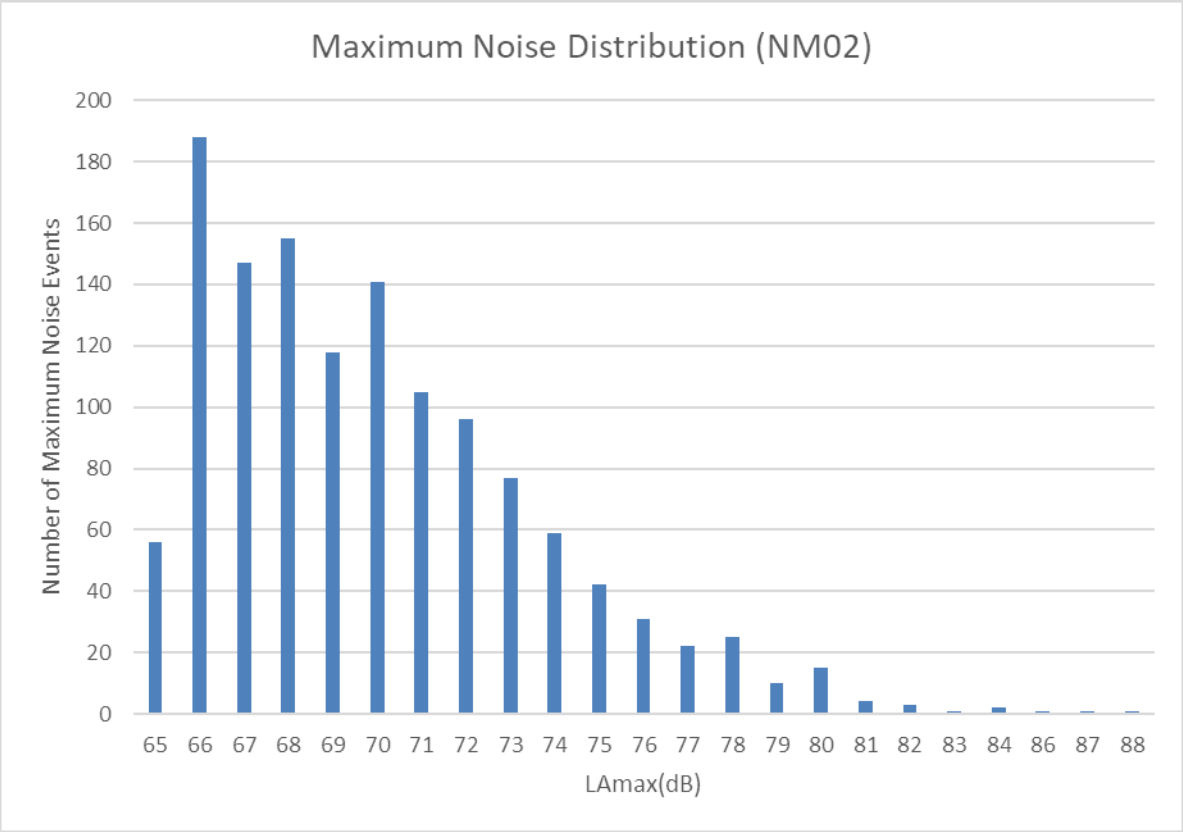


Figure F-2 Location NM02 – Maximum Night Time Noise Distribution Level Over Nine Days of Monitoring

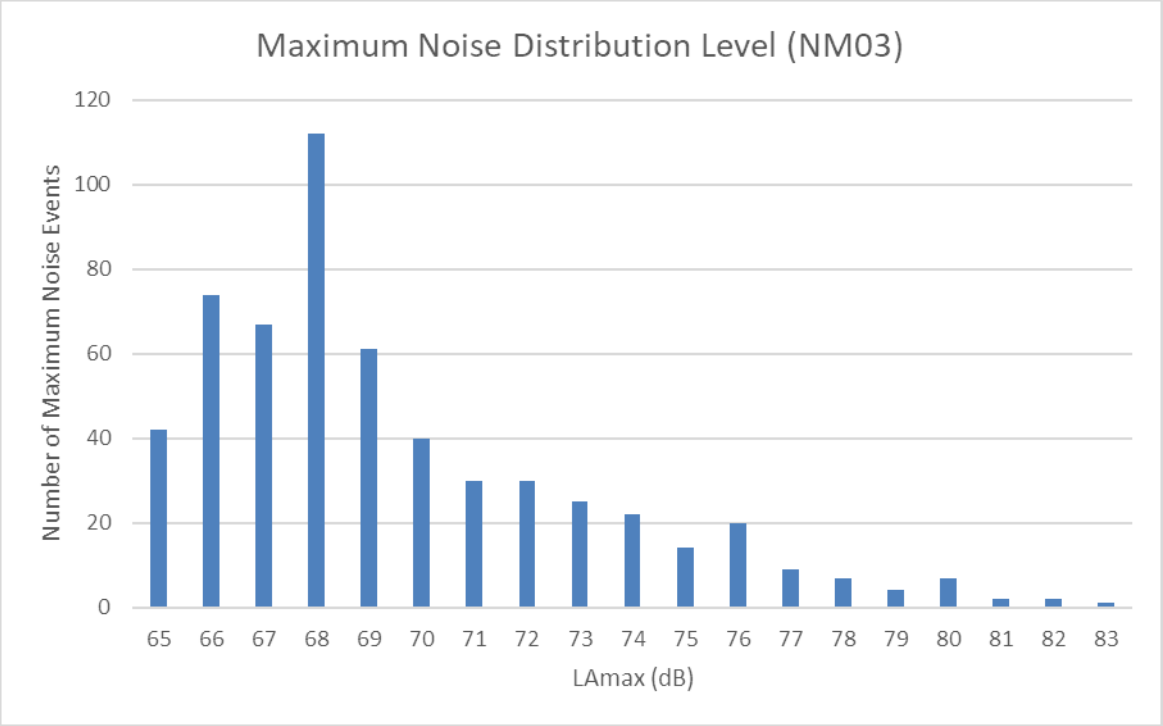


Figure F-3 Location NM03 – Maximum Night Time Noise Distribution Level Over Six Days of Monitoring

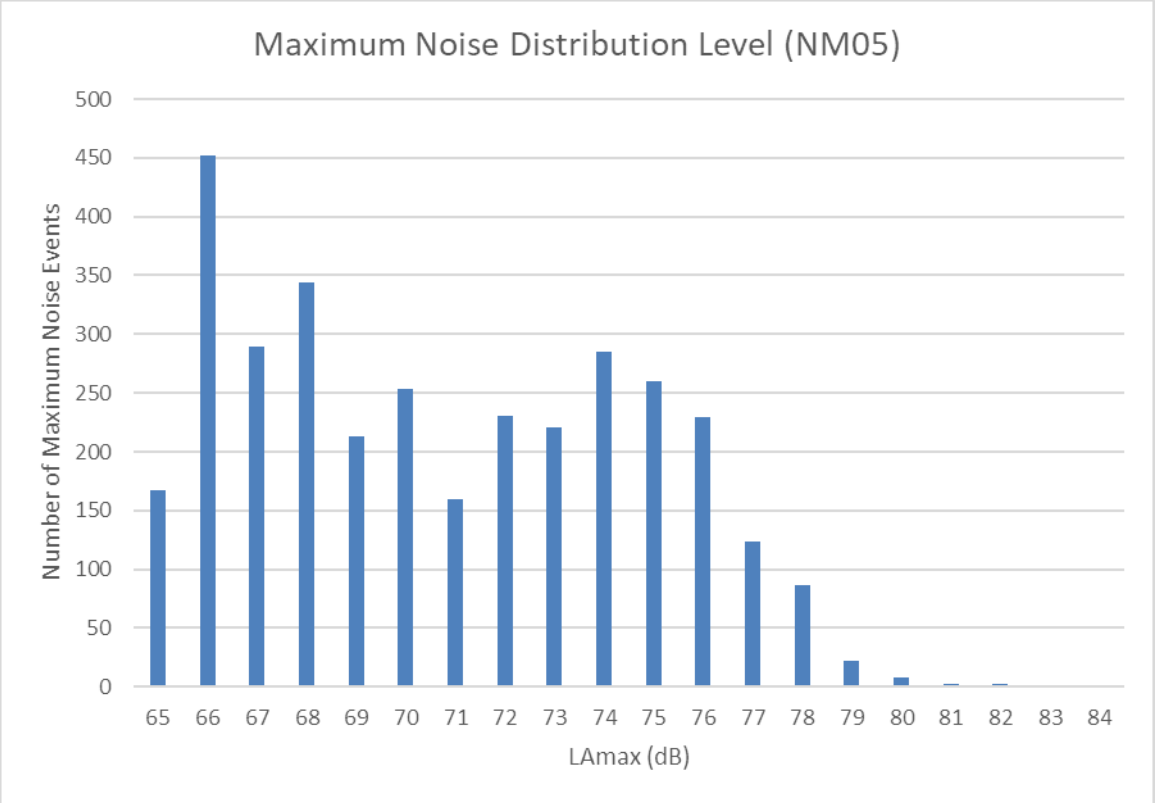


Figure F-4 Location NM05 – Maximum Night Time Noise Distribution Level Over Nine Days of Monitoring

Appendix G

Construction noise assessment

Appendix G-1

Predicted construction noise levels maps – $L_{AEQ(15MIN)}$ – SC03 bulk earthworks

NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

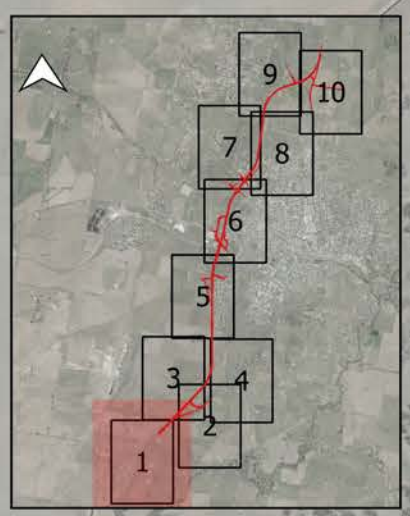
NEWELL HIGHWAY

PARKESBOROUGH ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY



Map: Predicted construciton noise level Map 1	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps
(Construcion, SC03 Earthworks)
Map 1 of 10

wsp

HIDEAWAY LANE

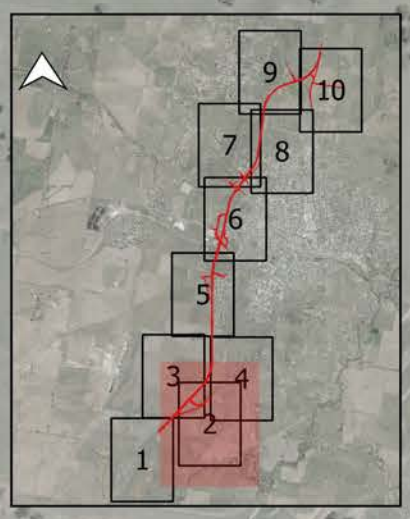
NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD



Map: Predicted construciton noise level Map 2	Author: TJG
Date: 15/01/2019	Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 2 of 10

wsp

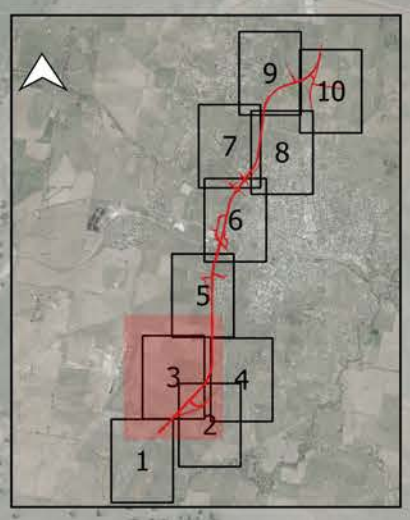
NCA02

NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD



Map: Predicted construciton noise level Map 3	Author: TJG
Date: 15/01/2019	Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 3 of 10

wsp

NCA01

BOYD CIRCUIT

HENDERSON STREET

HIDEAWAY LANE

NEWELL HIGHWAY

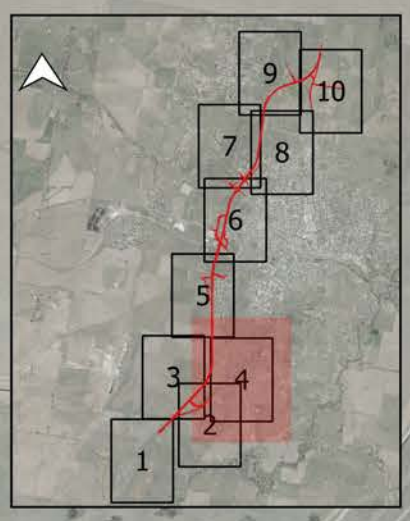
CONS LANE

CONS LANE

AITKEN LANE

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD



Map: Predicted construciton noise level Map 4	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 4 of 10

wsp

HARTIGAN AVENUE

HARTIGAN AVENUE

ROSEWOOD AVENUE

ALDER AVENUE

BLAXLAND STREET

WARRAGRAH PLACE

BALLERDEE LANE

LONDON ROAD

LONDON ROAD

LONDON ROAD

LONDON ROAD

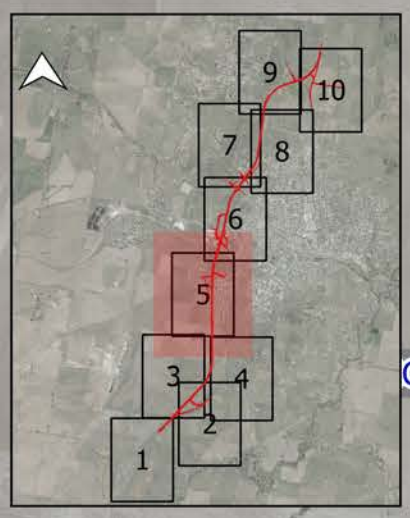
ACKROYD STREET

SALEYARDS ROAD

HIDEAWAY LANE

NCA01

CA02



Map: Predicted construciton noise level Map 5	Author: TJG
Date: 15/01/2019	Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 5 of 10

wsp

NCA03
NCA05
NCA04
HENRY PARKES WAY
BACK TRUNDLE ROAD
DUNNS LANE
MOULDEN STREET
REEDSDALE ROAD
THOMAS STREET
FARRER STREET
ROSE STREET
MITCHELL STREET
VICTORIA STREET
BAGE AVENUE
LEIGHTON STREET
CONDOBOLIN ROAD
WESTLIME ROAD
KING MERINO ROAD
BROLGAN ROAD
HARTIGAN AVENUE
CORONATION AVENUE
BIRANA PLACE
EBELINA CRESCENT
KINGSFORD AVENUE
THOMAS TOM CRESCENT
MIDDLETON STREET
SYDNEY STREET
GRENFELL STREET
PEARCE STREET
CLOSE STREET
LYNCH STREET
JUNCTION STREET
ALDER AVENUE
ROSEWOOD AVENUE
BLAXLAND STREET
YARRAGRAH PLACE
WESTCOTT CRESCENT
ALLUVIAL STREET
POWTER STREET
LONDON ROAD
CLARKE STREET
STATION STREET
ACKROYD STREET

1 2 3 4 5 6 7 8 9 10

Map: Predicted construciton noise level Map 6	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 6 of 10

wsp

GOLDRUSH ROAD
BACK TRUNDLE ROAD
REEDSDALE ROAD
ENDICOTT STREET
PAINTER STREET
NCA06
COOKAPIE STREET
MOULDEN STREET
DUNNS LANE
THOMAS STREET
HENRY PARKES WAY
ROSE STREET
MITCHELL STREET
VICTORIA STREET
EAGLE AVENUE
LEIGHTON STREET
CONDOBOLIN ROAD
WESTLIME ROAD

Map: Predicted construciton noise level Map 7	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 7 of 10

wsp

Map: Predicted construciton noise level Map 8

Author: TJG

Date: 15/01/2019

Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

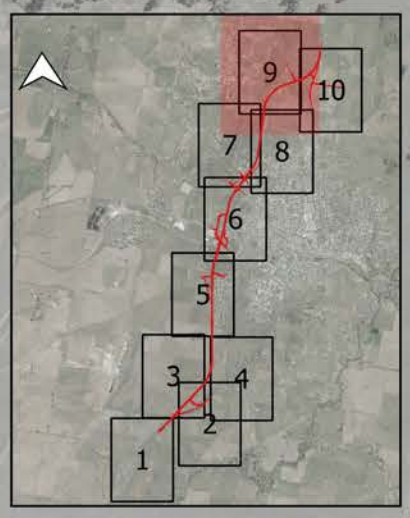
- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 8 of 10

wsp

DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NCA10
NCA08
REEDSDALE ROAD
NEWELL HIGHWAY
GOLDRUSH ROAD
ENDICOTT STREET
PAINTER STREET



Map: Predicted construciton noise level Map 9	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 9 of 10

wsp

NCA10

NCA09

NEWELL HIGHWAY

BOGAN ROAD

REEDSDALE ROAD

MAGUIRE ROAD

NOCK ROAD

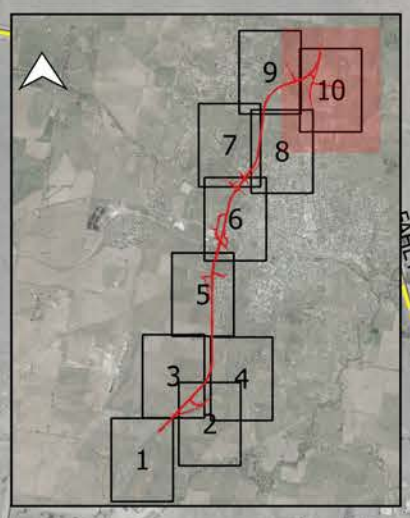
BEECHMORE ROAD

NOBLE ROAD

KABLES LANE

PEAK HILL ROAD

FAHEY ROAD



Map: Predicted construciton noise level Map 10	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

- Project road
- Existing road
- NCA boundary

Predicted Noise Level (Leq, dBA)

- Garage
- Highly Affected
- ≤ 40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90

Newell Highway Bypass Upgrade, Parkes

Predicted noise level maps (Construcion, SC03 Earthworks)
Map 10 of 10

wsp

Appendix G-2

Predicted construction noise levels – night-time exceedances – SC03 bulk earthworks

NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

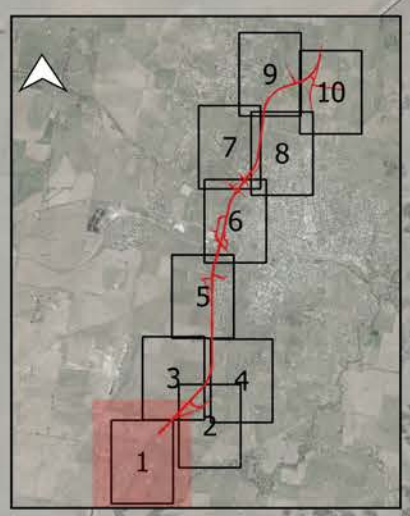
NEWELL HIGHWAY

PARKESBOROUGH ROAD

NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY



Map: Predicted construciton noise level OOHWs exceedances Map 1	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 1 of 10

wsp

HIDEAWAY LANE

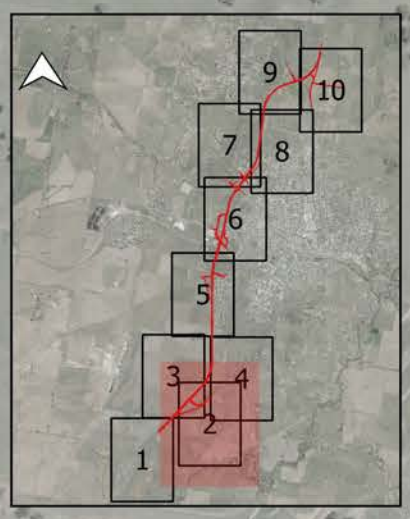
NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD

PARKESBOROUGH ROAD



Map: Predicted construciton noise level OOHWs exceedances Map 2

Author: TJG

Date: 15/01/2019

Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 2 of 10

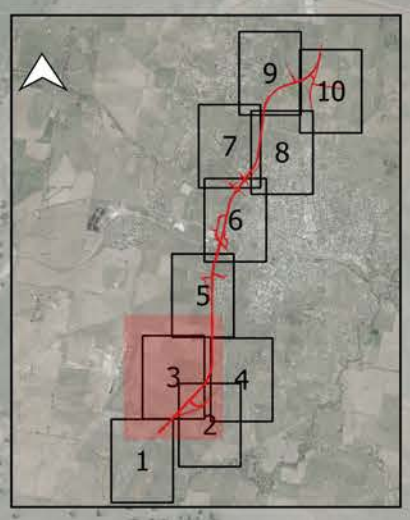
NCA02

NEWELL HIGHWAY

NEWELL HIGHWAY

NEWELL HIGHWAY

PARKESBOROUGH ROAD



Map: Predicted construciton noise level OOHWs exceedances Map 3

Author: TJG

Date: 15/01/2019

Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 3 of 10

wsp

NCA01

BOYD CIRCUIT

HENDERSON STREET

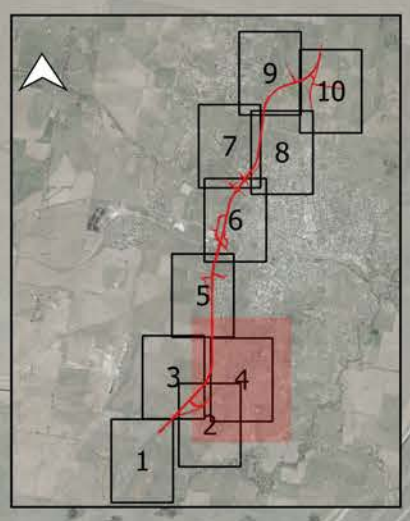
HIDEAWAY LANE

NEWELL HIGHWAY

CONS LANE

AITKEN LANE

PARKESBOROUGH ROAD



Map: Predicted construciton noise level OOHWs exceedances Map 4	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 4 of 10

wsp

HARTIGAN AVENUE

HARTIGAN AVENUE

ROSEWOOD AVENUE

ALDER AVENUE

BLAXLAND STREET

WARRAGRAH PLACE

BALLERDEE LANE

LONDON ROAD

LONDON ROAD

LONDON ROAD

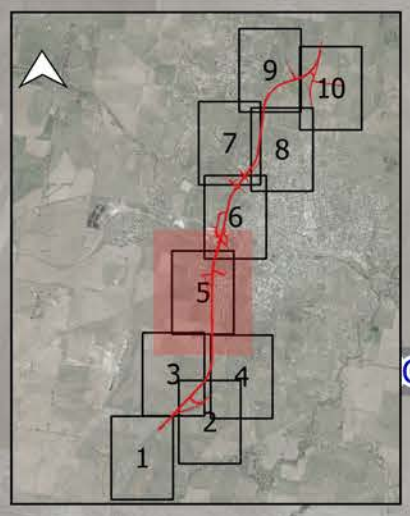
ACKROYD STREET

SALEYARDS ROAD

HIDEAWAY LANE

NCA01

CA02



Map: Predicted construciton noise level OOHWs exceedances Map 5	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 5 of 10

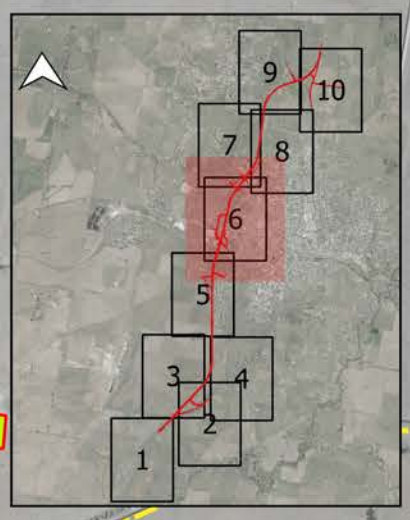
wsp

NCA03

NCA05

NCA04

HENRY PARKES WAY
BACK TRUNDLE ROAD
DUNNS LANE
MOULDEN STREET
REEDSDALE ROAD
THOMAS STREET
FARRER STREET
ROSE STREET
MITCHELL STREET
VICTORIA STREET
BASIL AVENUE
LEIGHTON STREET
CONDOBOLIN ROAD
WESTLIME ROAD
KING MERINO ROAD
BROLGAN ROAD
HARTIGAN AVENUE
CORONATION AVENUE
DIANA PLACE
EBELINA CRESCENT
KINGSFORD AVENUE
THOMAS TOM CRESCENT
MIDDLETON STREET
SYDNEY STREET
GRENFELL STREET
PEARCE STREET
CLOSE STREET
LYNCH STREET
JUNCTION STREET
ALDER AVENUE
ROSEWOOD AVENUE
BLAXLAND STREET
WARRAGRAH PLACE
WESTCOTT CRESCENT
ALLUVIAL STREET
POWTER STREET
LONDON ROAD
ACKROYD STREET
CLARKE STREET
STATION STREET



Map: Predicted construciton noise level OOHWs exceedances Map 6

Author: TJG

Date: 15/01/2019

Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

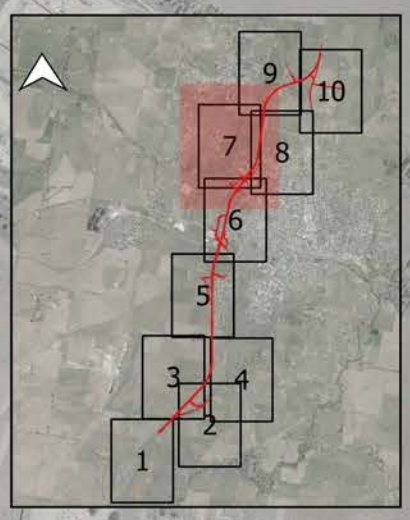
- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 6 of 10

wsp

GOLDRUSH ROAD
BACK TRUNDLE ROAD
REEDSDALE ROAD
ENDICOTT STREET
PAINTER STREET
NCA06
COOKAPIE STREET
MOULDEN STREET
DUNNS LANE
THOMAS STREET
HENRY PARKES WAY
ROSE STREET
MITCHELL STREET
VICTORIA STREET
BASIL AVENUE
LEIGHTON STREET
CONDOBOLIN ROAD
WESTLIME ROAD



Map: Predicted construciton noise level OOHWs exceedances Map 7	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

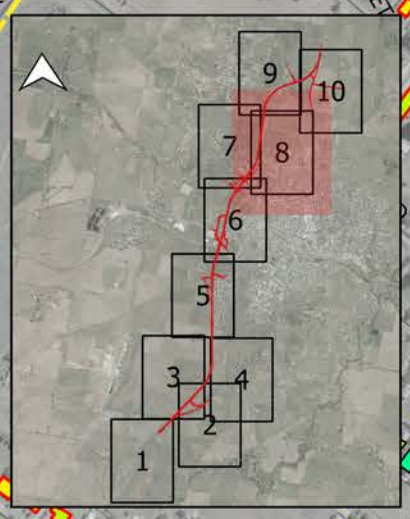
- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 7 of 10

wsp

GOLDRUSH ROAD
ENDICOTT STREET
REEDSDALE ROAD
BOGAN ROAD
NEWELL HIGHWAY
PAINTER STREET
BLEECHMORE ROAD
KABLES LANE
NCA09
NCA07
COOKAPIE STREET
MOULDEN STREET
DUNNS LANE
THOMAS STREET
BACK TRUNDLE ROAD
FARRER STREET
JUBILEE STREET
JONES STREET
MILLER STREET
COLEMAN STREET
REYMOND ROAD
HARWOOD STREET
FAHEY ROAD
PEAK HILL ROAD
PIONEER STREET
WEBB STREET
HARRIS STREET
HIGH STREET
ROSE STREET
MITCHELL STREET
GALLOP AVENUE
VICTORIA STREET
BASIL AVENUE
LEIGHTON STREET
CONDOBOLIN ROAD
WESTLIME ROAD
CLARINDA STREET
CURRAJONG STREET
HILL STREET
PHILLIP STREET



Map: Predicted construciton noise level OOHWs exceedances Map 8	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

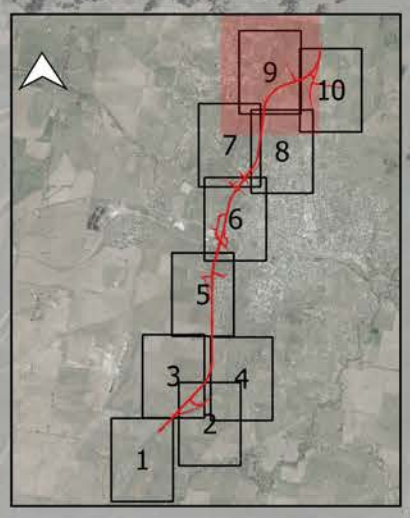
- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 8 of 10

wsp

DEEP LEAD ROAD
BOGAN ROAD
HERAGHTY ROAD
NCA10
NCA08
REEDSDALE ROAD
NEWELL HIGHWAY
GOLDRUSH ROAD
ENDICOTT STREET
PAINTER STREET



Map: Predicted construciton noise level OOHWs exceedances Map 9	Author: TJG	
Date: 15/01/2019	Approved by: ZL	

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 9 of 10

NCA10

NCA09

NEWELL HIGHWAY

BOGAN ROAD

REEDSDALE ROAD

MAGUIRE ROAD

NOCK ROAD

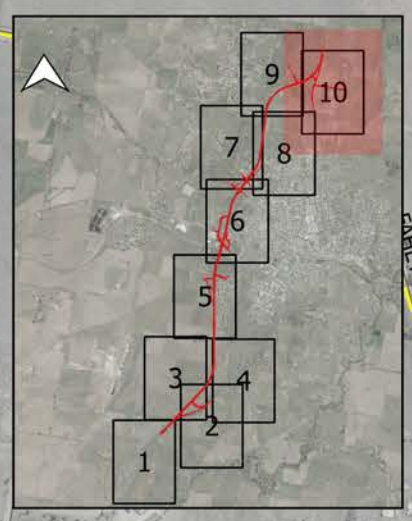
BEECHMORE ROAD

NOBLE ROAD

KABLES LANE

PEAK HILL ROAD

FAHEY ROAD



Map: Predicted construciton noise level OOHWs exceedances Map 10

Author: TJG

Date: 15/01/2019

Approved by: ZL

To be read in conjunction with report PS102430-NOI-REP-001 RevD

0 100 200 300 m

1:8,000 at A3

Coordinate system: GDA94, MGA zone 55

Aerial imagery source: NSW SIX Maps

Legend

Project road — Existing road — NCA boundary

Exceedance of night-time NML (Perception classification)

- Exd. Sleep dist. (Lmax >65 dBA)
- Noticeable (<5 dB)
- Clearly noticeable (5-15 dB)
- Moderately intrusive (15-25 dB)
- Highly intrusive (>25 dB)
- No exceedance

Newell Highway Bypass Upgrade, Parkes

Predicted exceedance of night-time NMLs (Construcion, SC03 Earthworks)
Map 10 of 10

wsp

Appendix H

Construction mitigation measures

H1 CNVG Standard mitigation measures

Action required	Applies to	Details
Management measures		
Implement any project specific mitigation measures required	Airborne noise	In addition to the measures set out in this table, any project specific mitigation measures identified in this report.
Implement community consultation or notification measures	Airborne noise Ground-borne noise and vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop in session (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All project specific and relevant standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on high noise generating activities • Location of nearest sensitive property • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos / radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise and vibration	Where specified under Appendix C of the CNVG, a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise and vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage.

Action required	Applies to	Details
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out of-hours work	Airborne noise Ground-borne noise and vibration	Please refer to Appendix C of the CNVG for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR).
Equipment selection	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plan works site and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Locate compounds away from sensitive properties and discourage access from local roads. Plan traffic flow, parking and loading / unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work cannot be undertaken during the day, it should be completed before 10 pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Plant noise levels	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Section 8.3 of this report. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Section 8.3 of this report.
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in (Table 2 of the CNVG).
Use and siting of plant	Airborne-noise	The offset distance between noisy plant and adjacent sensitive properties is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive properties. Only have necessary equipment on site.

Action required	Applies to	Details
Reduced equipment power	Airborne noise Ground-borne vibration.	Use only the necessary size and power.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive properties. Select site access points and roads as far as possible away from sensitive properties. Dedicated loading/unloading areas to be shielded if close to sensitive properties. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive properties from noisy activities	Airborne noise	Use structures to shield residential dwellings from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor controls		
Structural surveys and vibration monitoring	Ground borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
Additional measures applied at the property as specified by Appendix C of the CNVG.	Airborne noise Ground borne vibration	In some instances, additional mitigation measures may be required.

H2 CNVG Additional mitigation measures

Abbreviation	Measure	Description
N	Notification (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.
SN	Specific notifications	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 properties than covered in general letterbox drops. The exact conditions under which specific notifications would proceed are defined in the relevant Additional Mitigation Measures (Tables C1 to C3). This form of communication is used to support periodic notifications, or to advertise unscheduled works.
PC	Phone calls	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.
IB	Individual briefings	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.
RO	Respite offer	Respite offers should be considered where there are high noise and vibration generating activities near properties. 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 properties. 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.
R1	Respite Period 1	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.

Abbreviation	Measure	Description
R2	Respite Period 2	Night-time construction noise in out of hours period 2 shall be limited to two consecutive nights except for where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and 6 nights per month. Where possible, high noise generating works shall be completed before 11 pm.
DR	Duration respite	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. The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite. Where the noise level at a few dwellings are above the NML each of these dwellings should be visited to discuss the project to gain support for Duration Respite.
AA	Alternative accommodation	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.
V	Verification	See Appendix F of CNVG 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.

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