MOTT MACDONALD

Great Western Highway Upgrade - Medlow Bath

Noise and Vibration Technical Paper

July 2021

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Transport for New South Wales

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Contents

Tables

Figures

Executive summary

Transport for NSW (TfNSW) proposes to upgrade approximately 1.2 kilometres of the Great Western Highway at Medlow Bath between Railway Parade and approximately 330m south of Bellevue Crescent (the Proposal). This upgrade is part of the Great Western Highway Duplication project between Katoomba and Lithgow which aims to provide a safer and more efficient link between Central West NSW and the Sydney Motorway Network for freight, tourist and general traffic.

This report summarises a detailed assessment of construction and operational noise and vibration impacts associated with the Proposal. Noise and vibration management and mitigation measures have been recommended to minimise the impacts on the local community.

Ambient noise measurements have been completed at four locations throughout the project area. Concurrent road traffic counting was also completed during this monitoring period to evaluate the traffic movements on the Great Western Highway at Medlow Bath. The purpose of these measurements was to evaluate the existing noise environment, develop construction noise criteria, and to validate the operational road noise model.

Construction noise and vibration impacts have been predicted and assessed in accordance with the EPAs Interim Construction Noise Guideline and Assessing vibration: a technical guideline. The impacts from five representative construction scenarios have been assessed across all stages of the projects.

The construction noise impact assessment indicates that during noise intensive works, noise levels are likely to exceed the projects construction noise goals and would need to be carefully managed. The contractors Construction Noise and Vibration Management Plan would need to carefully consider any and all appropriate noise and vibration management and mitigation measures to control the impact. Stakeholder engagement would be a key feature of these measures, particular with key stakeholders such as the Hydro Majestic Hotel and residential receivers adjacent to the project.

A range of heritage receivers have been identified which would require careful consideration with respect to vibration impact when planning works. Vibration monitoring and consideration of appropriate vibration generating equipment (such as vibratory rollers) would be required throughout the construction of the project.

Operational noise has been assessed in accordance with the EPAs Road Noise Policy, and Road and Maritimes Noise Criteria Guideline. A noise prediction model has been developed in accordance with the six-category heavy vehicle approach (*A 6-category heavy vehicle noise emission model in free-flowing condition*, J. Peng et al) and validated with the noise monitoring results.

Detailed operational noise modelling was completed for the year of opening (2026), and the design year (2036). The assessment identified high existing noise levels throughout the project area which would continue in the future, with or without the project. On average, noise levels were predicted to decrease slightly in the future from the change in traffic mix. This reduction is typically less than 1 dB so is unlikely to be noticed by the community.

A total of 13 receivers were identified as exceeding applicable design noise criteria and were eligible for consideration of additional noise mitigation. The exceedances identified are predominantly a result of the existing and future road traffic flows on the Great Western Highway and are not a result of the project.

Noise mitigation has been recommended in accordance with Road and Maritimes Noise Mitigation Guideline. Stakeholders had expressed a clear preference to avoid noise barriers, so architectural treatment has been recommended for 13 remaining residential receivers.

As part of the design for the proposal, a new alternative signalised intersection is being considered to the Great Western Highway with a new road through vacant Lots to connect to the existing Bellevue Crescent. A construction noise assessment has been undertaken of these works. The construction noise impacts were largely similar to the remainder of the project, with an emphasis on noise management and mitigation measures.

An operational noise impact assessment of the Bellevue Crescent Option identified that three receivers would exceed the applicable noise criteria and would be eligible for consideration of additional noise mitigation. With low noise pavements and noise barriers impractical in these locations, these receivers would be eligible for consideration of architectural treatment.

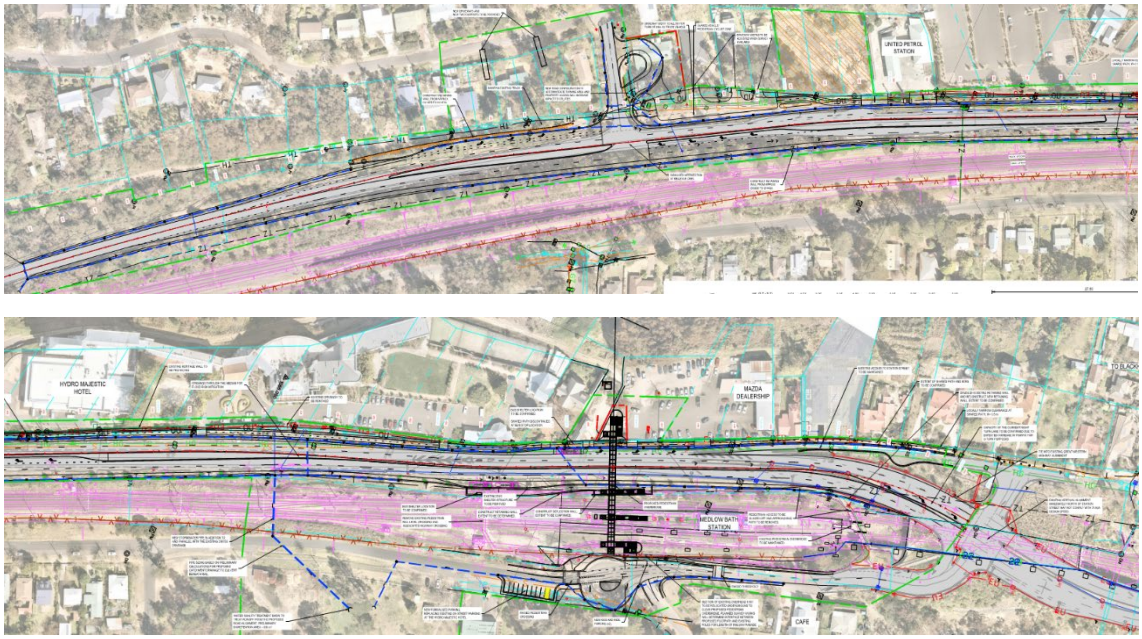
1 Introduction

Transport for NSW (Transport for NSW) proposes to upgrade approximately 1.2 kilometres of the Great Western Highway at Medlow Bath between Railway Parade and approximately 330m south of Bellevue Crescent (the proposal). This upgrade is part of the Great Western Highway Duplication project between Katoomba and Lithgow which aims to provide a safer and more efficient link between Central West NSW and the Sydney Motorway Network for freight, tourist and general traffic.

In addition to the road modifications, the proposal will also improve active transport links and public transport accessibility.

The Proposal is shown in Figure 1.

Figure 1 GWH Upgrade Proposal



Source: MRB - Medlow Bath Concept Design

Key features of the Proposal include:

- Construction of a four lane divided carriageway with consolidated access points at upgraded intersections including
  - Upgraded Bellevue Crescent intersection to include three way traffic signals for safe access/egress
  - Provision of a U-turn bay for traffic turning east bound to west bound at Bellevue Crescent
  - Right turn bay in east bound carriageway median for Hydro Majestic Hotel (no right turn egress)
  - Improvements on Railway Parade to formalise parking provisions, U-turns and commuter parking

- Construction of full depth highway pavement and associated local road, driveway, footpath, kerb and gutter reconstruction work within the proposal area
- Construction of a new pedestrian bridge that connects Railway Parade, Medlow Bath Station and new indented bus bays on both sides of the Highway in line with Transport Access Program requirements
- Shared use (pedestrian/cyclist) path adjacent to westbound carriageway
- Retaining wall and traffic barrier construction adjacent to existing rail corridor
- Utility relocation and stormwater drainage upgrade as required over length of the project including water quality control measures in Railway Parade
- Provision of 6m raised landscaped median for trees protected with modified redirective kerb

1.1 Objectives

The Great Western Highway (GWH) is a 201-kilometre highway crossing of the Great Dividing Range through the World Heritage listed Blue Mountains, connecting Bathurst and the surrounding Central West and Orana regions to Sydney.

Crossing the Great Dividing Range, the GWH follows a narrow and difficult alignment constrained by the Blue Mountains National Park, steep topography, a railway line and existing towns for which the highway acts as the main street.

The highway's topography and constrained two lane carriageway design (which in places is almost 200 years old) results in the following constraints:

- reduces freight efficiency by limiting access for safer and more sustainable high productivity vehicles
- limits access during incidents and natural disasters
- slows travel speeds with limited overtaking opportunities and steep gradients (more than double the recommended maximum level)
- causes delays of up to 80 minutes in peak times
- has higher than state average crash rates
- impairs amenity for local communities with high through traffic volumes and congestion, and

Without the GWH Upgrade Program, the infrastructure along the Katoomba to Lithgow section will continue to face a number of challenges and related impacts.

1.2 Purpose of the Report

The purpose of this report is to provide a detailed analysis for input into the Review of Environmental Factors (REF), as required under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This report summarises a detailed noise and vibration impact assessment associated with the construction and operational phases of the proposed road upgrade.

2 Existing environment

2.1 Overview

Medlow Bath is located between Katoomba and Blackheath in the Blue Mountains. The area predominantly comprises residential properties, with the local noise environment controlled by traffic on the existing Great Western Highway and the Blue Mountains Line. Both the road and rail line are freight routes, resulting in an appreciable noise contribution from trucks and diesel locomotives.

Adjacent to Medlow Bath Station there is a pedestrian crossing. Trains are required to sound their horn at this location to warn pedestrians of their approach which also contributes to the local noise environment. The project would remove this pedestrian crossing and provide an alternate means of access (a pedestrian bridge elevated above the railway and highway), also removing the crossing noise events.

To the east of the Great Western Highway, the residential area tucks behind a low rise, and noise generated by the highway and the railway slowly decreases, giving way to natural sounds of Australian Bushland.

2.2 Noise sensitive receivers

Noise sensitive receivers have been identified through aerial photography and visual inspection. The locations and occupancy of all receivers have been identified to classify each building as either residential, commercial, industrial, educational, and other non-sensitive uses.

To the east of the Great Western Highway, the receivers are generally residential, with a small number of guest houses dotted throughout the area. There is a single commercial building (a café) towards the northern end of Railway Parade.

On the western side the Hydro Majestic (a hotel) is a prominent feature of Medlow Bath with other commercial premises to the south including a restaurant and store. There is also a car dealership to the north of the Hydro Majestic. The remainder of the receivers are residential.

Receiver locations and uses are provided in Appendix A.

2.3 Vibration sensitive receivers

Provided below in Table 1 is a summary of heritage structures adjacent to the proposed works.

Table 1 Heritage listed structures adjacent to the proposed works

Location
Medlow Bath Railway Station
Hydro Majestic
Former Post and Telegraph Store, 1 Railway Parade, Medlow Bath
Urunga, 1 Park Street, Medlow Bath
Melbourne House, 2 Station Street, Medlow Bath
Cost Cot, 4 Station Street, Medlow Bath
Shelaugh Cottage, 6 Station Street, Medlow Bath

2.4 Ambient noise monitoring

Ambient noise monitoring was completed at 4 locations throughout Medlow Bath from Thursday 3 December to Monday 14 December 2020. The monitoring comprised unattended noise monitoring which occurred over the entire monitoring period and attended noise monitoring which was completed at the time of logger installation to evaluate the source and nature of the local noise environment.

Concurrent road traffic counting was also completed during this monitoring period to evaluate the traffic movements on the Great Western Highway. Road traffic volumes are provided in Appendix C.

The locations for the noise monitoring were determined through aerial photography and site inspections and confirmed with the TfNSW project team for local and project knowledge.

The noise logging locations are illustrated in Appendix A.

A noise logger measures the local noise environment and records noise statistics about the measurement period. For this project the noise logger was setup to measure 15-minute intervals and record:

- L_{AFmax} – the maximum noise level over the measurement period. This level is the maximum noise due to an individual noise event
- L_{A10} – the noise level which is exceeded for 10% of the measurement period
- L_{Aeq}, - the energy average noise level over the measurement period
- L_{A90} – the noise level which is exceeded for 90% of the measurement period. This is considered to be the background noise level over the measurement period.

All measured noise levels are A-weighted, which is used across Australia and international standards to account for the relative loudness perceived by the human ear.

The measured noise levels have been processed in accordance with the procedures in the NSW Road Noise Policy (RNP) and the Noise Policy for Industry (NPfI). Weather data has been obtained from the nearest Bureau of Meteorology weather station (Mount Boyce, IDN60900) and used to exclude data which is affected by adverse weather conditions.

All equipment used for the noise survey is within calibration and certification, and all measurements were performed in accordance with Australian Standard AS 1055 'Acoustics – Description and measurement of environmental noise'. The calibration of all equipment was also checked before and after each survey period and was found to be consistent.

Train noise has the potential to influence the calibration of the road traffic noise model, particularly during the night-time period when road traffic flows reduce. In order to determine the train noise impact on the nearest noise logging sites, the train timetable was compared against the noise logging results (both weekday and weekend time tables), and train noise events were excluded from the noise logging data (for the road traffic assessment only). Where extraneous high noise level events were observed in the noise logging data which did not coincide with a train pass-by, these were assumed to be due to a freight train horn or movement along the train line, these were manually inspected and removed from the logging data. It is noted that generally, the $L_{Aeq,15hour}$ and $L_{Aeq,9hour}$ noise levels were controlled by the Great Western Highway, rather than the Blue Mountains Line.

2.5 Noise monitoring locations

Provided below in Table 2 is a summary of the noise monitoring locations. These locations are illustrated in Appendix A.

Table 2 Noise logging locations

Site	Address	Logger Type	Distance from Great Western Highway
NL1	25 Delmonte Avenue, Medlow Bath	Rion NL-42EX	130 m
NL2	104 Great Western Highway, Medlow Bath	Rion NL-42EX	41 m
NL3	40 Railway Parade, Medlow Bath	ARL Ngara	48 m
NL4	5 Railway Parade, Medlow Bath	Rion NL-42EX	68 m

For the purposes of this project, these noise logger locations have been used to define the construction noise criteria, and to calibrate the road traffic noise model.

2.6 Noise monitoring results

Provided below in Table 3 is a summary of the measured ambient noise levels at each location. These noise levels have been used to define the construction noise management levels, in accordance with the Interim Construction Noise Guideline (ICNG).

The ICNG defines three separate assessment time periods: daytime (7am to 6pm); evening (6pm to 10pm); and night-time (10pm to 7am). For each time-period the assessment background level (ABL) has been established by determining the lowest 10th percentile of the background noise (the L_{A90}) over the defined period for each day. The rating background level (RBL) is the median ABL over the entire monitoring period.

Table 3 Ambient noise measurement results

Site	Rating background level, dB(A)			Ambient noise level, L_{Aeq}, dBl(A)		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
NL1	40	37	27	49	47	45
NL2	50	42	29	62	59	57
NL3	49	41	29	60	60	60
NL4	46	41	24	54	55	52

2.7 Operational road noise monitoring results

The RNP only has two time periods, daytime (7am to 10pm) and night-time (10pm to 7am). These are typically expressed as $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ respectively. Road traffic noise measurements are usually discussed separately to the ambient noise measurements as they only apply when road traffic noise dominates the local noise environment.

For this project, all noise monitoring locations are dominated by road traffic noise, with a lesser contribution from railway noise. An attempt has been made to exclude the railway noise however this is difficult without more sophisticated measurement techniques which are outside the scope of this assessment. Due to the dominance of noise from the Great Western Highway, the railway noise has been identified not to appreciably contribute to the overall measured noise levels. Provided below in Table 4 is a summary of the measured road traffic noise levels.

Table 4 Road traffic noise measurement results

Site	Daytime $L_{Aeq(15hour)}$, dB(A)	Night-time $L_{Aeq(9hour)}$, dB(A)
NL1	48	45
NL2	61	57
NL3	61	60
NL4	55	52

3 Assessment methodology

3.1 Construction noise

Construction noise has the potential to adversely impact sensitive receivers by appreciably changing the existing noise environment. The potential for impacts is assessed based on the increase in noise from the existing noise environment, and the duration while also taking into consideration annoying characteristics.

The Interim Construction Noise Guideline (ICNG) provides guidance on the appropriate construction noise goals, in addition to identifying appropriate noise management and mitigation strategies. The Roads & Maritime Services document Construction Noise and Vibration Guideline (CNVG) provides further, more detailed information on management and mitigation structures for Transport for New South Wales (TfNSW) road infrastructure projects.

The ICNG and CNVG also provide guidance on reasonable and feasible noise mitigation and management measures.

- Feasible - a mitigation or management measure is feasible if it is practical to build or capable of being put into practice given project constraints.
- Reasonable - a mitigation or management measure is reasonable if the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

Presented below is a summary of the residential noise management levels.

Table 5 Construction noise management levels – residential receivers

Time of day	Construction noise management level $L_{Aeq,15min}$[1]	How to apply
Recommended standard hours: • Monday to Friday 7am to 6pm • Saturday 8am to 1pm • No work on Sundays or public holidays	Noise affected RBL + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL +5dB(A)	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level.

Time of day	Construction noise management level $L_{Aeq,15min}$[1]	How to apply
		• Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

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

3.1.1 Noise catchment areas

Noise catchment areas are used to group receivers within a similar noise environment and define appropriate project construction noise management levels (NMLs).

While the background noise environment is relatively consistent throughout the project area, two noise catchment areas have been formed. The catchment areas are defined as NCA01 (west) and NCA02 (east), separated by the Great Western Highway.

Provided below in Table 6 is a summary of the projects NMLs.

Table 6 Construction noise management levels –residential land uses

Site | Logger	Rating background level, dB(A)			Noise management level, $L_{Aeq,15min}$ dB(A)		
	Daytime	Evening	Night-time	Daytime[1]	Evening[2]	Night-time[2]
NCA01 | NL1	40	37	30 (27)[1]	50	42	35
NCA02 | NL4	46	41	30 (24)[1]	51	46	35

Notes:

1. In accordance with the NpFI, the minimum assumed RBL is 30 dB(A)
2. Daytime noise management level = RBL + 10 dB(A)
3. Evening and night-time noise management level = RBL + 5 dB(A)

3.1.2 Non-residential criteria

Noise management levels for non-residential land uses are provided below in Table 7 and Table 8

Table 7 Construction noise management levels – non-residential sensitive land uses

Land use	Noise management level, $L_{Aeq,15min}$
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterise by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generates little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended “maximum internal levels in AS2107 fir specific uses.

Table 8 Construction noise management levels – commercial and industrial land uses

Land use	Noise management level, $L_{Aeq,15min}$
Industrial premises	External noise level 75 dB(A)
Offices, retail outlets	External noise level 70 dB(A)

3.1.3 Sleep disturbance noise criteria

The ICNG requires a sleep disturbance noise assessment to be completed for construction works which are proposed for more than two consecutive nights. Further guidance is provided in the RNP. Based on a review of a wide range of literature the study guideline has identified that:

- Maximum internal noise levels below 50 to 55 dB(A) are unlikely to awaken people from sleep, and
- One or two noise events per night, with maximum internal noise levels of 65 to 70 dB(A) are unlikely to affect health and wellbeing significantly.

The RNP currently uses a trigger level based on the emergence of noise. This is the amount the noise from the event raises above the existing background noise level. Rather than a noise criterion, a noise trigger level where further investigation should be undertaken has been established where:

- Screening criterion - $L_{A1,1minute} - L_{A90,15minute} > 15$ dB
- Awakening reaction – $L_{A1,1minute}$ 65 dB(A)

Provided below in Table 9 is a summary of the construction noise sleep disturbance noise criteria.

Table 9 Construction noise sleep disturbance noise criteria

NCA	Night-time rating background noise level, dB(A)	Sleep disturbance screening criteria, $L_{A1,1min}$ dB(A)	Sleep disturbance awakening reaction $L_{A1,1min}$ dB(A)
NCA01	30	45	65
NCA02	30	45	65

3.1.4 Construction road traffic noise

Road traffic impacts associated with road project construction is not explicitly provided in either the ICNG, nor the RNP. An approach similar to considering the work as a traffic generating development has been taken. An initial assessment has been completed to determine the increase in traffic noise due to the project construction. Where this increase is 2 dB(A) or less, no further assessment is required. Where the increase is greater than 2 dB(A) and exceeds the road category specific criterion a more detailed assessment is completed.

3.2 Construction vibration criteria

There are two areas of concern from construction vibration, structural damage and human comfort, which are discussed further in the following subsections.

3.2.1 Structural damage

There are currently no Australian standards for the assessment of structural vibration. The most common international; standard referenced for major infrastructure projects in NSW is the German Standard DIN 4150-3 *Vibrations in buildings – Part 3: Effects on structures*.

DIN 4150-3 provides recommended maximum vibration levels which reduce the likelihood of building damage. Provided below in Table 10 is a summary of the criteria.

Table 10 Structural damage safe limits for building vibration - DIN 4150-3

Group	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of:			Vibration at the horizontal plane of the highest floor
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	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 use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

3.2.2 Human comfort

Perceptible vibration can be an annoyance to building occupants, particularly if the duration or frequency of events is significant. Vibration criteria are provided by *Assessing Vibration: A technical guideline* and provides guidance in terms of continuous and impulsive vibration, and intermittent vibration. Vibration from construction activities associated with this project would be generally considered intermittent vibration.

The intermittent vibration criteria provided by Assessing Vibration: a technical guideline is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration are provided below in Table 11 . The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 11 Preferred and maximum vibration dose values for intermittent vibration, $m/s^{1.75}$

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Critical areas	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Workshops	0.8	1.6	0.8	1.6

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria.
2. Criteria for residences are lower than schools as people expect to be able to relax/sleep in their homes without annoyance and are generally more concerned about structural damage than would be the case within schools and offices.

Continuous and impulsive vibration

Acceptable levels of human exposure to continuous and impulsive vibration are dependent on the time of day and the activity taking place in the occupied space. Assessing Vibration: A Technical Guideline provides the preferred values for continuous and impulsive vibration. These are presented in Table 12.

There is low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values in Table 12. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short duration. Vibration levels above those indicated in Table 12 may be dealt with through negotiation with the regulator of the affected community.

Table 12 Peak particle velocity for continuous and impulsive vibration acceleration, mm/s

Location	Assessment period	Preferred (z-axis)	Maximum (z-axis)
Continuous vibration			
Critical areas	When in use	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices, schools, educational institutions, and places of worship	When in use	0.56	1.1
Workshops	When in use	1.1	2.2
Impulsive vibration			
Critical areas	When in use	0.14	0.28
Residences	Daytime	8.6	17.0
	Night-time	2.8	5.6
Offices, schools, educational institutions, and places of worship	When in use	18.0	36.0
Workshops	When in use	18.0	36.0

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria.
2. Criteria for residences are lower than schools as people expect to be able to relax/sleep in their homes without annoyance and are generally more concerned about structural damage than would be the case within schools and offices.

3.3 Operational assessment criteria

3.3.1 Operational road traffic noise criteria

Noise criteria for operational road traffic is provided by the RNP. The Roads and Maritimes (now Transport for New South Wales) Noise Criteria Guideline (NCG) provides guidance on how the RNP should be applied.

The RNP considers the overall noise levels in the future, in addition to the change in noise due to the project. To achieve this, two scenarios are assessed: the No Build scenario; and the Build scenario (also known as the no build and build scenarios). The difference between these two scenarios is the impact of the project.

The No Build and Build scenarios are assessed at two different time periods, the year of opening and the design year, which is typically 10 years after opening. For this project Year 2026 has been assessed as the year of opening and Year 2036 has been assessed as the design year.

The increase in noise from the project must also be considered. The relative increase criterion limits a project from creating a significant change on the local noise environment. This criterion is typically not triggered for road upgrade projects like the Great Western Highway Upgrade where the existing noise levels in the environment are already elevated by existing traffic.

Provided below in Table 13 is a summary of the RNP noise criteria.

Table 13 Road traffic noise assessment criteria for residential land uses

Road category	Type of project / land use	Assessment criteria, dB(A)	
		Daytime (7am to 10pm)	Night-time (10pm to 7am)
Freeway/ arterial/sub-arterial	Existing residences affected by noise from redevelopment of existing freeway/ arterial/ sub-arterial roads	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
	Existing residences affected by increases in traffic noise of 12 dB(A) or more from a freeway/arterial/ sub-arterial roads[1]	Between $L_{Aeq(15hour)}$ 42-60 (external)	Between $L_{Aeq(9hour)}$ 42-55 (external)
Local roads	Existing residences affected by noise from new local road corridors	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(9hour)}$ 50 (external)

Notes:

1. The relative increase criterion is the existing noise plus 12 dB(A).

Noise criteria for other sensitive land uses are provided below in Table 14. Where a noise criterion is identified as an internal level, an external to internal noise attenuation of 10 dB(A) has been considered, representing a typical open window. The actual value can vary considerably and may be much higher than assumed here. It is recommended that this assumption is reviewed throughout the design phase.

A review of hourly noise levels has identified that the highest $L_{Aeq(1hour)}$ noise level is driven by peak periods and comparable to the $L_{Aeq(15hour)}$ noise level.

Table 14 Road traffic noise assessment criteria for non-residential land uses

Existing sensitive land use	Assessment criteria		Additional considerations
	Daytime	Night-time	
School classrooms	$L_{Aeq(1hour)}$ 40 (internal)	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000)
Hospital wards	$L_{Aeq(1hour)}$ 35 (internal)	$L_{Aeq(1hour)}$ 35 (internal)	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000)
Places of worship	$L_{Aeq(1hour)}$ 40 (internal)	$L_{Aeq(1hour)}$ 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for

Existing sensitive land use	Assessment criteria		Additional considerations
	Daytime	Night-time	
			such external areas, it should be established what in these areas may be affected by road traffic noise. For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see row 5 Open space (passive use) of this table) may be applied.
Open space (active use)	$L_{Aeq(15hour)}$ 60 (internal)	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. playing chess, reading. In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, e.g. school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
Open space (passive use)	$L_{Aeq(15hour)}$ 55 (internal)	-	
Childcare facilities	Sleeping rooms $L_{Aeq(1hour)}$ 35 Indoor play areas $L_{Aeq(1hour)}$ 40 Outdoor play areas $L_{Aeq(1hour)}$ 55	-	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged care facilities	-	-	Residential land use noise assessment criteria should be applied to these facilities.

The RNP does not provide specific noise criteria for hotels. They are considered to be a commercial premise, unless there are permanent residents living in the building. Permanent residents have not been identified, hence this study has assessed the Hydro Majesitc Hotel as a commercial receiver.

3.3.2 Reasonable and feasible noise mitigation measures

The Roads and Maritimes Noise Mitigation Guideline (NMG) provides guidance on reasonable and feasible mitigation measures. Initially it provides guidance on when consideration of noise mitigation would be considered reasonable and provides a hierarchy of noise mitigation controls. The NMG provides triggers where a receiver may qualify for consideration of noise mitigation. These triggers are:

- The Build noise levels achieves or exceeds the cumulative noise limit (CNL) – The CNL is 5 dB(A) or more above the base NCG criteria. Hence for this project, a redeveloped road, a residential receiver would have to meet or exceed $L_{Aeq(15hour)}$ 65 dB(A) or $L_{Aeq(9hour)}$ 60 dB(A). This also applies to non-residential sensitive land uses.
- The total noise level increases by more and 2.0 dB(A) (Section 6.2)

- The acute noise criterion applies where the noise contribution from the road project adds less than 2.0 dB(A) to the total noise level in the build year. In this situation the CNL would not apply. A receiver is considered acute where receiver noise levels are at or above $L_{Aeq(15hour)}$ 65 dB(A) or $L_{Aeq(9hour)}$ 60 dB(A).

Consideration of a noise mitigation strategy is hierarchical, with source controls, path controls, and finally receiver controls considered in order. The NMG provides further guidance on how to determine appropriate noise barrier heights, and when at-property noise treatment is preferred to noise barriers.

The NCG also requires consideration of transition zones. A transition zone is an area between a new road and existing road category, where the noise criteria changes are based on the change in noise environment. This project does not have any new road sections, so transition zones are not a feature of the project.

3.3.3 Maximum noise levels

Maximum noise levels from road traffic is typically driven by engine braking from heavy vehicles, and loud car and motorcycle exhausts. Maximum noise events which emerge above the background noise sufficiently during the night-time period have the potential to cause sleep disturbance issues.

Neither the RNP nor NCG provides noise goals for the assessment of sleep disturbance events, however guidance is provided in *Practice Note iii of* the Environmental Noise Management Manual (ENMM). The maximum noise assessment should be used as a tool to help prioritise and rank mitigation strategies, but should not be used as a decisive criterion in itself and should not be used to aid in designing the degree of mitigation required.

The assessment procedure involves:

- Measurements of noise levels within in the project area
- Assessment of maximum noise levels for individual vehicle pass-bys. A maximum noise event is deemed to occur when the maximum noise level exceed the L_{Aeq} noise level for each hour of the night (i.e. L_{Amax} noise levels greater than 65 dB(A) where $L_{Amax} - L_{Aeq(1hr)} \geq$ 15 dB(A))
- The number of maximum noise events is reported for the project, for each hour of the night.

4 Assessment of construction noise and vibration impacts

4.1 Construction scenarios and equipment

Indicative construction scenarios and equipment have been provided by the project team. These will need to be reviewed and confirmed by the contractor during the detailed design phase of the project.

The indicative construction activities for the Proposal are identified in Table 15. This staging is indicative and is based on the current concept design and may change once the detailed design methodology is finalised. The staging is also dependent on the Contractor's preferred methodology, program, and sequencing of work.

Table 15 Construction activities

Stage	Activities	Indicative duration (weeks)	Maximum daily deliveries	Maximum daily workforce
Site preparation	• Utility investigations • Potential removal of redundant utilities and relocation of existing ones.	6	3	8
Site establishment	• clearing and grubbing • topsoil stripping • hardstand construction • utilities services • material storage areas • temporary security fencing • temporary pedestrian fencing • temporary access road the compound • temporary traffic control barriers, signage and lighting along the full length of the existing roadway in order to separate the construction site from passing traffic.	3	10	30
Vegetation clearing	Clearing trees, mulching	2	3	5
Roadworks	Road works would be required along the entire road alignment. The works would be split into constructing the westbound lanes first and then constructing the eastbound lanes. Road construction would include: • Removal / demolition of existing pavements • Embankment foundation treatments • Construction of the new embankment • Excavation of cuttings • Construction of the larger transverse drainage structures (box culverts) • Installation of drainage pit and pipe systems • Construction of the open drainage channels and permanent controls • Utility works typically including communications, power, gas, water and sewer (where necessary) along with ITS and TCS networks • Construction of the pavement layers including the subbase and the asphalt	70	20	75

Stage	Activities	Indicative duration (weeks)	Maximum daily deliveries	Maximum daily workforce
	• Major and minor sign structures including piling, concrete works and installation of overhead steel structure • Tie-ins to existing pavement at the southern and northern limits			
Finishing works	• Installation of road furniture (i.e. lighting, safety barriers, guide posts) • Pavement marking • Installation of urban design treatments and features • Landscaping works • Removal of all remaining temporary works such as traffic control barriers, lighting, etc.	10	15	25

The works above are anticipated to be undertaken during standard NSW Environment Protection Authority (EPA) construction hours. Standard work hours comprise:

- 7am to 6pm Monday to Friday
- 8am to 1pm Saturdays
- No work on Sundays or public holidays.

Certain works may be required outside standard hours. Typically, these works would be required for safety reasons or to minimise disruption to customers, pedestrians, road users and nearby sensitive receivers.

Provided below in Table 16 is a summary of the construction scenario and the equipment which have been modelled. The overall sound power levels (SWL) have been adjusted for operating time of the equipment. For example, a concrete saw would not typically be operated continuously for 15 minutes, so the contributing noise level is lower than the reported SWL for the piece of equipment.

Table 16 Construction source noise levels

Scenario | Equipment	SWL, dB(A)	Overall SWL, dB(A)
Site preparation		116
Excavator, 35t	110	
Dump truck	110	
Franna crane 20t	98	
Pneumatic hammer	113	
Concrete saw	118	
Vacuum truck	109	
Backhoe	111	
Power generator	103	
Site establishment		115
Truck, medium rigid	103	
Road truck	108	
Scissor lift	98	
Franna crane	98	
Vegetation clearing		121
Bulldozer D9	116	

Scenario | Equipment	SWL, dB(A)	Overall SWL, dB(A)
Excavator tracked	110	
Chainsaw	114	
Mulcher	116	
Dump truck	110	
Roadworks		118
Pavement laying machine	114	
Dump truck	110	
Asphalt truck & sprayer	103	
Concrete truck	109	
Smooth drum roller	107	
Concrete saw	118	
Bridge works		120
Franna crane 20t	98	
Piling rig	116	
Generator	100	
Concrete truck and [pump	109	
Pneumatic hammer	115	
Welding equipment	105	
Bridge Installation		98
Franna Crane	98	
Welding equipment	95	
Finishing works		110
Road truck	108	
Scissor lift	98	
Franna crane	98	
Line marking truck	108	

4.2 Construction noise modelling and prediction

Noise impacts from the proposed construction activities have been predicted throughout the project area using SoundPLAN noise modelling software v8.2. The modelling was completed using the ISO9613 algorithm. This algorithm models downwind noise propagation and is appropriate for consideration of a reasonable worst-case scenario.

The results presented in this assessment are considered a reasonable worst-case 15-minute period of work. The noise levels presented for each receiver is representative of works taking place at the closest position within the work site to the receiver. Typical noise levels would be lower than predicted here as the work moves further from each sensitive receiver.

4.3 Standard hours work activities

The noise modelling impacts for the proposed works are provided below in Table 17. The table provides the highest noise level in each catchment area, and the number of receivers which are predicted to exceed the NMLs in three bands. The number of highly affected receivers is also presented. These impacts are also presented graphically in the form of noise contours in Appendix C. Note that the ‘noticeable’ category in the CNVG is not included in this table because the receivers are compliant with the NML.

Table 17 Standard work hours construction noise impacts

NCA	L_{Aeq} NML dB(A)	Maximum L_{Aeq} noise level dB(A)	NML exceedances 1 – 10 dB(A)	NML exceedances 11 – 20 dB(A)	NML exceedances > 20 dB(A)	Highly noise affected
Site preparation						
NCA01	50	72	136	59	7	0
NCA02	51	90	49	31	16	12
Site establishment						
NCA01	50	71	127	56	2	0
NCA02	51	89	48	29	13	12
Vegetation clearing						
NCA01	50	79	81	115	47	23
NCA02	51	97	23	46	38	24
Roadworks						
NCA01	50	76	132	82	32	2
NCA02	51	94	41	37	28	16
Finishing works						
NCA01	50	66	76	32	0	0
NCA02	51	97	37	16	17	11
Bridge piling works						
NCA01	50	76	74	3	3	2
NCA02	51	73	138	0	0	0

The impacts show that due to the small offset distances to sensitive receivers there are likely to be exceedances of the NMLs. A small number of receivers are also predicted to be highly affected at some point during the works.

The noise levels presented here are considered typical of road infrastructure works and have the potential to adversely impact the local community at times. However, with the incorporation of reasonable and feasible noise mitigation measures the impacts can be managed and minimised as much as practicable.

Further discussion is provided in Section 6.1.

4.4 Out of hours work activities and sleep disturbance

Two out of hours scenarios have been assessed. These scenarios include roadworks, which is often required to be undertaken with traffic management measures outside peak periods and the bridge installation which also requires traffic management.

Presented below is a summary of the predicted noise impacts.

Table 18 Out of hours work construction noise impacts – Evening

NCA	L_{Aeq} NML dB(A)	Maximum L_{Aeq} noise level dB(A)	NML exceedance < 5 dB(A)	NML exceedance 5 – 15 dB(A)	NML exceedance 15 – 25 dB(A)	NML exceedance > 25 dB(A)	Highly noise affected
Roadworks							
NCA01	42	94	1	21	48	63	17
NCA02	46	77	3	94	45	49	6
Bridge installation							

NCA	L_{Aeq} NML dB(A)	Maximum L_{Aeq} noise level dB(A)	NML exceedance < 5 dB(A)	NML exceedance 5 – 15 dB(A)	NML exceedance 15 – 25 dB(A)	NML exceedance > 25 dB(A)	Highly noise affected
NCA01	42	54	1	3	0	0	0
NCA02	46	51	3	1	0	0	0

Table 19 Out of hours work construction noise impacts – Night

NCA	L_{Aeq} NML dB(A)	Maximum L_{Aeq} noise level dB(A)	NML exceedance < 5 dB(A)	NML exceedance 5 – 15 dB(A)	NML exceedance 15 – 25 dB(A)	NML exceedance > 25 dB(A)	Highly noise affected
Roadworks							
NCA01	35	94	0	2	34	100	17
NCA02	35	77	0	3	91	133	6
Bridge installation							
NCA01	35	54	4	3	3	0	0
NCA02	35	51	9	7	2	0	0

Table 19 indicates that here is potential for road works taking place at night to cause significant disturbance to the community. On this basis, such activities should take place during daytime hours unless necessary. Where they must take place out of hours, the duration of works should be minimised.

4.5 Construction road traffic noise

At the projects peak, there is forecast to be a maximum of 20 heavy vehicle deliveries and a workforce of 75. For the purposes of a conservative assessment of road traffic impacts, this has been assessed as an additional 40 heavy vehicle movements and 150 light vehicle movements during the daytime period. For reference existing traffic volumes are provided in Appendix C, with more than 17,800 vehicles (light and heavy combined) per day.

Based on these additional traffic movements, the increase in noise from construction traffic is predicted to be less than 0.1 dB. The additional movements would have a negligible impact on the local noise environment.

4.6 Construction vibration

Provided below in Table 20 are recommended minimum working distances. At the start of any vibration intensive works these distances should be confirmed through vibration site law measurements.

Table 20 Vibration minimum working distances

Plant item	Rating / description	Minimum working distance	
		Cosmetic damage	Human response
Vibratory roller	< 50 kN (typically 1 – 2 tonnes)	5 m	15 m to 20 m
	< 100 kN (typically 2 – 4 tonnes)	6 m	20 m
	< 200 kN (typically 4 – 6 tonnes)	12 m	40 m
	< 300 kN (typically 7 – 13 tonnes)	15 m	100 m
	> 300 kN (typically 13 - 18 tonnes)	20 m	100 m

Plant item	Rating / description	Minimum working distance	
		Cosmetic damage	Human response
	> 300 kN (> 18 tonnes)	25 m	100 m
Small hydraulic hammer	300 kg (5 to 12t excavator)	2 m	7 m
Medium hydraulic hammer	900 kg (12 to 18t excavator)	7 m	23 m
Large hydraulic hammer	1600 kg (18 to 34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	4 m
Jackhammer	Hand held	1 m (nominal)	2 m

Table 21 Vibration minimum working distances – heritage structures

Plant item	Rating / description	Heritage structure
Vibratory roller	< 50 kN (typically 1 – 2 tonnes)	20 m
	< 100 kN (typically 2 – 4 tonnes)	24 m
	< 200 kN (typically 4 – 6 tonnes)	48 m
	< 300 kN (typically 7 – 13 tonnes)	60 m
	> 300 kN (typically 13 - 18 tonnes)	80 m
	> 300 kN (> 18 tonnes)	100 m
Small hydraulic hammer	300 kg (5 to 12t excavator)	8 m
Medium hydraulic hammer	900 kg (12 to 18t excavator)	28 m
Large hydraulic hammer	1600 kg (18 to 34t excavator)	88 m
Vibratory pile driver	Sheet piles	8 to 80 m
Pile boring	≤ 800 mm	15 m
Jackhammer	Hand held	4 m

The works have the potential to impact heritage structures within the project area. Provided below in Table 21 is a review of sensitive receiver locations, and consideration if they may be impacted by the works.

Table 22 Heritage structures

Location	Distance to works (m)	Potentially vibration impacted
Medlow Bath Railway Station	18	Yes
Hydro Majestic	16	Yes
Hydro Majestic Heritage Wall	< 5m	Yes
Former Post and Telegraph Store, 1 Railway Parade, Medlow Bath	60	Yes
Urunga, 1 Park Street, Medlow Bath	60	Yes
Melbourne House, 2 Station Street, Medlow Bath	16	Yes
Cost Cot, 4 Station Street, Medlow Bath	32	Yes
Shelaugh Cottage, 6 Station Street, Medlow Bath	53	Yes

Further consideration should be given to heritage structures throughout the detailed design stage to ensure adequate mitigation and management measures are included in the construction strategy. Further discussion is provided in Section 6.1.

5 Assessment of operational noise impacts

5.1 Road traffic noise assessment

Noise generated by road traffic operating on the proposed road upgrade has been modelled and assessed in accordance with the RNP, NCG, and the NMG.

A noise validation model has been developed for the existing year (2020/2021). The model has incorporated concurrent traffic count and the output was compared with measured noise levels to determine the accuracy of the noise model.

Based on the validated noise model a future year noise model has been developed, considering the No Build, and Build scenarios for the year of opening (2026) and design year (2036). Reasonable and feasible noise mitigation measures have been recommended in accordance with the NMG.

5.2 Road traffic noise modelling methodology

A detailed noise model of the project area was developed using SoundPLAN v8.2, using the UK Department of Transport, Calculation of Road Traffic Noise (CORTN) algorithm. This approach has been proven to provide accurate noise predictions under Australian conditions with the appropriate correction factors applied.

The CORTN algorithm locates the traffic noise source 0.5 m above the pavement. For most projects this provides consistent and accurate results. In Australia the majority of heavy vehicles exhausts are located above the cabin, approximately 3.6 m above the ground rather than just above the ground. In situations with high noise barriers the model can sometimes overpredict barrier insertion losses for the exhaust noise than would typically be experienced.

To account for this a three-source height noise model is required in NSW. The road source has been modelled using source heights of 0.5 m, 1.5 m, and 3.6 m above ground level. The source height of 0.5 m corresponds to the noise sources from light vehicles tyre noise. The heavy vehicle noise source is split into 1.5 m and 3.6 m source heights, with the source at 1.5 m representing the combined engine and tyres noise, and 3.6 m source representing the exhaust noise.

Truck source corrections of -0.6 dBA and -8.6 dBA have been applied for tyres/engines and exhausts (based on Transportation Noise Reference Book, Paul Nelson, 1987). These modifications ensure that the noise predictions (particularly in the presence of noise barriers) address the significance of the elevated heights of noise emission from truck engines and exhausts.

Traffic volumes

The traffic volumes and heavy vehicle percentages are the main driver for noise source emissions. A higher heavy vehicle mix leads to significantly higher source noise levels. Measured traffic counts have been used to validate the existing noise model. Future traffic counts have been sourced from the projects traffic modelling. The traffic volumes are consistent with the traffic and transport technical paper, with small changes for different assessment time periods.

The existing posted speed limit throughout the project area is 60km/h and would remain at this speed in the future. The existing posted speed limits were used outside the 60 km/h zone.

Corrections

CoRTN predicts L_{A10} noise levels. An industry standard – 3 dB(A) correction has been applied to convert the L_{A10} noise level to an L_{Aeq} noise level. This correction is accounted for when using the six category approach, and is not required as an additional correction. Further discussion is provided in Section 5.3.

Terrain and receiver modelling

Topographic data with 1m resolution has been incorporated into the noise model. Terrain has been modelled as with 60% absorption. The model validation has shown that over the area of interest these values give good correlation with the local environment.

Prediction Position

Noise levels at 1m in front of each façade of each sensitive receiver have been predicted. The most affected façade has been reported for each receiver. Façade reflections have been included in the noise modelling. For CoRTN this represents a +2.5 dB correction to the façade predicted noise level.

5.3 Validation noise model

A noise model validation exercise has been completed using two approaches, the typical approach and using the six-category method. The six-category method is an attempt to improve the standard approach by accounting for the different types of heavy vehicles. It is generally used when there are a large proportion of B doubles and other large axle trucks. It has proven useful for motorway projects with posted speed limits above 100 km/h with large heavy vehicle percentages. While this project doesn't fit in this category, TfNSW has requested that the six-category approach be used for this project. The six-category approach divides the traffic into seven categories, one light vehicle and six heavy vehicle categories.

The accuracy of a CoRTN noise model is typically considered to be ±2 dB. A noise model is considered to be working appropriately when all noise loggers fall with the range of ±2.0 dB. The results in Table 22 Six-category correction factors indicate that almost all locations have been correctly validated. NL2 is an exemption, with an over-prediction during the night-time period. While it is not certain why NL2 would have lower than expected noise levels at night, given the measurement location it is possible that the resident may park a cark which shields the location during the night-time period.

A six-category noise validation model has been developed in accordance with "A 6-category heavy vehicle noise emission model in free-flowing condition" and guidance from TfNSW. Provided below is a summary of the calculated corrections factors, based on the project traffic flows.

Table 23 Six-category correction factors

Scenario	Daytime correction		Night-time correction	
	Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle
Validation 60km/h	0.0	-1.6	0.0	-0.6
Validation 70 km/h	-1.8	-2.8	-1.9	-1.8
Year 2036 No Build 60 km/h	0.0	-1.9	0.0	-0.5
Year 2036 No Build 70 km/h	-1.8	-3.1	-2.3	-1.9
Year 2036 Build 60 km/h	0.0	-2.0	0.0	-0.5
Year 2036 Build 70 km/h	-1.8	-3.2	-2.1	-1.7

Provided below in Table 23 is a summary of the six-category model validation.

Table 24 Noise logger validation – six-category approach

Noise Logger	Daytime $L_{Aeq(15hour)}$, dB(A)			Night-time $L_{Aeq(9hour)}$, dB(A)		
	Predicted	Measured	Difference	Predicted	Measured	Difference
NL1	47.0	48.3	-1.3	43.1	44.7	-1.6
NL2	62.6	61.2	1.4	59.0	57.4	1.6
NL3	62.1	60.8	1.3	58.9	60.0	-1.1
NL4	54.7	55.0	-0.3	51.2	51.5	-0.3

The noise model validation results in Table 23 identify that the six-category approach calibrates well in accordance with the accuracy of the CoRTN model. Predicted noise levels are generally slightly lower during the night-time period using the six-category approach.

5.4 Noise modelling scenarios

The RNP and NCG requires consideration of the Year of Opening and Design Year. For each year of consideration, the No Build and Build scenarios are modelled to assess the change in noise. The No Build scenario assumes the project was not to proceed. In this case, the No Build scenario assumes that the entire Great Western Highway widening was not to proceed. The Build scenario assumes that the entire project proceeds.

The follow scenarios have been considered:

- Year 2026 – No Build
- Year 2026 – Build
- Year 2036 – No Build
- Year 2036 – Build

Due to the traffic volumes and mix, Year 2036 scenario will have higher impacts to the surrounding community. On this basis only this scenario has been assessed.

5.5 Noise modelling results

Noise levels have been predicted at each sensitive receiver location throughout the project area. For each receiver, noise levels have been calculated on each floor of each façade and assessed against the RNP and in accordance with the NCG. For brevity, the report only discusses the most affected floor and façade of a receiver which has been found to exceed the RNP and NCG. Complete results are presented visually in the form of noise contours in Appendix D.

Residential sensitive receivers

A total of 13 residential receivers have been identified to exceed the applicable noise criteria and require further consideration of noise mitigation. Presented below in Table 24 and Table 28 is a summary of the predicted noise impacts for these receivers.

Table 25 Noise levels for receivers exceeding the RNP and NCG – Year 2026

ID	Daytime $L_{Aeq(15hour)}$				Night-time $L_{Aeq(9hour)}$			
	Criteria	No Build	Build	Increase	Criteria	No Build	Build	Increase
NSR-240	60	65	65	-0.1	55	61	61	-0.1
NSR-241	60	70	69	-0.2	55	65	65	-0.2
NSR-242	60	73	73	-0.4	55	68	68	-0.4
NSR-243	60	69	69	-0.3	55	65	64	-0.4

ID	Daytime $L_{Aeq(15hour)}$				Night-time $L_{Aeq(9hour)}$			
	Criteria	No Build	Build	Increase	Criteria	No Build	Build	Increase
NSR-259	60	68	67	-0.5	55	63	62	-0.5
NSR-260	60	65	65	-0.2	55	61	61	-0.2
NSR-262	60	67	67	-0.4	55	62	62	-0.3
NSR-308	60	68	67	-0.8	55	63	63	-0.8
NSR-309	60	66	65	-1.3	55	62	61	-1.3
NSR-310	60	67	68	1.0	55	63	64	1.0
NSR-311	60	65	67	2.6	55	60	63	2.3
NSR-312	60	59	61	2.7	55	55	57	2.5
NSR-313	60	62	64	2.0	55	58	59	1.9

Almost all sensitive receivers provided above exceed the CNL. They are predicted to exceed the noise criteria by 5 dB(A) or more both with or without the project. The exceptions to this are:

- NSR-312 is compliant with the CNL, however exceeds the RNP noise criteria and increases by more than 2.0 dB(A).
- NSR-313 is predicted to not be eligible for consideration of noise mitigation. It has been included in the list here, because it is eligible in the Year 2036 (the following table). It has been included here for reference.

Table 26 Noise levels for receivers exceeding the RNP and NCG – Year 2036

ID	Daytime $L_{Aeq(15hour)}$				Night-time $L_{Aeq(9hour)}$			
	Criteria	No Build	Build	Increase	Criteria	No Build	Build	Increase
NSR-240	60	66	66	-0.1	55	61	61	0.2
NSR-241	60	70	70	-0.2	55	65	65	0.1
NSR-242	60	73	73	-0.3	55	68	68	-0.1
NSR-243	60	70	69	-0.4	55	65	65	-0.2
NSR-259	60	68	68	-0.4	55	63	63	-0.2
NSR-260	60	66	66	-0.2	55	61	61	0.1
NSR-262	60	68	67	-0.4	55	62	62	0.0
NSR-308	60	68	68	-0.8	55	63	63	-0.6
NSR-309	60	67	65	-1.4	55	62	61	-1.0
NSR-310	60	68	68	0.9	55	63	64	1.2
NSR-311	60	65	68	2.5	55	61	63	2.6
NSR-312	60	59	62	2.6	55	55	57	2.7
NSR-313	60	62	64	1.9	55	58	60	2.1

Similar to the Year 2026 results, almost all receivers are predicted to exceed the CNL, both with and without the project. The only exception to this is NSR-312, which is predicted to exceed the RNP noise criteria and increase by more than 2.0 dB(A).

5.6 Bellevue Crescent U-turn bay

A U-turn bay is included in the design at Bellevue Crescent. The location is provided below in Figure 2. This road has been assessed as a new local road, in accordance with the RNP. Vehicle movements would be generally slow speed throughout this area, with movements no greater than 10 km/h on average while using the bay itself.

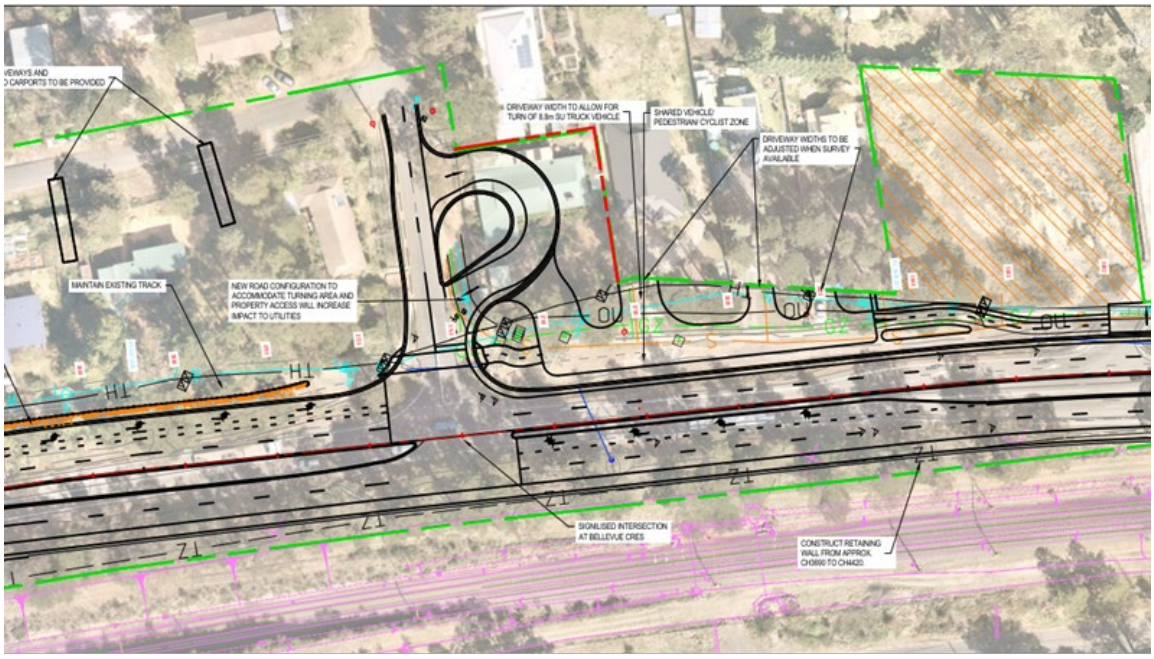


Figure 2 Bellevue Crescent U-turn bay

The CoRTN algorithm was developed for free flowing traffic at higher speeds than how a U-turn bay is typically used. To provide a more accurate calculation, source levels from Common Noise Assessment Methods (CNOSSOS-EU) have been used to calculate the impact. Provided below is a summary of the source levels used in the calculation.

Table 27 U-turn bay noise source levels

Source	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall dB(A)
Light rolling	50	46	47	64	65	58	47	36	67
Light propulsion	101	89	87	85	83	86	82	75	91
Heavy rolling	58	59	64	75	70	59	51	44	74
Heavy propulsion	113	107	107	106	105	101	96	90	109

During the busiest 1-hour period the traffic and transport assessment predicts 13 light vehicles and two heavy vehicles would use the U-turn bay in 2036. Traffic movements during Year 2026 and the night-time period are not available. At the façade of the most affected receiver, 108 Great Western Highway, noise levels are predicted to be 54 dB(A). Noise levels at the closest sensitive receiver, 106 Great Western Highway, are predicted to be 47 dB(A) during the busiest 1-hour period.

These predicted noise levels comply with the daytime local road noise criteria of $L_{Aeq(1hour)}$ 55 dB(A). While traffic volumes are not available for the night-time period, hourly night-time traffic volumes for Year 2036 are about 14% of the daytime figures, which yields noise levels about 9 dB lower. Based on these volumes it is likely that night-time noise levels also comply with the night-time criteria of $L_{Aeq(1hour)}$ 50 dB(A).

Consideration of noise mitigation is not required for the operation of the U-turn bay.

5.7 Maximum noise level assessment

The RNP includes a review of international sleep arousal research, concluding that at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of noise disturbance.

The ENMM considers a maximum noise level event to be defined as a vehicle pass-by event for which the $L_{A,max}$ noise level is equal to or greater than 15 dB(A) above the $L_{Aeq(1hr)}$. Maximum noise level events have been considered at 40 Railway Parade, Medlow Bath. This Location is considered representative of receivers along the proposed alignment.

Maximum noise levels are generally dependant on truck engine braking events; however, loud exhausts and horns may also contribute. A truck may engage its engine brakes at any location on the project alignment, but the likelihood is dependant of a range of factors. Maximum noise events are less likely further away from the alignment, as maximum noise levels decrease faster with distance than L_{Aeq} road traffic noise levels.

At this location, noise associated with trains also contributes to maximum noise events. The greatest sources include engine noise, fan noise, and horn noise events near the pedestrian crossing.

Although it is impossible to state that any given location is representative of the whole project, this location is considered representative of the worst-case scenario.

A summary of the typical and maximum number of maximum noise level events recorded over the measurement period are provided in Figure 3. Maximum noise levels were typically 78-85 dB(A), however, measurements were recorded as hight as 118 dB(A). Noise in the area is generally controlled by road and rail traffic, but it cannot be assumed that every maximum noise level is from these sources.

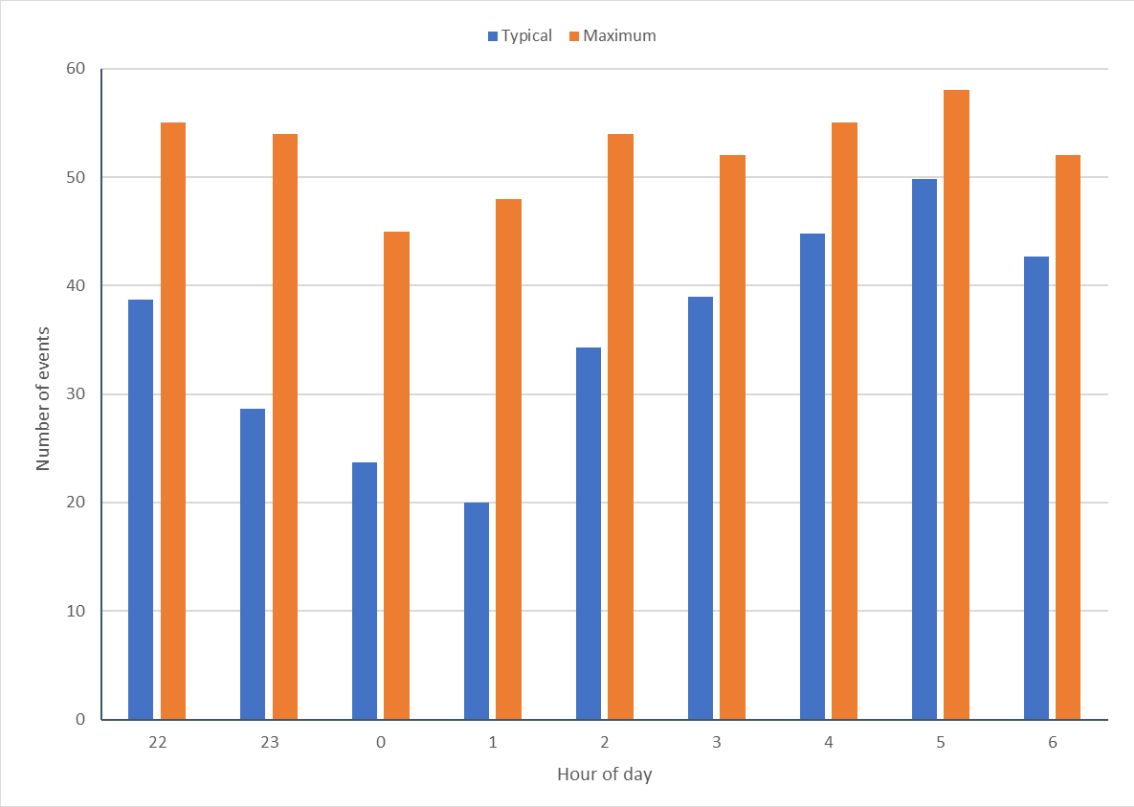


Figure 3 Typical and maximum noise level events

The maximum noise level events in Figure 3 Identify that the area is already exposed to a significant number of maximum noise events with the potential for awakening reactions.

Contributors to maximum noise events at 40 Railway Parade include traffic volumes, truck types, truck speed, and train activity. In future scenarios overall traffic volumes and consequently, overall noise levels are predicted to increase, resulting in higher L_{Aeq} noise levels. Truck type and speed are unlikely to change significantly during in future night periods. The increase in L_{Aeq} noise levels will reduce the difference between L_{Aeq} and maximum noise levels. This is likely to result in fewer maximum noise level events.

Removal of the at-grade rail crossing, and construction of a pedestrian overpass is expected to reduce maximum noise events by eliminating the need for trains to use horns on approach to the crossing. This will likely contribute to further reduction of maximum noise level events. However high noise events from freight exhausts and fans would persist.

There is the potential for a reduction in maximum noise events in the future, However, whether maximum noise events increase or decrease, there is no criterion associated with these impacts. Road and Maritime do not provide any requirements to provide noise mitigation options based on the maximum noise level assessment. Rather, maximum noise level assessments can be used to prioritise noise mitigation measures or to guide long term Roads and Maritime strategies.

6 Management and mitigation measures

6.1 Construction impacts

The noise and vibration predictions in Section 4 identified there is likely to be residual noise and vibration impacts from the proposed construction activities. The extent of the impacts is typical for a project of this size and can be reduced through the inclusion of appropriate management and mitigation measures.

The following section provides generic recommendations to reduce the potential impacts. The construction contractor will need to ensure that all reasonable and feasible noise and vibration mitigation measures are included in the construction practices to minimise the impact on the surrounding community.

6.1.1 Construction noise and vibration management plan

During the detailed design phase of the project a Construction Noise and Vibration Management Plan (CNVMP) would be prepared by the contractor. The purpose of the CNVMP is to identify how the project would manage noise and vibration impacts from the planned works. The CNVMP would include the following:

- The applicable noise and vibration criteria
- Noise and vibration sensitive receptors which have the potential to be impacted by the works.
- Noise management and mitigation measures from the Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime 2016) and details about when each would be applied
- Details about the procedures which would be adopted when carrying out location and activity specific noise and vibration impact assessments to assist with the selection of appropriate mitigation measures
- Protocols that would be adopted to manage works required outside standard construction hours, in accordance with relevant guidelines including for management of respite periods
- Detailed monitoring that would be carried out to confirm project performance in relation to noise and vibration performance criteria.

Feasible and reasonable mitigation measures would be detailed within the CNVMP to manage predicted noise levels at sensitive receivers and areas where construction fatigue could occur. Consultation with the affected community would also occur prior to and during construction.

6.1.2 Community consultation and complaints handling

Effective community consultation and complaints handling is sometimes the most valuable noise management measure. Considering Medlow Bath is a relatively contained township, all community and relevant stakeholders should be consulted about the project, prior to the commencement of works. On-going consultation should be undertaken will all receivers which are predicted to be exposed to noise impacts above the NMLs. Residents should be provided information including:

- Location and timing of proposed works
- Magnitude of the predicted noise and vibration impacts
- Construction noise and vibration mitigation and management measures which will be implemented as part of the works.

Community consultation regarding construction noise and vibration would be detailed in the Community Involvement Plan for the construction of the project and would include a 24-hour hotline and complaints management process.

6.1.3 Work practices

As part of the site inductions, noise and vibration training should be provided to all staff and sub-contractors, identifying the most noise and vibration sensitive receivers, project mitigation and management measures, and their responsibilities with regards to noise and vibration.

6.1.4 Construction hours and work scheduling

As far as practicable, all noise intensive works should be scheduled during standard construction hours. Noise intensive work which cannot be completed during standard construction hours are to be scheduled as early as possible during the evening and night-time periods.

Particularly noise intensive works such as concrete cutting and heavy rock breaking should be scheduled as far as practicable during times with the highest background noise levels.

6.1.5 Respite

The project approach to respite from noise and vibration intensive works should be provided in the CNVMP and developed in accordance with the CNVG. Respite measures may include limiting the hours of noise intensive plant or other agreements between the contractor and sensitive receiver (such as alternative accommodation for residential receivers).

6.1.6 Standard mitigation measures

As a minimum the standard noise and vibration mitigation measures in *Appendix B* of the CNG should be incorporated into the contractors CNVMP and work strategy, where practicable.

6.1.7 Additional mitigation measures

Provided below is a summary of additional mitigation measures. These measures are applied after standard noise mitigation measures (Section 6.1.6) have been applied and where the noise levels are still exceeding the noise management levels. The guideline recommends following the approach in *Table C.1* of the CNG where reasonable and feasible. An outline on when they should be applied is provided in Table 27 and Table 28.

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.

Specific notifications (SN)

Specific notifications are letterbox dropped (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. The specific notification provides additional information when relevant and informative to more highly affected receivers than covered in general letterbox drops.

The exact conditions under which specific notifications would proceed are defined in the relevant Additional Mitigation Measures (*Tables C1 to C3* of the CNG). This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Phone calls (PC)

Phone calls detailing relevant information made to identified/affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.

Individual briefings (IB)

Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. Where the resident cannot be met with individually then an alternative form of engagement should be used.

Respite Offers (RO)

Respite Offers should be considered made where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers.

The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis and may not be applicable to all projects.

Respite Period 1 (R1)

Out of hours construction noise in out of hours period 1 shall be limited to no more than three consecutive evenings per week except where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and no more than 6 evenings per month.

Respite Period 2 (R2)

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 11pm.

Duration Respite (DR)

Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer duration projects. In this instance and where it can be strongly justified it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly.

The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite.

Where there are few receivers above the NML each of these receivers should be visited to discuss the project to gain support for Duration Respite.

Alternative Accommodation (AA)

Alternative accommodation options may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels (*Tables C1-C3* of CNG). The specifics of the offer will be identified on a project-by-project basis. Additional

aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.

Verification

Please see Appendix F of the CNG for more details about verification of Noise and Vibration levels as part of routine checks of noise levels or following reasonable complaints. This verification should include measurement of the background noise level and construction noise. Note this is not required for projects less than three weeks unless to assist in managing complaints.

Table 28 Triggers for additional mitigation measures – airborne noise

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures types	Mitigation levels
Perception	dB(A) above RBL	dB(A) above NML		
All hours				
75 dB(A) or greater			N, V, PC RO	HA
Standard Hours Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun/Pub Hol (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly Audible	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: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Hol (8am – 6pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly Audible	10 to 20	5 to 15	N, R1, DR	NML + 5
Moderately Intrusive	20 to 30	15 to 25	V, N, R1, DR	NML + 15
Highly Intrusive	< 30	> 25	V, IB, N, R1, DR, PC, SN	NML + 25
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Pub Hol (6pm – 7am)				
Noticeable	5 to 10	< 5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML + 5
Moderately Intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML + 15
Highly Intrusive	< 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML + 25

6.2 Construction vibration

Any proposed works within the minimum working distances should be undertaken with concurrent vibration measurements to ensure the cosmetic damage criteria are not exceeded at sensitive receiver locations. Provided below in Table 28 is a summary of the additional vibration mitigation measures which should be followed anytime the human response minimum working distances could potentially be breached.

Table 29 Triggers for additional mitigation measures – vibration

Predicted vibration level at receiver	Additional mitigation measures types	Mitigation levels
Standard Hours Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun/Pub Hol (Nil)		
Predicted vibration exceeds maximum levels	V, N, RP	All
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Hol (8am – 6pm)		
Predicted vibration exceeds maximum levels	V, IB, N, RO, PC, RP, SN	All
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Pub Hol (6pm – 7am)		
Predicted vibration exceeds maximum levels	AA, V, IB, N, PC, RP, SN	All

6.3 Operational noise impacts

6.3.1 Recommended mitigation

The recommendation of noise mitigation is hierarchical. It should be considered at the source (eg pavement design), then the path (eg noise barriers) and then finally architectural treatment.

The typical low noise pavement is stone-mastic asphalt (SMA). TfNSW recommend a correction factor of 0.0 dB for SMA with a standard aggregate size of 10mm. SMA with 7mm aggregate does provide noise reductions, however the *Roads and Maritime Supplement to Austroads Guide to Pavement Technology* does not allow for SMA with 7 mm aggregate as a standard pavement. An alternative low noise pavement, Open Graded Asphalt (OGA) is not being considered for this project due to design life concerns.

A noise barrier would typically be considered as the next step. The project team has identified that commitments have been made to the community that noise walls would not be provided on this project. The final consideration is architectural treatment.

Architectural treatment

All receivers which have been identified for further consideration of noise mitigation would be eligible for architectural treatment.

The Roads and Maritime document At-Receiver Treatment Guideline (ARTG) provides direction on suitable noise mitigation for exceedances of the noise criteria. The installed treatment is dependent on the construction of the building and the exceedance.

Provided below in Table 29 is a summary of the eligible sensitive receivers, and potential treatment. In accordance with the Roads and Maritime NMG, the actual noise mitigation which would be incorporated in the project design would be confirmed at the detailed design phase. Controlling noise at the source is always the preferred approach to noise control, and changes in the design may mitigate the design sufficiently so that at-receiver noise mitigation is no longer required, or a lower level of treatment required instead. Further information on the treatment specification can be found in the ARTG. The eligible houses listed below are also identified in Appendix F.

Table 30 Architectural treatment

Receiver ID	Address	2036 Daytime $L_{Aeq,15hour}$	2036 Night-time $L_{Aeq,9hour}$	Greatest exceedance	ARTG treatment package[1]
NSR-240	4 Station Street	66	61	6	2
NSR-241	2 Station Street	70	65	10	3
NSR-242	40 Great Western Highway	73	68	13	4
NSR-243	50 Great Western Highway	69	65	10	3
NSR-259	106 Great Western Highway	68	63	8	2
NSR-260	100 Great Western Highway	66	61	6	2
NSR-262	104 Great Western Highway	67	62	7	2
NSR-308	108 Great Western Highway	68	63	8	2
NSR-309	110-114 Great Western Highway	65	61	6	2
NSR-310	116-118 Great Western Highway	68	64	9	3
NSR-311	14 Delmonte Avenue	68	63	8	2
NSR-312	122 Great Western Highway	62	57	2	1
NSR-313	126 Great Western Highway	64	60	5	1

Note 1: For further details on the treatment package, refer to the Roads and Maritimes At-Receiver Treatment Guideline

7 Proposed alternative intersection at Bellevue Crescent

As part of the design for the proposal, a new alternative signalised intersection is being considered to the Great Western Highway with a new road through vacant Lots to connect to the existing Bellevue Crescent and approximately 25 metres south of the United Petrol Station.

The figure below shows the arrangement of the road, and the existing Bellevue Crescent intersection as a cul-de-sac.

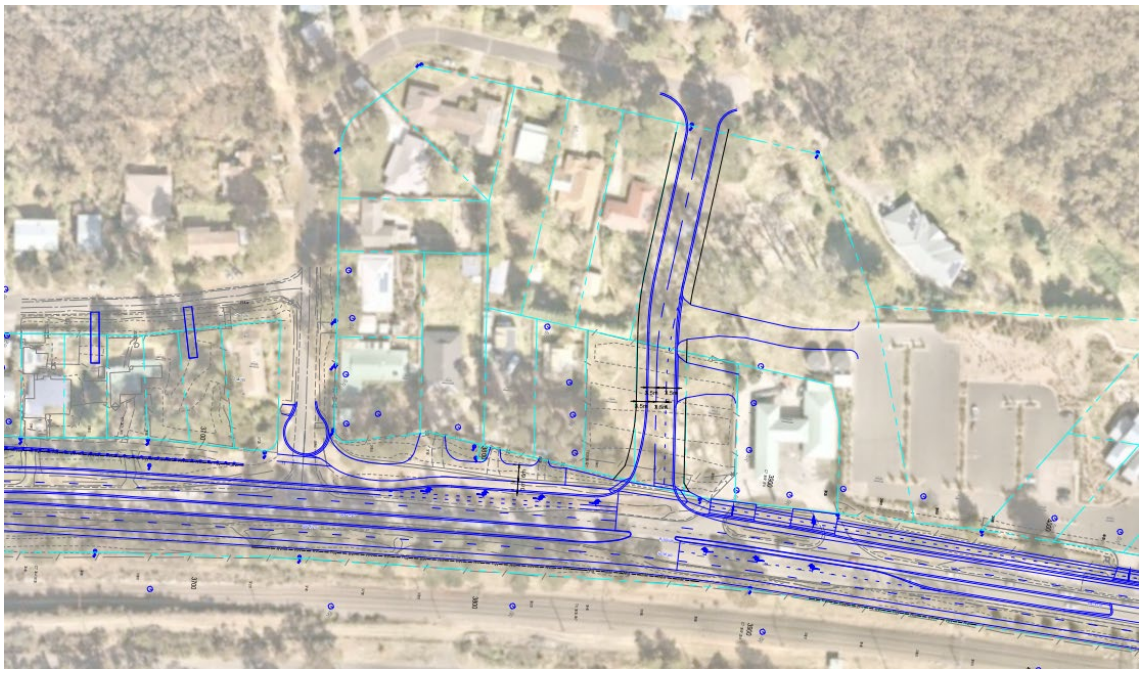


Figure 4 Bellevue Crescent Intersection Relocation

The arrangement includes the following key design features:

- A signalised intersection would be built along the southern perimeter of the United Petrol Station in Medlow Bath utilising a corridor (anticipated to be 20 metres) through vacant Lots.
- Closing the existing Bellevue Crescent and Great Western Highway intersection but still maintaining a service road/shared zone for the properties fronting the highway
- Creating new access options from Bellevue Crescent to the petrol station Hydro Majestic Pavillion
- Allows left and right turns out of Bellevue Crescent on to the Great Western Highway (enabling west and east bound movement) and left turn into the alternative Bellevue Crescent from Great Western Highway westbound

This section provides a high-level noise and vibration impact assessment of this option.

7.1 Construction noise impacts

Similar to the main assessment, the works would consist of vegetation clearing, roadworks, and finishing works. The same equipment and associated SWLs described in Section 4 would be

used. The works area would not be impact by road traffic so out of hours works is unlikely for this area. Provided below in Table 30 is a summary of the predicted noise impacts.

Table 31 Standard work hours construction noise impacts

NCA	L_{Aeq} NML dB(A)	Maximum L_{Aeq} noise level dB(A)	NML exceedances 1 – 10 dB(A)	NML exceedances 11 – 20 dB(A)	NML exceedances > 20 dB(A)	Highly noise affected
Vegetation clearing						
NCA01	50	77	80	3	3	2
NCA02	51	72	123	3	3	0
Roadworks						
NCA01	50	74	68	3	3	0
NCA02	51	69	84	0	0	0
Finishing works						
NCA01	50	66	56	0	0	0
NCA02	51	61	13	0	0	0

7.2 Operational noise impacts

The alternative Bellevue Crescent option would be considered a new local road in accordance with the RNP. The applicable noise criteria is provided in Section 3.3.1. Noise levels have been calculated using SoundPLAN v8.2, incorporating the CoRTN road traffic noise modelling algorithm.

Traffic volumes

At this stage of the design traffic volumes for only the Year 2036 morning and afternoon peak periods is available. Provided below is a summary of the predicted 2036 peak hour volumes on the alternative Bellevue Crescent option. The traffic volumes assume the project would be built.

Table 32 Alternative Bellevue Crescent option peak hour traffic volumes

Scenario	Light vehicles	Heavy vehicles	Total
2036 Morning Peak	63	5	68
2036 Afternoon Peak	73	1	74

Predicted noise impacts

Year 2036 Build traffic noise impacts have been calculated based on the traffic volumes provided above. Without night-time traffic volumes it is not possible to determine the night-time noise impacts. Presented below in Table 32 is a summary of the noise impacts at adjacent sensitive receivers for the morning and afternoon peak periods.

Table 33 Alternative Bellevue Crescent option $L_{Aeq(15hour)}$ daytime noise impacts

Receiver	Criteria, dB(A)	Morning peak, dB(A)	Afternoon peak, dB(A)	Exceeds criteria
5 Bellevue Crescent	55	54	52	No
6 Bellevue Crescent	55	55	53	No
7 Bellevue Crescent	55	52	51	No
9 Bellevue Crescent	55	55	54	No
11 Bellevue Crescent	55	52	50	No

Receiver	Criteria, dB(A)	Morning peak, dB(A)	Afternoon peak, dB(A)	Exceeds criteria
12 Bellevue Crescent	55	52	50	No
14 Bellevue Crescent	55	53	51	No
15 Bellevue Crescent	55	50	49	No
16 Bellevue Crescent	55	54	53	No
17 Bellevue Crescent	55	58	57	Yes
18 Bellevue Crescent	55	56	54	Yes
20 Bellevue Crescent	55	52	51	No
22 Bellevue Crescent	55	57	55	Yes
24 Bellevue Crescent	55	54	52	No
26 Bellevue Crescent	55	39	37	No
100 Great Western Highway	55	50	48	No

The results in Table 32 indicate that three residential locations are predicted to exceed the applicable daytime noise criteria. Further analysis would be required during the detailed design stage of the project to confirm the predicted noise levels during the night-time period.

If the project was to proceed these three sensitive receivers would likely be consideration of additional noise mitigation measures. A low noise pavement and noise barrier would not be practicable in this location, hence the receivers would be eligible for architectural treatment. The identified exceedances are between 1 to 5 dB(A), hence the receivers would be eligible for treatment type 1, in accordance with the ARTG. Further information on the treatment specification can be found in the ARTG.

8 Conclusion

A detailed construction and operational noise and vibration impact assessment has been completed identifying the potential impacts from the construction and operational phases of the proposed road upgrade.

Ambient noise measurements have been undertaken at four locations throughout the project area. Concurrent road traffic counting was also completed during this monitoring period to evaluate the traffic movements on the Great Western Highway.

Construction noise and vibration impacts have been assessed in accordance with the ICNG and AVATG. Five construction scenarios have been assessed across all stages of the projects. The proposed works are during standard construction hours only and have been assessed against the ICNG daytime noise criteria.

The construction noise impacts identify that during noise intensive works, impacts would need to be carefully managed. The contractors CNVMP would need to carefully consider any and all appropriate management and mitigation measures to control the impacts. Stakeholder engagement will be a key feature of these measures, particular with key stakeholders such as the Hydro Majestic Hotel. A range of vibration sensitive receivers have been identified which would require careful consideration when planning works and, dependent on the nature of the works, may require vibration monitoring throughout the project.

Operational noise has been assessed in accordance with the RNP, and the NCG. A noise validation model has been developed in accordance with the six-category heavy vehicle approach and found to calibrate appropriately in line with the accuracy of the CoRTN noise model.

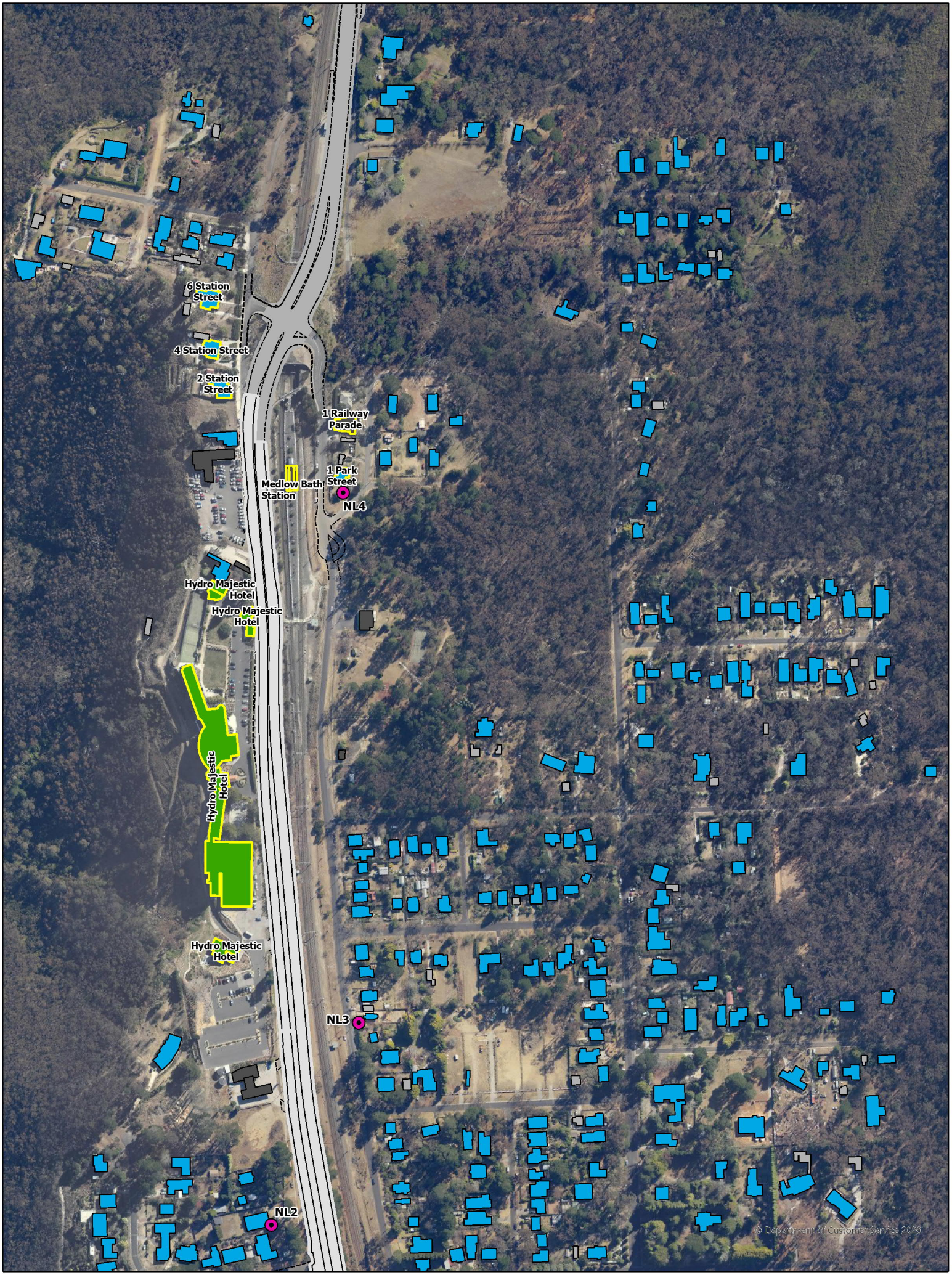
Detailed operational noise modelling was completed for the year of opening (2026), and the design year (2036). The assessment identified high existing noise levels throughout the project area which would continue in the future, with or without the project. On average noise levels were predicted to decrease slightly in the future from the change in traffic mix. However, receivers were identified exceeding the cumulative noise limit. This criterion protects the community from impacts where noise levels are predicted to be 5 dB(A) or more above the RNP noise criteria.

Noise mitigation has been recommended in accordance with Road and Maritimes Noise Mitigation Guideline. Stakeholders had expressed a clear preference to avoid noise barriers, so architectural treatment has been recommended for 13 remaining residential receivers.

As part of the design for the proposal, a new alternative signalised intersection is being considered to the Great Western Highway with a new road through vacant Lots to connect to the existing Bellevue Crescent and approximately 25 metres south of the United Petrol Station. A construction noise assessment has been undertaken of these works. The construction noise impacts were largely similar to the remainder of the project, with an emphasis on noise management and mitigation measures.

An operational noise impact assessment of the Bellevue Crescent Option identified that three receivers would exceed the applicable noise criteria and would be eligible for consideration of additional noise mitigation. With low noise pavements and noise barriers impractical in these locations, these receivers would be eligible for consideration of architectural treatment.

A. Site Plan



0 25 50 m

Datum: MGA Zone 56
Date: 20/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Design Alignment
Existing Road Alignment
Noise Logging Locations
Footprint

Commercial Building
Hotel
Residential Building
Shed / Other
Outline - Indicates Heritage Listed
Footprint

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Noise Logging Locations, Building Use and Heritage - Northern Extent

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0 25 50 m

Datum: MGA Zone 56
Date: 20/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Design Alignment
Existing Road Alignment
Noise Logging Locations
Footprint

Commercial Building
Hotel
Residential Building
Shed / Other
Outline - Indicates Heritage Listed
Footprint

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Noise Logging Locations, Building Use and Heritage - Southern Extent

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B. Ambient noise measurements

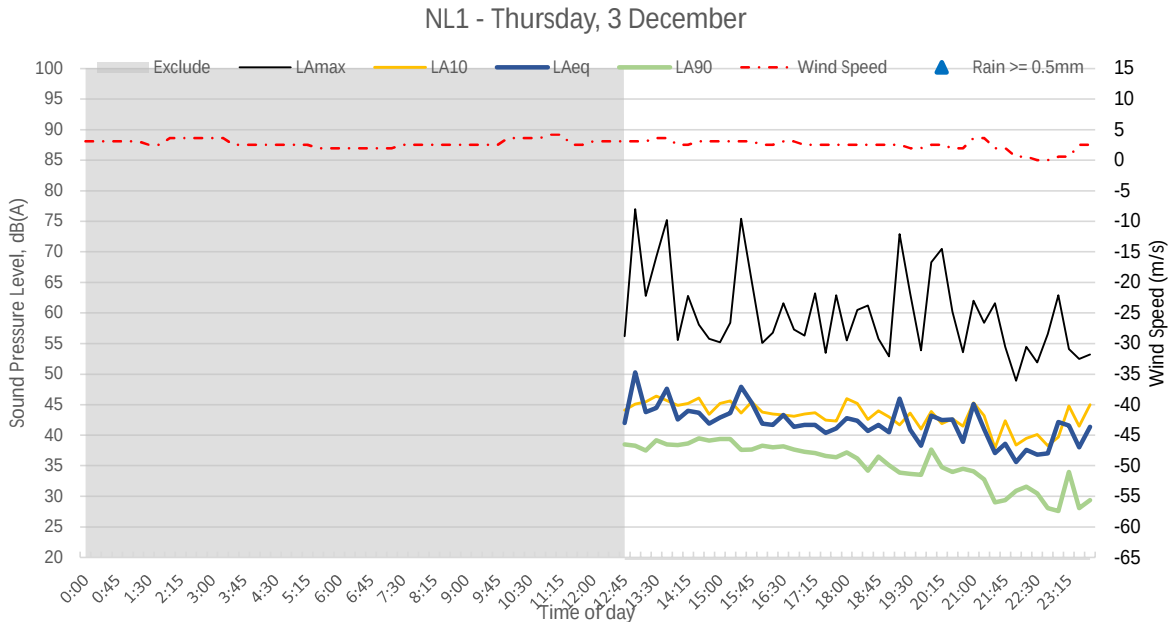
Noise Logging Report

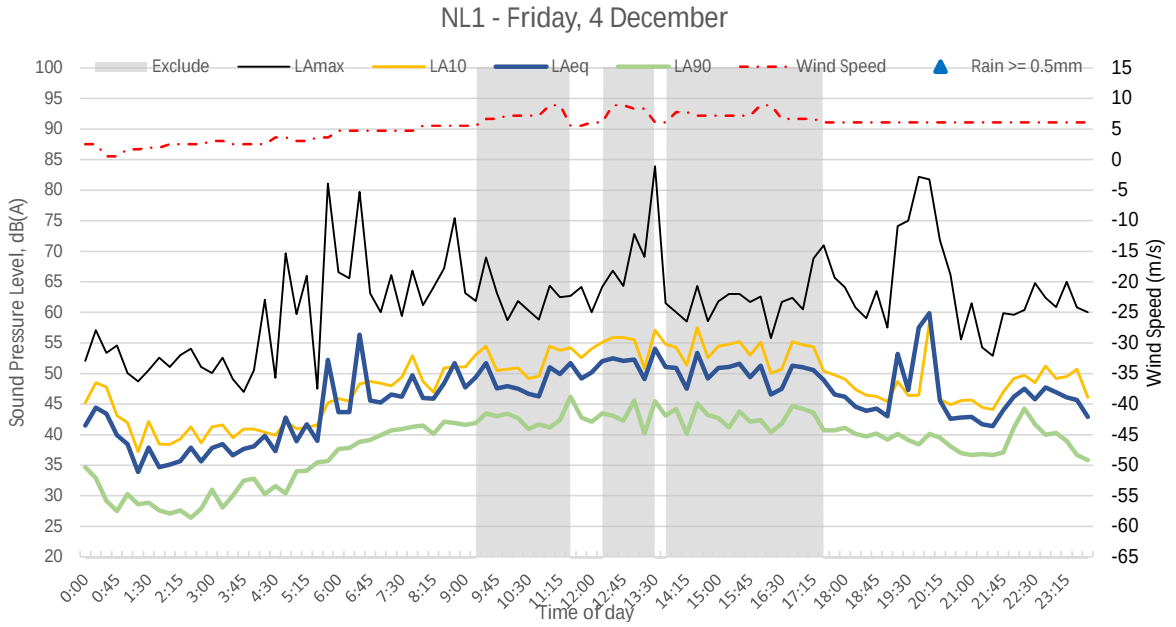
NL1 - 25 Delmonte Avenue, Medlow Bath

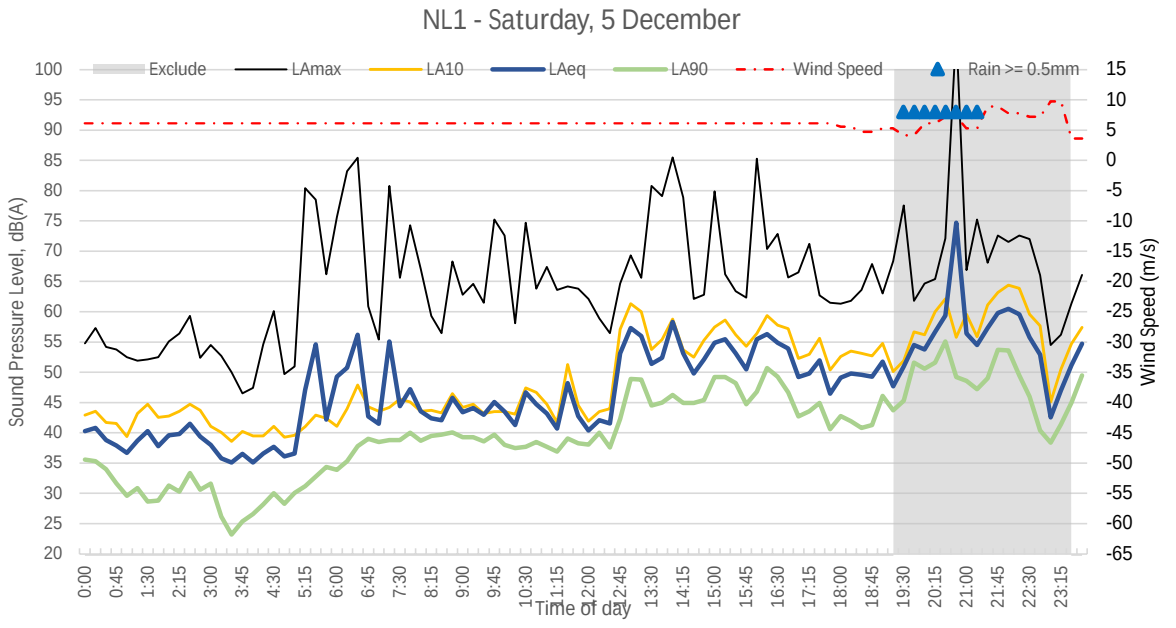
Logger ID	NL1
Address	25 Delmonte Avenue, Medlow Bath
Start date	Thursday, 3 December 2020
End date	Monday, 14 December
Noise logger type	Rion NL-42EX
Noise logger serial number	
Façade / Free field	Façade
Description	Environmental noise controlled by Great Western Highway

Date	$L_{Aeq,period}$, dBA			Ambient background level, dBA			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
Thursday, 3 December	-	42	44	-	29	28	43	44
Friday, 4 December	-	51	46	-	37	26	50	46
Saturday, 5 December	51	-	-	38	-	-	51	-
Sunday, 6 December	-	-	-	-	-	-	-	-
Monday, 7 December	-	-	-	-	-	-	48	-
Tuesday, 8 December	-	45	41	-	34	24	45	41
Wednesday, 9 December	46	45	43	35	34	24	45	43
Thursday, 10 December	49	50	49	36	42	35	49	49
Friday, 11 December	51	48	45	45	40	31	50	45
Saturday, 12 December	51	48	43	44	40	25	50	43
Sunday, 13 December	49	46	47	42	38	37	48	47
Monday, 14 December	-	-	-	-	-	-	50	-

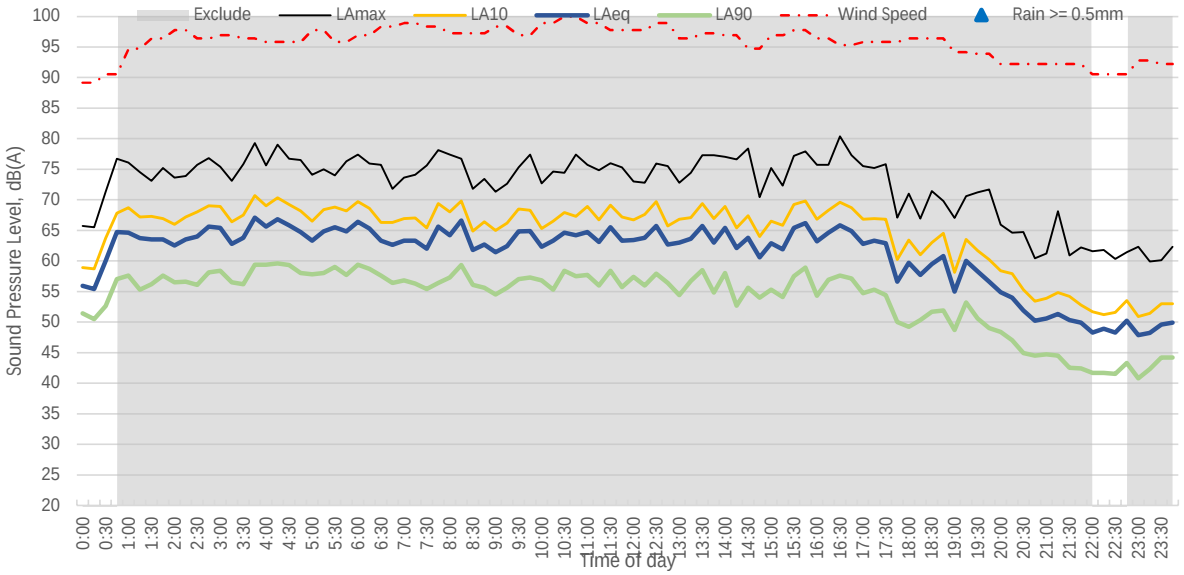
Summary	Ambient noise level			Rating background level			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
	49	47	45	40	37	27	48	45


NL1 - Thursday, 3 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day

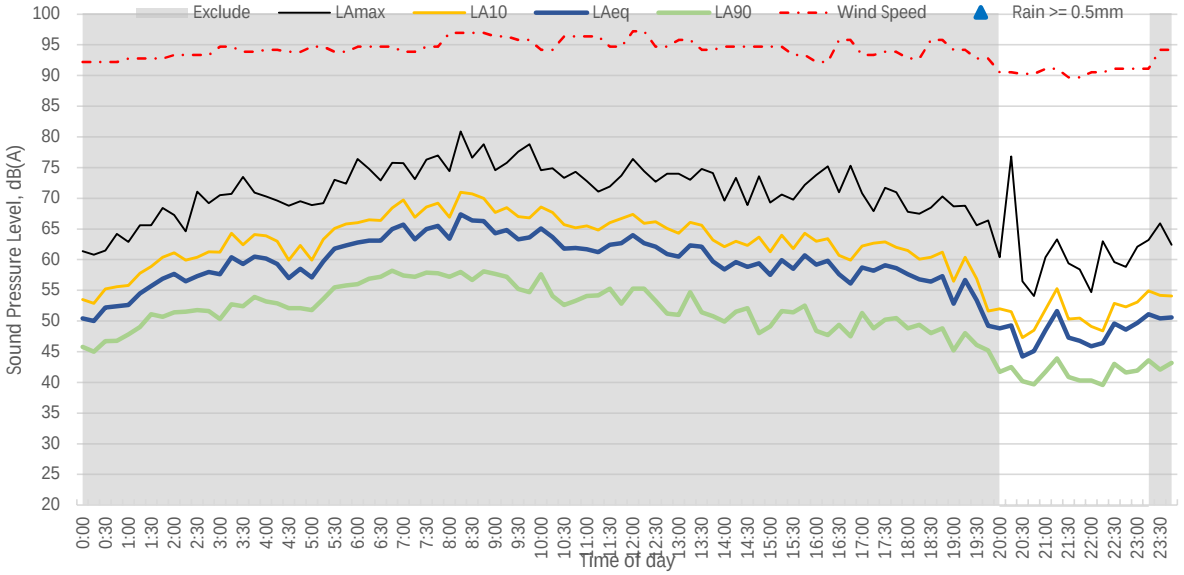

NL1 - Friday, 4 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL1 - Saturday, 5 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day

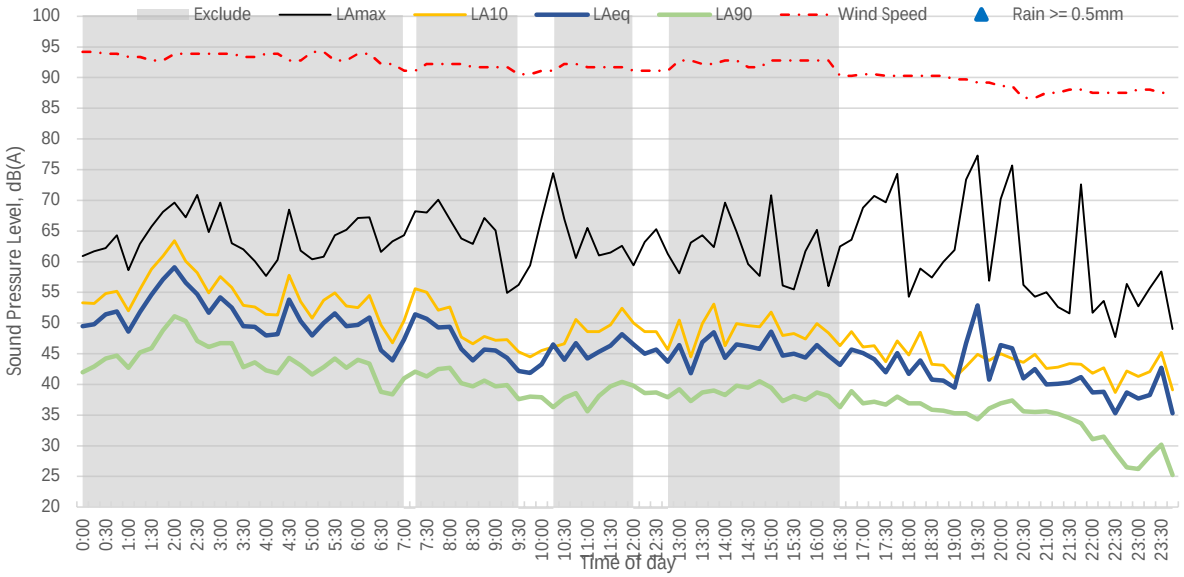
NL1 - Sunday, 6 December

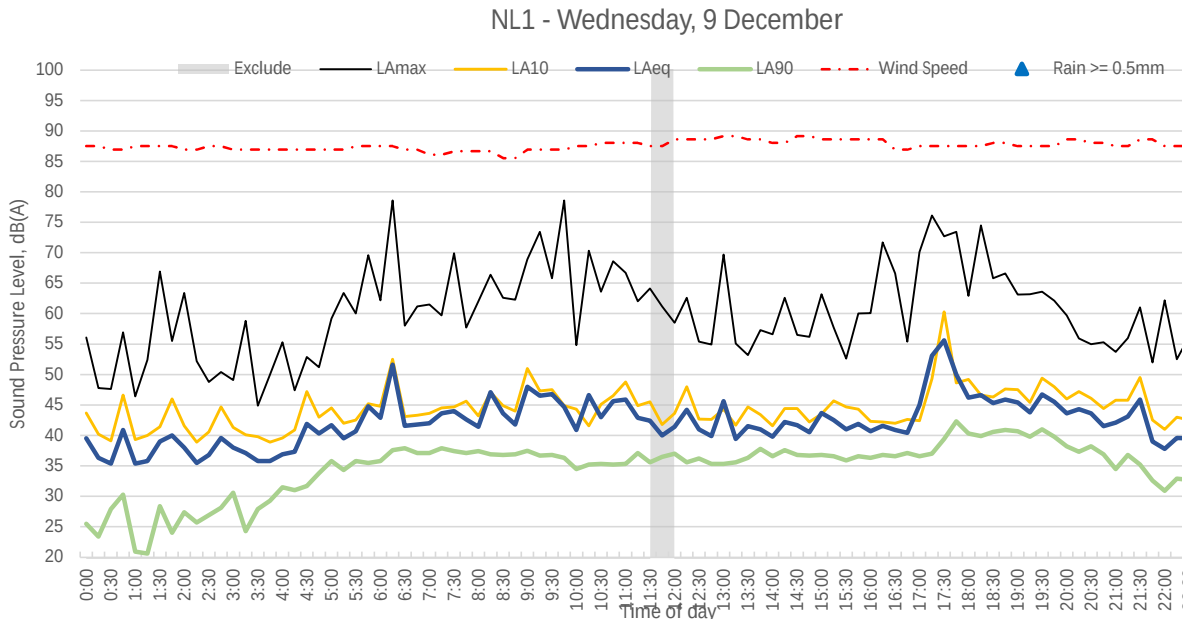


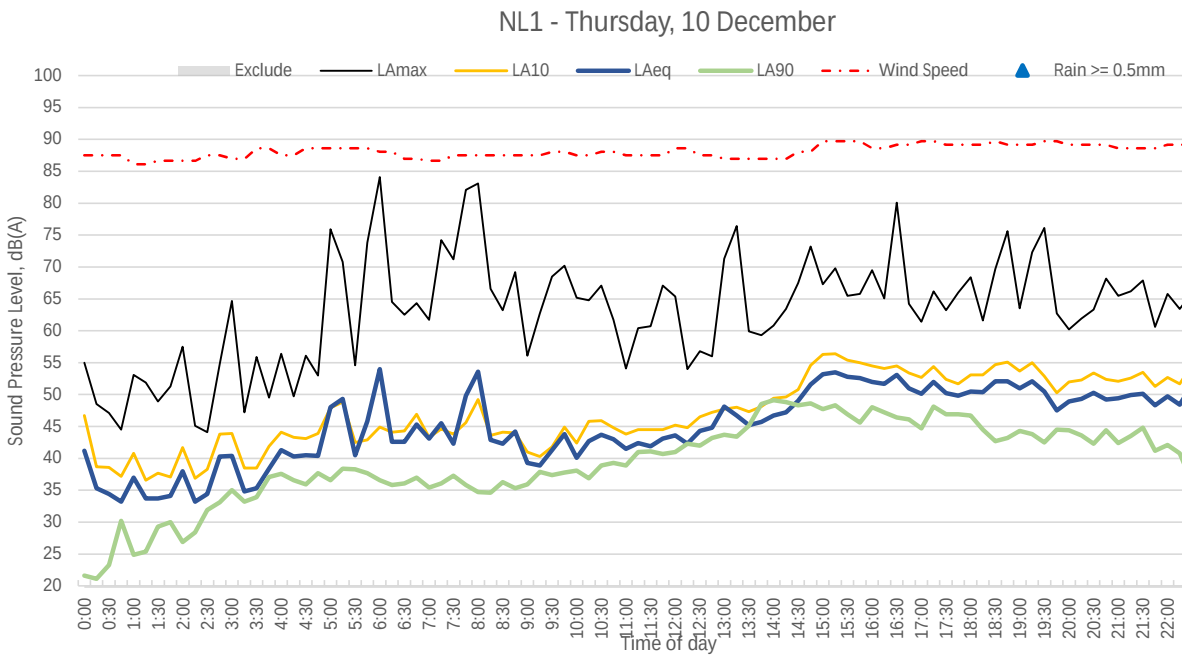
NL1 - Monday, 7 December

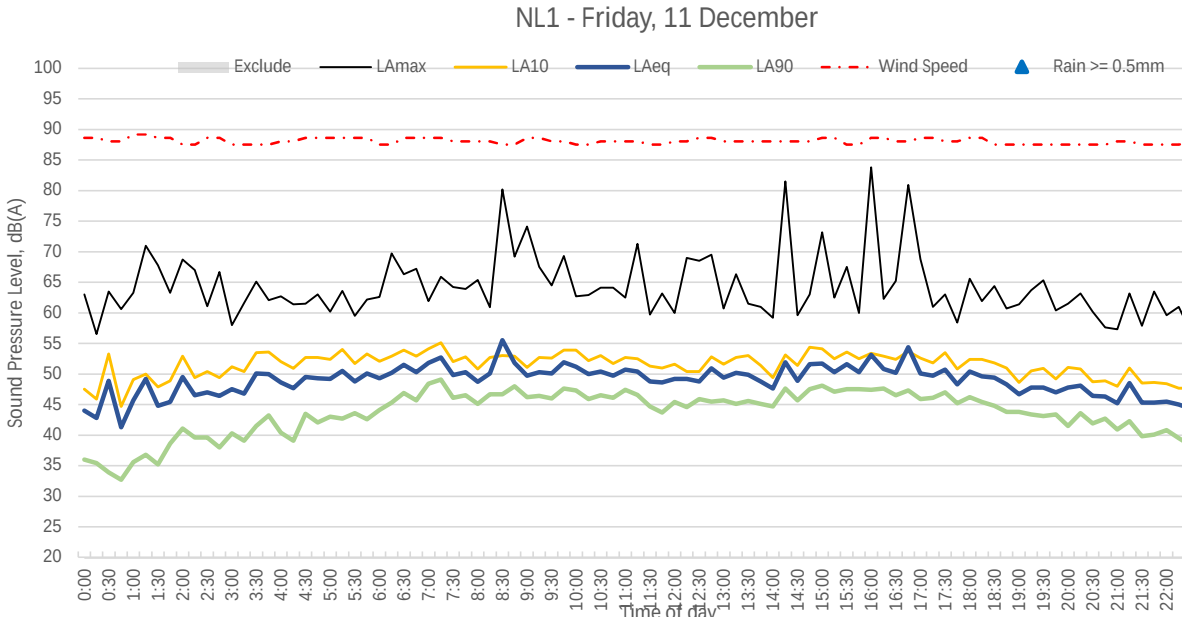


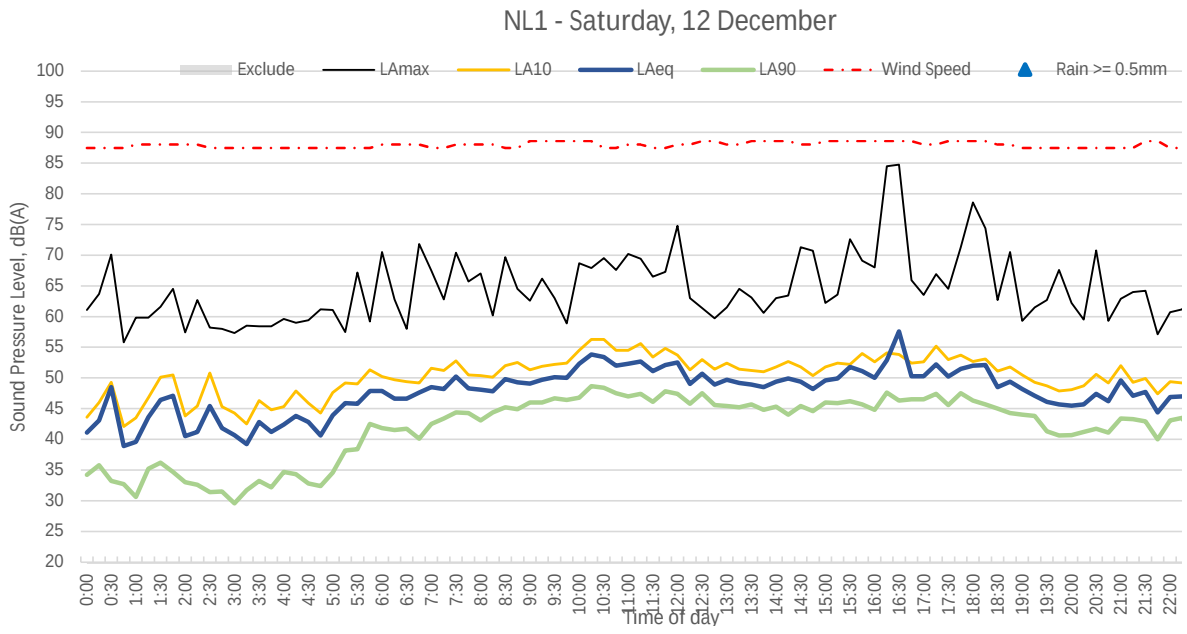
NL1 - Tuesday, 8 December

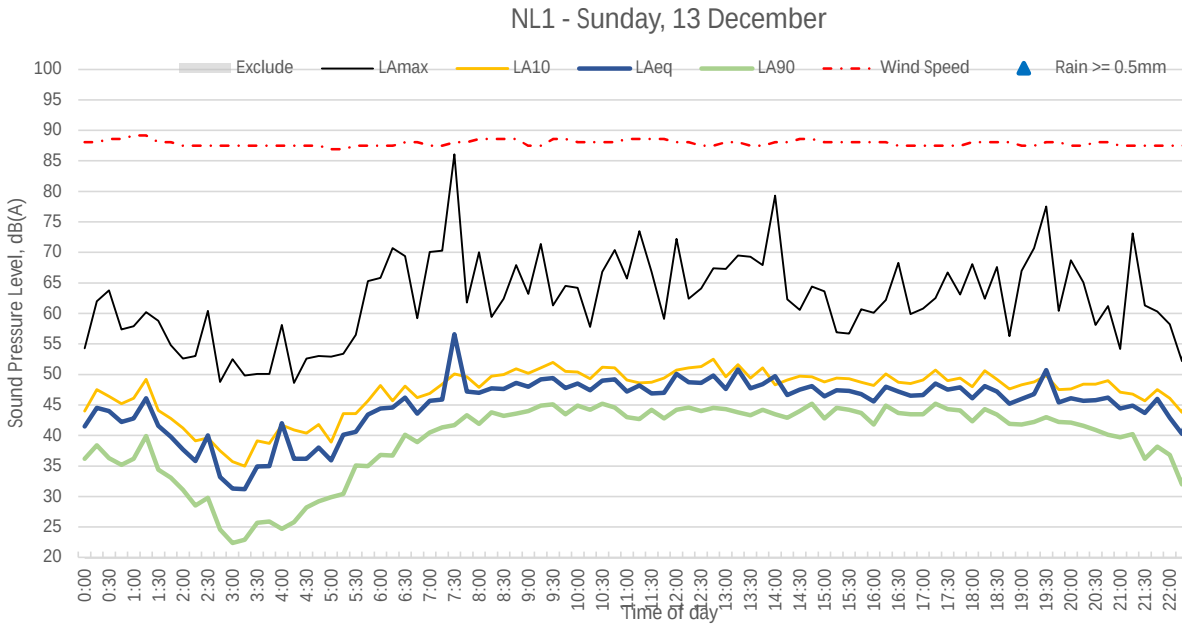


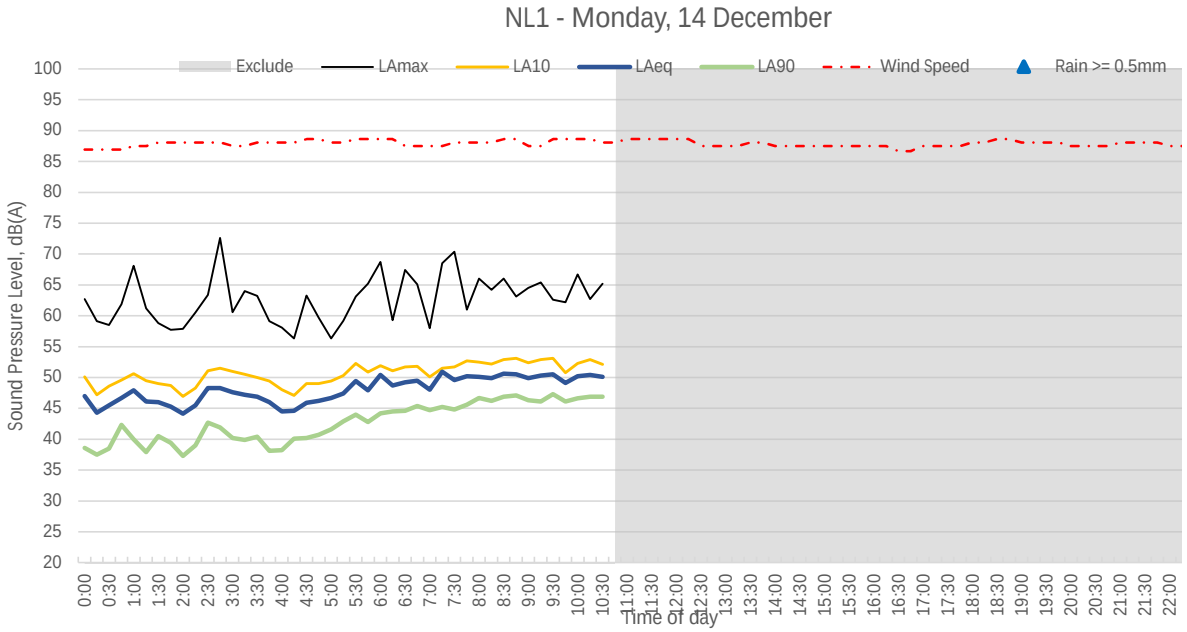

NL1 - Wednesday, 9 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Time of day


NL1 - Thursday, 10 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Time of day


NL1 - Friday, 11 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Time of day


NL1 - Saturday, 12 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Time of day


NL1 - Sunday, 13 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Time of day


NL1 - Monday, 14 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Time of day

Noise Logging Report

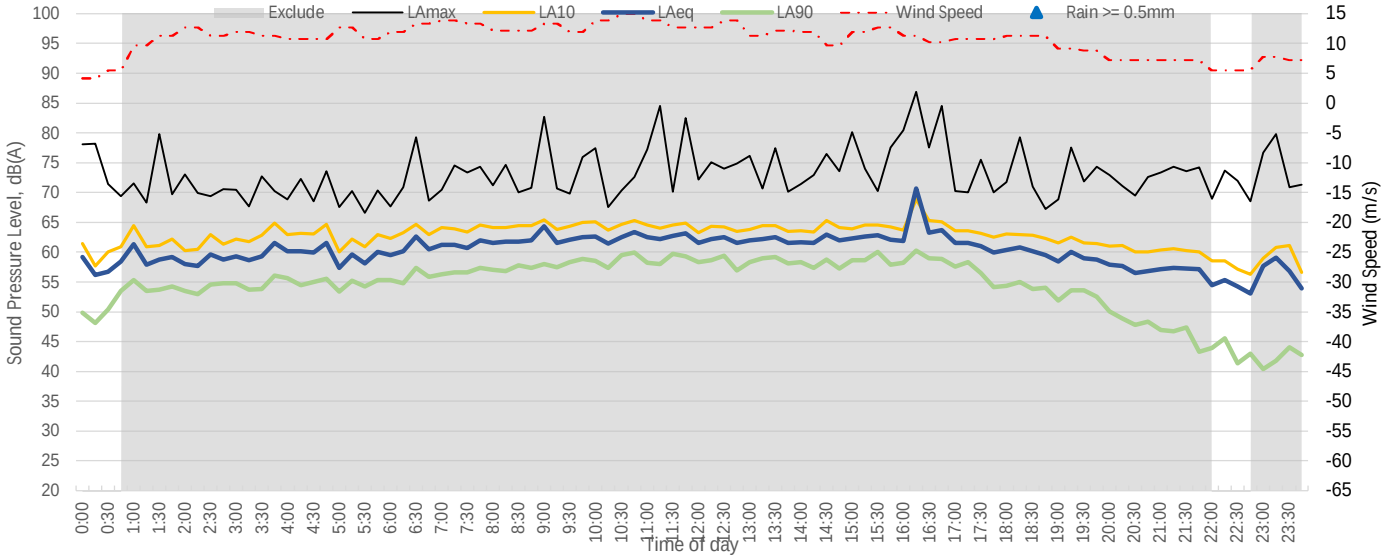
NL2 - 104 Greater Western Highway, Medlow Bath

Logger ID	NL2
Address	104 Greater Western Highway, Medlow Bath
Start date	Thursday, 3 December 2020
End date	Monday, 14 December
Noise logger type	Rion NL-42EX
Noise logger serial number	
Façade / Free field	Façade
Description	Ambient noise controlled by Great Western Highway

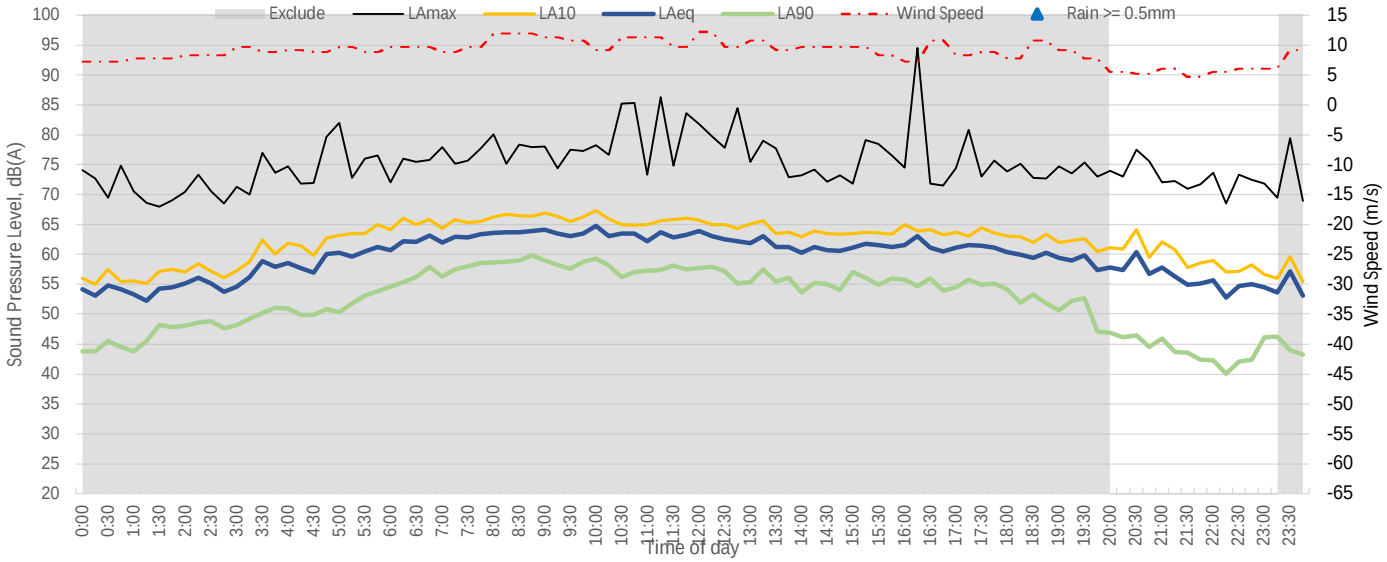
Date	$L_{Aeq,period}$, dBA			Ambient background level, dBA			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
Thursday, 3 December	-	59	58	-	40	26	61	58
Friday, 4 December	-	59	57	-	43	30	61	57
Saturday, 5 December	61	-	-	50	-	-	61	-
Sunday, 6 December	-	-	-	-	-	-	-	-
Monday, 7 December	-	-	-	-	-	-	57	-
Tuesday, 8 December	-	58	58	-	37	26	60	58
Wednesday, 9 December	61	59	58	50	40	27	61	58
Thursday, 10 December	62	60	59	51	43	34	62	59
Friday, 11 December	63	60	56	54	43	31	62	56
Saturday, 12 December	62	59	54	53	43	28	61	54
Sunday, 13 December	62	60	59	50	42	37	61	59
Monday, 14 December	-	-	-	-	-	-	65	-

Summary	Ambient noise level			Rating background level			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
	62	59	57	50	42	29	61	57

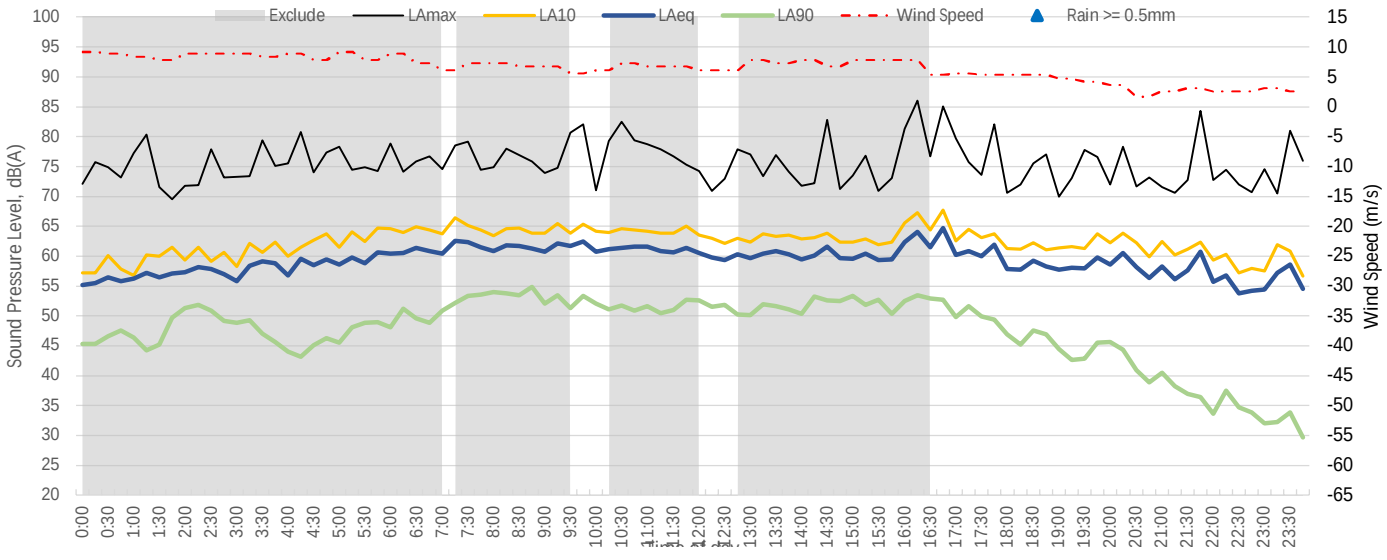
NL2 - Sunday, 6 December



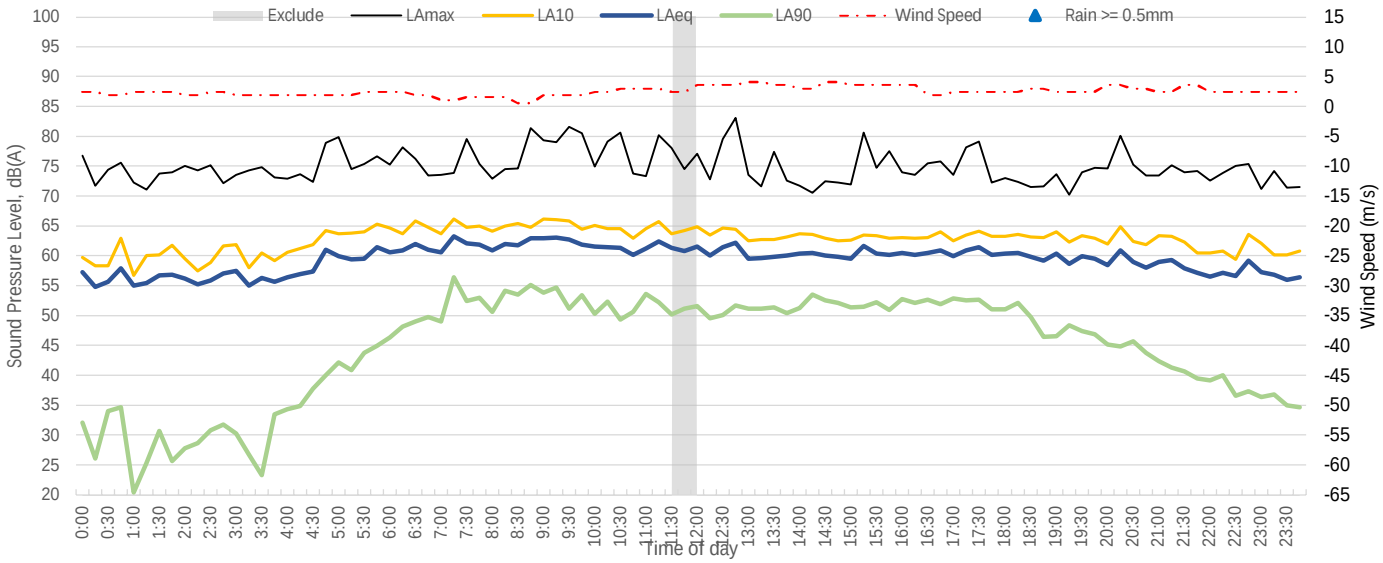
NL2 - Monday, 7 December



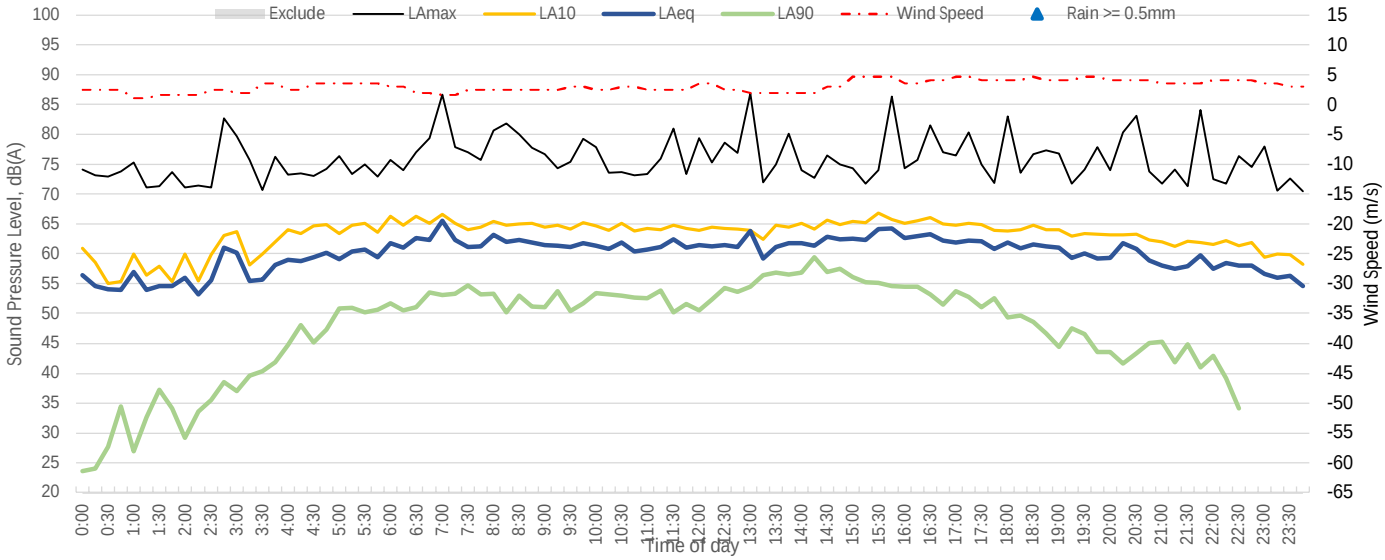
NL2 - Tuesday, 8 December



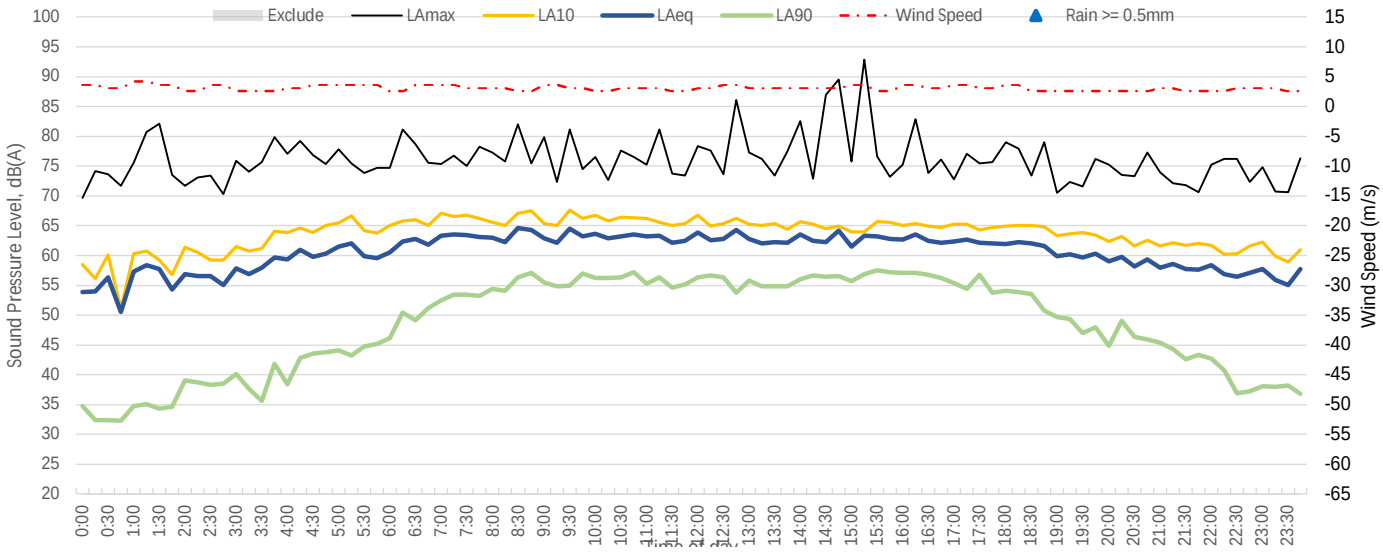
NL2 - Wednesday, 9 December

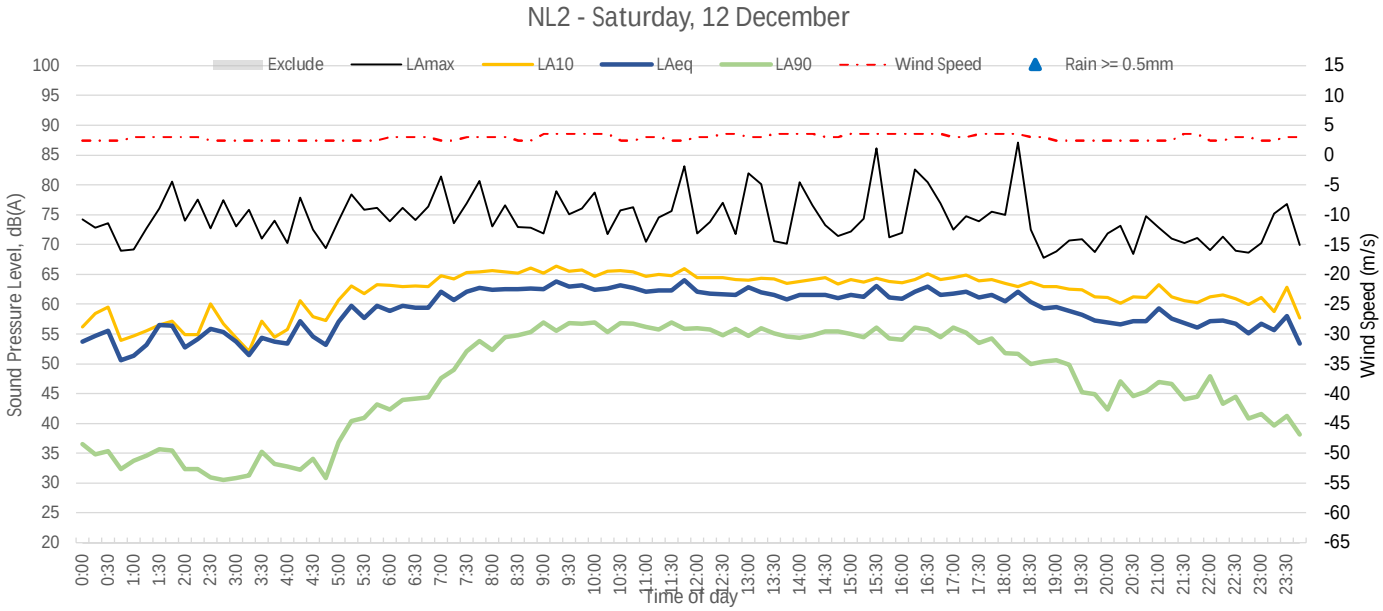


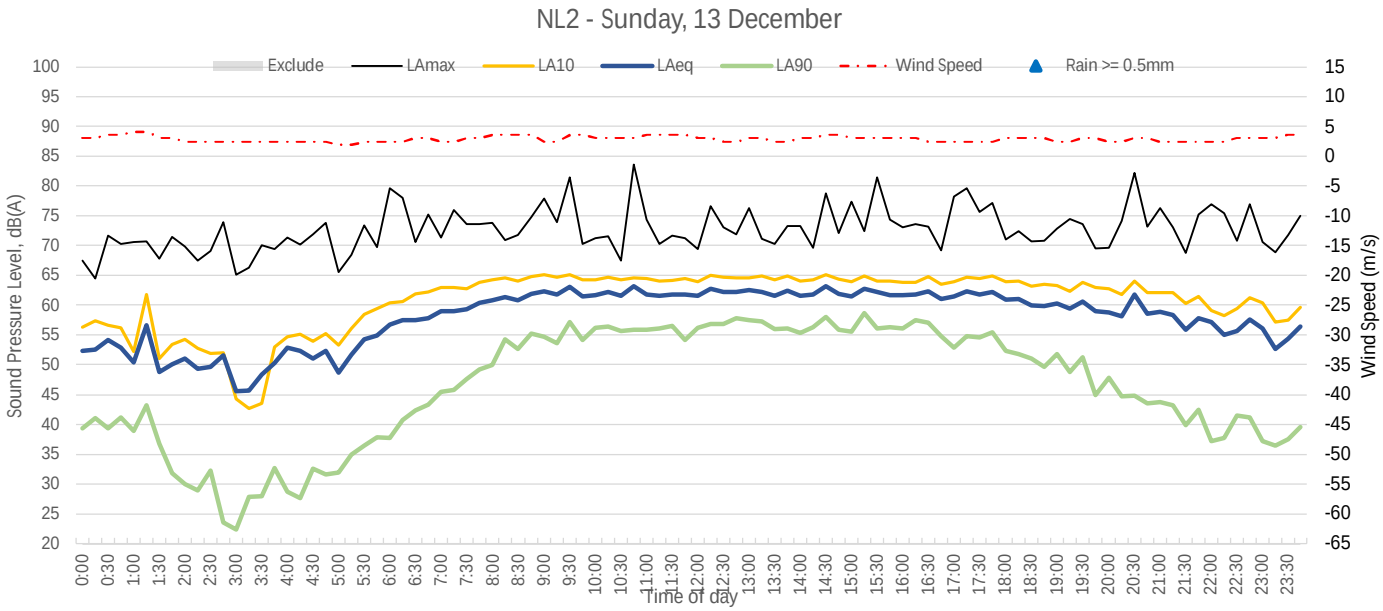
NL2 - Thursday, 10 December

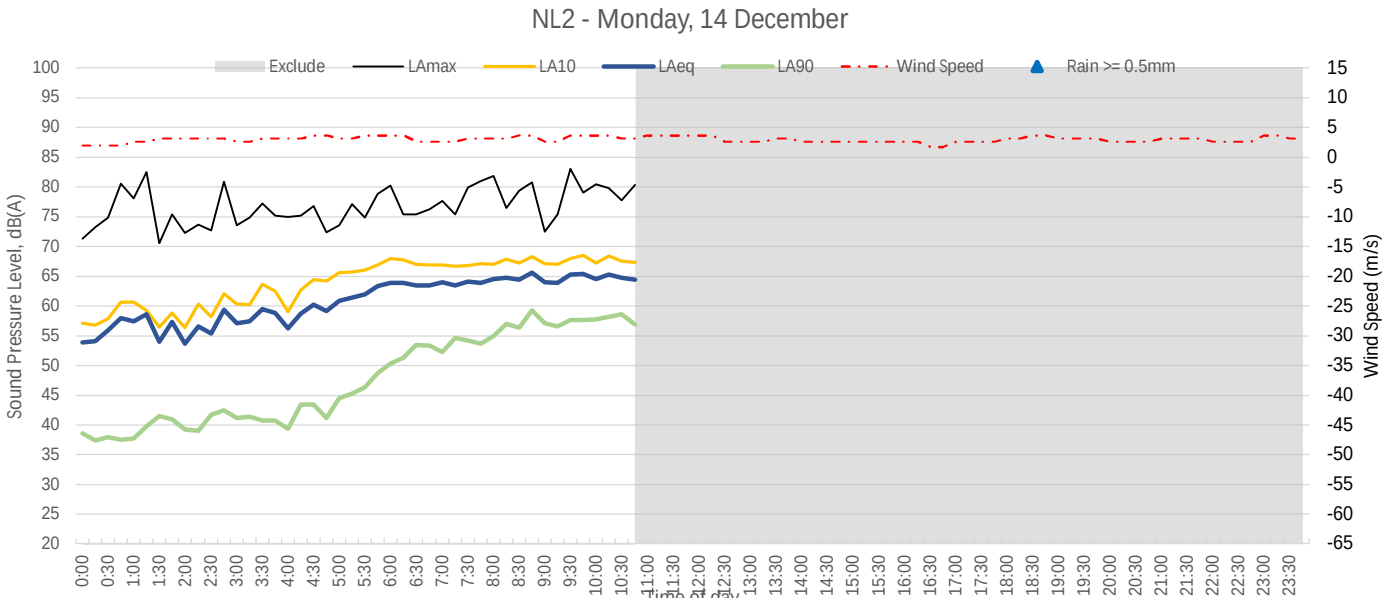


NL2 - Friday, 11 December




NL2 - Saturday, 12 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL2 - Sunday, 13 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL2 - Monday, 14 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)

Noise Logging Report

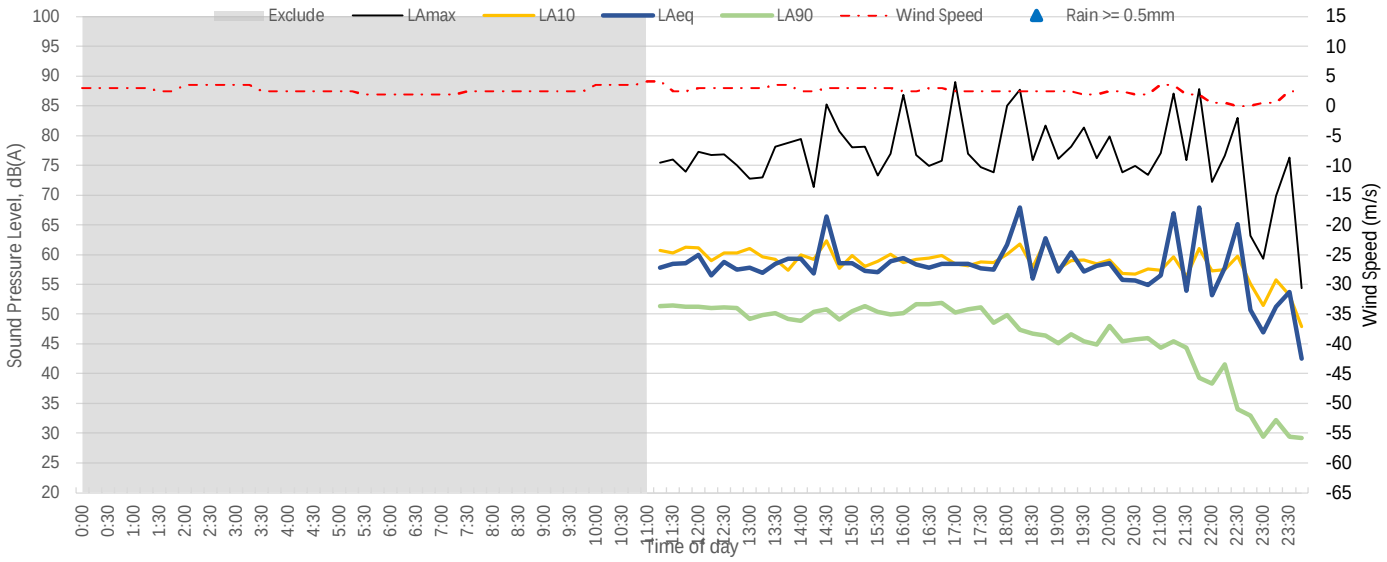
NL3 - 40 Railway Parade, Medlow Bath

Logger ID	NL3
Address	40 Railway Parade, Medlow Bath
Start date	Thursday, 3 December 2020
End date	Monday, 14 December
Noise logger type	ARL Ngara
Noise logger serial number	
Façade / Free field	Free field
Description	Ambient noise controlled by the Great Western Highway

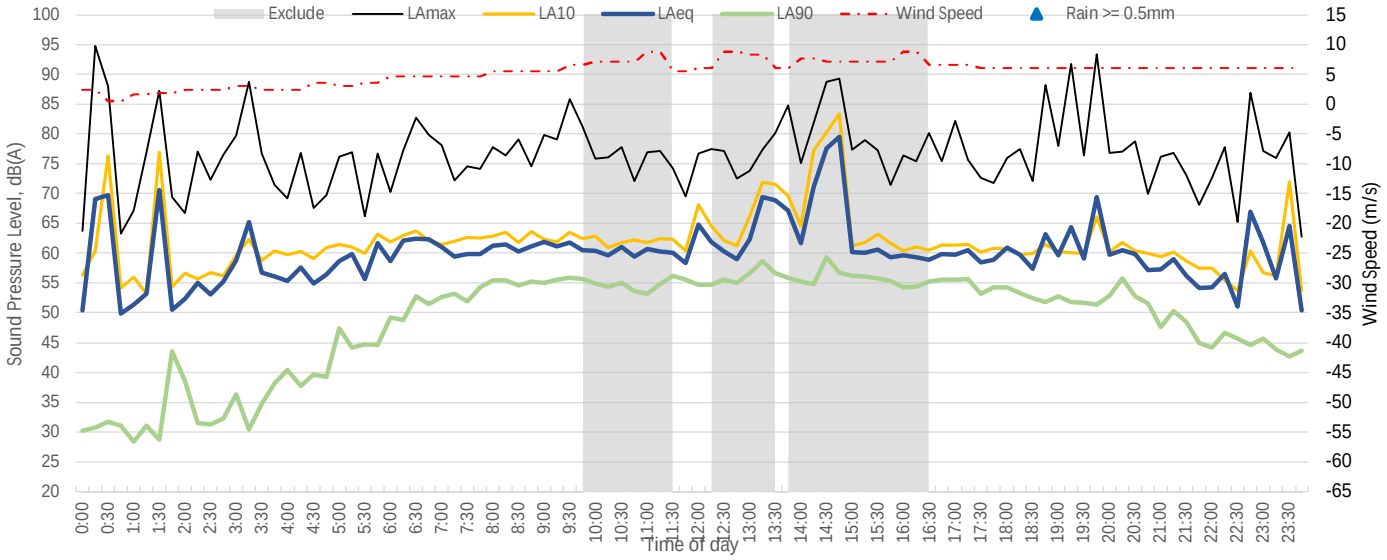
Date	$L_{Aeq,period}$, dBA			Ambient background level, dBA			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
Thursday, 3 December	-	62	62	-	43	29	60	62
Friday, 4 December	-	62	58	-	47	31	62	58
Saturday, 5 December	61	-	-	49	-	-	62	-
Sunday, 6 December	-	-	-	-	-	-	-	-
Monday, 7 December	-	-	-	-	-	-	62	-
Tuesday, 8 December	-	59	61	-	38	27	60	61
Wednesday, 9 December	59	58		49	0		58	
Thursday, 10 December								
Friday, 11 December								
Saturday, 12 December								
Sunday, 13 December								
Monday, 14 December								

Summary	Ambient noise level			Rating background level			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
	60	60	60	49	41	29	61	60

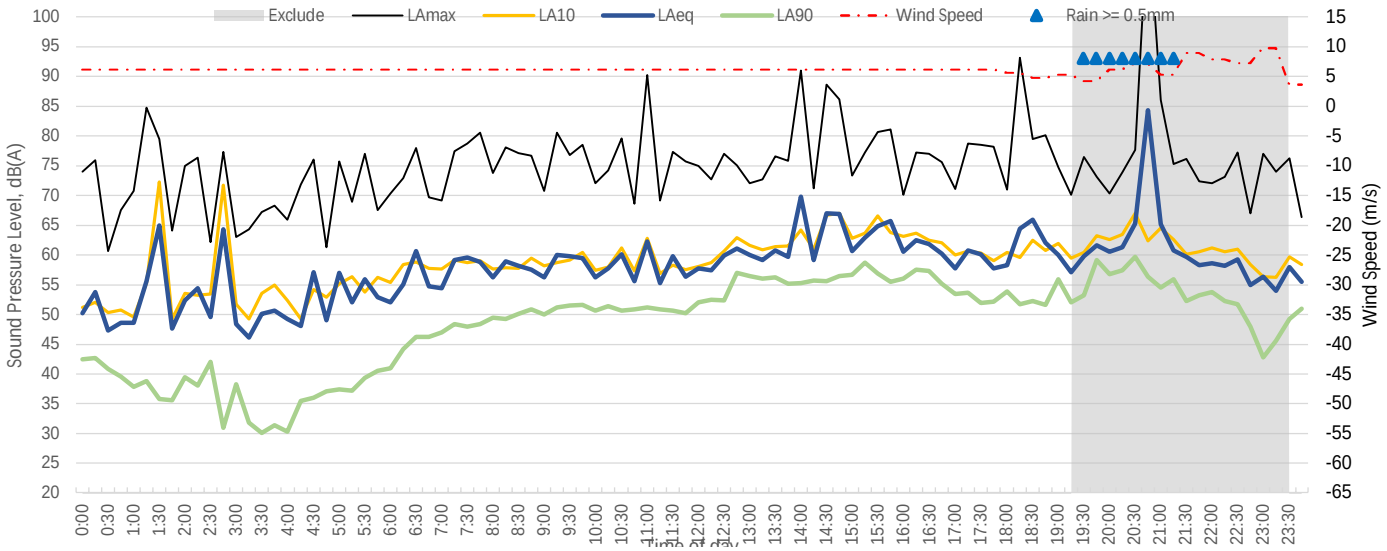
NL3 - Thursday, 3 December

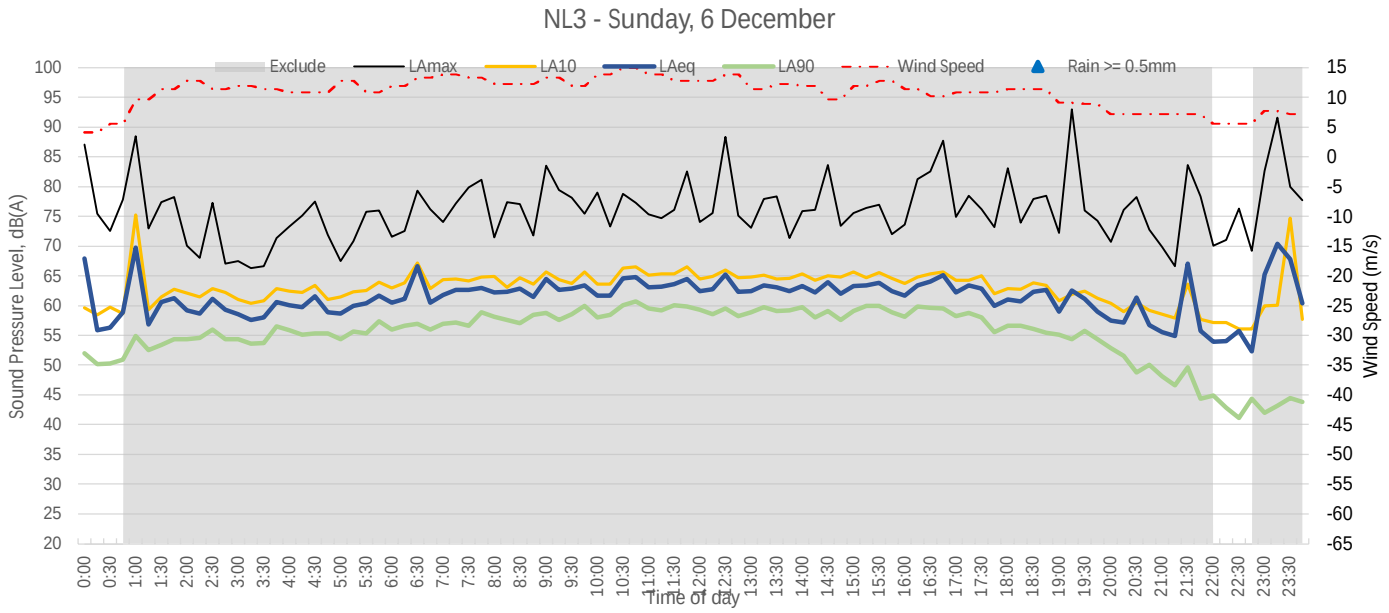


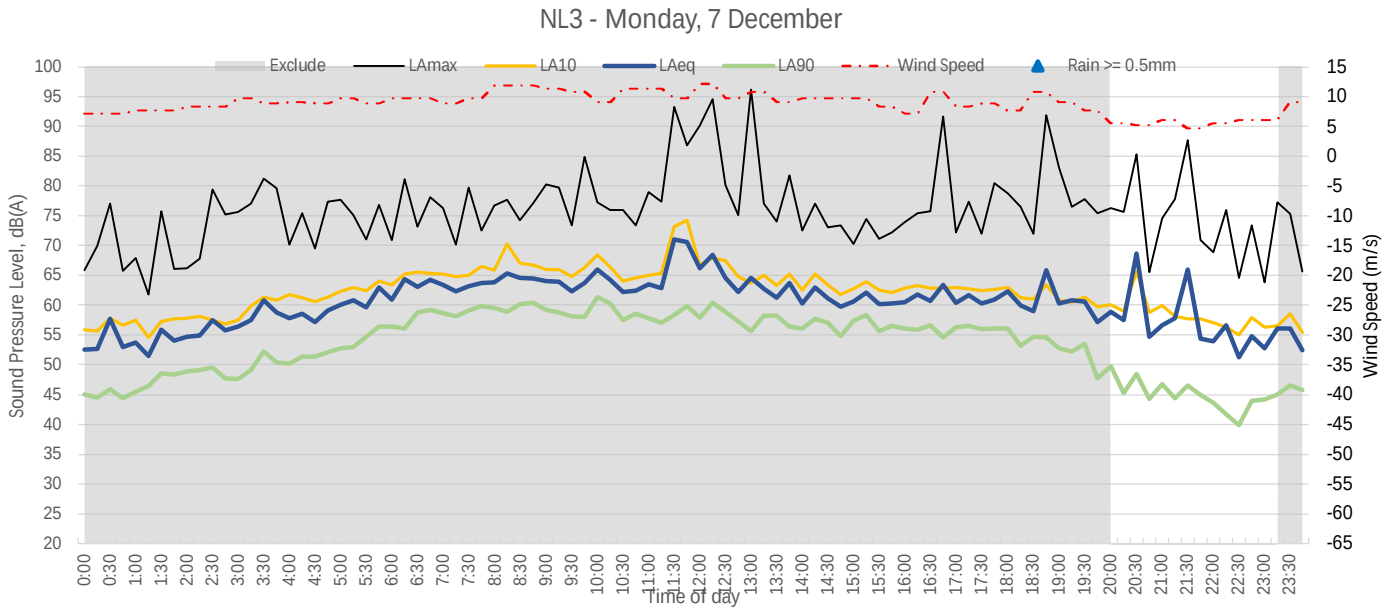
NL3 - Friday, 4 December

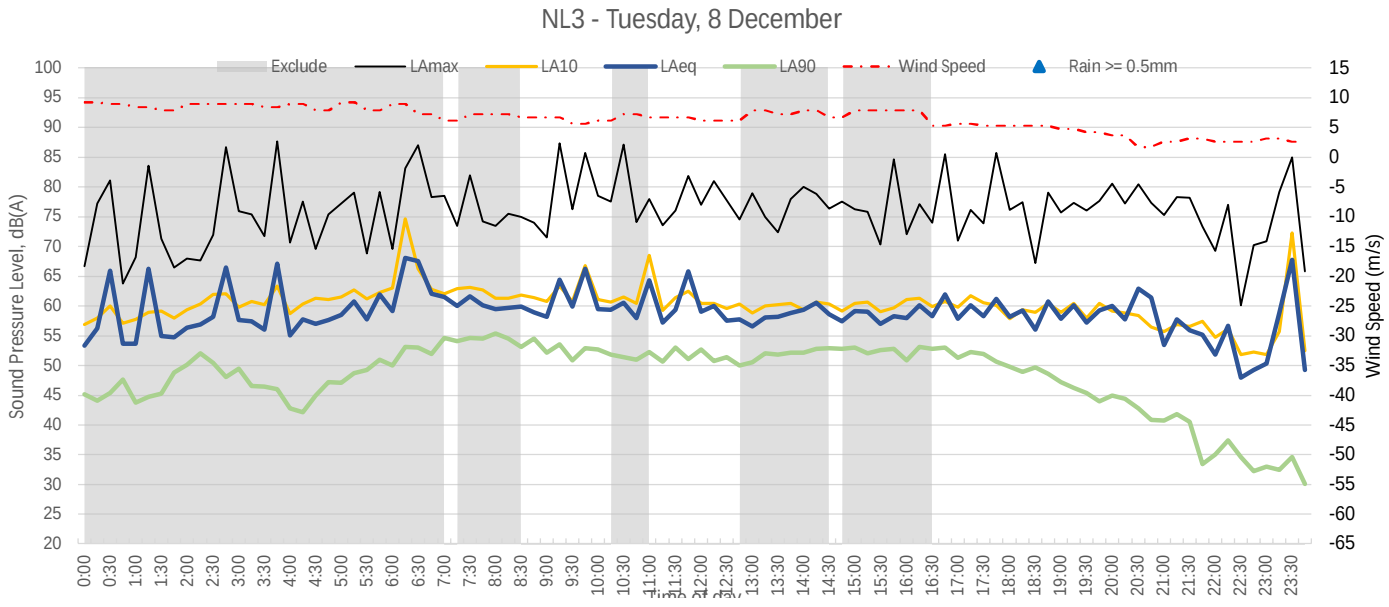


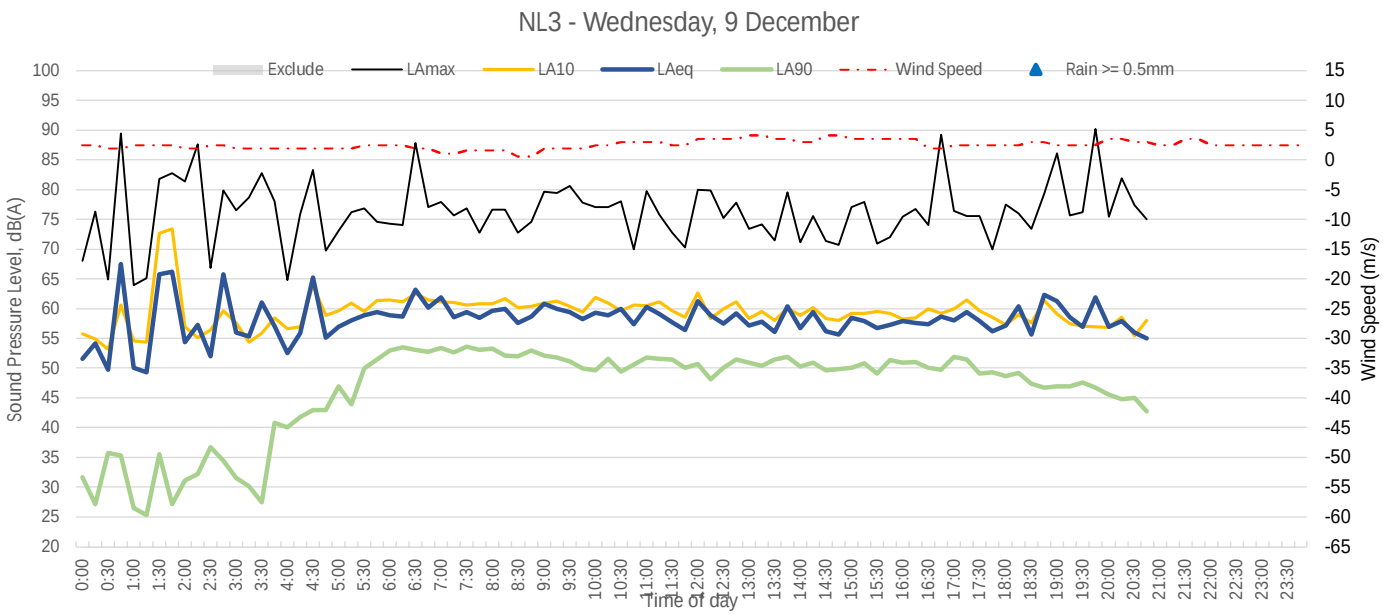
NL3 - Saturday, 5 December




NL3 - Sunday, 6 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL3 - Monday, 7 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL3 - Tuesday, 8 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)


NL3 - Wednesday, 9 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day

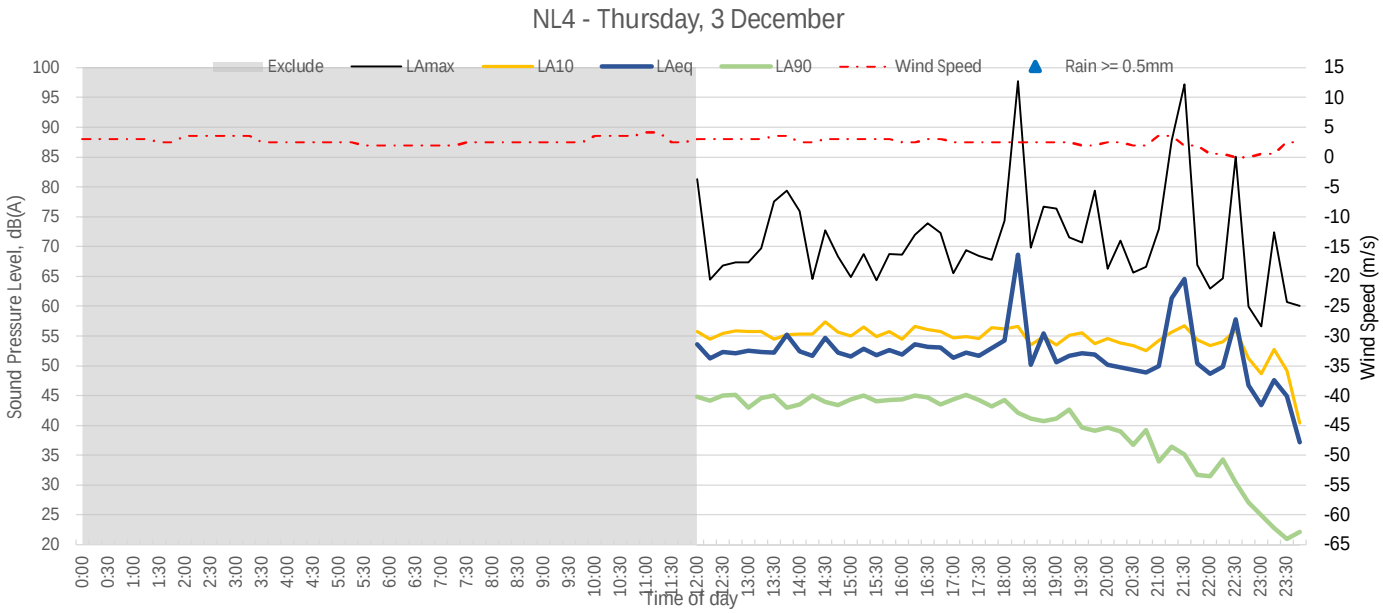
Noise Logging Report

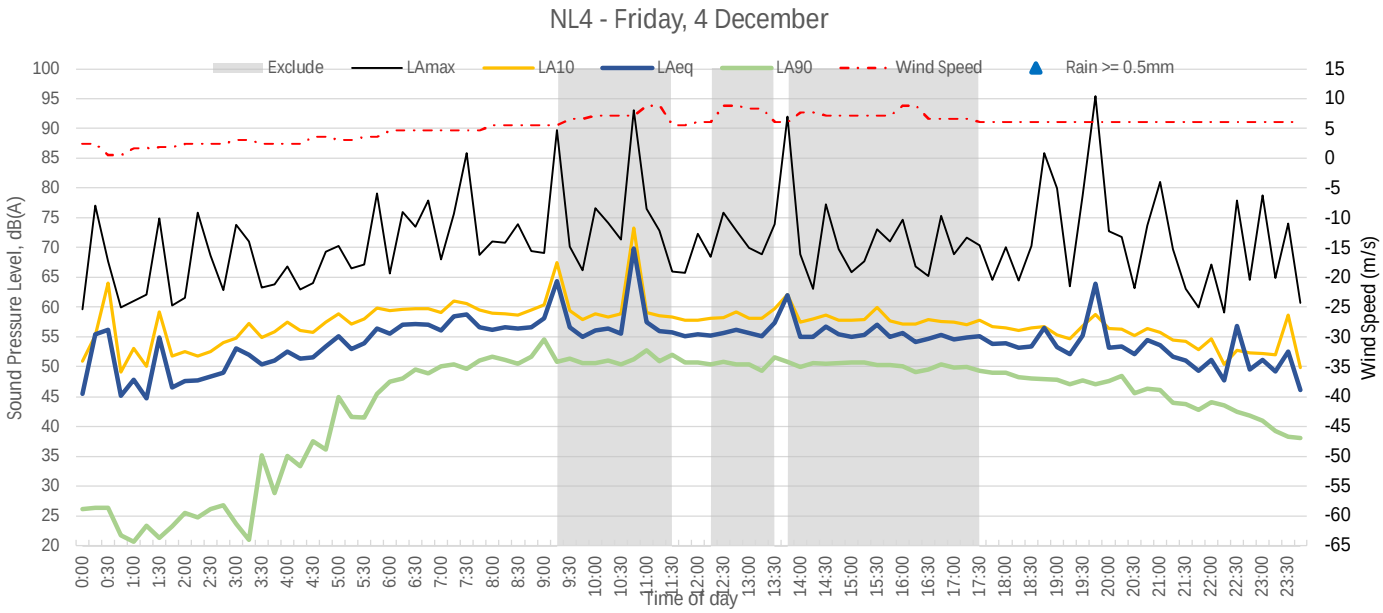
NL4 - 5 Railway Parade, Medlow Bath

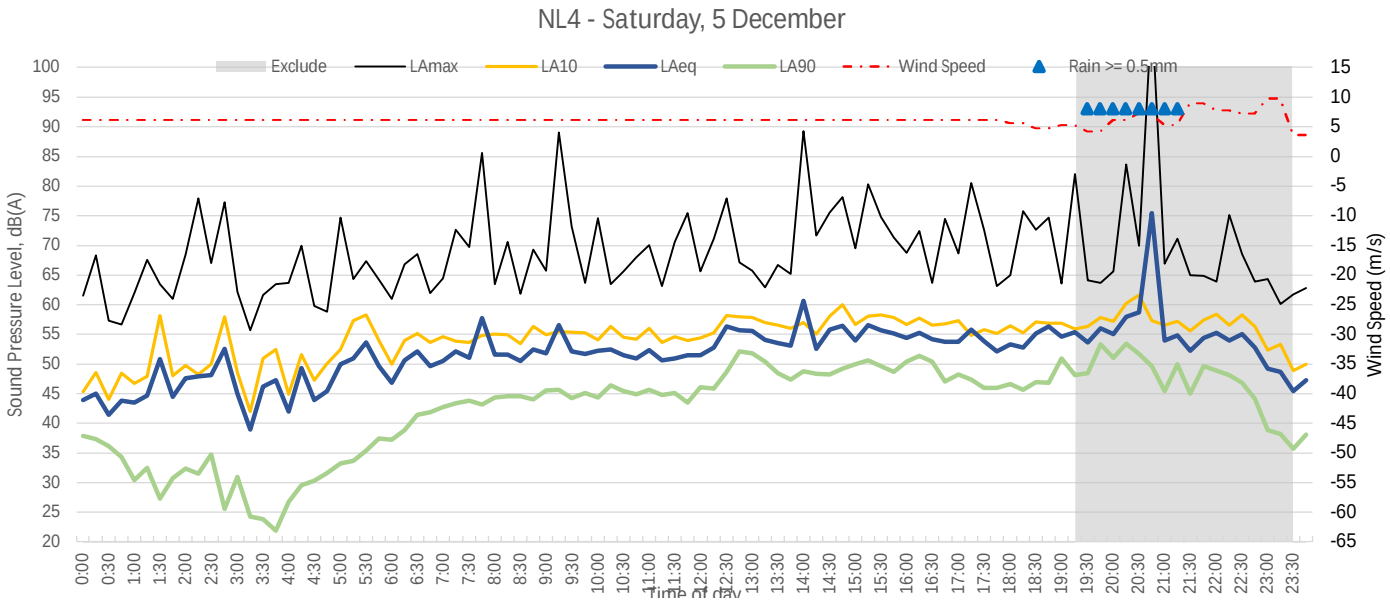
Logger ID	NL4
Address	5 Railway Parade, Medlow Bath
Start date	Thursday, 3 December 2020
End date	Monday, 14 December
Noise logger type	Rion NL-42EX
Noise logger serial number	
Façade / Free field	Free field
Description	Ambient noise controlled by Great Western Highway

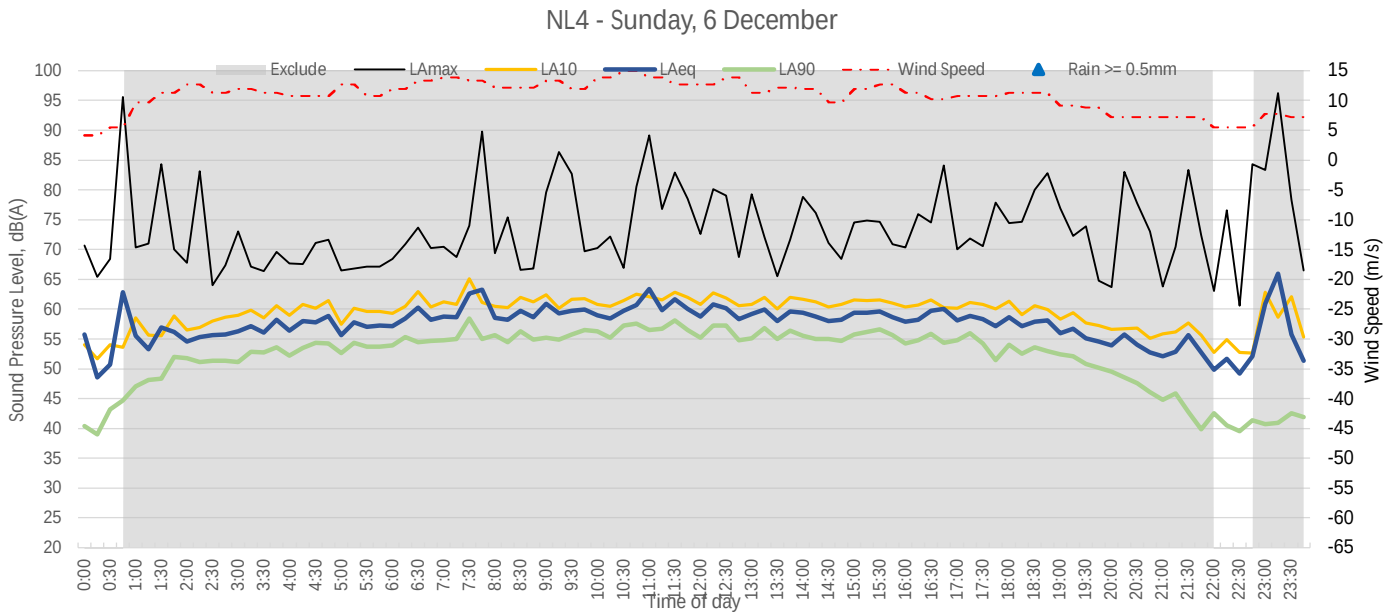
Date	$L_{Aeq,period}$, dBA			Ambient background level, dBA			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
Thursday, 3 December	-	59	53	-	33	21	57	53
Friday, 4 December	-	56	49	-	44	25	57	49
Saturday, 5 December	54	-	-	44	-	-	54	-
Sunday, 6 December	-	-	-	-	-	-	-	-
Monday, 7 December	-	-	-	-	-	-	56	-
Tuesday, 8 December	-	53	55	-	34	23	54	55
Wednesday, 9 December	54	52	52	43	39	23	54	52
Thursday, 10 December	54	56	54	46	44	33	55	54
Friday, 11 December	56	56	50	49	43	28	56	50
Saturday, 12 December	55	52	49	47	43	23	54	49
Sunday, 13 December	54	55	51	46	39	35	54	51
Monday, 14 December	-	-	-	-	-	-	56	-

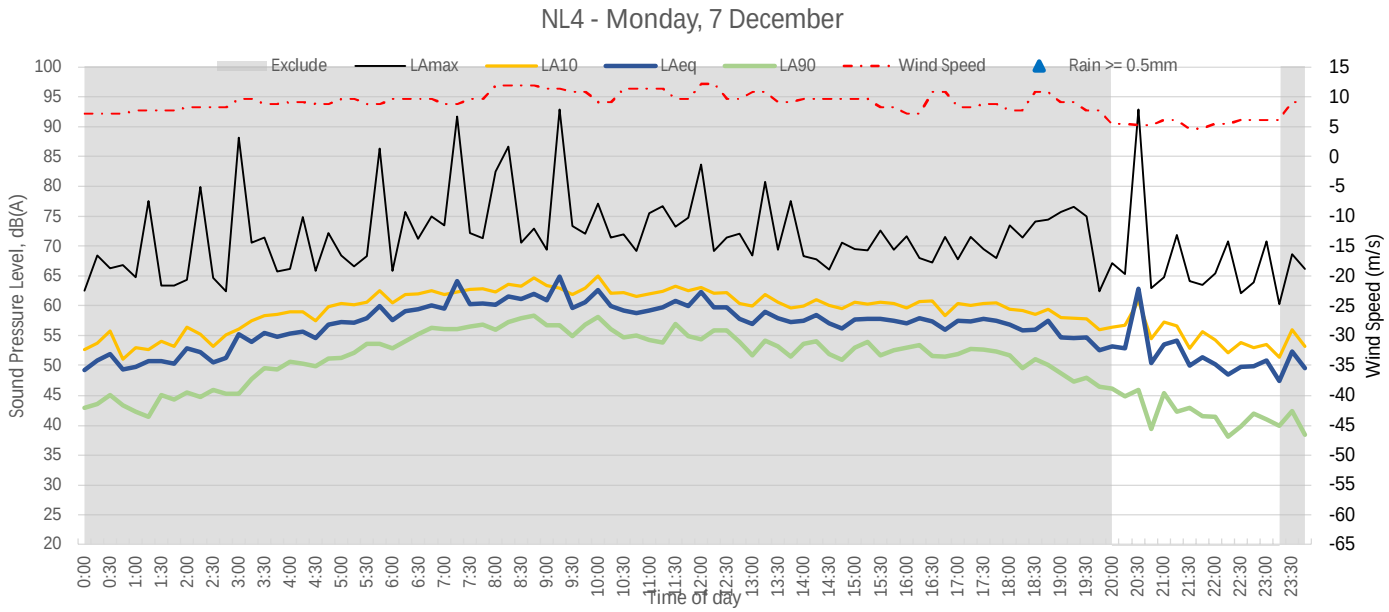
Summary	Ambient noise level			Rating background level			Road traffic levels	
	Daytime	Evening	Night-time	Daytime	Evening	Night-time	$L_{Aeq,15hour}$	$L_{Aeq,9hour}$
	54	55	52	46	41	24	55	52

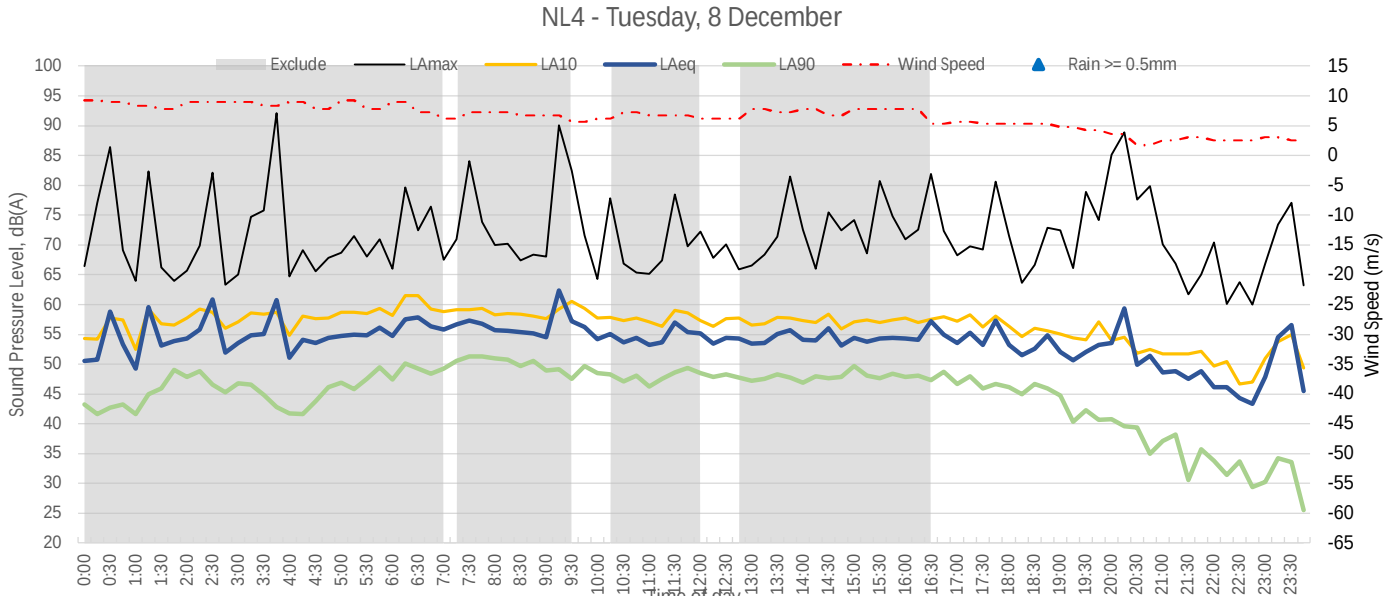

NL4 - Thursday, 3 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL4 - Friday, 4 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day

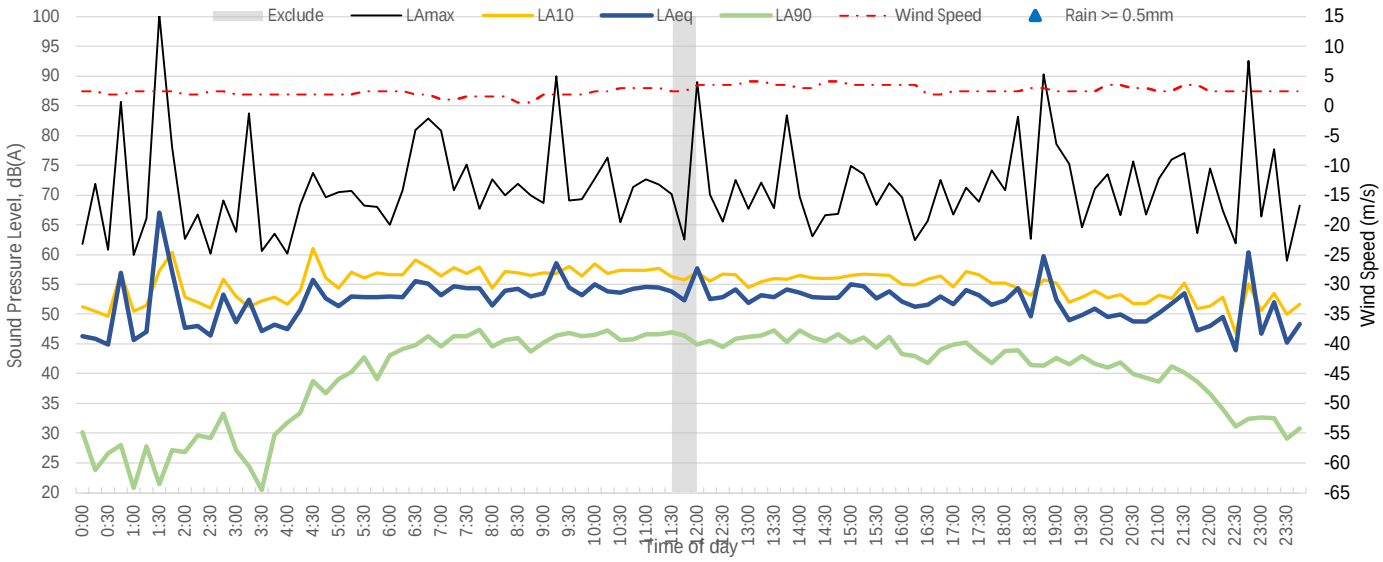

NL4 - Saturday, 5 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL4 - Sunday, 6 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day

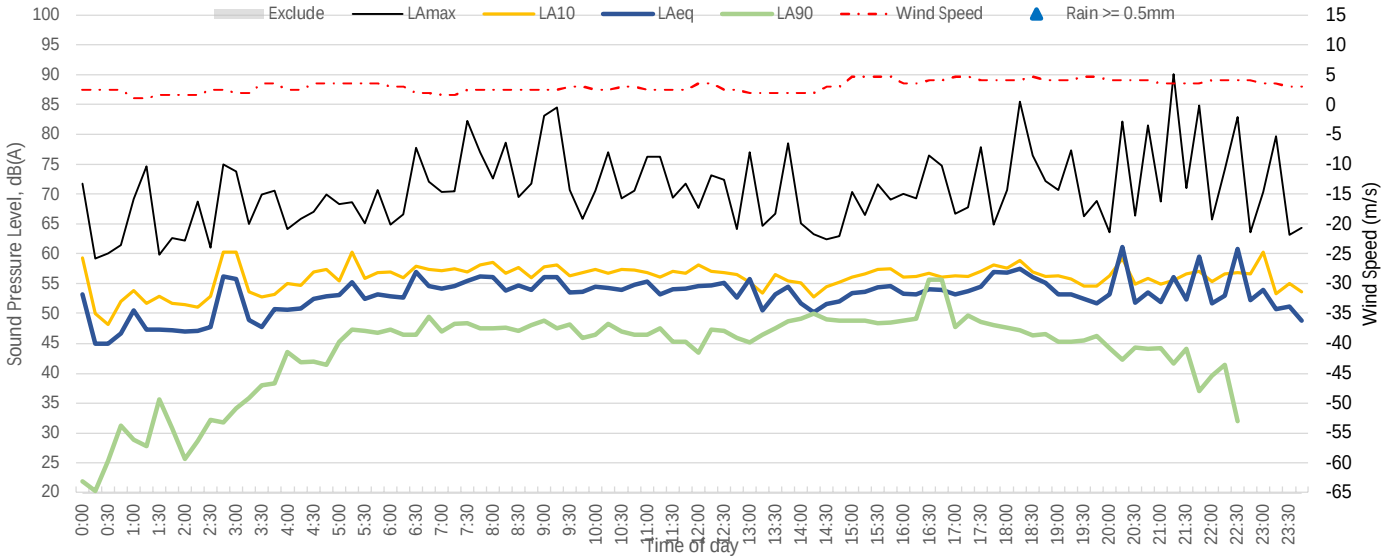

NL4 - Monday, 7 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL4 - Tuesday, 8 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)

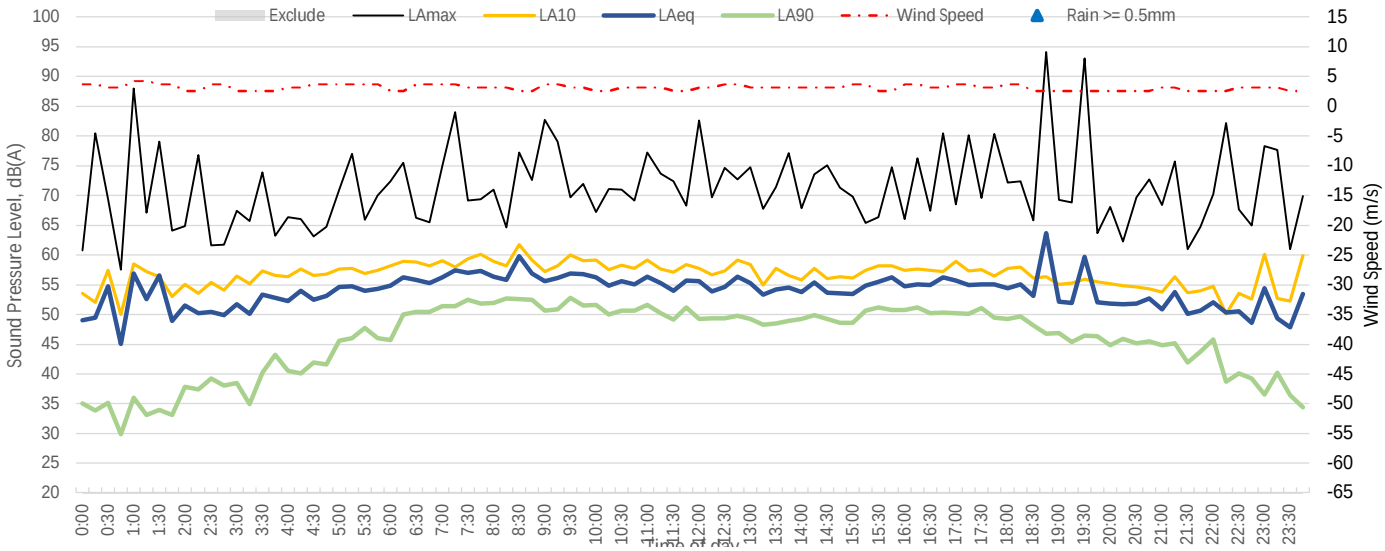
NL4 - Wednesday, 9 December

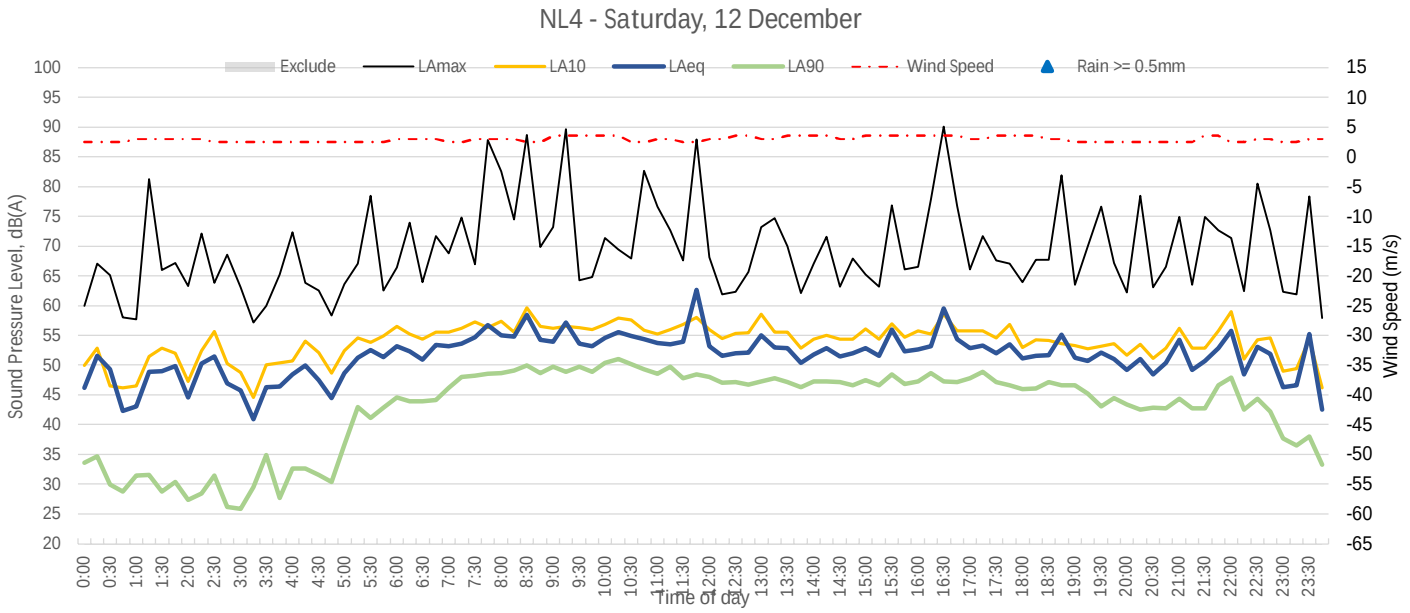


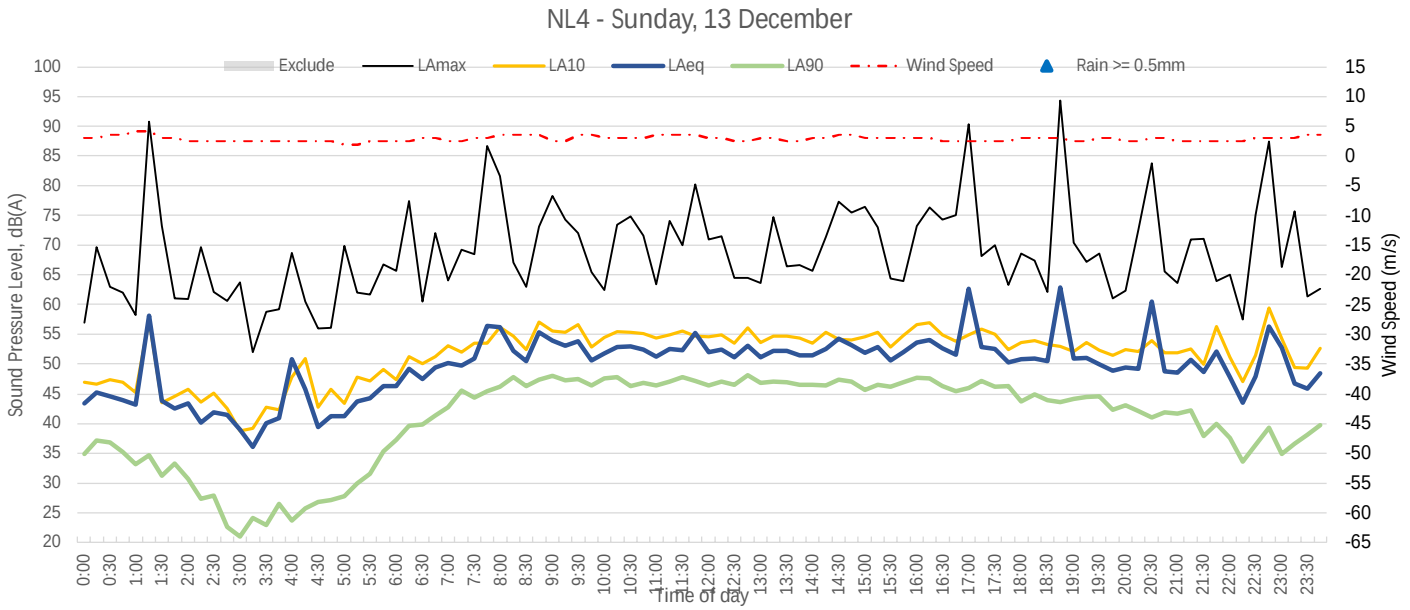
NL4 - Thursday, 10 December

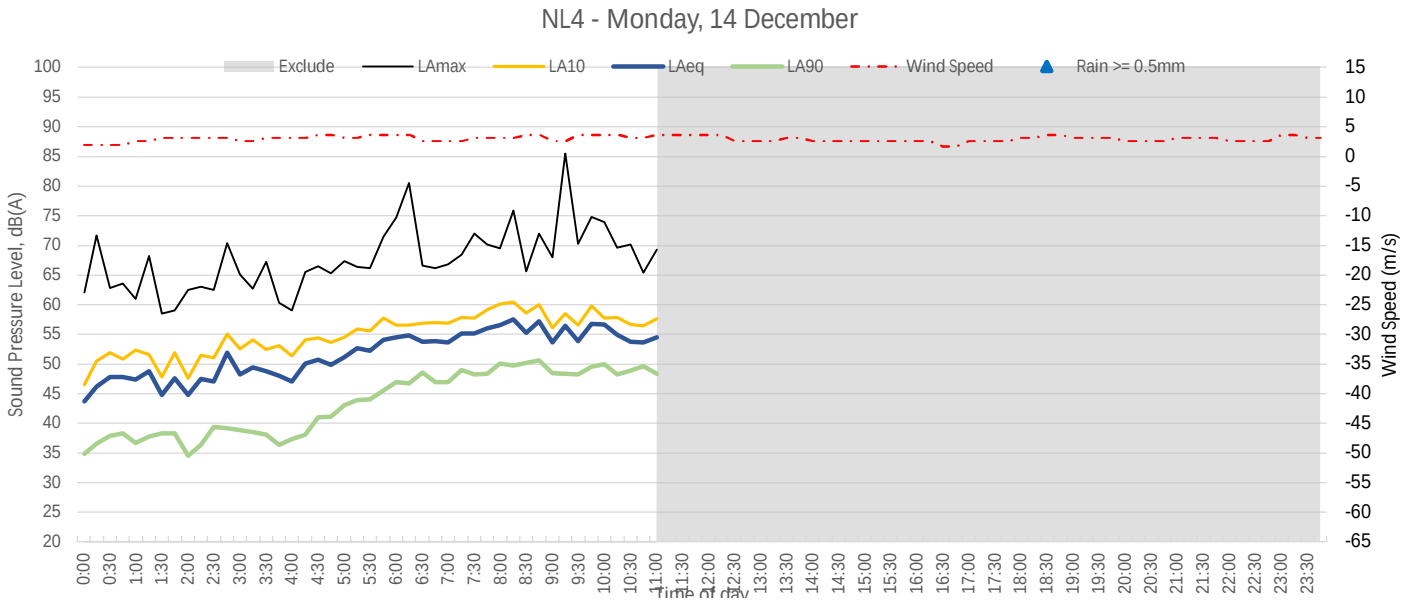


NL4 - Friday, 11 December




NL4 - Saturday, 12 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL4 - Sunday, 13 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day


NL4 - Monday, 14 December
Exclude
LAmax
LA10
LAeq
LA90
Wind Speed
Rain >= 0.5mm
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time of day

C. Traffic Volumes

Road traffic volumes have been categorised in accordance with the six-category approach. Provided below in Table 33 is a table comparing the six-category classification to the Austroads vehicle classification.

Table 33 Vehicle classification comparison

Six-category classification	Austroads classification	Vehicle type
LV	Class 1, Class 2	Light vehicles
HV1	Class 3	2 axle rigid trucks
HV2	Class 4, Class 5	3, 4 axle rigid trucks
HV3	Class 6, Class 7, Class 8	3, 4, 5 axle articulated trucks
HV4	Class 9	6 axle articulated trucks
HV5	Class 10	9 axle B-doubles, heavy truck and trailer
HV6	Class 11, Class 12	12 axle B-triples, road trains or equivalent

Provided below in Table 34 and Table 35 are summaries of the road traffic volumes used in this assessment.

Table 34 Daytime (7am to 10pm) traffic volumes

Scenario	LV	HV1	HV2	HV3	HV4	HV5	HV6
Year 2021	15220	1039	923	137	281	165	39
Year 2026 No Build	16163	1931	135	209	576	282	5
Year 2026 Build	16163	1931	135	209	576	282	5
Year 2036 No Build	17040	2317	162	237	652	320	5
Year 2036 Build	19613	2207	154	205	564	277	5

Table 35 Night-time (10pm to 7am) traffic volumes

Scenario	LV	HV1	HV2	HV3	HV4	HV5	HV6
Year 2021	1111	249	40	47	256	107	1
Year 2026 No Build	1150	262	43	49	258	107	1
Year 2026 Build	1150	262	43	49	258	107	1
Year 2036 No Build	1212	315	42	55	293	121	1
Year 2036 Build	1169	270	45	55	289	120	1

C. Traffic Volumes

Road traffic volumes have been categorised in accordance with the six-category approach. Provided below in Table 33 is a table comparing the six-category classification to the Austroads vehicle classification.

Table 34 Vehicle classification comparison

Six-category classification	Austroads classification	Vehicle type
LV	Class 1, Class 2	Light vehicles
HV1	Class 3	2 axle rigid trucks
HV2	Class 4, Class 5	3, 4 axle rigid trucks
HV3	Class 6, Class 7, Class 8	3, 4, 5 axle articulated trucks
HV4	Class 9	6 axle articulated trucks
HV5	Class 10	9 axle B-doubles, heavy truck and trailer
HV6	Class 11, Class 12	12 axle B-triples, road trains or equivalent

Provided below in Table 34 and Table 35 are summaries of the road traffic volumes used in this assessment.

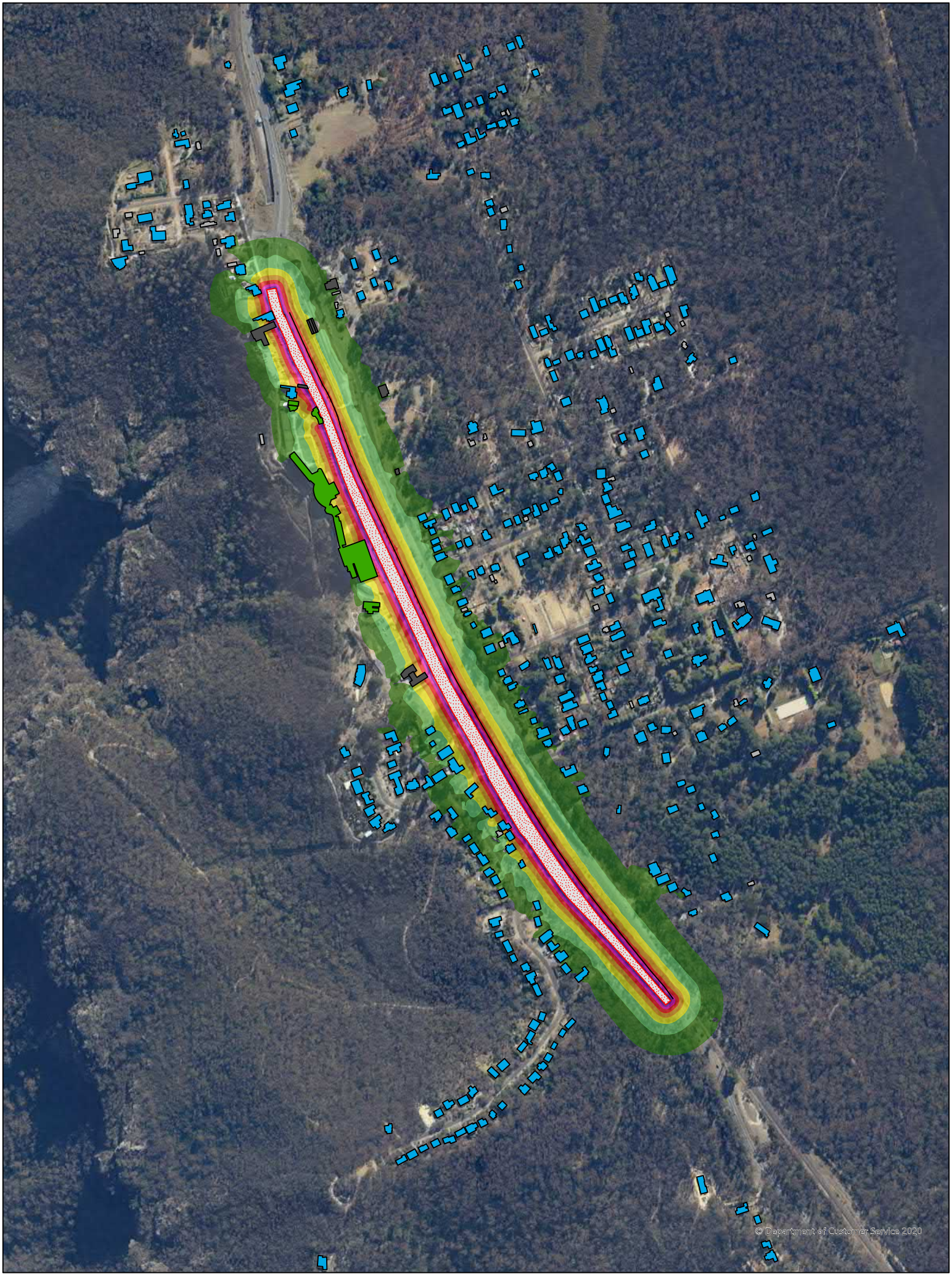
Table 35 Daytime (7am to 10pm) traffic volumes

Scenario	LV	HV1	HV2	HV3	HV4	HV5	HV6
Year 2021	15220	1039	923	137	281	165	39
Year 2026 No Build	16163	1931	135	209	576	282	5
Year 2026 Build	16163	1931	135	209	576	282	5
Year 2036 No Build	17040	2317	162	237	652	320	5
Year 2036 Build	19613	2207	154	205	564	277	5

Table 36 Night-time (10pm to 7am) traffic volumes

Scenario	LV	HV1	HV2	HV3	HV4	HV5	HV6
Year 2021	1111	249	40	47	256	107	1
Year 2026 No Build	1150	262	43	49	258	107	1
Year 2026 Build	1150	262	43	49	258	107	1
Year 2036 No Build	1212	315	42	55	293	121	1
Year 2036 Build	1169	270	45	55	289	120	1

D. Construction noise contour results



Datum: MGA Zone 56

Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Northbound Lanes Construction Area
Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$
50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
65-70 dB(A)
70-75 dB(A)
75-80 dB(A)
80-85 dB(A)
>85 dB(A)

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Predicted Construction Noise Levels - Northbound lanes – Road Furniture Installation Scenario

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Datum: MGA Zone 56

Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Northbound Lanes Construction Area
Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$

50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
65-70 dB(A)
70-75 dB(A)
75-80 dB(A)
80-85 dB(A)
>85 dB(A)

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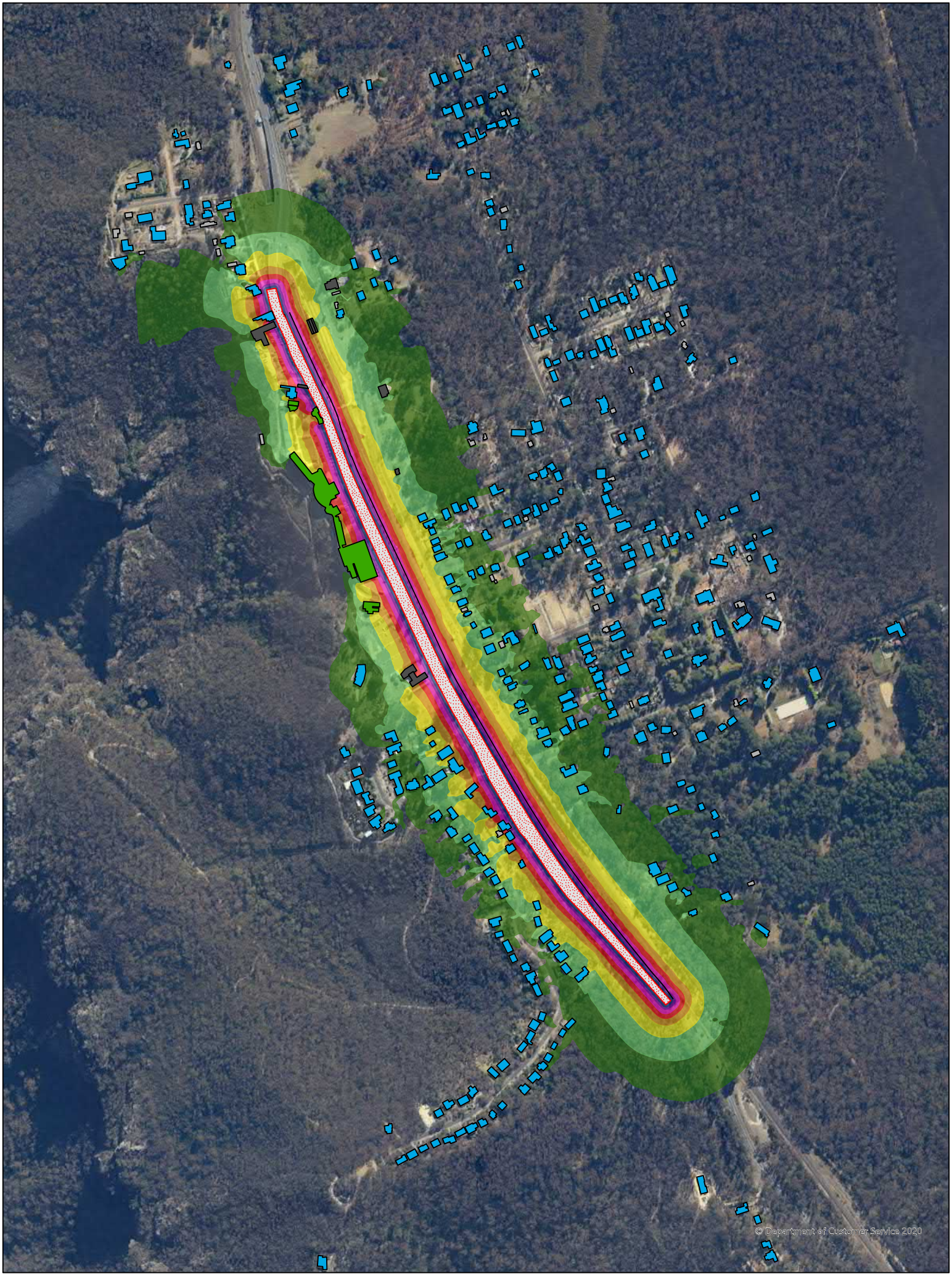
Predicted Construction Noise Levels - Northbound lanes – Mobilisation and Site Establishment / Drainage Infrastructure Scenario

MOTT MACDONALD



Datum: MGA Zone 56

Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Northbound Lanes Construction Area
Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$

50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
65-70 dB(A)
70-75 dB(A)
75-80 dB(A)
80-85 dB(A)
>85 dB(A)

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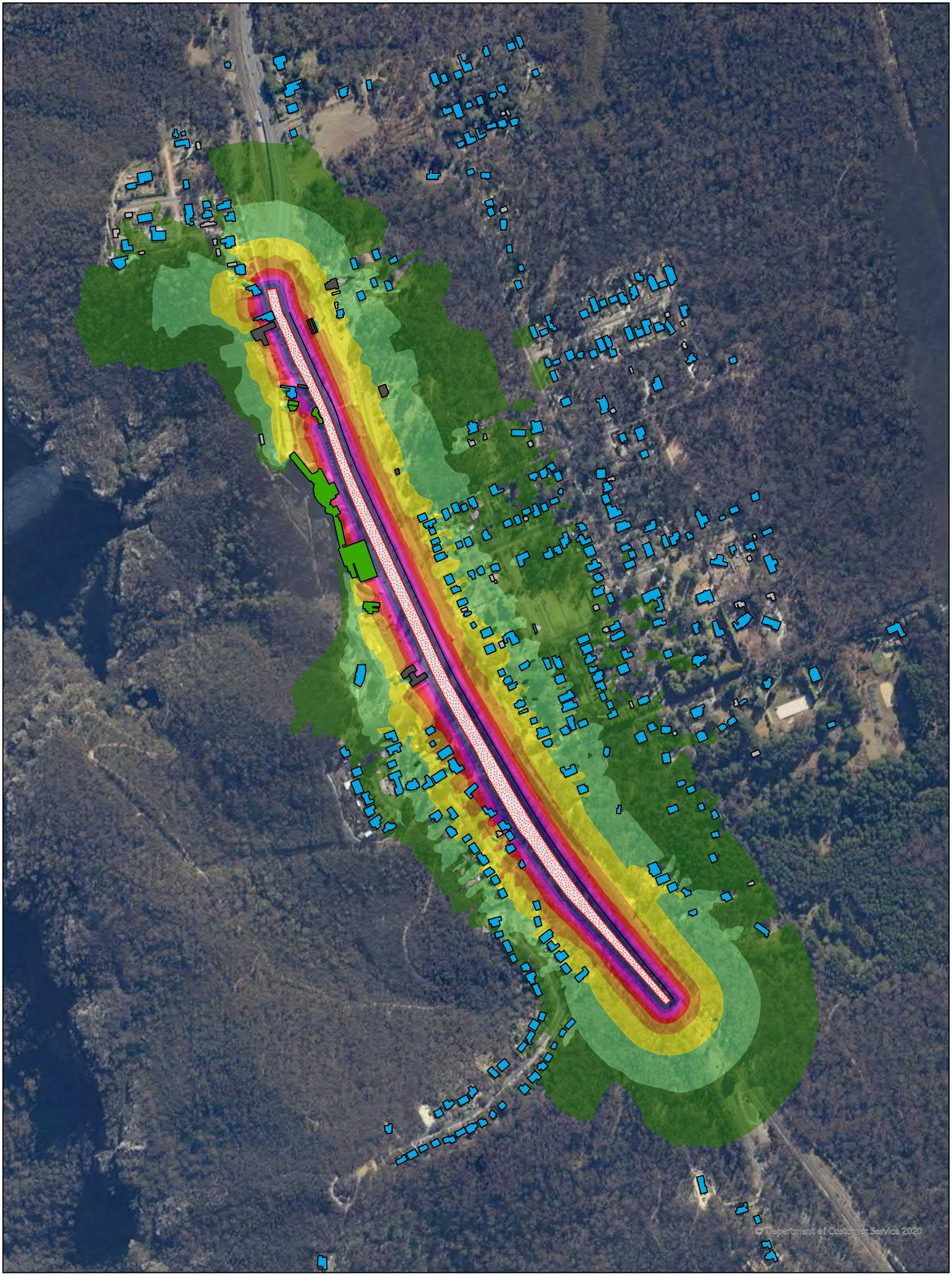
Predicted Construction Noise Levels - Northbound lanes – Utility Property and Service Adjustment Scenario

MOTT MACDONALD



Datum: MGA Zone 56

Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Northbound Lanes Construction Area
Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$
50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
65-70 dB(A)
70-75 dB(A)
75-80 dB(A)
80-85 dB(A)
>85 dB(A)

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Predicted Construction Noise Levels - Northbound lanes – Road Surfacing Works Scenario

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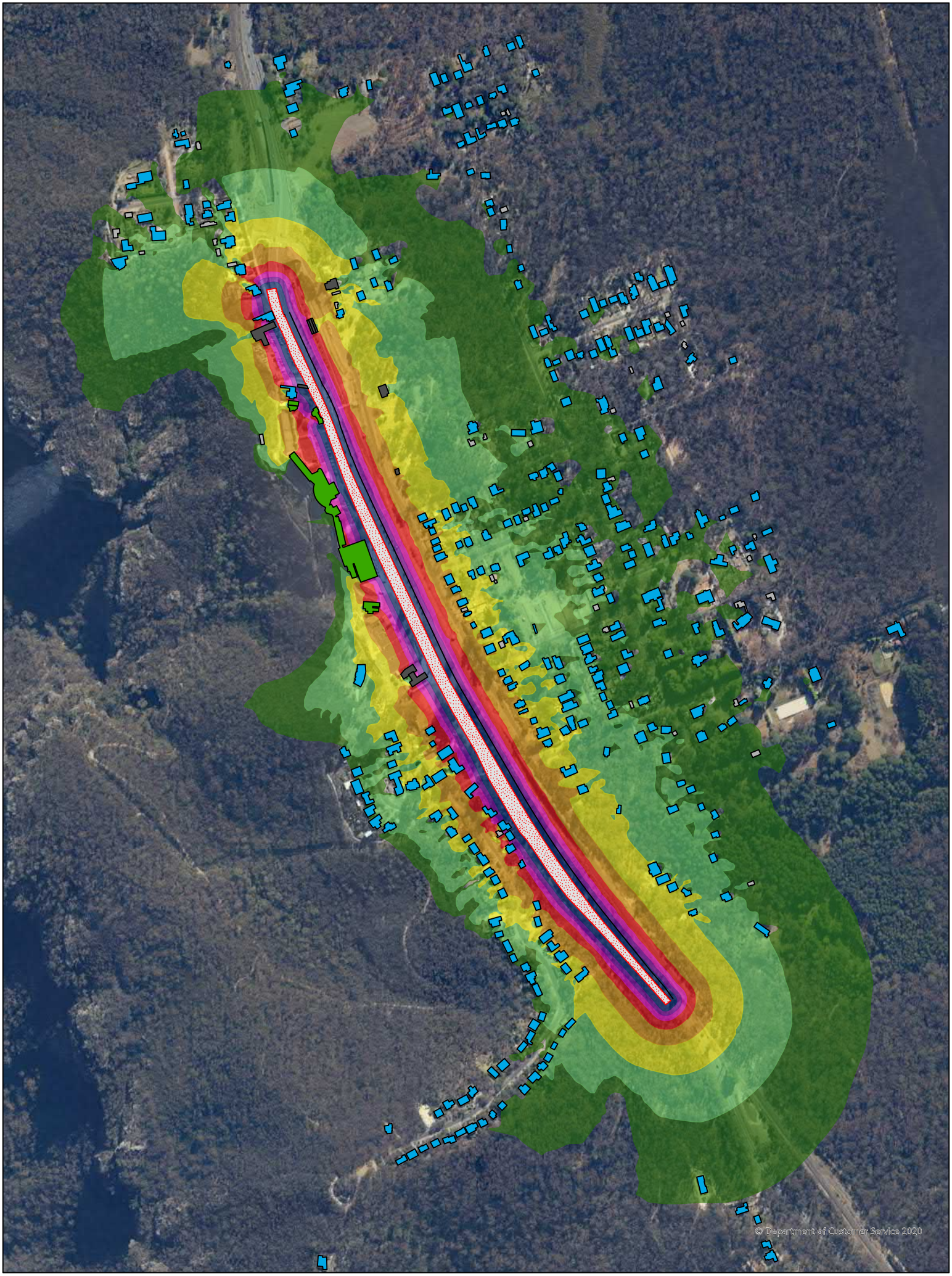

Datum: MGA Zone 56

Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Northbound Lanes Construction Area
Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$
50-55 dB(A)
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60-65 dB(A)
65-70 dB(A)
70-75 dB(A)
75-80 dB(A)
80-85 dB(A)
>85 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Construction Noise Levels - Northbound lanes – Corridor clearing / Bulk Earthworks Scenario

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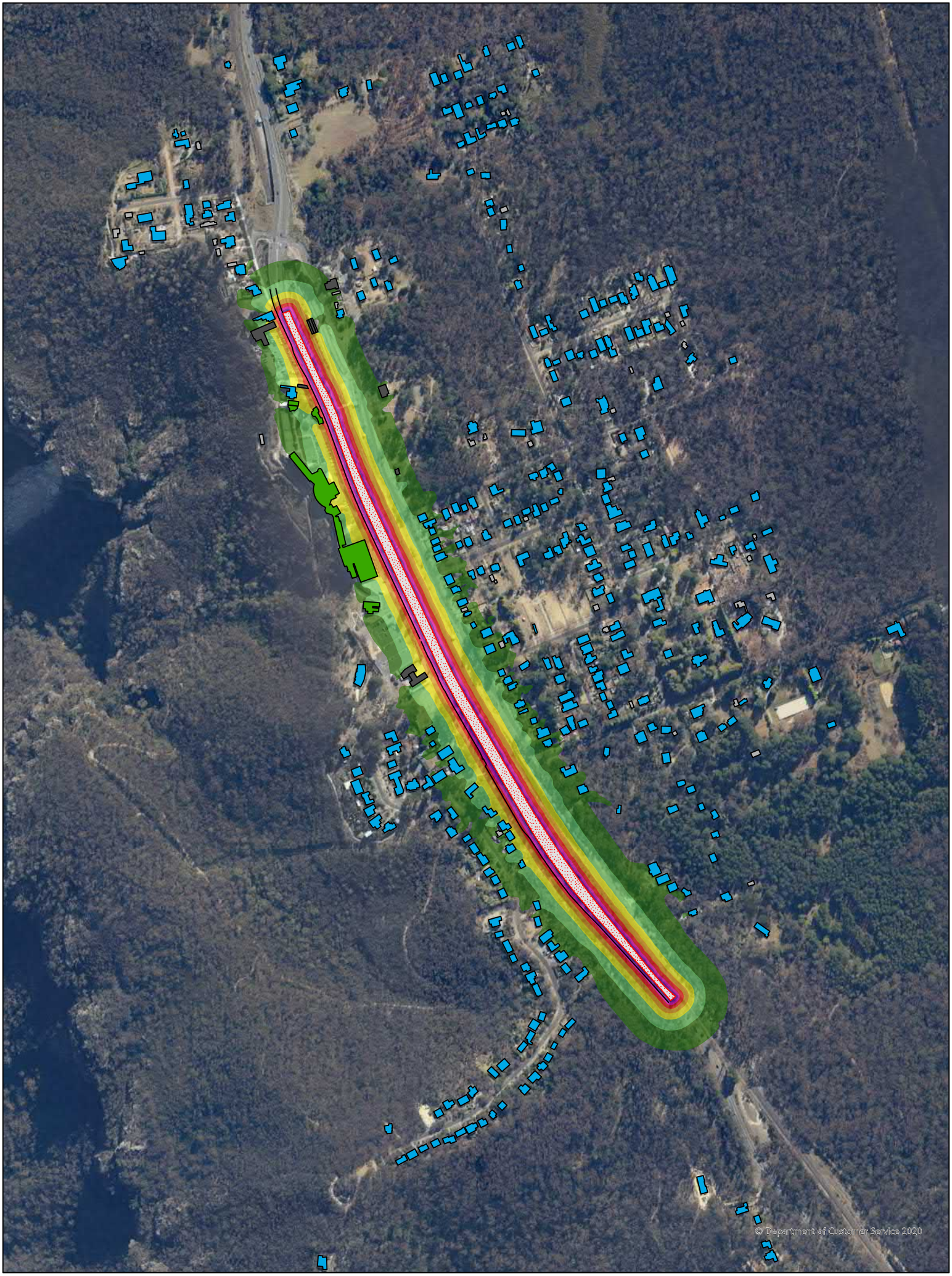

Datum: MGA Zone 56

Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Southbound Lanes Construction Area
Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$

50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
65-70 dB(A)
70-75 dB(A)
75-80 dB(A)
80-85 dB(A)
>85 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Construction Noise Levels - Southbound lanes – Road Furniture Installation Scenario

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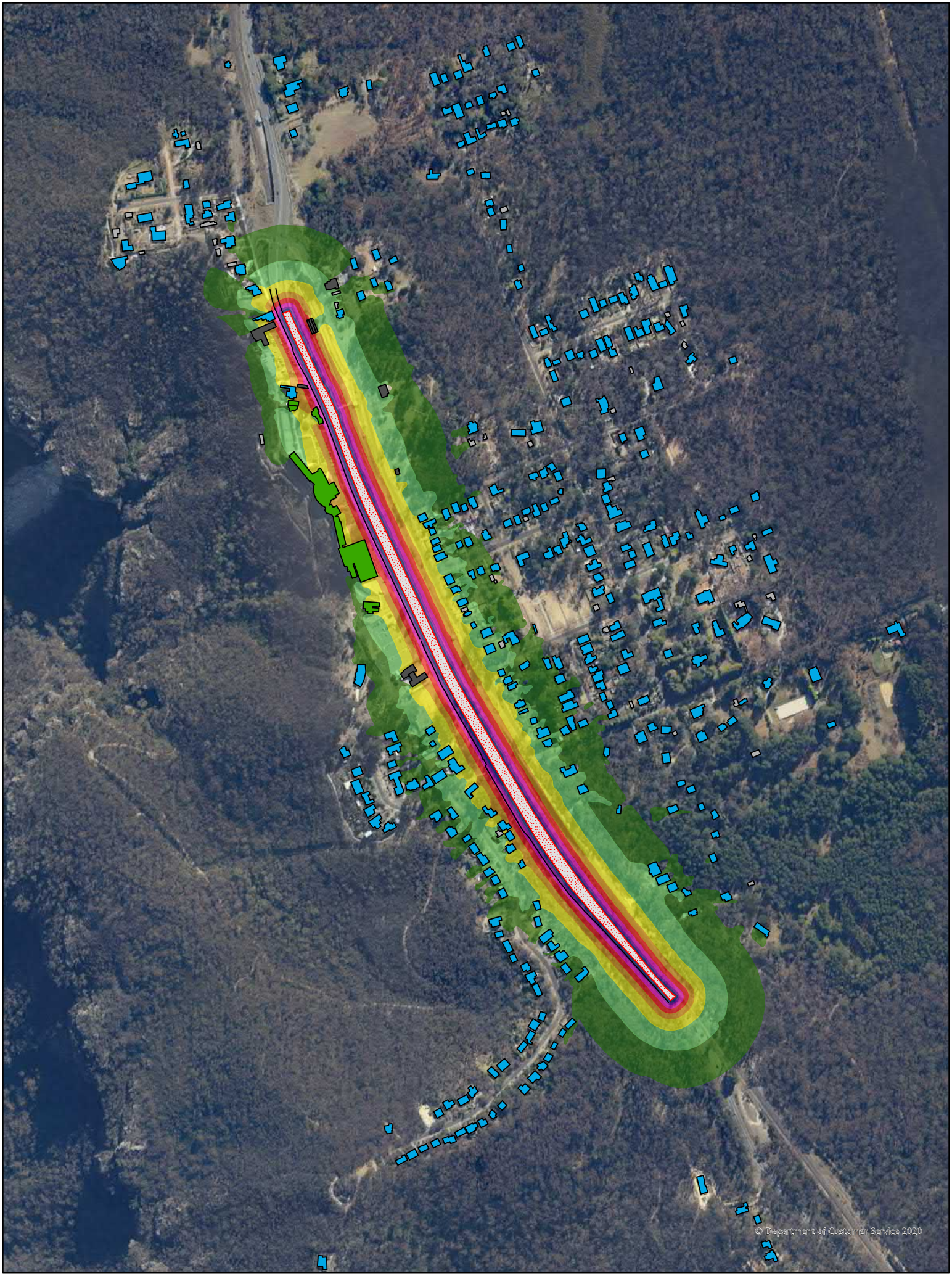

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Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Southbound Lanes Construction Area
Design Alignment
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Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$

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Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Construction Noise Levels - Southbound lanes – Mobilisation and Site Establishment / Drainage Infrastructure Scenario

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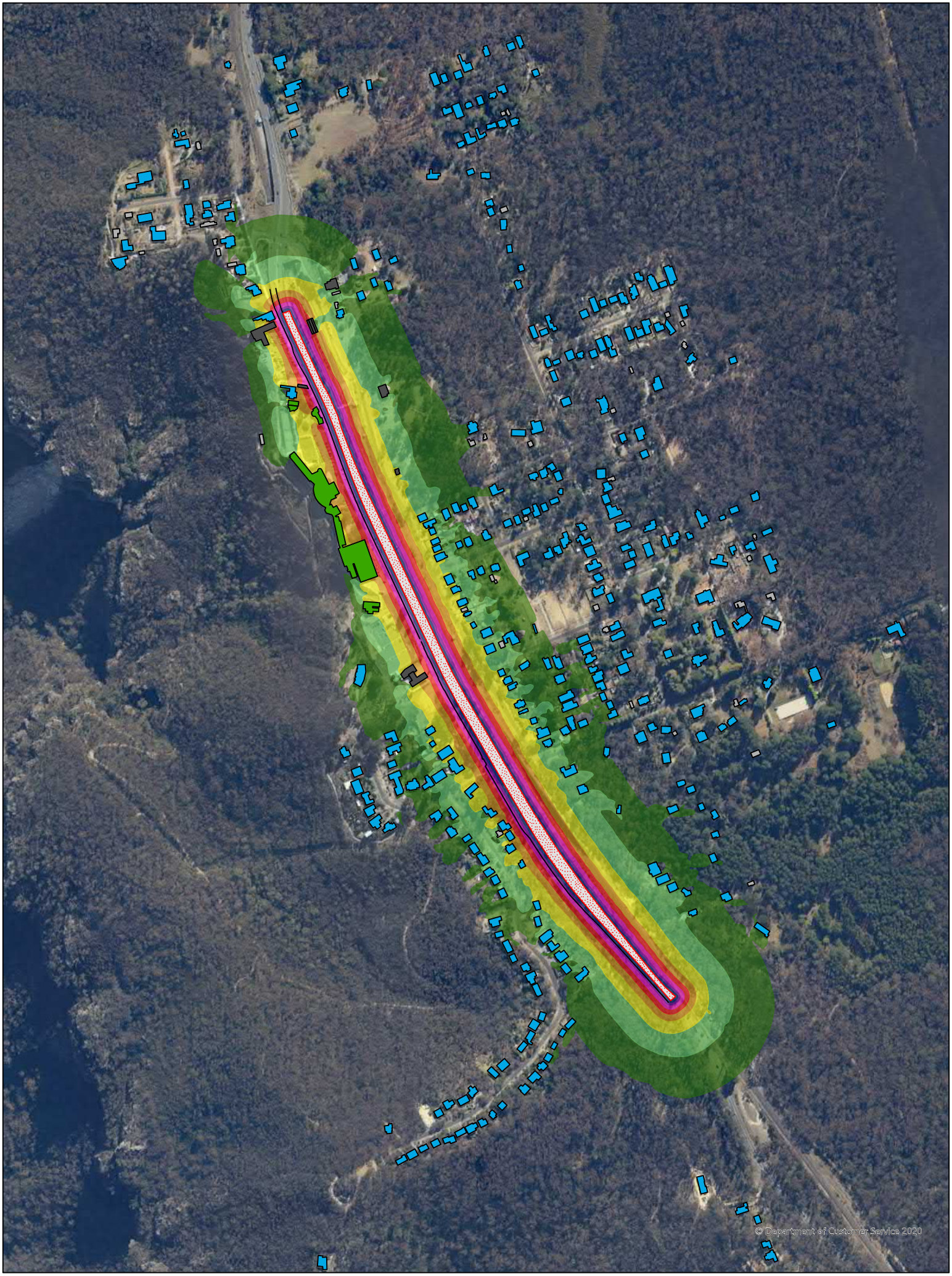

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Date: 25/03/2021

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0 50 100 m

Southbound Lanes Construction Area
Design Alignment
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Hotel
Residential Building
Shed / Other

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Predicted Construction Noise Levels - Southbound lanes – Utility Property and Service Adjustment Scenario

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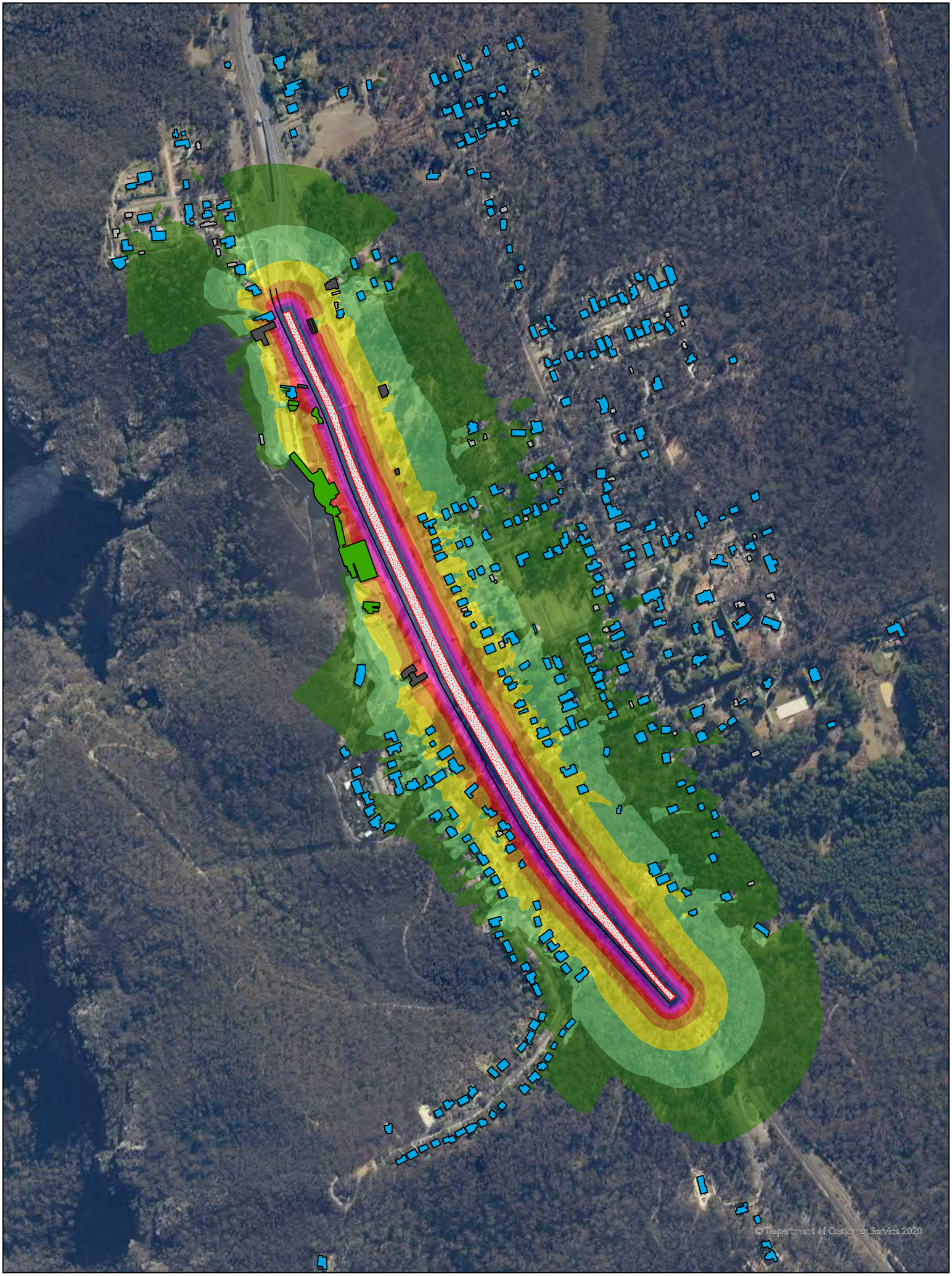

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Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Southbound Lanes Construction Area
Design Alignment
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Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$

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>85 dB(A)

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Predicted Construction Noise Levels - Southbound lanes – Road Surfacing Works Scenario

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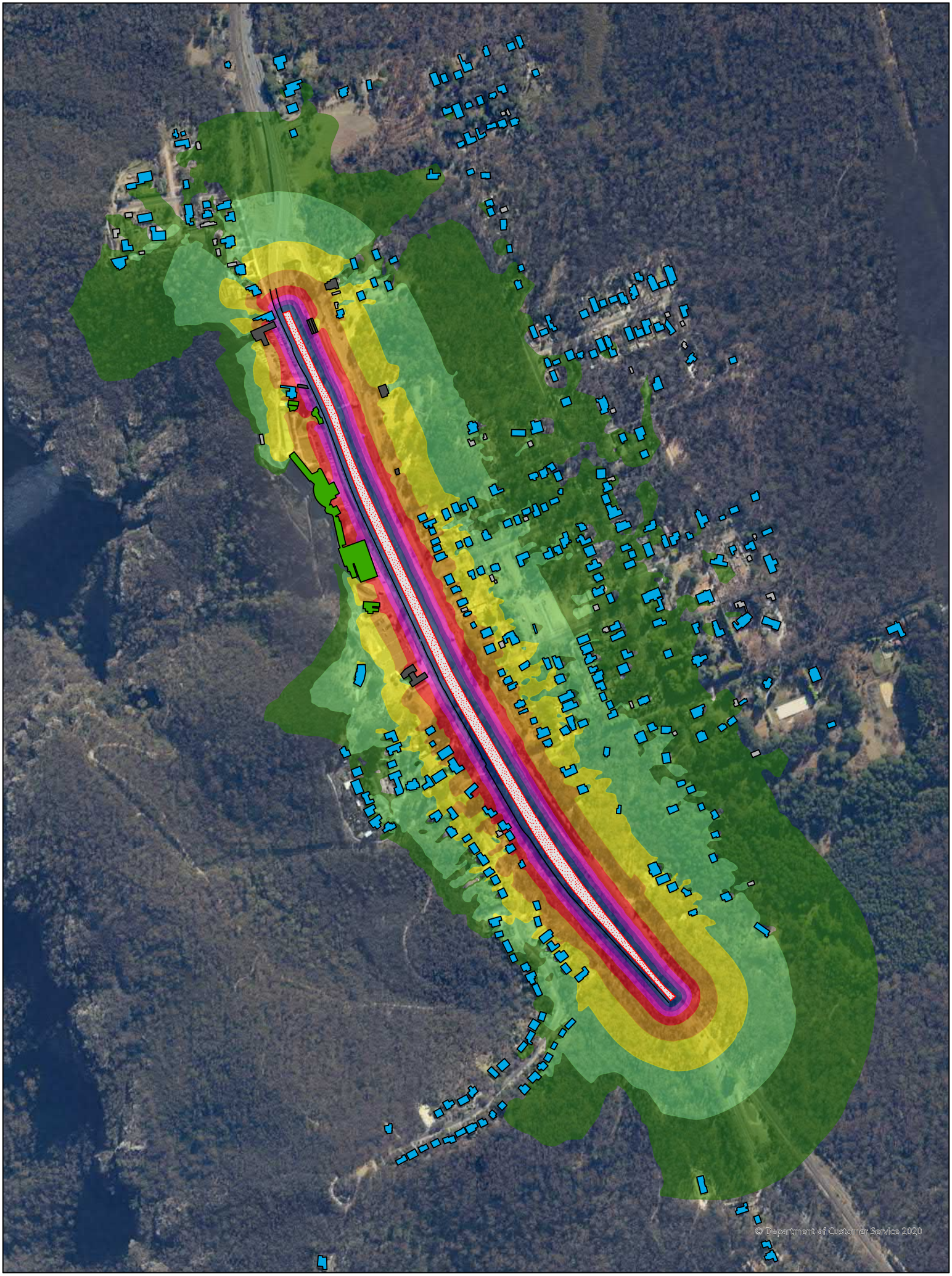

Datum: MGA Zone 56

Date: 25/03/2021

Basemap: SixMaps

Scale: 1:5,000 @A3

0 50 100 m

Southbound Lanes Construction Area
Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Construction Noise Level, $L_{Aeq,15min}$

50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
65-70 dB(A)
70-75 dB(A)
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>85 dB(A)

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Predicted Construction Noise Levels - Southbound lanes – Corridor clearing / Bulk Earthworks Scenario

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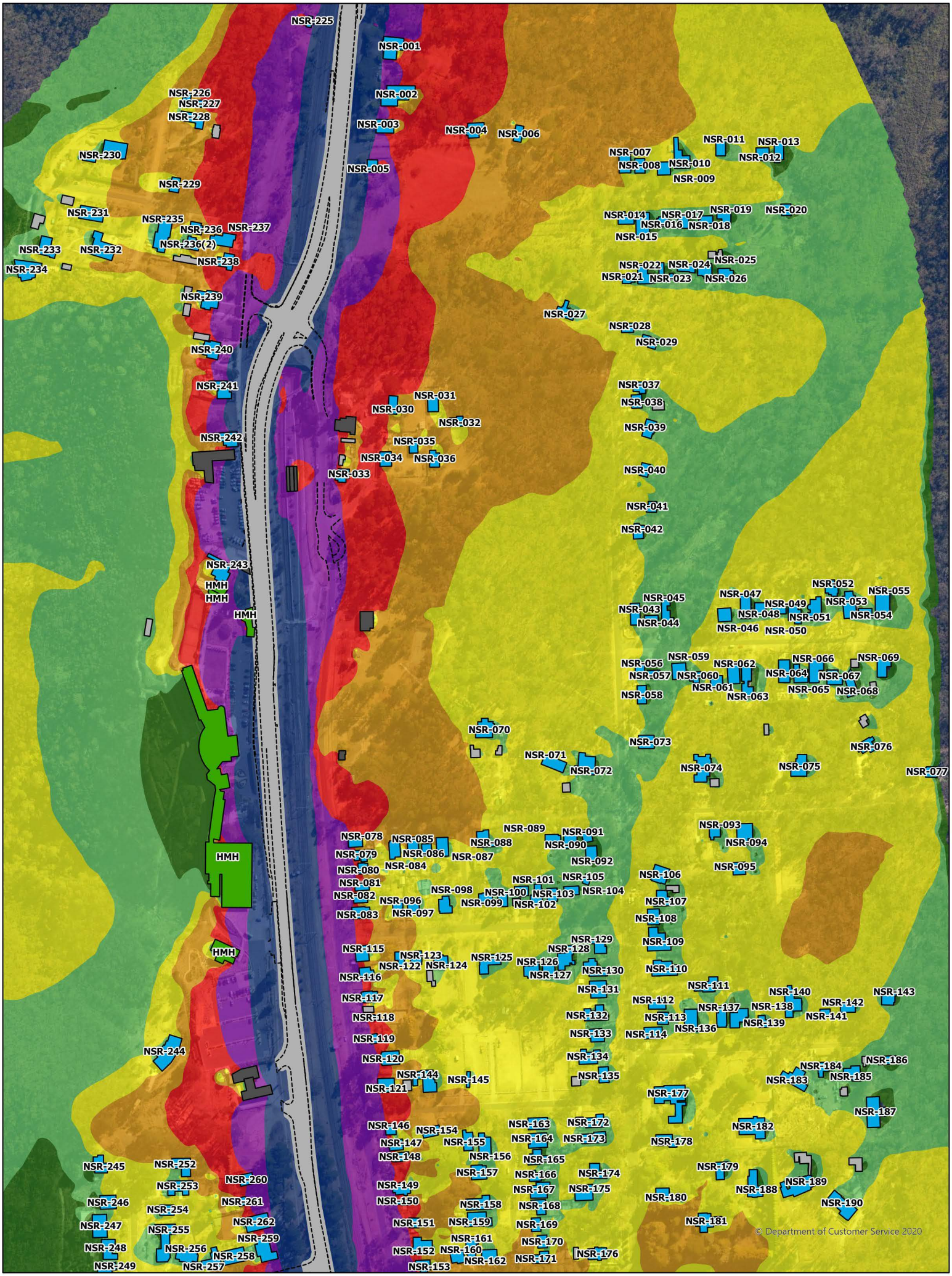
E. Operational noise contour results



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Existing Road Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Daytime Noise Level, $L_{Aeq,15hr}$

35-40 dB(A)
40-45 dB(A)
45-50 dB(A)
50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
>65 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Daytime - 2026 - Without Build
Northern Extent

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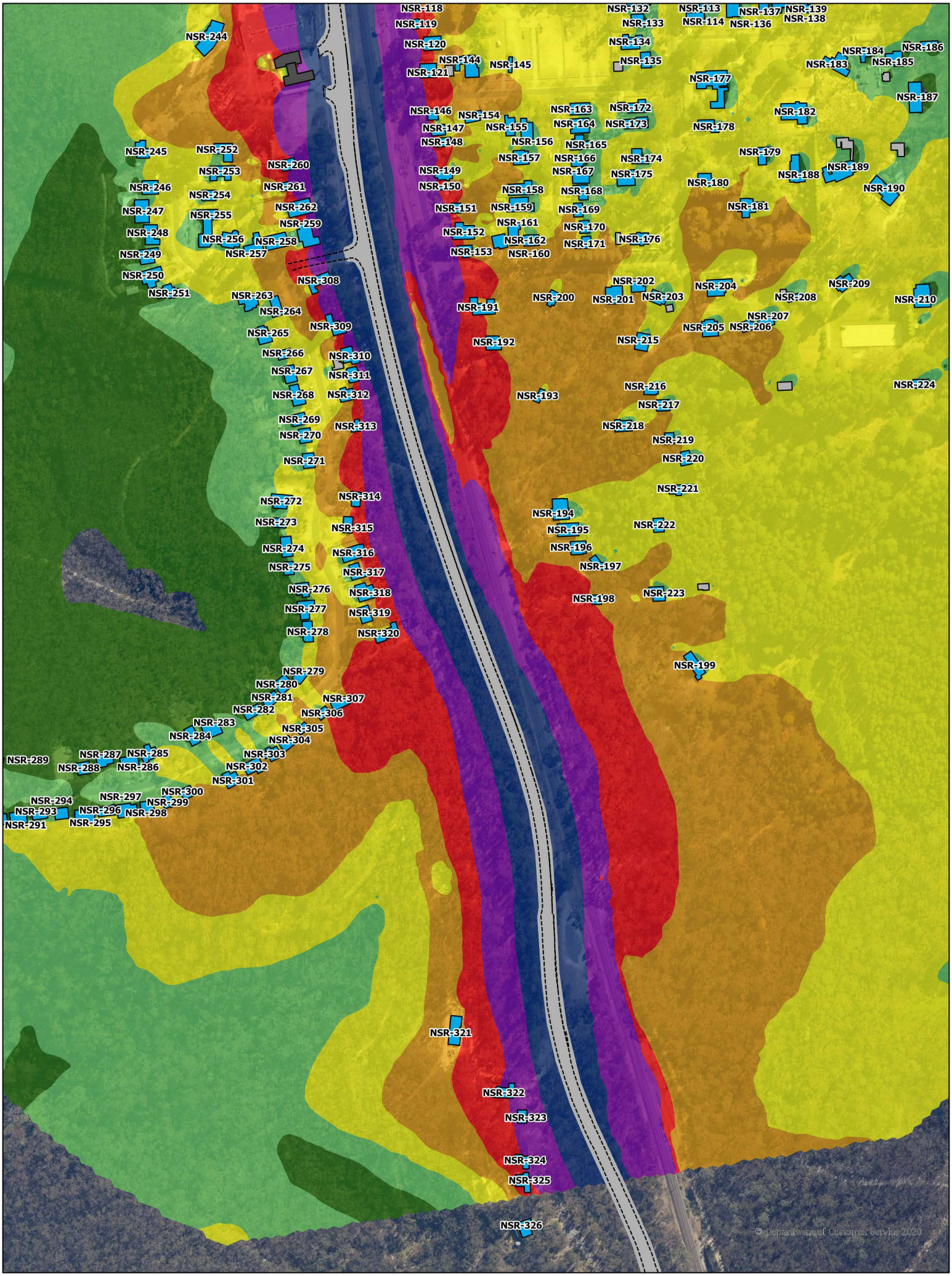


0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Existing Road Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other

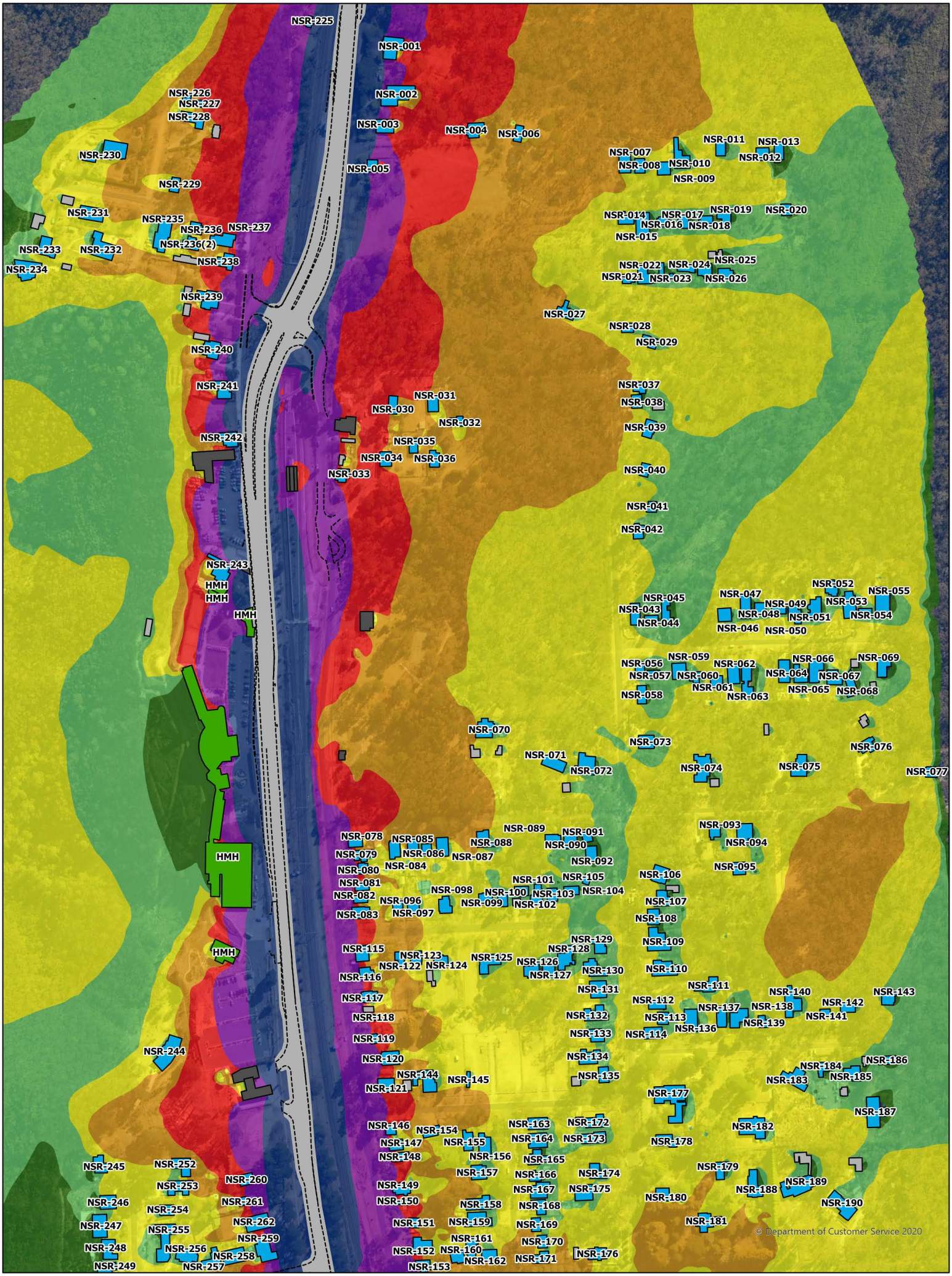
Predicted Daytime Noise Level, $L_{Aeq,15hr}$

- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- 60-65 dB(A)
- >65 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Daytime - 2026 - Without Build
Southern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Existing Road Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Night Time Noise Level, $L_{Aeq,9hr}$

30-35 dB(A)
35-40 dB(A)
40-45 dB(A)
45-50 dB(A)
50-55 dB(A)
55-60 dB(A)
>60 dB(A)

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Predicted Operational Traffic Noise Levels - Night Time - 2026 - Without Build
Northern Extent

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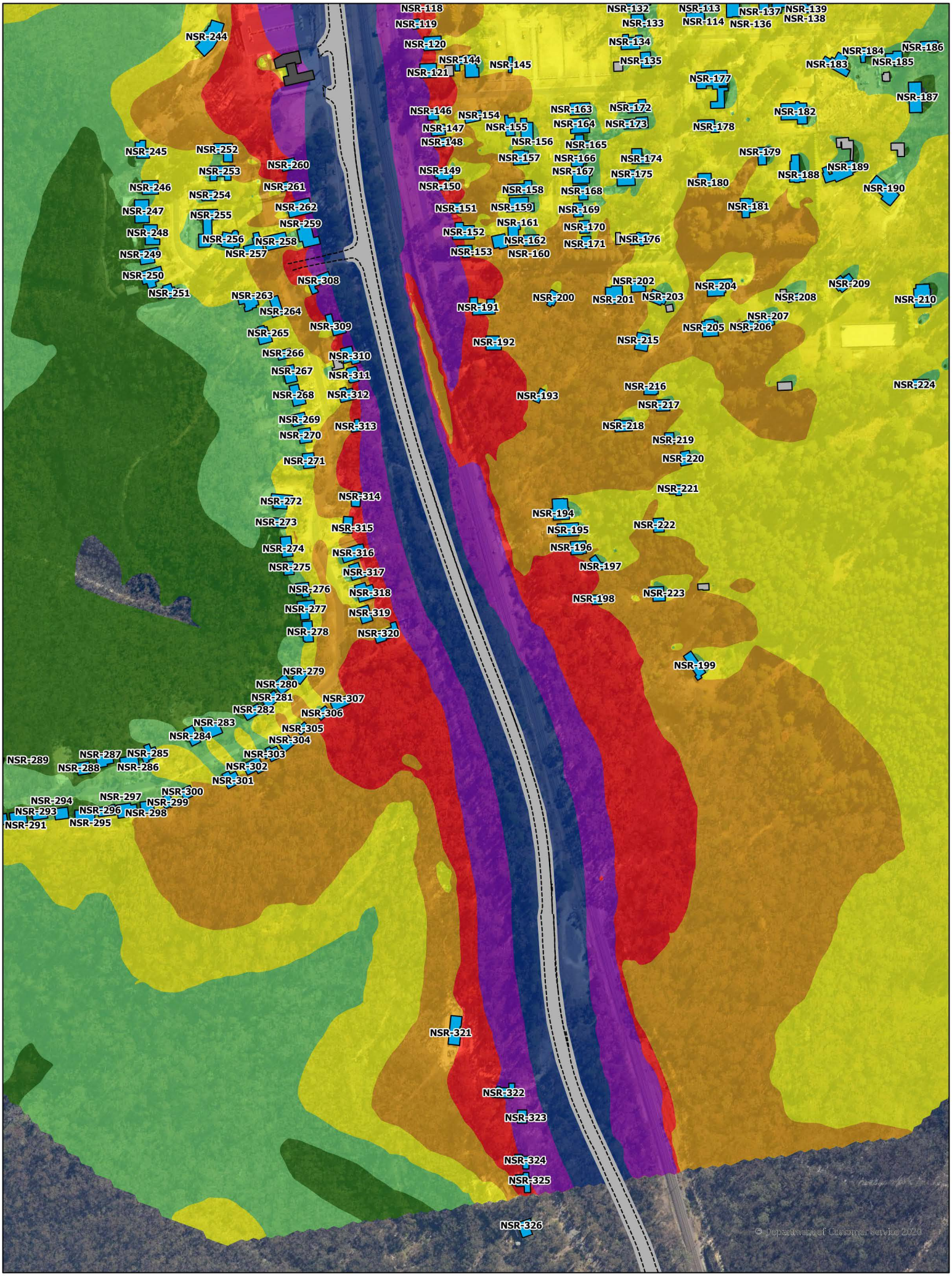

0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Existing Road Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Night Time Noise Level, $L_{Aeq,9hr}$

30-35 dB(A)
35-40 dB(A)
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55-60 dB(A)
>60 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Night Time - 2026 - Without Build
Southern Extent

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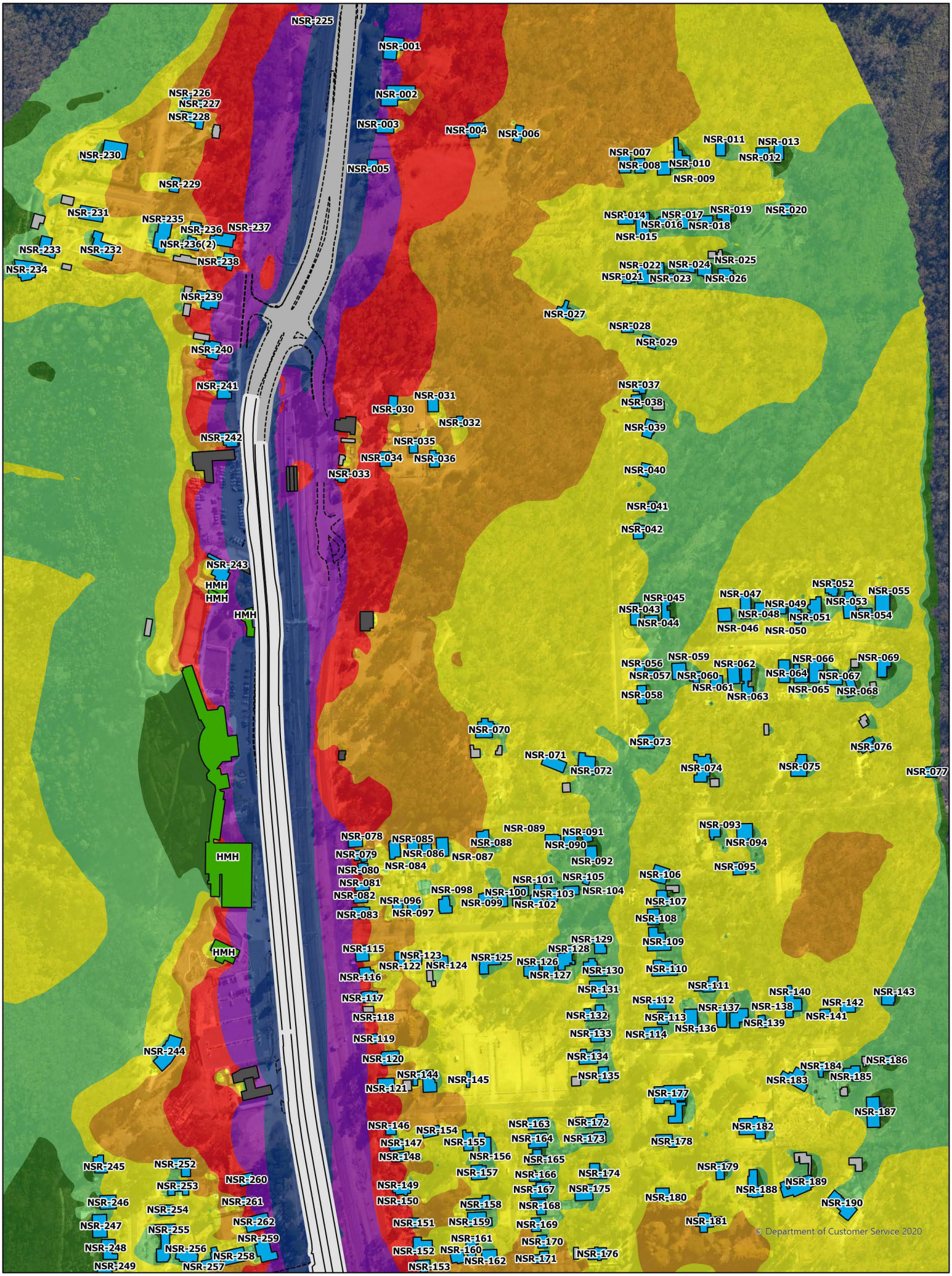

0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Design Alignment
- Existing Road Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other

Predicted Daytime Noise Level, $L_{Aeq,15hr}$

- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- 60-65 dB(A)
- >65 dB(A)

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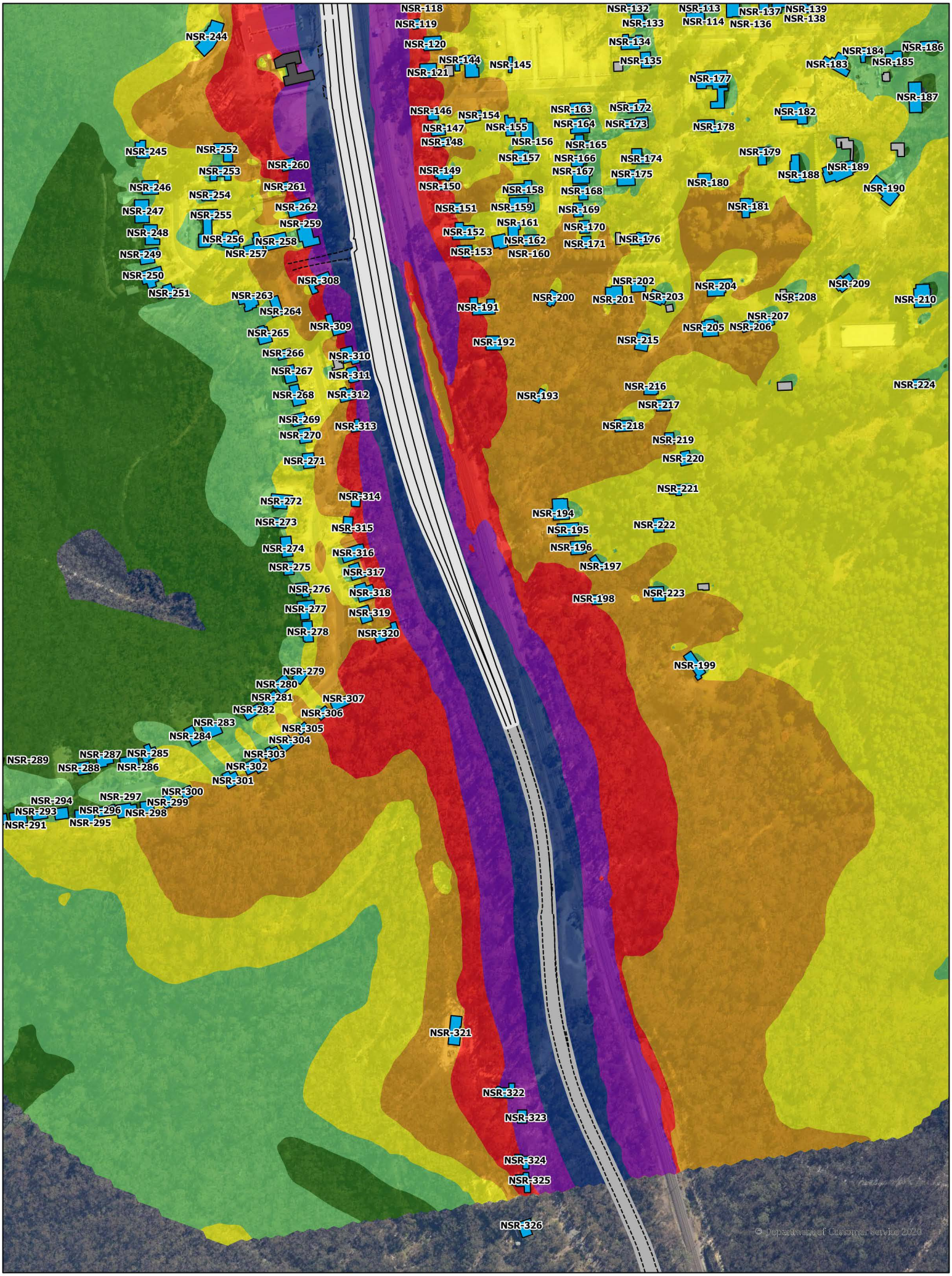
Predicted Operational Traffic Noise Levels - Daytime - 2026 - With Build
Northern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Design Alignment
- Existing Road Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other

Predicted Daytime Noise Level, $L_{Aeq,15hr}$

- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- 60-65 dB(A)
- >65 dB(A)

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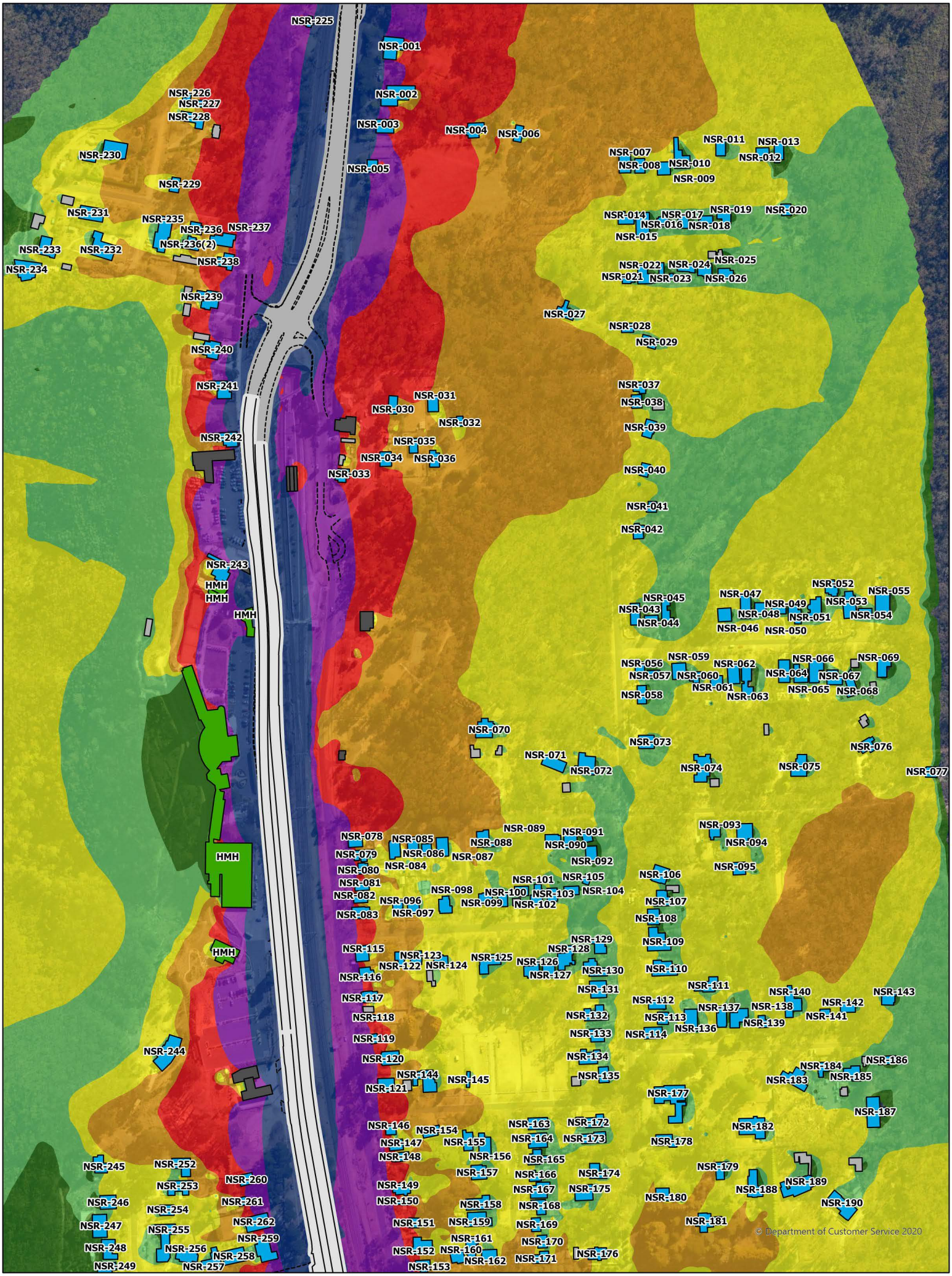
Predicted Operational Traffic Noise Levels - Daytime - 2026 - With Build

Southern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Design Alignment
Existing Road Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Night Time Noise Level, $L_{Aeq,9hr}$

30-35 dB(A)
35-40 dB(A)
40-45 dB(A)
45-50 dB(A)
50-55 dB(A)
55-60 dB(A)
>60 dB(A)

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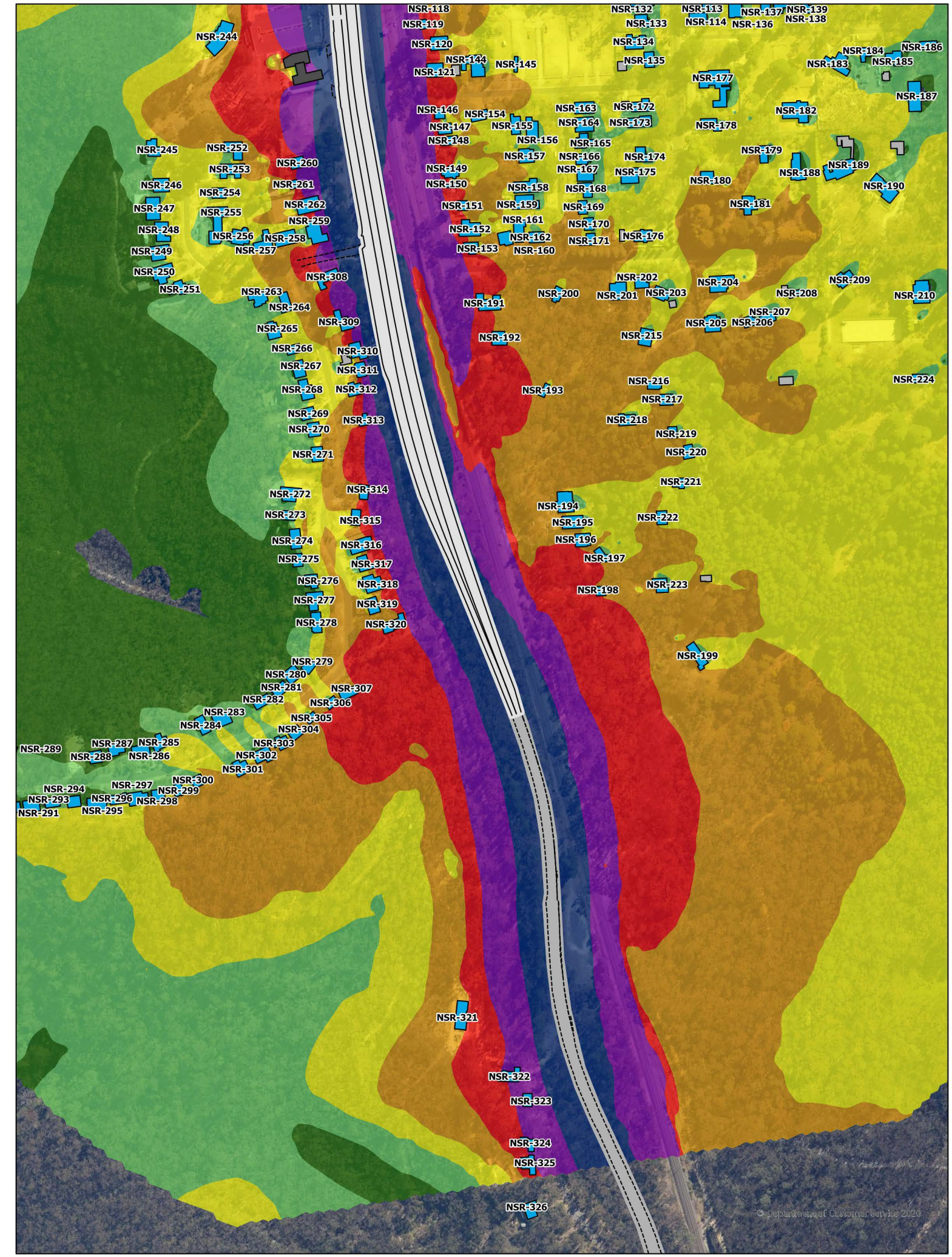
Predicted Operational Traffic Noise Levels - Night Time - 2026 - With Build
Northern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Design Alignment
- Existing Road Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other

Predicted Night Time Noise Level, $L_{Aeq,9hr}$

- 30-35 dB(A)
- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- >60 dB(A)

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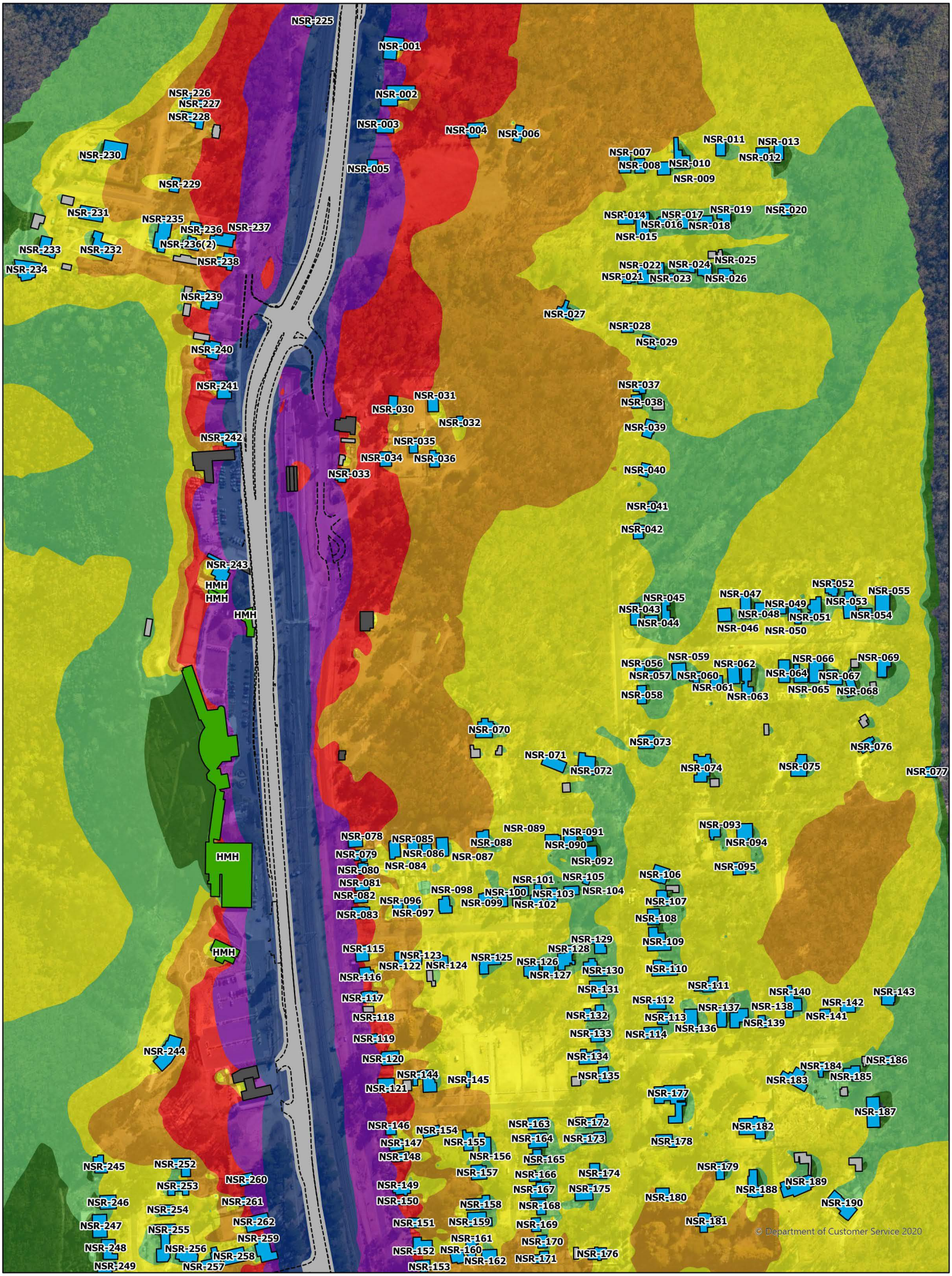
Predicted Operational Traffic Noise Levels - Night Time - 2026 - With Build

Southern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Existing Road Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Daytime Noise Level, $L_{Aeq,15hr}$

35-40 dB(A)
40-45 dB(A)
45-50 dB(A)
50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
>65 dB(A)

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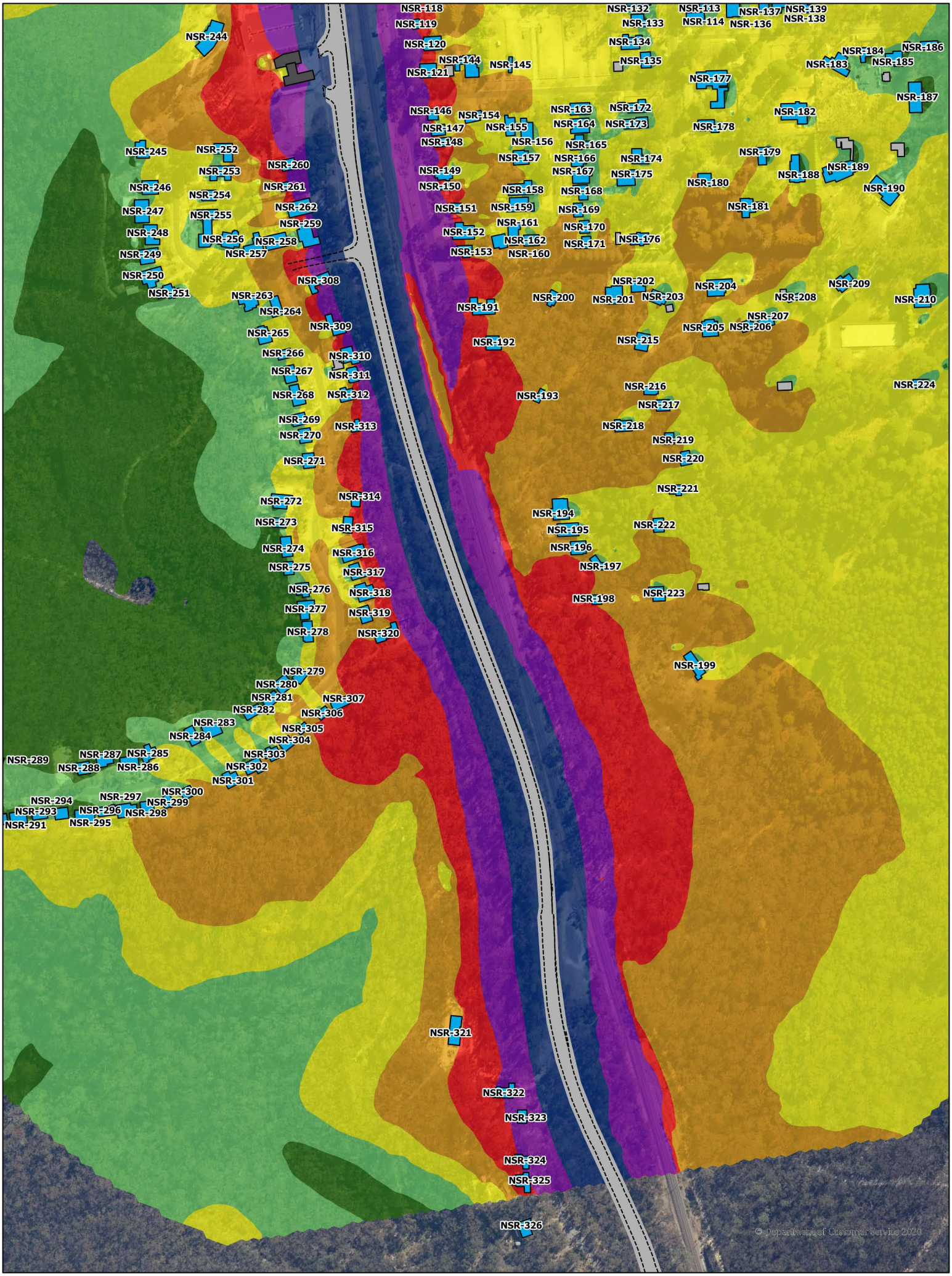
Predicted Operational Traffic Noise Levels - Daytime - 2036 - Without Build
Northern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Existing Road Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other

Predicted Daytime Noise Level, $L_{Aeq,15hr}$

- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- 60-65 dB(A)
- >65 dB(A)

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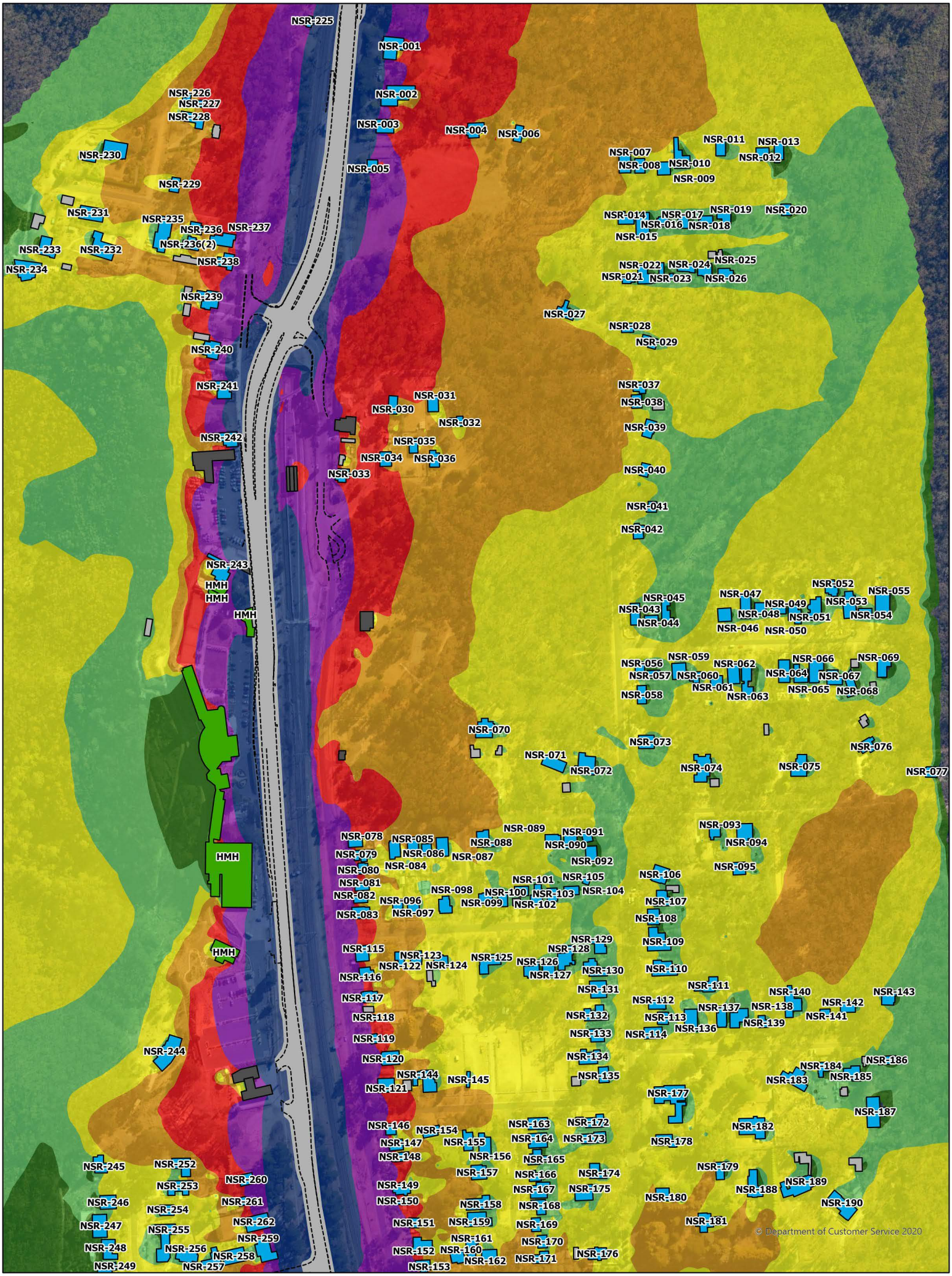
Predicted Operational Traffic Noise Levels - Daytime - 2036 - Without Build
Southern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Existing Road Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other

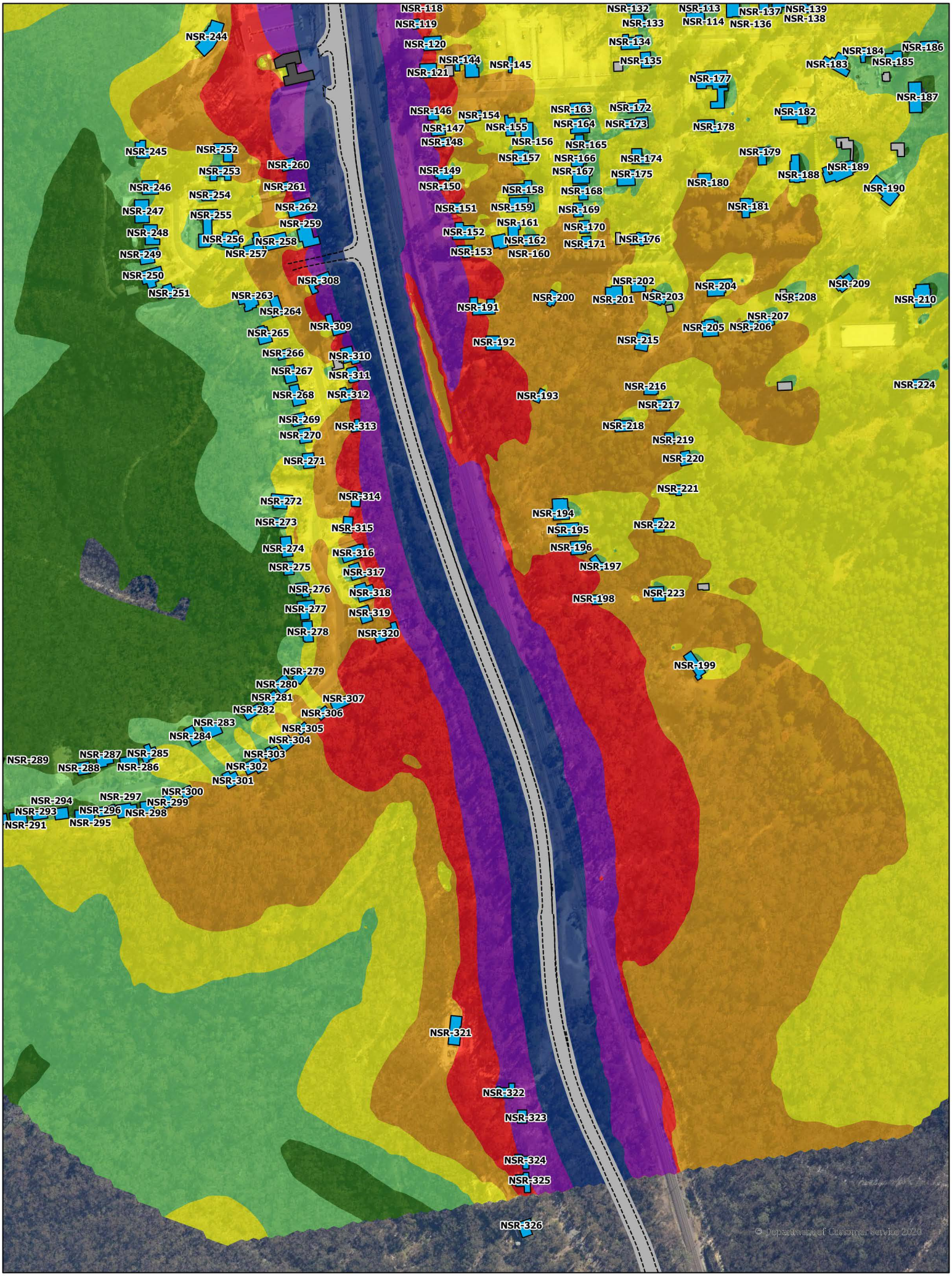
Predicted Night Time Noise Level, $L_{Aeq,9hr}$

- 30-35 dB(A)
- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- >60 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Night Time - 2036 - Without Build
Northern Extent

MOTT MACDONALD



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Datum: MGA Zone 56
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Existing Road Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Night Time Noise Level, $L_{Aeq,9hr}$

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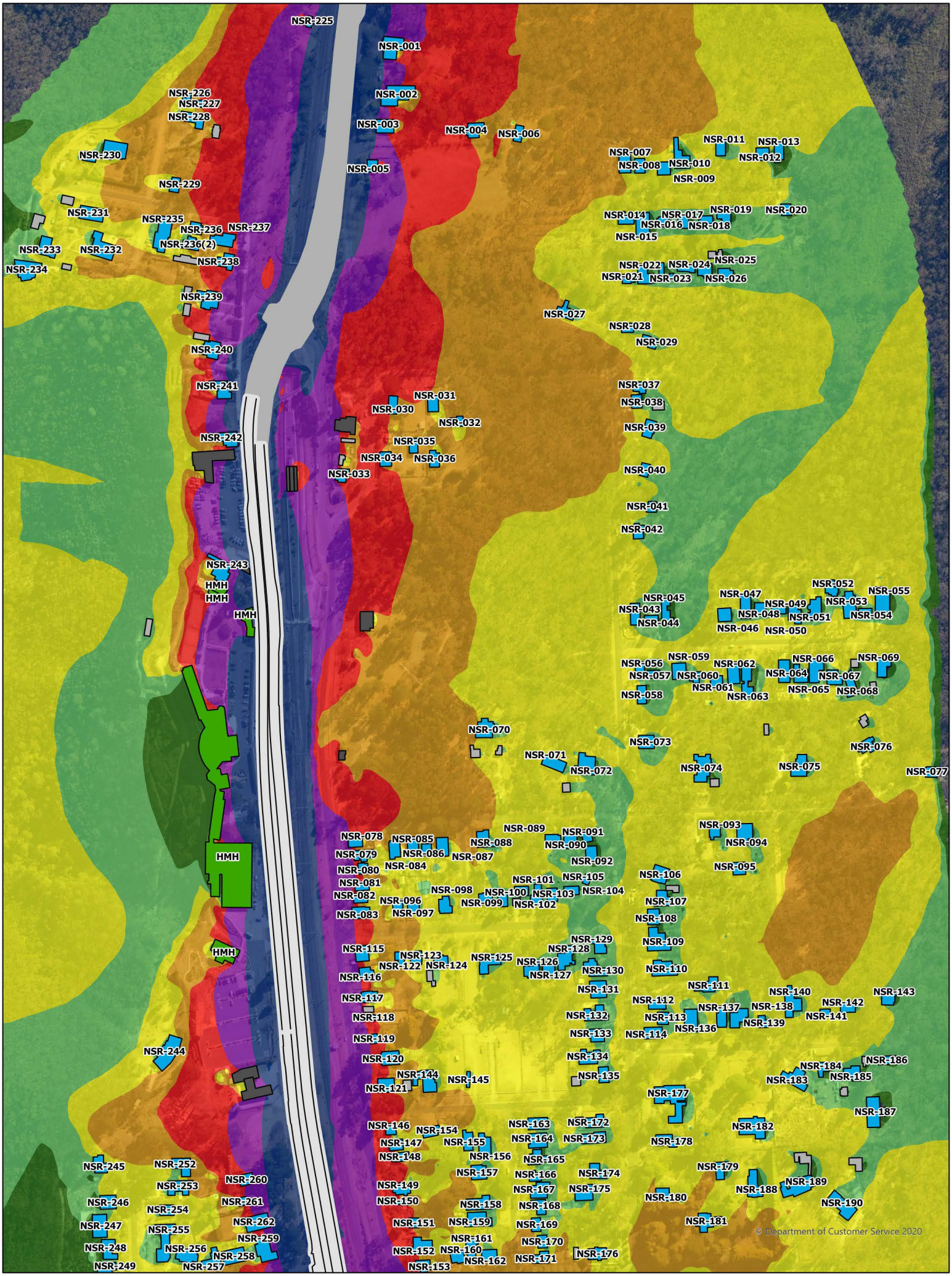
55-60 dB(A)
>60 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Night Time - 2036 - Without Build
Southern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Design Alignment
Commercial Building
Hotel
Residential Building
Shed / Other
Footprint

Predicted Daytime Noise Level, $L_{Aeq,15hr}$
35-40 dB(A)
40-45 dB(A)
45-50 dB(A)
50-55 dB(A)
55-60 dB(A)
60-65 dB(A)
>65 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Daytime - 2036 - With Build
Northern Extent

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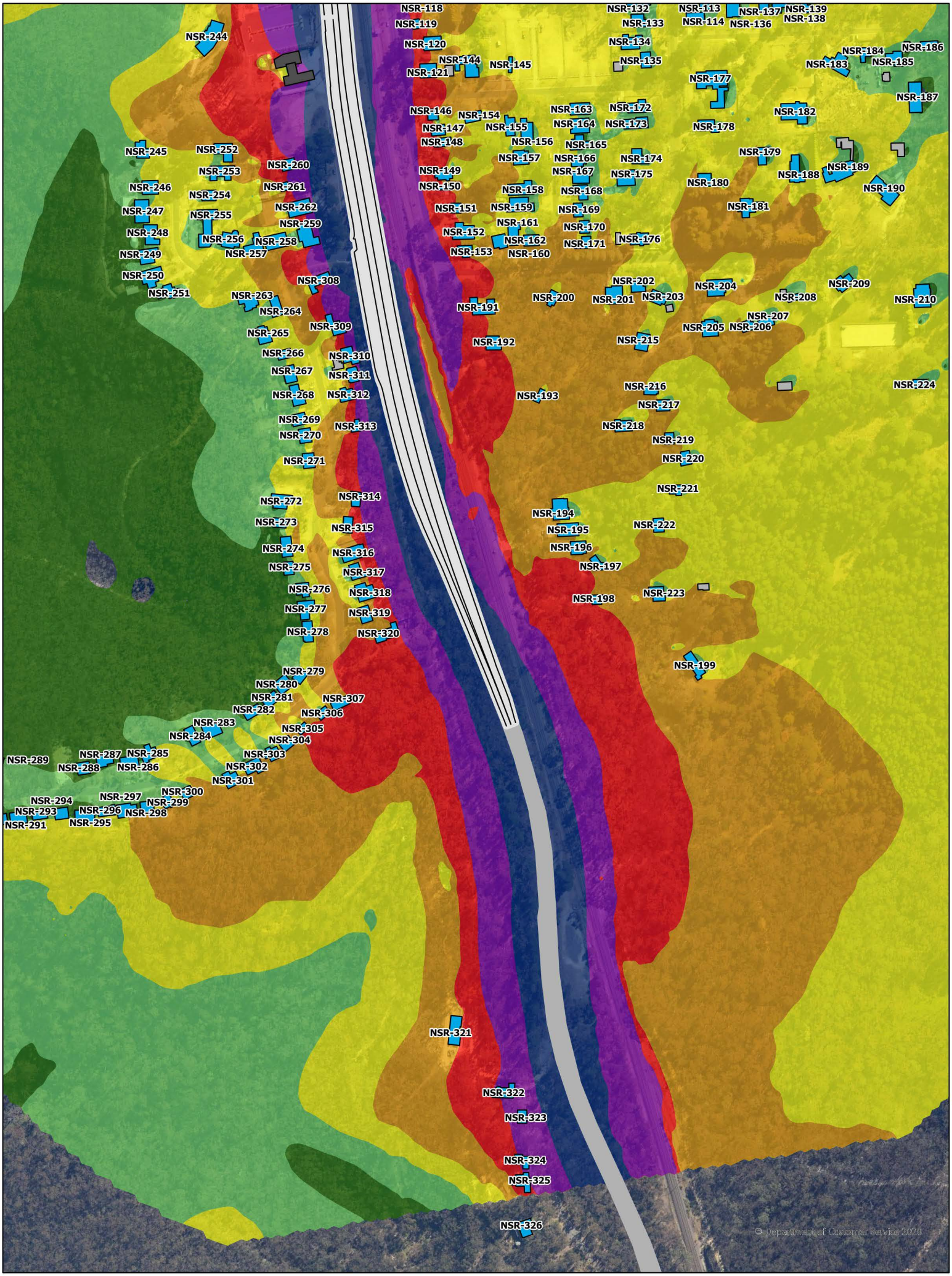


0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Design Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other
- Footprint

Predicted Daytime Noise Level, $L_{Aeq,15hr}$

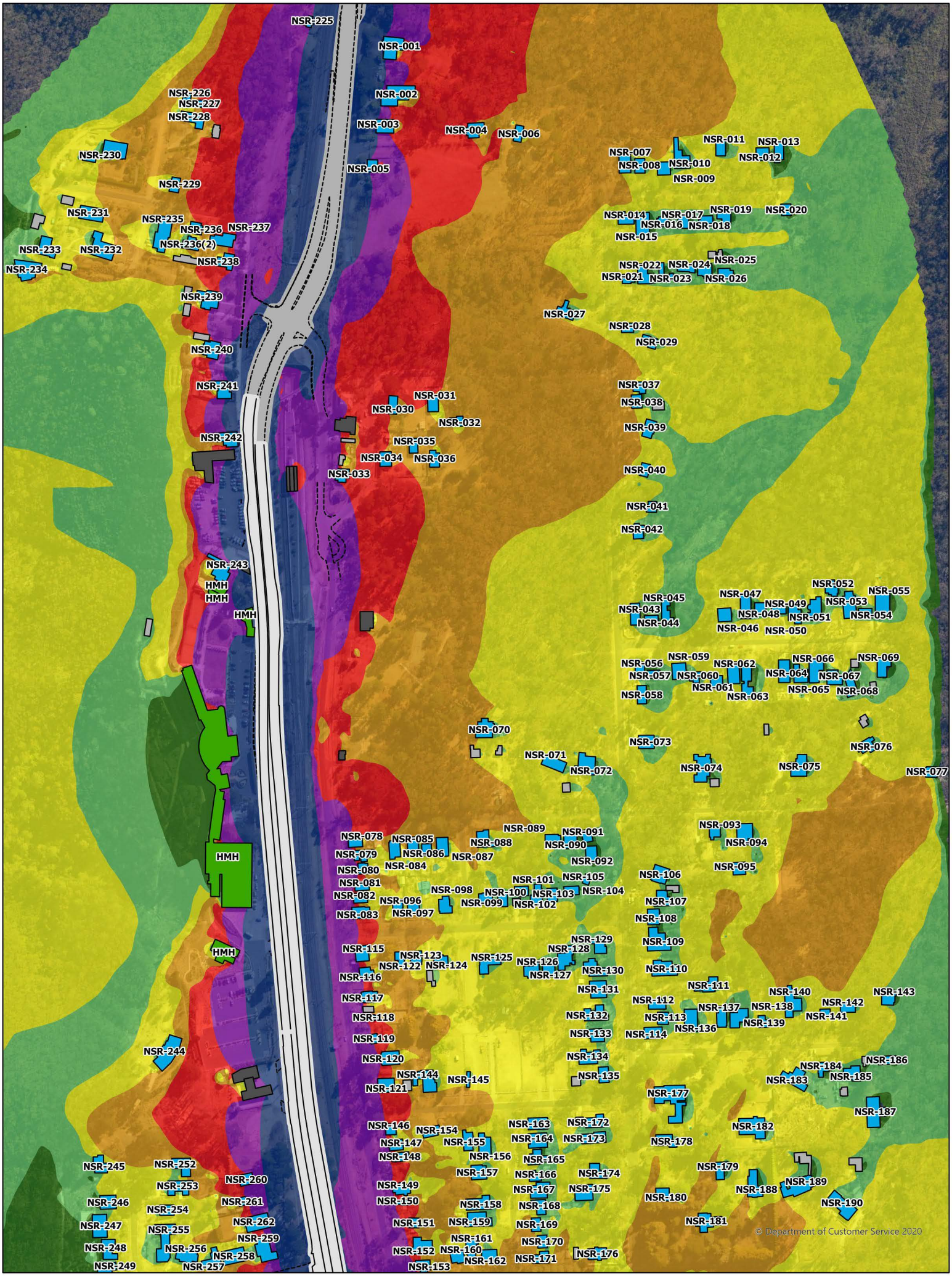
- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- 60-65 dB(A)
- >65 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Daytime - 2036 - With Build

Southern Extent

MOTT MACDONALD



0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

Design Alignment
Existing Road Alignment
Commercial Building
Hotel
Residential Building
Shed / Other

Predicted Night Time Noise Level, $L_{Aeq,9hr}$

30-35 dB(A)
35-40 dB(A)
40-45 dB(A)
45-50 dB(A)
50-55 dB(A)
55-60 dB(A)
>60 dB(A)

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Predicted Operational Traffic Noise Levels - Night Time - 2036 - With Build
Northern Extent

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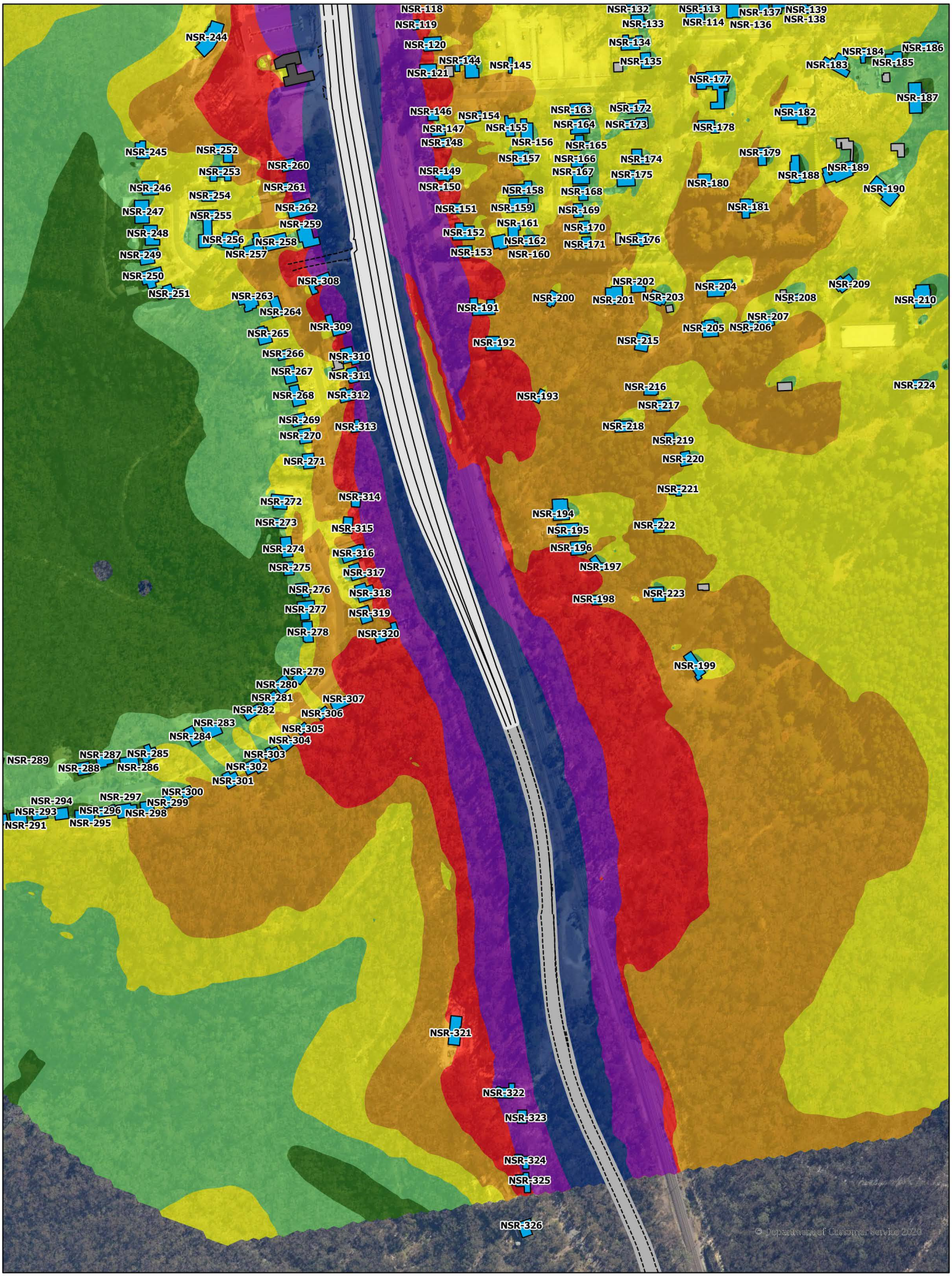

0 25 50 m

Datum: MGA Zone 56
Date: 19/05/2021
Basemap: SixMaps
Scale: 1:3,000 @A3

- Design Alignment
- Existing Road Alignment
- Commercial Building
- Hotel
- Residential Building
- Shed / Other

Predicted Night Time Noise Level, $L_{Aeq,9hr}$

- 30-35 dB(A)
- 35-40 dB(A)
- 40-45 dB(A)
- 45-50 dB(A)
- 50-55 dB(A)
- 55-60 dB(A)
- >60 dB(A)

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Predicted Operational Traffic Noise Levels - Night Time - 2036 - With Build
Southern Extent

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F. Operational noise mitigation measures

0 25 50m

Datum: MGA Zone 56

Date: 7/07/2021

Basemap: SixMaps

Scale: 1:3,000 @A3

- Design Alignment
- Existing Road Alignment
- Eligible for Architectural Treatment
- Not Eligible for Architectural Treatment
- Footprint

Great Western Highway Upgrade - Medlow Bath - Noise and Vibration Technical Paper

Operational Noise Mitigation

Northern Extent

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Datum: MGA Zone 56

Date: 7/07/2021

Basemap: SixMaps

Scale: 1:3,000 @A3

0 25 50m

- Design Alignment
- Existing Road Alignment
- Eligible for Architectural Treatment
- Not Eligible for Architectural Treatment
- Footprint

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Operational Noise Mitigation

Southern Extent

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