Appendix D
Noise and vibration assessment

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NARELLAN ROAD UPGRADE (CAMDEN VALLEY WAY TO BLAXLAND ROAD)

NOISE AND VIBRATION ASSESSMENT

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NSW Roads and Maritime Services

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1 INTRODUCTION

Narellan Road has been identified as a road requiring upgrade to meet current traffic demands of the South West Growth Centre of Sydney.

The existing corridor is generally four lanes with auxiliary lanes for added capacity at three major intersections. The project is to upgrade the existing corridor between Camden Valley Way and Blaxland Road from four lanes to six lanes including bridgeworks over the Hume Highway and Sydney Water Upper Canal. The project will also include construction of a Heavy Vehicle Inspection Bay, Incident Response Facility, shared pathway, and decommission or relocation of bus stops.

The total project length is 6.8km with an expected roadwork's length of 3.8km owing to 1.3km already upgraded to six lanes in recent years. Previous upgrades included the Narellan Road roundabouts (2006), Narellan Road Extension (2007) and the Blaxland Road and Gilchrist Drive intersection upgrade (2008).

Renzo Tonin & Associates were engaged to conduct an environmental noise and vibration assessment for the proposed upgrade. Noise emissions from road traffic have been calculated and assessed at the potentially most affected residential receivers in accordance with the NSW Road Noise Policy (RNP) and the Roads and Maritime Services' Environmental Noise Management Manual (ENMM). Noise and vibration associated with the construction phase of the project has also been assessed in accordance with the NSW Interim Construction Noise Guideline (ICNG).

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 PROJECT DESCRIPTION

2.1 Background

Narellan Road is about 7.7km long. It is a key road in South Western Sydney and provides access between the Hume Highway and the regional centres of Camden and Campbelltown for motorists, commuters, cyclists and freight. There is expected to be significant traffic growth on Narellan Road in the future due to increased residential and commercial development in South West Sydney. Roads and Maritime Services (RMS) has been working to improve traffic flow, travel times and road safety on the route during 2012 by undertaking road maintenance work and adding an interim third lane westbound for afternoon peak hour traffic leaving the Hume Highway. The school zone on Narellan Road was also removed.

2.2 Project Objectives

Investigations have highlighted the extent of morning and afternoon peak period congestion on Narellan Road. Current traffic congestion leads to overspilling of right turn bays, delays to buses and trucks, safety issues at the Hume Highway on and off ramps and underperformance of traffic lights in managing traffic congestion. The modelled future traffic demand also shows Narellan Road would need to cater for an increased number of vehicles using the corridor.

The key project objectives are to address current congestion, to improve road safety, to improve access to the Hume Highway at Campbelltown and to improve the efficiency of freight movement.

2.3 Project Staging

RMS is currently planning the upgrade of Narellan Road in stages, with the first stage expected to be delivered by the end of 2014. Construction time frames for the remaining stages are yet to be confirmed.

This report assesses the concept road design including all stages of construction. The concept design and staging is shown in Figures 1, 2 and 3.

2.4 Project Design Features

The key design features of the project proposal are detailed in Table 1 below.

Table 1 - Key Project Design Features

Component	Description
Carriageway	Six lane divided carriageway
Design speed	90 km/hr
Posted speed	80 km/hr
Road Pavement Surface	Dense Graded Asphalt (DGA)
Lane Widths	3.5m

Component	Description
Median	Varies 0.9 m – 2.0 m
Minimum Horizontal Curve Radii	150m
On road cycleway	No
Allowance for B-doubles	Yes

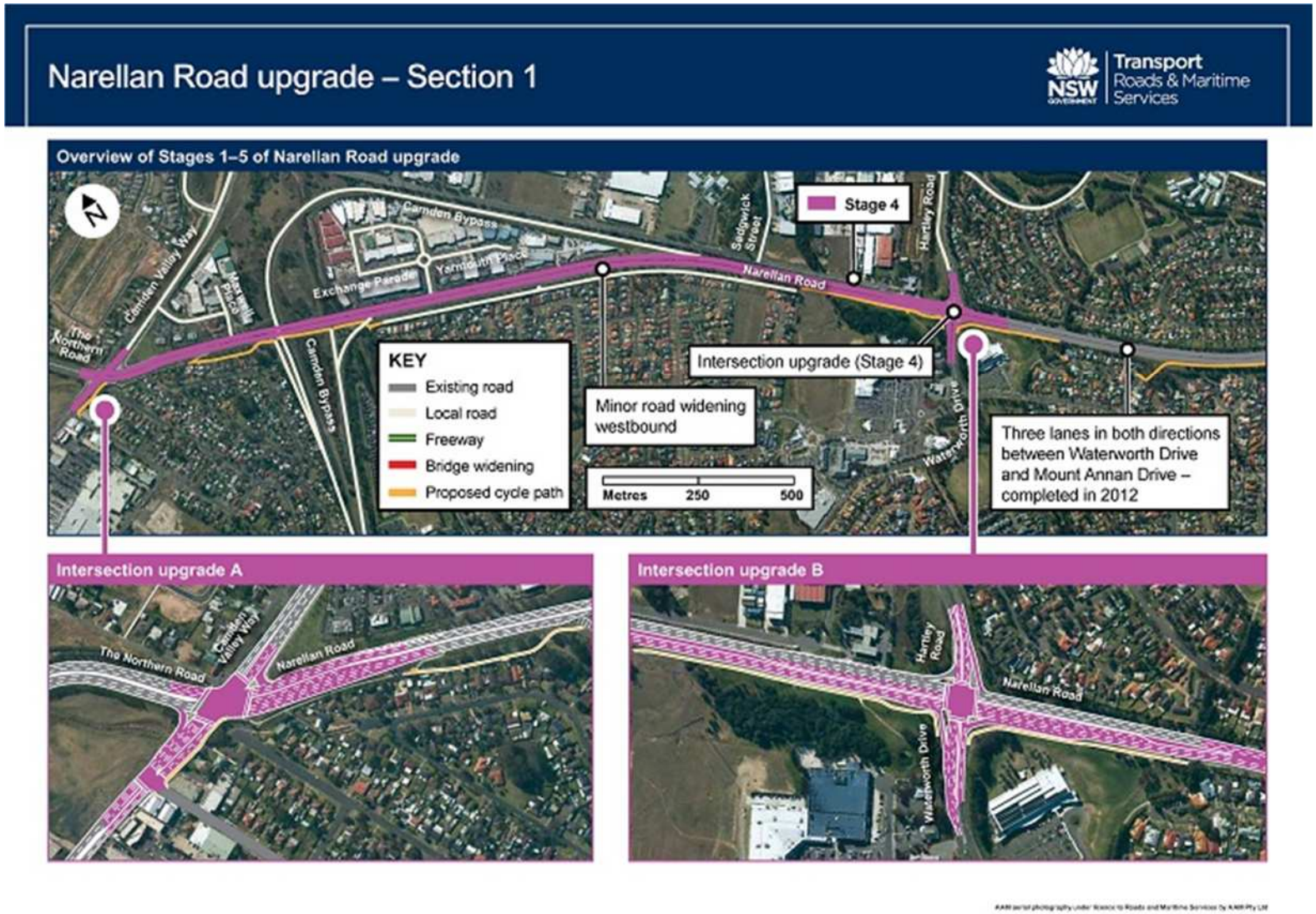


Figure 1 – Narellan Road Upgrade (Section 1)

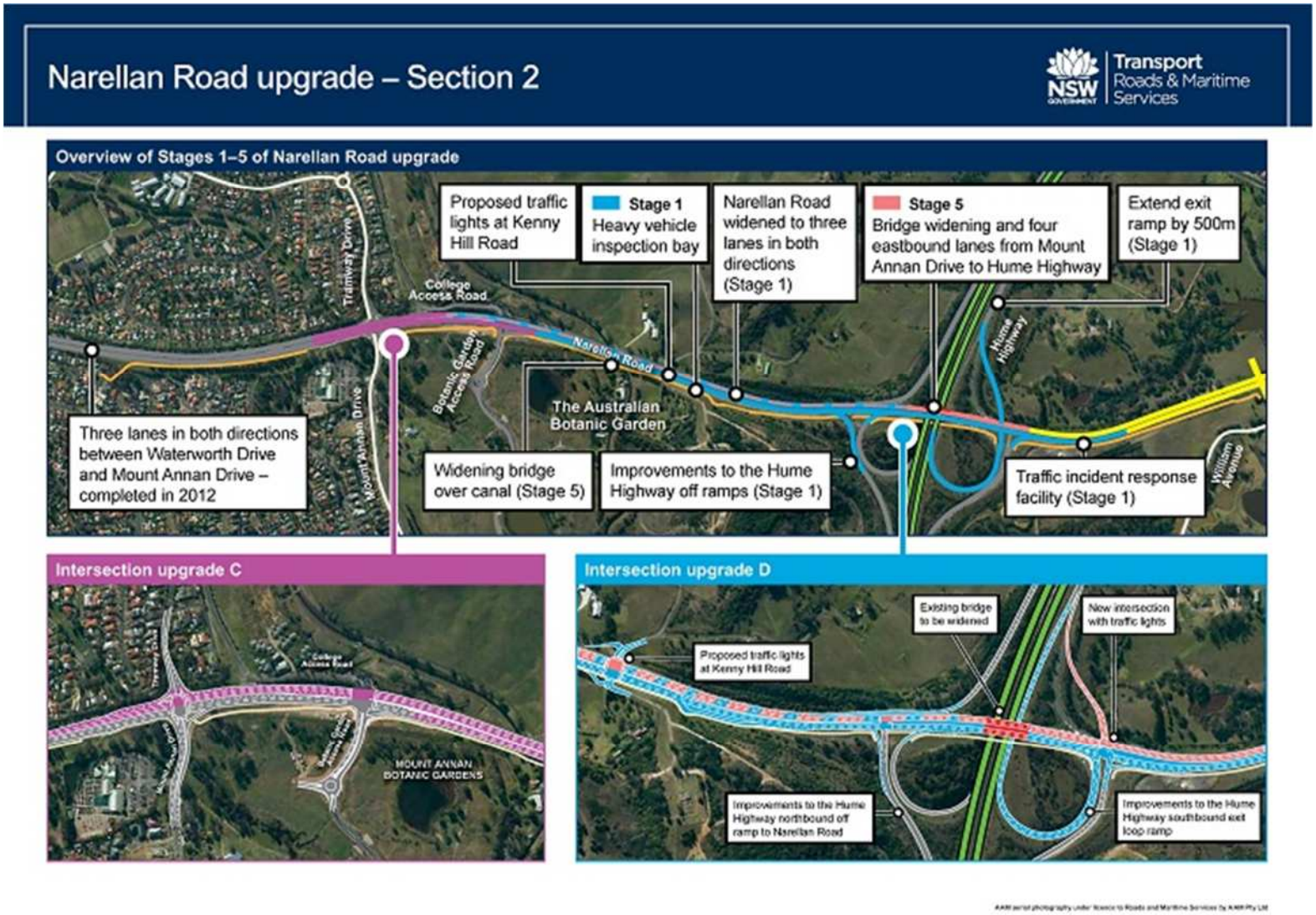


Figure 2 – Narellan Road Upgrade (Section 2)

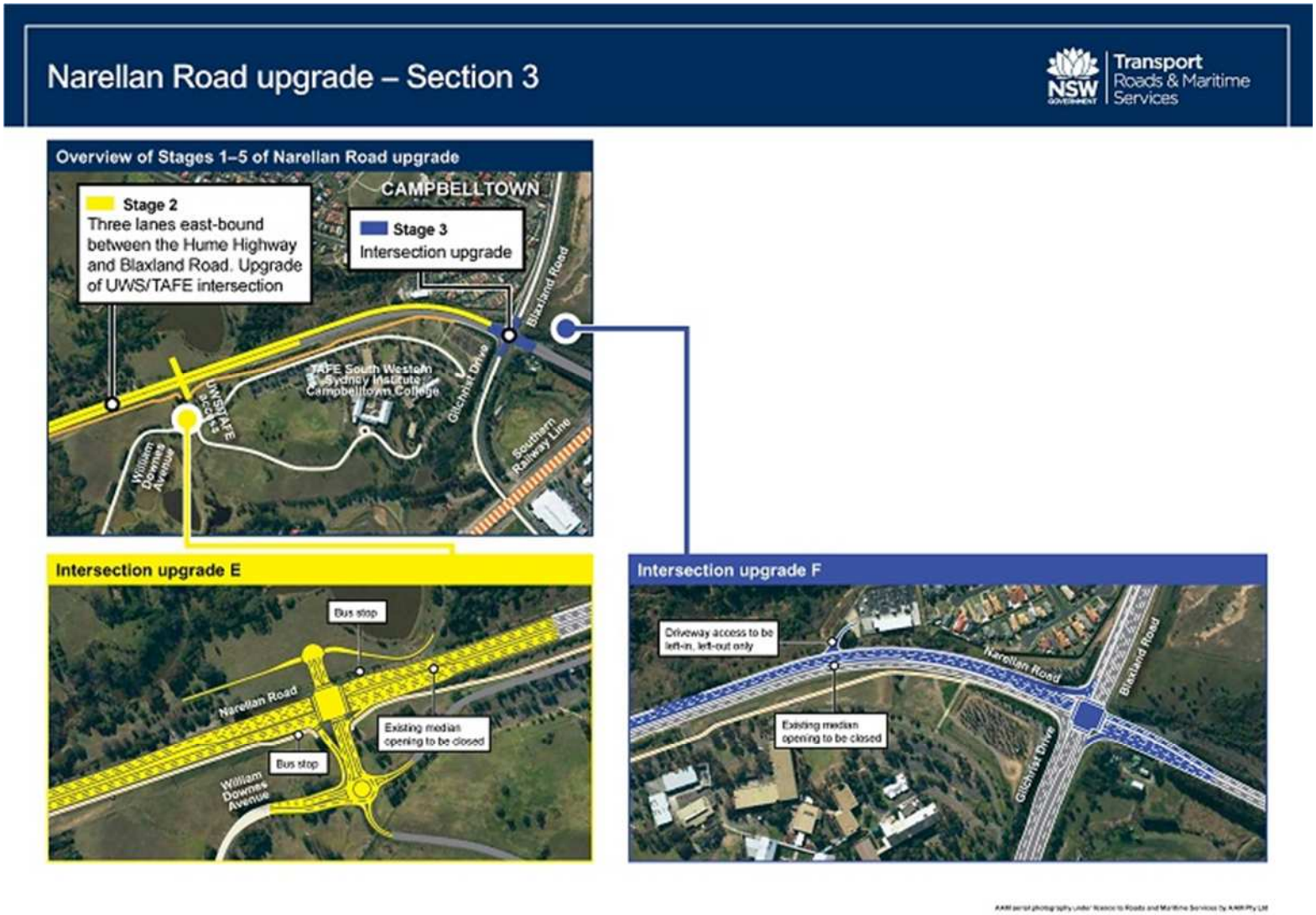


Figure 3 – Narellan Road Upgrade (Section 3)

3 EXISTING NOISE ENVIRONMENT

3.1 Noise Catchment Areas

To facilitate the assessment of noise impacts from the proposed Narellan Road Upgrade, noise sensitive receiver areas along the route have been divided into Noise Catchment Areas (NCAs).

NCAs are areas that are likely to have similar noise exposures, on the basis of factors such as topography, road design (cuttings, embankments, intersections etc), setbacks and types of residences or other noise receptors.

The noise catchment areas identified for this project are described in Table 2 and shown on Figure 4 and Figure 5.

Table 2 - Noise Catchment Areas

NCA	Location	Description
NCA 1	Camden Valley Way to Camden Bypass (south)	• Residential receivers bordering southern side of Narellan Road. • Typical setbacks of 30-40m from facade to road edge. • Typically standard height colourbond rear boundary fences. • Architectural treatment (upgraded window glazing) has already been implemented at some properties within this NCA as a result of previous upgrade works.
NCA 2	Camden Bypass to Waterworth Drive (south)	• Residential receivers bordering southern side of Narellan Road • Typical setbacks of 30-40m from facade to road edge. Similar elevation to road. • Rear boundary fences typically timber or colourbond on top of retaining wall to the western end, decreasing in height to the east. • Receiver floor height above ground level of boundary fence to the eastern end of NCA.
NCA 3	Magdalene Catholic High School (north)	• Nearest buildings are setback approximately 120m from Narellan Road.
NCA 4	Hartley Road to Water Canal (north)	• Residential receivers bordering northern side Narellan Road. • Typical setbacks of 25-30m from dwellings to road edge. • Existing lapped timber rear boundary fencing on top of mound for noise mitigation. • Lots are typically at lower elevation than Narellan Road. • Includes unoccupied retirement village.
NCA 5	Waterworth Drive to Mount Annan Drive (south)	• Residential receivers bordering southern side Narellan Road. • Typical setbacks of 20-25m from dwellings to road edge. • Typically lapped timber rear boundary fencing on top of mound for noise mitigation. • Receivers in Bransby Place typically slightly elevated although rear boundary fences still obstruct Narellan Road. • Receivers in Martin Place generally face Narellan Road with no boundary fence. Existing roadside earth mounding in this area provides some shielding.
NCA 6	Water Canal to F5 (north)	• A few residences on large rural type lots on northern side of Narellan Road. • Approximately 60-180m from dwellings to road edge.

NCA	Location	Description
NCA 7	Mount Annan Drive to F5 (south)	• A few residences on large lots on southern side of Narellan Road. • Approximately 40-70m from dwellings to road edge.
NCA 8	F5 to Electrical Substation (north)	• One rural residence at Maryfields Recovery Centre. • Includes Maryfields Friary. • Includes small pocket of residences in St Luke Place.
NCA 9	Campbelltown TAFE College (south)	• Campbelltown TAFE College buildings on southern side of Narellan Road. • Setbacks of approximately 50-60m to nearest buildings.
NCA 10	Electrical Substation to Blaxland Road (north)	• Residential receivers boarding northern side of Narellan Road and western side of Blaxland Road. • Typical dwelling setbacks of 15-40m from road edge. • Existing noise walls along Narellan Road and Blaxland Road.

3.2 Existing Ambient Noise Conditions

The ambient noise environment in the study area is controlled by traffic noise from Narellan Road. Long-term noise monitoring was conducted to quantify ambient noise levels. The purpose of the noise monitoring is to establish:

- existing traffic noise levels for benchmarking and validation of the operational noise model, and
- background noise levels for the setting of construction noise goals for the project.

3.2.1 Noise Monitoring Locations

Long-term noise monitoring was conducted in October 2012. The following monitoring locations were selected as being representative of the different groups of receivers along the project route. The monitoring locations are shown on Figure 4 and Figure 5.

Table 3 – Noise Monitoring Locations

Location	Address	Description
M1	63 Liquid Amber Drive	South side of Narellan Road. Monitor in rear yard and shielded from road by existing rear boundary fence.
M2	17 Kokoda Circuit	South side of Narellan Road. Monitor in rear yard. Rear yard slopes down towards road. Base of rear boundary fence lower than floor level of house so monitor only partially shielded fence.
M3	3 Jacks Circuit	North side of road. Monitor in rear yard and shielded from road by existing rear boundary fence.
M4	17 Paddy Miller Avenue	North side of road. Monitor in rear yard shielded from road by existing rear boundary fence.
M5	4 Martin Place	South side of Narellan Road. Monitor in front yard and exposed to Narellan Road with no boundary fencing. Small earth mounds alongside Narellan Road partially shield road.
M6	409 Narellan Road	North side of Narellan Road. Monitor in front yard and exposed to Narellan Road with no boundary fencing. House on large rural lot.

Location	Address	Description
M7	30 Ager Cottage Road	North side of Narellan Road. Monitor in front yard and shielded from road by existing noise wall.

3.2.2 Measured Noise Levels

The noise monitoring methodology is described in Appendix B. A summary of the long-term noise monitoring results are in Table 4 below, and the graphical outputs from the noise monitors are presented in Appendix E.

Table 4 – Results of Long Term Noise Monitoring

	Monitoring Location	L_{Aeq} Traffic Noise Levels		L_{A90} Background Noise Levels		
		Day	Night	Day	Evening	Night
M1	63 Liquidamber Drive	60	54	48	45	30
M2	17 Kokoda Circuit	66	61	56	50	35
M3	3 Jacks Circuit	60	56	51	46	34
M4	17 Paddy Miller Avenue	59	55	47	46	35
M5	4 Martin Place	62	58	53	51	36
M6	409 Narellan Road	66	63	55	53	38
M7	30 Agar Cottage Road	55	50	46	44	37

Figure 4 – Noise Catchment Areas and Monitoring Locations (Camden Valley Way to Mount Annan Drive)

Figure 5 - Noise Catchment Areas and Monitoring Locations (Mount Annan Drive to Blaxland Road)

4 NOISE CRITERIA

4.1 Operational Traffic Noise Criteria

This report assesses road traffic noise impact in accordance with the NSW 'Road Noise Policy' (RNP) and RTA's 'Environmental Noise Management Manual' (ENMM). Narellan Road is currently classed as an arterial road in that it handles through traffic bound for another locality and has characteristically heavy and continuous traffic flows.

According to the ENMM, this project does not constitute a 'new road traffic noise source' because the road is not new and does not produce noise to receptors from a different direction. The project is within the existing road corridor and therefore the project is classed as a 'road redevelopment'.

4.1.1 Residential Land Uses

The RNP is used to assess the potential traffic noise impact from a redevelopment of road infrastructure. The 'redevelopment' criteria for residential type receivers, as set out in the RNP apply and are presented in the table below. These criteria are for assessment against noise levels when measured in front of a building facade, or facade corrected noise levels when measured in the free-field.

Table 5 – Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Development	Assessment Criteria, dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by noise from redevelopment of existing freeway / arterial / sub-arterial roads	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)

Where feasible and reasonable, noise levels from existing roads would be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulations of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

The criteria set out above are the noise levels that the road redevelopment project would try to achieve. All feasible and reasonable noise mitigation measures would be considered in the design of the project.

4.1.2 Sensitive Land Use Developments

The RNP also sets guidelines for the assessment of traffic noise on sensitive land uses such as schools, hospitals, places of worship and recreation areas. The applicable road traffic noise criteria are presented in Table 6 below.

Table 6 – Road Traffic Noise Assessment Criteria for Non-Residential Land Uses

Existing sensitive land use		Assessment Criteria, dB(A)		Additional considerations
		Day (7am-10pm)	Night (10pm-7am)	
1.	School classrooms	$L_{Aeq,1hour}$ 40 (internal) when in use	–	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).
2.	Hospital wards	$L_{Aeq,1hour}$ 35 (internal)	$L_{Aeq,1\ hour}$ 35 (internal)	
3.	Places of worship	$L_{Aeq,1hour}$ 40 (internal)	$L_{Aeq,1\ hour}$ 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 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 point 5) may be applied.
4.	Open space (active use)	$L_{Aeq,15hour}$ 60 (external) when in use		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.
5.	Open space (passive use)	$L_{Aeq,15hour}$ 55 (external) when in use		
6.	Childcare facilities	Sleeping rooms $L_{Aeq,1hour}$ 35 (internal) Indoor play areas $L_{Aeq,1hour}$ 40 (internal) Outdoor play areas $L_{Aeq,1hour}$ 55 (external)	–	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.
7.	Aged care facilities	–	–	Residential land use noise assessment criteria should be applied to these facilities

Notes: Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for sensitive developments near busy roads.

It is generally accepted that most buildings provide a noise reduction of at least 10dB(A) when windows are left 20% open, without providing additional treatment. Therefore for a conservative assessment a minimum of 10dB(A) reduction from external noise levels to internal noise levels has been adopted.

4.2 Relative Increase Criteria

According to the RNP, the traffic noise impact from the proposed road 'redevelopment' would need to also comply with the 'Relative Increase Criteria' as discussed in Section 2.4 of the RNP. The relative increase criteria are to be applied to the external areas of existing residential and sensitive land uses impacted upon by the redeveloped road.

The relative increase criteria as set out in the RNP applicable to this project are reproduced below and apply for all NCAs.

Table 7 – Relative Increase Criteria

Type of Development	Total Traffic Noise Level Increase, dB(A)
Redevelopment of existing road	Existing Traffic $L_{Aeq(period)}$ + 12 dB (external)

Note: 'Existing traffic' refers to the traffic noise levels for the relevant 'no build' option

Receivers alongside Narellan Road are already exposed to high levels of traffic noise. Since this project is an upgrade of an existing road and only minor changes to the road width and alignment are being proposed, there are no locations where the project will cause an increase of more than 12dB over the existing noise levels. The project therefore complies with these relative increase criteria.

4.3 Maximum Noise Level Criteria

The RNP does not specify a night-time L_{max} noise limit or noise goal. This is primarily because research conducted to date in this field has not been definitive and the relationship between maximum noise levels, sleep disturbance and subsequent health effects is not currently well defined.

According to the policy however, the likely maximum or peak noise levels are to be broadly assessed and reported for the night-time period, which is considered by the NSW Environment Protection Authority (EPA) as being 10pm to 7am.

5 OPERATIONAL NOISE ASSESSMENT

5.1 Traffic Flow and Composition Summary

5.1.1 Existing Traffic Volumes

Traffic counts of Narellan Road and major cross roads were conducted concurrently with the long term noise monitoring in October 2012 to allow validation of the computer noise model. The results of the traffic survey are summarised in Table 8 below.

Table 8 – Existing 2012 Traffic Volumes and Compositions

ROAD	DAY (7:00 – 22:00)			NIGHT (22:00 – 7:00)		
	Volume	HV%	Speed km/h	Volume	HV%	Speed km/h
Narellan Road						
East of Exchange Pde EB	11754	4.0	67	1246	5.8	74
East of Exchange Pde WB	19452	4.4	69	2048	4.7	76
West of Tramway EB	20115	5.0	74	3545	6.1	78
West of Tramway WB	20798	5.4	74	2768	4.8	80
Near Kenny Hill Rd EB	26956	4.5	73	5076	4.9	78
Near Kenny Hill Rd WB	26172	4.4	70	3413	4.2	75
Adjacent to TAFE EB	24926	4.1	71	3081	4.2	79
Adjacent to TAFE WB	24670	3.9	69	3535	4.4	75
Hume Highway						
North of Narellan Rd NB	22631	6.3	108	5498	7.9	106
North of Narellan Rd SB	26346	5.2	102	3851	7.3	103
Blaxland Road						
North of Narellan Rd NB	15244	4.1	60	2075	3.9	64
North of Narellan Rd SB	16895	2.9	61	1410	2.9	63
Hartley Road						
South of Currans Hill Rd NB	6956	6.2	55	1211	3.7	58
South of Currans Hill Rd SB	7455	5.8	53	609	6.9	53
Camden Bypass						
North of Narellan Rd NB	6577	4.5	95	1444	1.0	95
South of Narellan Rd SB	10113	4.0	95	992	4.7	94

Note: EB = east bound, WB = west bound, NB = north bound, SB = south bound

HV% = percentage of heavy vehicles

5.1.2 Opening and Design Year Traffic Volumes

Traffic data has been provided by Roads and Maritime Services (RMS) for future years 2016 and 2026 in the form of AADT, as shown in Table 9. The 2016 (year of opening) and 2026 (design year) data were used as the basis for noise modelling.

Table 9 – Narellan Road Future AADT Volumes

Road/Ramp	2016	2026
East of Camden Valley Way	39877	45136
West of Hartley Drive	48821	63986
West of Mt Annan Drive	58675	71012
West of F5	79163	91994
West of UWS entrance	64721	70134

Since the project is a road redevelopment essentially involving the addition of lanes within the existing road corridor, whether the project is built or not will not change the volume of traffic on the road. Therefore the noise models for both the 'build' and 'no build' options utilise the same traffic data.

The Traffic and Transport assessment for the Narellan Road upgrade has assessed the heavy vehicle percentages in the future to be similar to existing levels. This is based on the proportion of future employment over population growth and forecasted freight growth. Therefore the day/night proportions and heavy vehicle percentages data obtained from the existing traffic counts have also been used for the future traffic noise assessment.

5.2 Road Traffic Noise Prediction Modelling

Noise predictions are based on a method developed by the United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)" known as the CoRTN (1988) method. This method has been adapted to Australian conditions and extensively tested by the Australian Road Research Board and as a result it is recognised and accepted by the NSW Environment Protection Authority. The model predicts noise levels for steady flowing traffic and noise from high truck exhausts is also taken into account.

The CoRTN algorithms are contained within the 'CadnaA' noise modelling software which has been used to calculate traffic noise levels at receivers. The noise prediction model takes into account the following inputs.

Table 10 - Summary of Modelling Inputs

Input Parameters	Data Acquired From
Traffic volumes and mix	Based on AADT forecast data from RMS and traffic counts
Vehicle speed	Validation model: Based on measured speeds during traffic counting Future Model: 80km/h
Gradient of roadway	Topographic data provided by RMS
Source height	0.5 metre for car exhaust, 1.5 metres for car and truck engines and 3.6 metres for truck exhaust and detailed within CORTN88
Ground topography at receiver and road	2m Ground Contours
Angles of view from receiver	Contained within model

Input Parameters	Data Acquired From
Reflections from existing barriers, structures and cuttings on opposite side of road	Calculated in CadnaA through CoRTN algorithm
Ground absorption	1 [can vary between 0 (hard surface) to 1 (soft ground)]
Receiver Heights	1.5 metre above ground level for ground floor and 4.5 metre above ground level for 1st floor
Facade correction	+2.5dB(A)
Correction for Australian conditions	-1.7 dB(A) for 'at facade' conditions from Australian Road Research Board (ARRB) Transport Research (Saunders et al 1983)
Acoustic properties of road surfaces	Dense graded asphalt – no corrections applied
Noise mitigation measures	Existing earth mounds, retaining walls and fences. Top of fence heights were provided by RMS

5.3 Model Validation

The noise model was validated using the long-term noise monitoring results. Table 11 below summarises the results of the validation, providing a comparison of the modelled traffic noise levels for existing conditions compared to the measured traffic noise levels.

Table 11 - Noise Model Validation

Location	$L_{Aeq,15hr}$ Daytime Noise Level			$L_{Aeq,9hr}$ Night time Noise Level		
	Measured	Modelled	Variation	Measured	Modelled	Variation
63 Liquidamber Drive	60	60	-0.4	54	53	0.7
17 Kokoda Circuit	66	67	-0.6	61	61	0.6
4 Martin Place	62	64	-1.4	58	58	-0.2
3 Jacks Circuit	60	59	0.9	56	54	1.9
17 Paddy Miller Avenue	59	60	-0.8	55	55	0.2
409 Narellan Road	66	67	-1.1	63	63	0.7
30 Ager Cottage Crescent	55	59	-1.8	50	51	-0.6
Mean Variation			***-0.7***			***0.5***

The noise model validation results presented in Table 11 above show that the noise model predicts results that are in good agreement with the noise monitoring and there is a reasonable level of confidence that can be placed on the noise model for predicting future traffic noise levels. No corrections have been applied to the model when generating the operational noise predictions for future traffic noise scenarios.

5.4 Noise Model Prediction Results

Operational noise modelling has been conducted based on the traffic volumes presented in Section 5.1. The scenarios predicted are:

- **'Opening Year',** where noise levels are the levels produced by the 2016 traffic volumes for both the 'build' and 'no build' options, for the day and night.

- **'Design Year',** where noise levels are the predicted noise levels for 2026 for both the 'build' and 'no-build' options, for the day and night periods.

The outcomes of noise modelling are:

- Existing noise levels at many properties already exceed the RNP criteria of 60dB(A) $L_{Aeq,15h}$ and/or 55dB(A) $L_{Aeq,9h}$,
- The increase in noise levels between the design year 'no build' and 'build' options is not more than 2dB(A) at any residence and therefore the impact of the project is considered to be acceptable.
- Existing and design year noise levels were found to be 'acute' at a number of residential receivers, particularly at the upper level of double storey residences. The 'acute' properties are identified in Appendix C by 'red' font.

Further noise mitigation should be considered where design year noise levels are acute, that is greater than or equal to $L_{Aeq,15hr}$ 65dB(A) or $L_{Aeq,9hr}$ 60dB(A), or where noise levels exceed the RNP criteria and have increased by more than 2dB(A) as a result of the project.

The predicted noise levels produced by the noise model are shown in detail in Appendix C. A summary of the results is shown in Table 12. Specific properties where further noise mitigation should be considered are identified in Appendix C and a discussion of possible noise mitigation options is presented in Section 5.6.

Table 12 – Summary of Operational Noise Model Results

NCA	Does project increase noise levels by more than 2dB(A)?	Are the noise levels at any residential property acute?	Number of properties where further noise mitigation should be considered
1	No	Yes	1[1]
2	No	Yes	19
3	No	n/a	0
4	No	Yes	7
5	No	Yes	19
6	No	Yes	1
7	No	Yes	1
8	No	No	0
9	No	n/a	0
10	No	Yes	1
		Total	49

NCA	Does project increase noise levels by more than 2dB(A)?	Are the noise levels at any residential property acute?	Number of properties where further noise mitigation should be considered

Note: 1. The Narellan Road extension was completed in 2007. As part of these works noise mitigation was considered for residences in NCA 1. A noise barrier was considered, however, at property treatments were preferred by residences at this location. Some properties in NCA1 have therefore already received noise mitigation treatment and would not be considered for further treatment because there is no significant increase in noise levels in NCA1 as a result of the proposal. Properties in NCA 1 that are acute, and have not previously been treated would be considered for reasonable and feasible noise mitigation as part of this proposal.

5.5 Noise Contours

The $L_{Aeq,15hr}$ Day and $L_{Aeq,9hr}$ Night noise contours for the 2026 'Build' and 'No Build' scenarios are presented in Appendix D. The noise contours assume no noise mitigation measures have been incorporated into the road development (other than existing noise barriers and boundary fences). The noise contours are produced by interpolation from a series of calculations to specific points within a regularly spaced grid, 1.5 metres above ground level. It is noted that the noise contours are estimates of the predicted noise levels, and that contour values may differ slightly from equivalent spot calculations.

5.6 Road Traffic Noise Mitigation Options

Although the noise impact of the project is acceptable (not more than 2dB(A) increase), some residences within the project area are already exposed to 'acute' noise levels, as identified in Appendix C, and therefore an assessment of feasible and reasonable noise mitigation options is required.

This project is still at 'concept design phase' and final noise mitigation treatments will not be decided until the 'detailed design phase' to allow for all design changes to be considered in the noise assessment. Nonetheless, the following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

It is noted that in accordance with Section 3.4.1 of the RNP the following is stated:

> *"…identify feasible and reasonable mitigation measures in the following order of priority:*
>
> *i. Road design and traffic management*
>
> *ii. Quieter pavement surfaces*
>
> *iii. In-corridor noise barriers/mounds*
>
> *iv. At-property treatments or localised barriers/mounds"*

We confirm that all reasonable and feasible traffic management and road design opportunities to reduce road traffic noise have been considered in the concept design. Therefore, the following sections assess the feasible and reasonableness of the remaining mitigation options in accordance with the order of priority stated above.

5.6.1 Quieter Pavements

RTA's 'Environmental Noise Management Manual' (ENMM) gives guidance on appropriate treatment of dwellings affected by traffic noise. 'Quiet' road pavement surfaces such as Stone Mastic Asphalt (SMA) and Open Graded Asphaltic Concrete (OGAC) could be laid along the proposed realignment as part of the road redevelopment. At speeds of greater than 80 km/h, this treatment can provide a 2-4dB(A) noise reduction at the source compared to standard pavements, although noise reductions are less for speeds less than 80km/h.

Application of a quiet pavement is not recommended for this project for the following reasons:

- The posted speed limit for the upgraded road is to be 80 km/h, and the noise reductions achieved from this mitigation measure would be minimal.
- There are several intersections where traffic slows down and then accelerates, which is not ideal for quiet pavements and can cause increased wear and maintenance.
- While the application of a quiet pavement could reduce noise levels slightly, the pavement alone would not be sufficient to mitigate all the predicted noise impacts and other measures would still need to be applied.

5.6.2 Noise Barriers

Noise barriers are most feasible where residences are closely grouped, where the barriers do not cause access difficulties to properties, and where they are visually acceptable. Where driveway access is required it is preferred not to use noise barriers as the overall noise reduction provided by the barrier is compromised by the need to install an access gate.

There are already existing noise mounds and boundary fences along much of the road corridor that were built as part of the residential developments. These existing fences are not high enough in some locations to prevent residences being exposed to acute noise levels [65dB(A) Day / 60dB(A) Night], or to achieve the base RNP noise goals for arterial roads [60dB(A) day / 55dB(A) Night]. In some areas the fences are in various states of disrepair, with gaps in the fence in some places.

The decision to provide noise barriers as a mitigation measure for this project will be made at the detailed design stage of the project after further analysis of the balance between barrier height and effectiveness. At this stage, the following table provides a summary of the feasibility and indicative heights and lengths of noise barriers required to achieve the RNP base noise goal, should they be implemented.

Table 13 – Noise Barrier Feasibility

NCA	Indicative noise barrier height/length	Number of properties remaining non-compliant	Comment
1	Not reasonable	n/a	A noise barrier is not considered reasonable at this location because residences chose at-property treatments rather than a noise barrier during previous works.
2	**5m high option**. Approx. 370m between Blaney Place and Bardia Place	2	Barrier is located at rear property boundary. All 17 acute properties behind noise barrier become compliant. Two properties at 31 and 33 Kokoda Place are acute at first floor only so consider at-property treatment.
	4m high option. Approx. 370m between Blaney Place and Bardia Place	6	Four properties behind barrier still non-compliant and should be considered for at-property treatment. Two properties at 31 and 33 Kokoda Place are acute at first floor only so consider at-property treatment.
3	Not required	n/a	Magdalene Catholic School. Noise mitigation not required as Project does not increase noise levels.
4	**5m high option**. Approx. 230m between French Place and access road	3	Barrier located on land between Narellan Road and access road. Barrier length is limited by access road. 3 dwellings at east end of retirement village remain non-compliant and should be considered for at property treatment
	4m high option. Approx. 230m between French Place and access road	7	Barrier not high enough to make properties compliant.
5	**5m high option.** Approx. 600m between Bransby Place and Collins Grove	0	Barrier is located at rear property boundary for Bransby Place, and on vacant land alongside Narellan Road for Martin Place and Collins Grove. All 19 acute properties behind noise barrier become compliant.
	4m high option. Approx. 600m between Bransby Place and Collins Grove	1	One property behind barrier still non-compliant and should be considered for at-property treatment.
6	Not reasonable	n/a	Only one property is acute. Noise barrier not reasonable. Consider at-property treatment.
7	Not reasonable	n/a	Only one property is acute. Noise barrier not reasonable. Consider at-property treatment.
8	Not required	n/a	No acute properties.
9	Not required	n/a	TAFE. Noise mitigation not required as Project does not increase noise levels.
10	Not reasonable	n/a	Only one property acute at first floor level. Consider at-property treatment.

5.6.3 At-Property Treatment

At-property treatment would only be considered for dwellings where other noise mitigation measures are either exhausted or are not feasible or cost effective.

The RNP's noise criteria are external noise goals, and building treatment only reduces noise levels inside a dwelling. Therefore, any building treatment would be designed to achieve the internal noise levels that would have been achieved had the project complied with the RNP criteria externally.

It is generally accepted that most buildings provide a noise reduction of at least 10dB(A) when windows are left 20% open, without providing additional treatment. This equates to an RNP internal criteria of $L_{Aeq(15\ hour)}$ 50dB(A) and $L_{Aeq(9\ hour)}$ 45dB(A) for residences along the road upgrade.

According to the ENMM, building treatments (in no particular order) may comprise:

- Fresh air ventilation systems that allow existing windows and doors to be kept shut;
- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only (these techniques are unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls);
- Upgrading window and door seals;
- Sealing wall vents; and
- External screen walls or property boundary fencing.

The following table provides guidance on the level of treatment required in relation to the exceedance above the RNP external assessment criteria.

Table 14 - Residential At-Property Treatment Options

Treatment	Predicted exceedance of RNP external criteria, dB(A)	At-Property Acoustic Treatment
1	<5	Ducted air-conditioning with fresh air ventilation or split air-conditioning system with separate fresh air mechanical ventilation where ducted systems are not practical.
2	6-10	Treatment 1 + replace existing weather seals with acoustic seals on windows and doors.
3	11-15	Treatment 1 + Treatment 2 + replace existing glazing with thicker laminated glazing.
4	>15	Treatment 1 + Treatment 2 + install supplementary window, fitted with acoustic seals, to inner side of existing window.

5.7 Bus Stops

The following relocation and decommissioning of existing bus stops will be made during the project:

1. decommission the bus stop westbound 680m after Mount Annan Drive;
2. decommission the bus stop eastbound at Macarthur Ford;
3. relocate the bus stop outside Woolworths Caltex on eastbound approach to Hartley Rd 70m to west;
4. relocate the bus stop 70m west of Waterworth Drive closer to Waterworth Drive.
5. relocate the bus stop at Kenny Hill Road (both eastbound and westbound) to the west to the Botanical Gardens access/College Access Road;

Items 1 and 2 are decommissions of existing bus stops and therefore operationally these changes will not cause any noise impacts.

Items 3 and 4 are both relocations where the bus stop still remains within an area of commercial buildings and there are no nearby residences, therefore there will be no change to residential noise impacts.

For Item 5, the relocated east bound bus stop will be near College Access Road, at the eastern end of the aged care village. However there is already an existing bust stop at the western end of the aged care village, which is being moved further west towards Tramway Drive. In general, there are already bus stops in this area and noise from buses slow down and accelerate away from bus stops is already part of the acoustic environment. There is not expected to be any significant change in noise impacts as a result of these bus stop relocations.

5.8 Incident Response Facility

An Incident Response Facility (IRF) is proposed as part of the project, to be located on the south eastern side of the Hume Hwy interchange (CH5400).

As a general guide the IRF would be used as a base for incident response staff to operate from, as well as a location to store incident response equipment and resources. While the IRF would potentially be utilised on a 24/7 basis, vehicle movements would be very minimal and intermittent. Crews and vehicles generally remain on patrol and respond to incidents in the field during patrols. There is not a lot of 'coming and going' from the site.

Vehicles movements would include a combination of:

- Employee's private vehicles (light vehicles) at start and end of shift. Two vehicles per shift as there are two employees in each Traffic Emergency Patrol (TEP) vehicle.
- Traffic Emergency Patrol (TEP) vans (light vehicles) generally outgoing at commencement of shift and incoming at completion of shift (on road most of shift).
- Tow vehicles (light & heavy) generally on standby at the IRF and only responding on a needs basis.
- Visits by Traffic Commanders / Supervisors / Managers.

Since the location of the IRF is more than 300m from the nearest residence and more than 300m from the nearest university building, and since vehicle movements to and from the site are low in number, operational noise emissions from the facility are not predicted cause any

adverse noise impacts. The site is also too far from residences for night time L_{max} noise events to be an issue.

5.9 New Traffic Signals at Kenny Hill Rd

New traffic signals are proposed at the intersection of Narellan Road and Kenny Hill Road. The signals are for vehicle traffic only and do not include pedestrian crossings with audio tactile push buttons.

Interrupted (or stop-and-go) traffic flow conditions resulting from changing traffic signals result in deceleration and acceleration noises as vehicles approach and depart road intersections. These deceleration and acceleration noises differ from the cruising traffic noise that occurs in the absence of traffic signal. The different characteristics which are apparent during interrupted traffic flow conditions make formulating a theoretical traffic noise model difficult and complex for this kind of condition.

Notwithstanding the above, the RLS-90 noise prediction method defines a correction for signalised intersections which is dependent on distance from the road. Assuming a reduced traffic speed as vehicles approach an intersection to stop, and adding the RLS-90 correction, we have conducted noise calculations with and without signalised intersections, and we expect the L_{eq} noise levels to change by less than 1dB(A) at the nearest residence (409 Narellan Road) due to the introduction of the signalised intersection compared to free-flowing traffic. This is consistent with our past experience where noise levels from vehicles were measured at an intersection for both free-flowing and stop-and-go conditions, and the levels were measured to fall within 1dB(A) for each scenario.

This outcome can be explained by there being relatively quiet periods with very little to no traffic noise generated from stopped or slow moving vehicles at an intersection, while there is generally more noise generated from faster continuous moving vehicles found under free-flowing traffic conditions.

In terms of L_{max}, noise levels can be higher near intersections than along equivalent sections of road with continuous traffic flow. This is due to the acceleration of vehicles away from an intersection; however this only occurs for vehicles traveling with instantaneous speeds of less than 60km/h. At instantaneous speeds of approx. 60km/h or greater, a vehicle's passby noise level will tend to be the same whether the vehicle is travelling at a constant speed or accelerating at that instant in time. This is likely due to tyre-to-road noise dominating over engine noise at higher speeds. [Reference: '*Prediction of noise changes due to traffic speed control'*, p2074-2081, JASA 122(4), October 2007].

Therefore, while it is expected that the introduction of the Kenny Hill Road traffic signals may alter the 'character' of noise that the residence at 409 Narellan Road is currently experiencing, it will not significantly alter the absolute level of noise. In any case, at-property treatment is already recommended for this residence due to acute noise.

6 MAXIMUM NOISE LEVEL ASSESSMENT

The RNP does not specify a night-time L_{max} noise limit or noise goal. This is primarily because research conducted to date in this field has not been definitive and the relationship between maximum noise levels, sleep disturbance and subsequent health effects is not currently well defined.

According to the policy however, the likely maximum or peak noise levels are to be broadly assessed and reported for the night-time period, which is considered by the EPA as being 10pm to 7am.

Other than the proposed Kenny Hill Road traffic signals which have been addressed in Section 5.9, this project is a road redevelopment that does not introduce new interruptions to the traffic flow or changes to the traffic mix. Taking guidance from Practice Note iii of the ENMM, we have used the following methodology for assessing maximum noise levels;

- Collate external L_{Amax} and L_{Aeq} noise levels from the monitored existing noise levels between 10 pm and 7 am based on 1 second stored data at all available monitoring locations.
- Calculate the $L_{Amax} - L_{Aeq}$ range from the monitored existing noise levels at each location.
- Predict the future L_{Amax} noise levels based on the proposed road design and distance corrections.
- Analyse L_{Amax} noise levels based on 1 second stored to determine the number of maximum noise events per hour during the night period.
- Predict the future L_{Amax} events by factoring the measured events to the increase in traffic between existing (2011) and future (2026) traffic volumes data provided by RMS.
- Evaluate whether maximum noise impacts will reduce or increase for the design year.

Long term unattended noise monitoring carried out at the monitoring locations along Narellan Road indicated L_{max} traffic noise levels at night as shown in Table 15. Future maximum noise levels at night have been predicted using existing L_{max} noise level data and taking into consideration the proposed road design. It is noted that the assessment of maximum noise levels are only applicable to residential receivers.

Table 15 - Maximum Night-Time Levels at Monitoring Locations, dB(A)

Receiver	Measured 2012									Predicted 2026						
	L_{Amax} Range		L_{Amax} - L_{Aeq} Range		L_{Amax} events Per hour		L_{Amax} Events per Night		Average No. of L_{Amax} Events per night	L_{Amax} Range		L_{Amax} Events per hour		L_{Amax} Events per Night		Average No. of L_{Amax} Events per night
	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max	
63 Liquidamber Dr	65	95	15	36	0	29	10	48	22	65	95	0	43	15	71	32
17 Kokoda Circuit	72	90	15	31	0	12	22	47	39	72	90	0	26	47	100	82
3 Jacks Circuit	66	88	15	29	0	11	30	48	35	66	88	0	16	44	70	51
17 Paddy Miller Ave	65	82	15	26	0	8	10	30	17	65	82	0	12	15	44	26
409 Narellan Rd	70	83	15	24	0	8	5	22	14	70	83	0	12	7	32	20
30 Agar Cottage Cres	65	86	15	31	0	9	14	22	18	65	86	0	12	18	29	23
4 Martin Pl	69	86	15	26	0	8	13	44	23	69	86	0	12	19	64	33

1. Night-time LAmax values are shown only where LAmax > 65dB(A) and where LAmax – LAeq ≥ 15dB(A)

Since the road upgrade involves widening of the road within the same road corridor, the change in distance from road to receiver as a result of the project will be minor and therefore L_{Amax} noise levels in the future will remain similar to current levels.

The number of maximum noise events occurring on any night would increase in proportion to the volume of trucks on the road, and an indication of the expected number of maximum noise events for the future year 2026 has been provided.

7 HEAVY VEHICLE INSPECTION BAY

7.1 Site Description

As part of the Narellan Road upgrade project it is proposed to create a formal heavy vehicle inspection bay. There are currently two options for the location of the proposed truck inspection bay which are as follows:

- Option 1 – Southern side of Narellan Road, west of Mt Annan Drive with Collins Grove and Martin Place to the south
- Option 2 – Southern side of Narellan Road, approximately 100m west of the F5 interchange

The hours of operation for the inspection bay will generally be 6am to 6pm Monday to Saturday, although there may be ad-hoc inspections outside these hours.

Figure 6 and Figure 7 show the locations of the proposed inspection bay and nearby receivers for location Options 1 and 2 respectively. The nearest residential receivers are identified in Table 16.

Table 16 - Truck Inspection Bay Receivers

Option	Receiver ID	Address
1	R1	residences in Collins Grove to the east
	R2	residence in Martin Place to the east
	R3	residences in Paddy Miller Avenue to the north
2	R4	410 Narellan Road
	R5	409 Narellan Road
	R6	4 Kenny Hill Road

Figure 6 – Heavy Vehicle Inspection Bay and Receivers (Option 1)

Figure 7 – Heavy Vehicle Inspection Bay and Receivers (Option 2)

7.2 Operational Noise Criteria

There are no specific criteria for addressing noise from truck inspection bays. Therefore for the purpose of this assessment, it is appropriate to assess its potential impact on the general noise amenity surrounding the site based on the NSW 'Industrial Noise Policy' (INP, Environment Protection Authority 2000) and the EPA's sleep disturbance guidelines.

7.2.1 NSW INP

The assessment procedure in terms of the INP has two components:

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

Intrusiveness Criteria

In order to assess the intrusiveness impact of the inspection bay in accordance with the INP, the applicable noise intrusiveness criterion is as follows:

$L_{Aeq,15min}$ ≤ rating background level plus 5 dB(A)

Amenity Criteria

Assessment of the operation of the inspection bay against the amenity criteria is not suitable as noise events are short duration and only occur infrequently within the day, evening and night periods. The few short duration noise events that do occur within these periods would have no impact on the noise amenity of the surrounding area.

7.2.2 Sleep Disturbance Noise Criteria

Noise emanating from the inspection bay after 10pm and before 7am has the potential for creating sleep disturbance. The INP does not address the issue of sleep disturbance. A number of other publications produced by the EPA however make the general observation that a person's sleep can be significantly disrupted by noise and provide guidance on this matter.

Guidance for assessing sleep disturbance resulting from short-duration high-level noises which occur between 10pm and 7am is taken from the EPA's (ex OEH's) policy with respect to sleep disturbance as follows:

> *"Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*
>
> *OEH reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range*

of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, OEH recognised that current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, OEH will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:

- *how often high noise events will occur*
- *time of day (normally between 10pm and 7am)*
- *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*

The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. OEH will accept analysis based on either LA1, (1 minute) or LAMax).”

The policy states that a sleep disturbance criterion of $L_{A1(1min)} \leq L_{A90(15min)} + 15$dB(A), should be used as a first step 'guide' as it is 'not ideal' and 'where it is not met, a more detailed analysis is required'. That detailed analysis includes a reference to the research material contained in the NSW 'Environmental Criteria for Road Traffic Noise' (ECRTN), 1999 in the assessment of the subject proposal.

Appendix B of the ECRTN summarises the findings of world-wide research undertaken on sleep disturbance from noise up until the time when this publication was produced. It summarises all of the research with the following statement:

“Considering all of the foregoing information the following conclusions can be drawn:

- *Maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions.*
- *One or two noise events per night, with maximum internal noise levels of 65-70dB(A), are not likely to affect health and wellbeing significantly.”*

Therefore, from the above research a 50-55 dB(A) maximum internal noise level would be equivalent to approximately 65-70 dB(A) maximum noise level outside a bedroom window.

These external noise limits are in line with the noise limits described by Griefahn (ref. Acoustics Australia vol 20 No 2 August 1992 pp 43-47) and the NSW ECRTN policy which addresses sleep disturbance.

In summary, the sleep disturbance criteria described in policies presented above are used for the purpose of noise impact assessment for this study. However, due consideration is also given to the ECRTN's research findings in setting an appropriate 'upper' limit, which herein is set as a conservative level of 65dB(A).

7.3 Operational Noise Sources

Typical noise sources for truck inspection bays were obtained from measurements and data in the Renzo Tonin & Associates' library and are summarised in Table 17. The data includes individual sound power levels for a variety of sources associated with trucks, allowing for the assessment of noise impacts against the INP. L_{Amax} source noise levels are also provided as they are to be used to assess the potential for sleep disturbance impact. These levels are used to predict noise levels at the potentially most affected residences.

Table 17 – Sound Power Levels for Truck Inspection Bay Activities

Activity	Sound Power Level, dB(A)	
	L_{eq}	L_{max} / L_1
Truck entering inspection bay	102	–
Truck exiting inspection bay	108	–
Truck idling and refrigerator condenser units on	96	–
Truck reverse signal	–	107
Truck air brake release	–	116

7.4 Predicted Noise Levels & Assessment

7.4.1 Operational Noise

Noise emissions from typical activities at the inspection bay were determined by modelling the noise sources, receiver locations and topographical features of the surrounding area.

We are advised that a typical truck inspection takes approximately five minutes, and generally only one truck is inspected at a time. Allowing time for changeover between the conclusion of one inspection and the beginning of the next, the 'worst-case' scenario for any 15-minute period was assumed to be:

- 2 trucks entering the inspection bay;
- 2 trucks idling continuously with mounted refrigeration equipment on and in use; and
- 2 trucks exiting the inspection bay.

Based on the above worst-case scenario, the predicted operational noise levels at the nearest affected receivers during the day and night time periods are presented below.

Table 18 – Predicted L_{Aeq} Truck Inspection Bay Noise Levels

Receiver		Criteria			Predicted Noise Level, $L_{Aeq,15min}$
ID	Address	Day	Evening	Night	
Option 1					
R1	Collins Grove	58	56	41	49
R2	Martin Place				50
R3	Paddy Miller Avenue	52	51	40	45
Option 2					
R4	410 Narellan Road	60	58	43	44
R5	409 Narellan Road				35
R6	4 Kenny Hill Road				49

Notes:
1. *R1-R2 Noise criteria based on background noise levels measured at Martin Place*
2. *R3 Noise criteria based on background noise levels measured at 17 Paddy Miller Avenue*
3. *R4-R6 Noise criteria based on background noise levels measured at 409 Narellan Road*

Noise levels from the operation of the proposed truck inspection bay for both Options 1 and 2 are predicted to comply with the day and evening criteria. Therefore operation of the bay between 7am and 10pm is permissible.

The inspection bay is also proposed to operate between 6am and 7am. This shoulder period has background noise levels similar to daytime levels due to high levels of traffic during the morning peak. Therefore noise emissions from the inspection bay between 6am and 7am would also comply and operation during this period is also permissible.

The night time noise goals ranging between 40-43dB(A) are determined from the low background noise levels measured in the middle of the night between about 1am and 4am. It would only be during this period where noise from the inspection bay would potentially exceed the noise goals.

In summary, the operational hours of the inspection bay are proposed to generally be from 6am to 6pm Monday to Saturday. Operation during these proposed hours is permissible for both Option 1 and Option 2 locations. While there may also be ad-hoc inspections outside these hours, provided that use of the bay is avoided during the quietest part of the night period between about 1am and 4am, then no adverse noise impacts are expected. In terms of comparison, potential night time noise impacts are less severe, and fewer houses are affected, if the Option 2 location is selected.

7.4.2 Sleep Disturbance

For any use of the inspection bay during the night between 10pm and 7am, sleep disturbance should be considered. For the assessment of sleep disturbance the following worst-case scenario during the night time period was assumed:

- 1 truck releasing air brakes on site; and
- 1 truck reversing with beeping alarm on site.

Based on the above worst-case scenario, the predicted maximum noise levels at the receiver locations are as follows:

Table 19 – Predicted Truck Inspection Bay Maximum Noise Levels

Receiver		Criteria dB(A)		Predicted L_{Amax}
ID	Address	'Background' + 15dB(A)	Upper Limit	
Option 1				
R1	Collins Grove	36+15 = 51	65dB(A)	70
R2	Martin Place			71
R3	Paddy Miller Avenue	35 + 15 = 50		65
Option 2				
R4	410 Narellan Road	38 + 15 = 53	65dB(A)	58
R5	409 Narellan Road			53
R6	4 Kenny Hill Road			63

Maximum noise levels from the operation of the inspection bay are predicted to exceed the 'background + 15' criteria during the night time period at all receivers for both location options of the truck inspection bay.

In terms of the upper limit criteria where research shows that noise levels are unlikely to cause awakening reactions, the Option 2 location complies with this criterion whilst the Option 1 location does not. Therefore Option 2 is the preferred location to avoid sleep disturbance.

If the Option 1 location was selected, approximately eight dwellings in Collins Grove and Martin Place would require some form of noise mitigation. To achieve compliance with the 65dB(A) upper noise limit, suitable noise mitigation measures would be either:

- 'at-property' treatment of approximately 8 dwellings, or
- Construction of a noise barrier approximately 5m in height on the southern boundary of the inspection bay.

8 CONSTRUCTION NOISE ASSESSMENT

8.1 Construction Noise Objectives

8.1.1 Construction Noise Management Levels at Residences

Construction noise management levels are determined by the NSW 'Interim Construction Noise Guideline' (ICNG, DECC 2009). Table 20 below (reproduced from Table 2 of the ICNG) sets out the noise management levels for residences and how they are to be applied.

The guideline intends to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 20 - Noise Management Levels at Residential Receivers

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

Residential receivers are considered 'noise affected' where construction noise levels are greater than the noise management levels identified in Table 20 above. The noise affected level represents the point above which there may be some community reaction to noise. Where predicted and/or measured construction noise levels exceed noise management levels, all feasible and reasonable work practices will be applied to meet the management levels.

During standard construction hours a highly affected noise objective of $L_{Aeq(15min)}$ 75 dB(A) applies at all receivers.

Table 21 identifies the adopted construction noise management levels (NMLs) for receivers within the various NCA's along the route. The NMLs for each NCA are derived from the RBL results of the nearest long term noise monitoring location.

Table 21 - Construction Noise Management Levels at Residential Receivers

NCA	L_{A90} Background Noise Level (RBL)			Noise Management Level $L_{Aeq(15min)}$		
	Day	Evening	Night	Day	Evening	Night
1	48	45	30	58	50	35
2 (west)	48	45	30	58	50	35
2 (east)	56	50	35	66	55	40
4 (west)	51	46	34	61	51	39
4 (east)	47	46	34	57	51	39
5	53	51	36	63	56	41
6	55	53	38	65	58	43
7	55	53	38	65	58	43
8	55	53	38	65	58	43
10	46	44	37	56	49	42

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

8.1.2 Construction Noise Management Levels at Other Sensitive Land Uses

Table 22 sets out the noise management levels for various noise-sensitive land use developments adopted from the ICNG. The noise management levels are applicable where the premises are in use.

Table 22 - Noise Management Levels at Other Noise Sensitive Land Uses

Land use	Where Objective Applies	Management level $L_{Aeq\ (15\ min)}$
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)

Land use	Where Objective Applies	Management level $L_{Aeq\ (15\ min)}$
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)

The sensitive land uses for this project are;

- Narellan child care centre in NCA 1,
- Magdalene Catholic High School in NCA 3,
- Maryfields Friary and Bethlehem Monastery in NCA 8,
- Campbelltown TAFE in NCA 9.

For schools, hospitals and places of worship where an internal management level of 45dB(A) is specified, an equivalent external management level is 65dB(A) assuming 20dB(A) noise reduction through a closed window.

As identified for residential receivers, at all other noise sensitive receivers a highly affected noise objective of $L_{Aeq(15min)}$ 75dB(A) shall apply. Construction activity noise above this level should be handled as described in Table 20 above.

8.1.3 Sleep Disturbance

The ICNG recommends that where construction works are planned to extend over two or more consecutive nights, the assessment should consider maximum noise levels and the extent and frequency of maximum noise level events exceeding the RBL. The ICNG (p15) refers to the discussion on sleep disturbance provided in the NSW Environmental Criteria for Road Traffic Noise (ECRTN, Environment Protection Authority 1999, pp 25-30). The ECRTN presents a summary of the findings from all the research conducted world-wide on sleep disturbance, and after consideration of all the information presented it concludes the following:

- Maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions.
- One or two events per night with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing. (ECRTN p29)

Based on the above, an upper external noise limit of L_{Amax} 65 dB(A) is set as a NML for the purposes of this construction noise assessment.

8.2 Construction Activities

Construction is anticipated to begin in 2014. Whilst construction work would be carried out during daytime hours whenever practicable, due to high traffic volumes on Narellan Road during the day, it is likely that much of the construction work will need to be carried out during the evening and night. All out-of-hours works would be undertaken in accordance with RTA's

'Environmental Noise Management Manual' (2001): Practice Note vii — Road works outside normal working hours.

The following table lists construction activities and the associated major plant and equipment likely to be used by the contractor to carry out the necessary construction work for this project.

Table 23 - Construction Activity & Equipment List

Activity	Plant/ Equipment
Clearing	Chain Saw Tracked Excavator Dump Truck Bull Dozer
Utility Adjustment	Tracked Excavator Dump Truck Mobile Crane
Asphalt pavement demolition	Milling Machine Tracked Excavator Front end loader Dump Truck
Bridgeworks	Piling Drilling Rig Tracked Excavator Concrete Pump Concrete Truck Dump Truck Mobile Crane
Bulk earthworks	Tracked Excavator Dump Truck Rock Breaker Bull Dozer Front end loader Backhoe
Drainage	Tracked Excavator Drilling Rig Dump Truck Front end loader Backhoe
Pavement construction	Mobile Crane Concrete Truck Concrete pump Grader Pavement Laying Machine Roller Generator
Street lighting	Mobile Crane
Signposting and line marking	Mobile Crane Truck
Noise Wall Construction (if required)	Piling Drilling Rig Concrete Truck Mobile Crane Tracked Excavator

8.3 Construction Noise Sources

The following table lists the sound power levels of the plant and equipment likely to be used by the contractor to carry out the necessary construction work for this project.

Table 24 - Typical Construction Equipment & Sound Power Levels

Plant Description	Sound Power Levels, dB(A)	
	L_{Aeq}	L_{Amax}
Rock Breaker	117	125
Concrete Saw	115	118
Piling Drilling Rig	111	124
Mobile Crane	110	116
Compactor	110	116
Front End Loader	110	112
Pavement Laying Machine	109	118
Bulldozer	109	115
Tracked Excavator	107	115
Grader	107	115
Road Milling Machine	108	111
Concrete Truck	106	110
Dump Trucks	105	110
Rollers	104	110
Truck (>20tonne)	103	106
Concrete Pump	102	104
Backhoe	101	108
Power Generator	100	106

Note: LAmax levels only noted for equipment potentially used during the night period

The sound power levels for the majority of activities presented in the above table are based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 "Guide to Noise Control on Construction, Demolition and Maintenance Sites", ICNG, information from past projects and information held in the Renzo Tonin & Associates library files.

8.4 Predicted Noise Levels

Noise emissions were determined by modelling the noise sources, receiver locations, and operating activities as outlined above. Predicted noise levels assume all listed equipment for individual tasks are operating concurrently. This approach is conservative and has been adopted to ensure the full extent of possible noise impacts are assessed (what might occur in the worst-case). Therefore, the noise generated during construction works will generally be below the predictions presented below.

All construction activities are assessed against all time periods to give an indication of the potential noise impacts should construction occur out of hours.

Table 25 presents a summary of the predicted L_{Aeq} noise levels for each activity associated with the construction phase.

Table 26 presents a summary of the predicted L_{Amax} noise levels during potential night time works.

Table 25 – Predicted L_{Aeq} Construction Noise Levels

Activity		NCA 1	NCA 2		NCA 3	NCA 4		NCA 5		NCA 6	NCA 7	NCA 8	NCA 9	NCA 10
			west	east	School	west	east	west	east				TAFE	
NML	*Day*	*58*	*58*	*66*	*65*	*57*	*57*	*63*	*63*	*65*	*65*	*65*	*65*	*56*
	Evening	*50*	*50*	*55*	*65*	*51*	*51*	*56*	*56*	*58*	*58*	*58*	*65*	*49*
	Night	*35*	*35*	*40*	*-*	*39*	*39*	*41*	*41*	*43*	*43*	*43*	*-*	*42*
Clearing		**70**	68	71	50	**69**	**72**	72	67	70	66	45	62	64
Utility adjustments		65	63	66	46	64	67	68	63	65	61	40	58	59
Asphalt Pavement Demolition		67	66	69	48	66	**69**	70	65	67	64	42	60	61
Bridgeworks		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	44	36	39	39	**-**
Bulk earthwork		**72**	**70**	73	52	71	**74**	**74**	69	72	68	47	64	66
Drainage		68	66	69	48	67	**70**	70	65	68	64	43	61	62
Pavement construction		68	66	69	48	67	**70**	70	65	68	64	43	60	62
Street lighting		62	61	64	43	61	64	65	60	62	59	37	55	57
Signposting and line marking		63	61	65	44	62	65	66	61	63	59	38	56	57
Noise Wall Construction (if required)		-	-	**86**	-	58	-	**78**	70	-	-	-	-	-

Notes: *1. **Bold** font represents exceedance of greater than 10dB(A) above the daytime NML (20dB(A) above daytime RBL).*

*2. **Red** font represents exceedance of the 75dB(A) **highly affected** noise objective.*

Table 26 – Predicted L_{Amax} Construction Noise Levels for Night Works

Activity	NCA 1	NCA 2		NCA 3	NCA 4		NCA 5		NCA 6	NCA 7	NCA 8	NCA 9	NCA 10
		west	east	School	west	east	west	east				TAFE	
Sleep Disturbance Night Upper Limit	*65*	*65*	*65*	*-*	*65*	*65*	*65*	*65*	*65*	*65*	*65*	*65*	*65*
Clearing	**71**	**69**	**72**	-	**70**	**73**	**74**	**69**	**71**	**67**	46	-	65
Utility adjustments	**68**	**66**	**69**	-	**67**	**70**	**70**	**65**	**68**	64	43	-	62
Asphalt Pavement Demolition	**69**	**67**	**70**	-	**67**	**70**	**71**	**66**	**68**	65	44	-	63
Bridgeworks	**-**	**-**	**-**	-	**-**	**-**	**-**	**-**	52	44	46	-	**-**
Bulk earthwork	**78**	**76**	**79**	-	**77**	**80**	**81**	**76**	**78**	**74**	53	-	**72**
Drainage	**77**	**75**	**78**	-	**76**	**79**	**80**	**75**	**77**	**73**	52	-	**71**
Pavement construction	**68**	**66**	**69**	-	**67**	**70**	**70**	**65**	**68**	64	43	-	62
Street lighting	**68**	**66**	**69**	-	**67**	**70**	**71**	**66**	**68**	64	43	-	62
Signposting and line marking	**68**	**66**	**69**	-	**67**	**70**	**71**	**66**	**68**	64	43	-	62
Noise Wall Construction (if required)	**-**	**-**	**95**	-	**67**	**-**	**87**	**79**	**-**	**-**	**-**	-	**-**

*Notes: 1. **Bold** font represents exceedance of night time sleep disturbance upper limit.*

8.5 Construction Site Compounds

There are five construction site compounds proposed to be setup during the construction phase to store equipment and materials, site sheds and storage containers. The proposed compounds are:

- Road work compound 1, located on south side of road at CH3200
- Road work compound 2, south eastern side of the Hume Hwy interchange at CH5400
- Road work compound 3, north side of road near Camden Bypass
- Bridge work compound 1, north side of road at CH4350
- Bridge work compound 2, north of Hume Hwy interchange between main carriageways

The proposed hours of use for the compound are generally Monday to Friday (7am to 6pm), Saturday (8am to 1pm), and no work on Sundays and public holidays, however night use will occur to support night time construction works where required.

Figure 8, Figure 9 and Figure 10 display the proposed locations of the site compounds.

Figure 8 – Location of construction compounds (west)

Figure 9 – Location of construction compounds (middle)

Figure 10 – Location of construction compounds (east)

8.5.1 Construction Site Compound Sources

During the period of road construction the activities associated with the compound are likely to include the following:

- light and heavy vehicles accessing the compounds,
- deliveries through heavy vehicles,
- maintenance of plant and equipment,
- mechanical plant associated with the site amenities, and
- people talking.

The following table lists the sound power levels of the plant and equipment associated with the construction site compound.

Table 27 – Site Compound Construction Equipment & Sound Power Levels

Plant/Equipment	L_{Aeq} Sound Power Levels, dB(A)
Typical diesel engine machine warming up	110
Delivery Truck	108
Dump Trucks	108
Water Cart	107
Truck (>20tonne)	106
Light commercial vehicles (eg 4WD)	103
Person talking loudly	76

8.5.2 Predicted Noise Levels from Compounds

Noise levels from site compound activities have been predicted to the nearest affected receivers within nearby noise catchment areas as shown in Table 28 below.

Table 29 presents a summary of the predicted L_{Amax} noise levels during potential night time use of the compounds based on a sound power level of 118dB(A) which represents the impact sound of metal clangs and bangs from the compounds.

Table 28 – Predicted L_{Aeq} Noise Levels from Site Compounds

Compound		NCA1	NCA2	NCA 4	NCA 5	NCA 6	NCA 7	NCA 8	NCA 9
NML	*Day*	*58*	*58*	*57*	*63*	*65*	*65*	*65*	*65*
	Evening	*50*	*50*	*51*	*56*	*58*	*58*	*58*	*65*
	Night	*35*	*35*	*39*	*41*	*43*	*43*	*43*	*-*
Road Compound 1		-	-	61	69	29	28	-	-
Road Compound 2		-	-	-	-	29	34	41	40
Road Compound 3		47	46	-	-	-	-	-	-
Bridge Compound 1		-	-	29	28	73	49	25	28
Bridge Compound 2		-	-	-	-	28	40	40	33

Compound	NCA1	NCA2	NCA 4	NCA 5	NCA 6	NCA 7	NCA 8	NCA 9

Notes:
1. ***Bold*** *font represents exceedance of greater than 10dB(A) above the daytime NML (20dB(A) above daytime RBL).*
2. ***Red*** *font represents exceedance of the 75dB(A)* ***highly affected*** *noise objective.*

Table 29 – Predicted L_{Amax} Noise Levels from Site Compounds

Compound		NCA 1	NCA 2	NCA 4	NCA 5	NCA 6	NCA 7	NCA 8	NCA 9
NML	*Night*	*65*	*65*	*65*	*65*	*65*	*65*	*65*	*65*
Road Compound 1		-	-	60	68	31	31	-	n/a
Road Compound 2		-	-	-	-	32	37	43	n/a
Road Compound 3									-
Bridge Compound 1		-	-	32	31	65	50	28	n/a
Bridge Compound 2		-	-	-	-	26	42	43	n/a

Notes:
1. ***Bold*** *font represents exceedance of night time sleep disturbance upper limit.*

For Road Compound 2 and Bridge Compound 2, all receivers are a sufficient distance away to prevent adverse noise impacts. No additional noise mitigation is required for these compounds.

Road Compound 1 and Bridge Compound 1 could potentially exceed the day, evening and night noise goals while Road Compound 3 would only likely exceed the night time goals at the nearest residential receivers.

For Road Compound 1, Road Compound 3 and Bridge Compound 1, the mitigation options provided below should be applied where reasonable and feasible.

8.6 Construction Noise Mitigation Options

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

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

8.6.1 Standard Noise and Vibration Management Measures

Table 30 sets out standard noise and vibration mitigation, as outlined in the ENMM (Section 5), to be implemented on the Project as required.

Table 30 – Standard Mitigation Measures to Reduce Construction Noise and Vibration

Action Required	Applies to	Details
Management Measures		
Implement community consultation measures – inform community of construction activity and potential impacts	Airborne noise Ground-borne vibration	Incorporate into Community Liaison Plan
Site inductions	Airborne noise Ground-borne vibration	All employees, contractors and subcontractors are to receive a Project induction. The environmental component may be covered in toolboxes and should include: • all relevant project specific and standard noise and vibration mitigation measures; • relevant licence and approval conditions; • permissible hours of work; • any limitations on high noise generating activities; • location of nearest sensitive receivers; • construction employee parking areas; • designated loading/unloading areas and procedures; • site opening/closing times (including deliveries); and • environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height where practicable, throwing of metal items and slamming of doors.
Monitoring	Airborne noise Ground-borne vibration	See Section 8.6.3
Site specific attended vibration measurements	Ground-borne Vibration	As required
Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods if practicable.
Construction respite period	Airborne noise Ground-borne vibration	Noise and vibration generating activities with impulsive, tonal or low frequency characteristics (such as jack hammering, rock breaking, rock hammering, vibratory rolling) should only be carried out: • in continuous blocks, up to but not exceeding 3 hours each; and • with a minimum respite period of one hour between each block.
Equipment selection	Airborne noise Ground-borne vibration	Use quieter and less noise/ vibration emitting construction methods where feasible and reasonable. Where vibration intensive equipment is used within the minimum working distances identified, determine whether alternative construction methodology or less vibration intensive equipment can be used, e.g. when piling is required, use bored piles rather than impact-driven piles.
Maximum noise levels	Airborne noise	All plant and equipment to be appropriately maintained to ensure optimum running conditions, with periodic monitoring.

Action Required	Applies to	Details
Use and siting of plant	Airborne noise Ground-borne vibration	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be limited/ avoided where possible. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised where practicable. Plant used intermittently to be throttled down or shut down when not in use where practicable. Noise-emitting plant to be directed away from sensitive receivers where possible.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) should be fitted and used on all construction vehicles and mobile plant regularly used on site for periods of over two months where practicable.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Ensure all deliveries occur during standard construction hours.
Path Controls		
Shield sensitive receivers from noisy activities	Airborne noise	Where reasonable and feasible, use structures to shield residential receivers from noise such as: • site shed placement; • earth bunds; • temporary noise screens (where practicable) • enclosures to shield fixed noise sources such as pumps, compressors, fans etc screens (where practicable); and • consideration of site topography when situating plant.

8.6.2 Additional Airborne Noise Mitigation Measures

Additional mitigation measures to be considered in preparing CNVMs include:

- **Phone calls:** phone calls detailing relevant information would be made to identified/ affected stakeholders;
- **Letter box drops:** used to disseminate Project information to interested stakeholders and/or to provide advanced warning of high noise impact activities during the day or potentially audible OOHW activities (can also be emailed);
- **Individual briefings:** used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented;
- **Project specific respite offer:** residents subjected to lengthy periods of noise or vibration may be eligible for a Project specific respite offer (e.g. pre-purchased movie tickets);
- **Specific notifications:** letterbox dropped, emailed or hand delivered to advise stakeholders that construction activities are likely to exceed the noise objectives;
- **Monitoring:** noise or vibration monitoring offered to stakeholders likely to incur noise and/ or vibration levels above the applicable levels; and

- **Alternative accommodation:** offered to residents living in close proximity to Project construction works that are likely to incur noise levels at night that are significantly above the applicable levels in Section 8.1.

Table 31 below should be used to advise the appropriate additional noise mitigation.

Table 31 - Additional Airborne Noise Mitigation Measures

Time Period		Mitigation Measures/Predicted LAeq(15min) Noise Level above RBL			
		0 to 10 dB(A) Noticeable	10 to 20 dB(A) Clearly audible	20 to 30 dB(A) Moderately intrusive	>30 dB(A) Highly intrusive
Standard	Mon-Fri (7am-6pm) Sat (8am-1pm) Sun/ Public Hol (Nil)	-	-	Letterbox drop, Monitoring	Letterbox drop, Monitoring
OOHW Period 1	Mon-Fri (6pm-10pm) Sat (7am to 8am & 1pm-10pm) Sun/ Public Hol (8am -6pm)	-	Letterbox Drop	Monitoring, Letterbox Drop	Monitoring, Individual Briefing, Letterbox Drop Project Specific Respite Offer, Phone Calls, Specific Notification
OOHW Period 2	Mon-Fri (10pm-7am) Sat (10pm-7am) Sun/ Public Hol (6pm-8am)	Letterbox Drop	Monitoring, Letterbox Drop	Monitoring, Individual Briefing, Letterbox drop, Phone Calls, Specific Notification	Alternate Accommodation, Monitoring, Individual Briefing, Letterbox Drop, Phone Calls, Specific Notification

Source: TCA Construction Noise Strategy, October 2010

8.6.3 Noise Monitoring

The following approach would be adopted with regard to noise monitoring procedures during the construction works.

- Where potential noise impacts are predicted to be within 10 to 15dB(A) of the noise management level, the potential construction noise nuisance is considered to be moderate. Noise monitoring should be carried out to confirm predicted noise impacts within two weeks of commencement of construction. Reasonable and feasible noise reduction measures would be investigated, where necessary.

- Where potential noise impacts are predicted to be more than 15dB(A) above the noise management levels, the potential construction noise nuisance is considered to be high. All reasonable and feasible noise control measures should be implemented prior to the commencement of construction works. Noise compliance monitoring for all major equipment and activities on the sites should be undertaken prior to their commencement of work on site. Finally, noise levels during construction should be monitored and where

exceeded, further noise reduction measures (where reasonable and feasible) should be implemented eg. restrict working hours, use silencing equipment.

8.6.4 Complaints Handling Procedure

In addition to the noise mitigation measures outlined above, it is recommended that a management procedure be put in place to deal with noise complaints that may arise from the construction works. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.

9 CONSTRUCTION VIBRATION ASSESSMENT

9.1 Construction Vibration Objectives

9.1.1 Disturbance to Buildings Occupants

For disturbance to human occupants of buildings, we refer to the NSW EPA's (ex DECC) 'Assessing Vibration; a technical guideline', published by DECC in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)'.

Vibration sources are defined as Continuous, Impulsive or Intermittent. Table 32 below provides a definition and examples of each type of vibration.

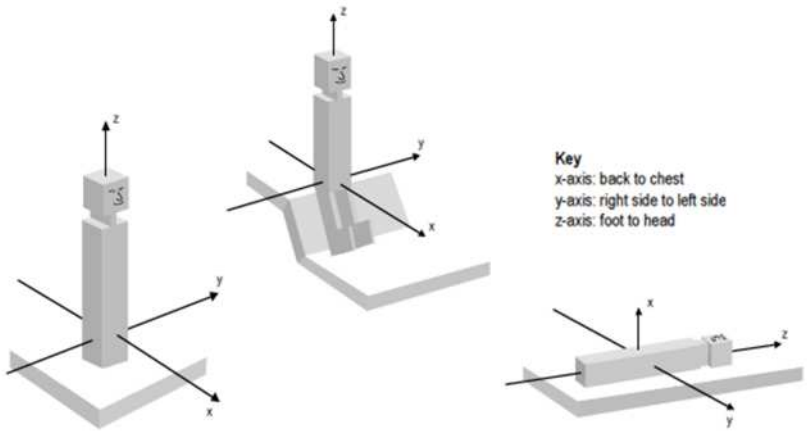
Table 32 – Types of Vibration

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

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

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states: 'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

When applying the criteria, it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.



Source: Assessing Vibration; a technical guideline, Dept Environment & Climate Change 2006 p4

Figure 11 – Orthogonal Axes for Human Exposure to Vibration

Preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced below.

Table 33 – Preferred and Maximum Levels for Human Comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration[3] *(Weighted RMS Acceleration, m/s^2, 1-80Hz)*					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration[3] *(Weighted RMS Acceleration, m/s^2, 1-80Hz)*					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92
Intermittent vibration[4] *(Vibration Dose Values, VDV, m/s$^{1.75}$, 1-80Hz)*					
Critical areas[2]	Day- or night-time	0.10		0.20	
Residences	Daytime	0.20		0.40	
	Night-time	0.13		0.26	
Offices, schools, educational institutions and places of worship	Day- or night-time	0.40		0.80	
Workshops	Day- or night-time	0.80		1.60	

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

Notes:
1. *Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am*
2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992*
3. *For continuous and impulsive vibration the preferred and maximum values are weighted acceleration rms values (m/s^2)*
4. *For intermittent vibration the preferred and maximum values are vibration dose values (VDVs), based on the weighted acceleration values ($m/s^{1.75}$)*

9.1.2 Structural Damage to Buildings

Safe limits for construction generated vibration have been determined using the vibration limits set out in the German Standard *DIN 4150 Part 3-1999 Structural Vibration in Buildings – Effects on Structures*.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (eg historical with preservation orders etc), it is 3mm/s. These limits increase as the frequency content of the vibration increases. These values are presented in Table 34 below and are generally recognised to be conservative.

Table 34 – DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation at Frequency of			Plane of Floor Uppermost Storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	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 Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

9.2 Vibration Sources

The vibration generated from construction works will vary depending on the level and type of activity carried out at each site during each activity.

Table 35 below identifies the dominant vibration generating plant and their typical vibration levels based on library data and measurements from past projects. Potential vibration generated to receivers for this project will be dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver structure.

Table 35 – Typical Ranges of Construction Plant Vibration Levels

Plant Noise Source	PPV Vibration (mm/s) at distance from plant							
	5m	10m	15m	20m	30m	40m	50m	100m
Bobcat (Mustang 2054)	<1	-	-	-	-	-	-	-
Compactor (852G)	5.3	2.0	2.2	1.4	<1	-		
Dozer (D810) (with ripper)	<2	-	-	-	-	-		
Drilling machine – Pneumatic (Atlas Copco (ROC 812HC 20T)	3.2	1	-	-	<0.1	-	<0.1	-
Drilling Rig – Air Trac Rotary (Ingersoll/Rand CM350)	4.4	1.4	-	-	0.6	-	<0.1	-
Drilling Rig – Tracked (Samsung SE 240 LC3 18T)	<2	-	-	-	-	-	-	-
Excavator ≤30T (travelling)	8.0	3.4	1.6	-	-	-		
Excavator ≤30T (digging)	5.8	4.0	0.0	-	-	-		
Excavator & Rock Hammer (20T)	4.5	1.3	-	0.4	0.2	0.15		
Excavator & Rock Hammer (27T)	10.5	2.5	-	-	-	-		
Excavator & Heavy Rock Hammer (eg 1500 kg)	4.5	1.3	-	0.4	0.2	0.15	0.02	-
Grader (20 tonne)	2.0	-	0.2	-	-	-		
Jack hammers	2.0	1.0	0.2	0.1	0.0	0.1		
Piling Rig – Bored (Soilmec 60T) *	2.4	0.2	0.2	-	-	-		
Piling Rig – Sheet (blow energy 60,000 joules)	>90	40	25	20	12	11	7.5	3.5
Piling Rig – Sheet (blow energy 20,000 joules)	>50	20	14	10	7	6	4	2
Piling Rig – Vibratory (Mertz M26)	29-36	16-40	7-17	19-22	2-13	1-15	1-7	1-3.5
Ripper (D10 D375A-2)	1-2	-	-	-	-	-	-	-
Rocksaw (Komatsu AVANCE PC300)	1.5	-	-	-	-	-	-	-
Timber Pole Drill	3.2	1	-	-	-	<0.2		
Truck & Trailer (45T net)	14.5	10.3	3.4	-	-	-		
Vibratory Roller ≤ 3T (Smooth Drum)#	8.7	5.4	-	-	-	-	-	-
Vibratory Roller ≤ 8T (Pad Footed)#	9-12	3.1						
Vibratory Roller ≤ 17T (Smooth Drum)	24.5	8.9	4.2	-	-	-		
Vibratory Roller ≤ 17T (Pad Footed)	15.1	10.3	3.2	-	-	-		

Notes: *Source – Renzo Tonin & Associates database*
** data based on sand/clay soil conditions*
 # Monitor mounted on plate in sands

Site specific buffer distances for vibration significant plant items (e.g. vibratory rollers, compactors, pile boring, pole drilling) must be measured on site. Unlike noise, vibration can't be 'predicted'. There are many variables from site to site, for example soil type and conditions; sub surface rock; building types and foundations; and actual plant on site. The data relied upon in this assessment (tabulated above) is taken from a database of vibration levels measured at various sites or obtained from other sources (e.g. BS5228-2:2009). They are not specific to this project.

9.3 Potential Vibration Impacts

Based on the vibration data presented in Section 9.2 above, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 36 below.

Table 36 – Potential Vibration Impact Assessment

NCA	Approximate distance to nearest buildings	Assessment on Potential Vibration Impacts		
		Structural Damage Risk	Human Disturbance	Vibration Monitoring
1	10 - 15m	**Medium** risk of structural damage from vibratory rolling. **Low** risk of structural damage from other activities.	**High** risk of adverse comment as a result of vibratory rolling.	Vibration monitoring shall be conducted.
2	25 - 30m	**Low** risk of structural damage. **Very Low** risk of structural damage from other activities.	**Medium** risk of adverse comment as a result of vibratory rolling.	Vibration monitoring shall be conducted, where required.
3 School	>100m	**Very Low** risk of structural damage.	**Very Low** risk of adverse comment.	Not required.
4	20 - 25 m	**Low** risk of structural damage. **Very Low** risk of structural damage from other activities.	**Medium** risk of adverse comment as a result of vibratory rolling.	Vibration monitoring shall be conducted, where required.
5	20 - 25 m	**Low** risk of structural damage. **Very Low** risk of structural damage from other activities.	**Medium** risk of adverse comment as a result of vibratory rolling.	Vibration monitoring shall be conducted, where required.
6	60m	**Very Low** risk of structural damage.	**Very Low** risk of adverse comment.	Not required.
7	40m	**Very Low** risk of structural damage.	**Very Low** risk of adverse comment.	Not required.
8	>200m	**Very Low** risk of structural damage.	**Very Low** risk of adverse comment.	Not required.
9	50m	**Very Low** risk of structural damage.	**Very Low** risk of adverse comment.	Not required.

NCA	Approximate distance to nearest buildings	Assessment on Potential Vibration Impacts		
		Structural Damage Risk	Human Disturbance	Vibration Monitoring
10	15 – 20m	**Low** risk of structural damage from vibratory rolling. **Very Low** risk of structural damage from other activities.	**Medium** risk of adverse comment as a result of vibratory rolling.	Vibration monitoring shall be conducted, where required.

Recommendations for reducing potential vibration impacts, including minimum working distances for construction plant are provided in Section 9.4 below.

9.4 Vibration Mitigation

9.4.1 Recommended Minimum Buffer Distances

The pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific. Accordingly, based on our database containing vibration measurements from past projects and library information, Table 37 below presents the recommended minimum working distances for high vibration generating plant.

Table 37 - Recommended Minimum Working Distances for Vibration Intensive Plant

Plant Item	Rating / Description	Minimum Working Distance	
		Cosmetic Damage	Human Response
Vibratory Roller[1]	< 50 kN (Typically 1-2 tonnes)	5 m	15m – 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
	< 300 kN (Typically > 18 tonnes)	25 m	100 m
Compactors[2]	-	15 m	100 m
Dozer[1]	(D810) with ripper	2 m (nominal)	10 m
Excavators[2]	≤ 30 Tonne (travelling/ digging)	10 m	15 m
Grader[1]	<= 20 tonne	2 m (nominal)	10 m
Loaders[2]	-	-	5 m
Small Hydraulic Hammer[2]	300kg (5-12 tonne excavator)	2 m	7 m
Medium Hydraulic Hammer[2]	900kg (12-18 tonne excavator)	7 m	23 m
Large Hydraulic Hammer[2]	1600kg (18-34 tonne excavator)	22 m	73 m
Jackhammer[2]	Hand held	1 m (nominal)	Avoid contact with structure
Truck Movements[2]	-	-	10 m

Notes: 1. *TCA Construction Noise Strategy (Rail Projects) November 2011*
2. *Renzo Tonin & Associates project files, databases & library*

Site specific buffer distances should be determined once vibration emission levels are measured from each plant item prior to the commencement of their regular use on site. Where construction activity occurs in close proximity to sensitive receivers, minimum buffer distances to affected receivers should be determined by site measurements and maintained in order to comply with relevant vibration limits.

9.4.2 Vibration Management Measures

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers and to meet the relevant human comfort and structural damage vibration limits:

1. A management procedure should be implemented to deal with vibration complaints. Each complaint should be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures should be put in place to mitigate future occurrences.

2. Where vibration is found to be excessive, management measures should be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones as mentioned above, and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

3. Where construction activity occurs in close proximity to sensitive receivers, vibration testing of actual equipment on site would be carried out prior to their commencement of site operation to determine acceptable buffer distances to the nearest affected receiver locations.

4. Dilapidation surveys should be conducted at all buildings within the distances identified in the last column of Table 37. These distances are set to address potential community concerns that perceived vibration may have caused damage to property.

9.5 Vibration Impacts on Sydney Water Upper Canal

The Sydney Water Upper Canal is a heritage listed item. There are proposed bridge works over the canal which includes boring of piles either side of the canal.

Whilst it is not known what level of vibration would necessarily cause damage to the canal, guidance is taken from the structural damage criteria outlined in DIN 4150 (see Table 34). The Group 3 limits apply to sensitive structures and heritage listed items, and the criterion suggests that 3mm/s is a safe vibration limit.

Based on the vibration levels for bored piling rigs and excavators presented in Table 35, a buffer distance of approximately 10m is initially suggested as a safe working distance between the piling rig and the canal and culvert. However RMS has advised that bored piles could be as close as 1.2m to the canal.

Vibration emission levels from the specific plant on site should be measured prior to the commencement of piling works so that site specific safe buffer distances can be more accurately determined. A pre-construction survey of the condition and structural integrity of the canal is also recommended.

Wherever piles are to be bored within the site determined safe buffer distance, vibration monitoring should be carried out during piling. Modification to the bridge design, piling method or use of smaller equipment may be required to reduce vibration levels.

10 CONCLUSION

Renzo Tonin & Associates have completed a noise and vibration assessment of the proposed upgrade of Narellan Road, between Camden Valley Way and Blaxland Road. Noise from the operation of the upgraded road has been assessed, along with noise and vibration associated with the project construction activities.

The findings of this study are:

Traffic Noise Assessment:

- Traffic noise levels at the design year for the 'build' option are predicted to be within 2dB(A) of the 'no build' option and therefore the noise impact of the project is considered acceptable with regard to operational noise.
- Existing and future traffic noise levels are 'acute' at some residential receivers and therefore according to RMS assessment procedures, these properties must be considered for noise mitigation. The properties to be considered for noise treatment have been identified and possible noise mitigation options have been discussed. Since the project is still in concept phase, final noise mitigation treatments will not be decided until the 'detailed design phase' to allow for all design changes to be considered.
- Two options for the location of the Heavy Vehicle Inspection Bay have been investigated. Whilst neither location is expected to cause adverse noise impacts during the daytime hours when the bay is most commonly used, the selection of the Option 2 location near the F5 interchange would better avoid potential sleep disturbance of residents during any night time use.

Construction Noise and Vibration Assessment:

- Construction noise is likely to exceed the construction noise goals during all periods for the majority of receivers along with the construction route. Impacts will be greatest during any night time work, especially for those residences that front Narellan Road with minimal shielding and distance to the road. All reasonable and feasible noise mitigation should be applied during the construction phase. Possible noise mitigation measures and their effectiveness have been discussed.
- The risk of structural damage during construction is generally assessed as being low risk, although there is medium risk for the nearest receivers. There is generally a medium risk of adverse comment from the nearest receivers for felt vibration. Vibration mitigation measures and indicative buffer distances have been provided.
- The Sydney Water Upper Canal could potentially be adversely impacted due to bored piling close to the canal. Specific safe buffer distances shall be determined on site prior to the commencement of piling and a pre-construction survey of the condition and structural

integrity of the canal shall be carried out. Modification to construction process or equipment size may be required.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

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

Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A):	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
Lmax	The maximum sound pressure level measured over a given period.
Lmin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

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

APPENDIX B - NOISE MONITORING METHODOLOGY

B.1 Noise Monitoring Equipment

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

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave Band Data
RTA05 (NTi Audio XL2)	Type 1	1/1 octaves
RTA06 (NTi Audio XL2, with low noise microphone)	Type 1	1/1 octaves

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

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 or 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology during Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the INP. The Bureau of Meteorology (BOM) provided meteorological data, which is considered representative of the site, for the duration of the noise monitoring period. The data was modified to allow for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data was taken from *Australian Standard AS1170.2 1989 Section 4.2.5.1*.

B.3 Noise vs Time Graphs

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

APPENDIX C - OPERATIONAL NOISE PREDICTIONS (WITHOUT MITIGATION)

Narellan Road Upgrade - Operational Noise Assessment

NCA	Receiver	Floor	Year of Opening 'No Build' Scenario dB(A)		Year of Opening 'Build' Scenario dB(A)		Design Year 'No Build' Scenario dB(A)		Design Year 'Build' Scenario dB(A)		RNP Criteria dB(A)		Are the RNP Criteria exceeded?		Change in noise level dB(A)				Acute Level of Noise?		Consider Noise Mitigation (YES/NO)	Comments
															Year Opening		Design Year					
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night		
NCA 1 - Camden Valley Way to Camden Bypass																						
1	40 Woodland Crescent	G	59	51	59	51	59	52	59	52	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
1	42 Woodland Crescent	G	60	53	60	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
1	44 Woodland Crescent	G	61	54	61	54	62	54	62	54	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
1	46 Woodland Crescent	G	62	54	62	54	62	55	62	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
1	48 Woodland Crescent	G	64	57	64	57	64	57	64	57	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	At-property treatment already applied in the past
1	50 Woodland Crescent.	G	62	55	62	55	63	56	63	56	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	At-property treatment already applied in the past
1	52 Woodland Crescent	G	63	56	63	56	63	56	63	56	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	At-property treatment already applied in the past
1	54 Woodland Crescent	G	64	57	64	57	64	57	64	57	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	At-property treatment already applied in the past
1	56 Woodland Crescent	G	63	56	63	56	64	57	64	57	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	At-property treatment already applied in the past
1	58 Woodland Crescent	G	65	58	65	58	66	59	66	59	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	NO	NO	At-property treatment already applied in the past
1	60 Woodland Crescent	G	64	57	64	57	65	58	65	58	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	NO	NO	At-property treatment already applied in the past
1	62 Woodland Crescent	G	64	57	64	57	65	57	65	57	60	55	YES	YES	0.0	0.0	0.0	-0.1	YES	NO	NO	At-property treatment already applied in the past
1	64 Woodland Crescent	G	64	57	64	57	65	58	65	57	60	55	YES	YES	0.0	-0.1	0.0	-0.1	YES	NO	NO	At-property treatment already applied in the past
1	66 Woodland Crescent	G	63	56	63	56	64	57	64	57	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	At-property treatment already applied in the past
1	66 Woodland Crescent	1	66	59	66	59	67	60	67	60	60	55	YES	YES	-0.1	-0.1	0.0	0.0	YES	YES	NO	At-property treatment already applied in the past
1	68 Woodland Crescent	G	67	60	67	60	68	60	67	60	60	55	YES	YES	-0.1	-0.1	-0.1	-0.1	YES	YES	NO	At-property treatment already applied in the past
1	70 Woodland Crescent	G	67	59	67	59	67	60	67	60	60	55	YES	YES	0.0	-0.1	0.0	-0.1	YES	YES	NO	At-property treatment already applied in the past
1	72 Woodland Crescent	G	64	57	64	57	65	58	65	58	60	55	YES	YES	0.0	0.0	0.0	-0.1	YES	NO	NO	At-property treatment already applied in the past
1	74 Woodland Crescent	G	62	55	62	55	62	55	62	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	At-property treatment already applied in the past
1	1A Doncaster - Narellan Child Care Centre	G	66	-	66	-	66	-	66	-	45/50	-	YES	-	0.0	-	0.0	-	N/A	-	NO	At-property treatment already applied in the past
1	1 Doncaster	G	58	51	58	51	58	51	58	51	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
1	2A Doncaster	G	63	56	64	57	63	56	64	57	60	55	YES	YES	0.9	0.8	0.8	0.9	NO	NO	NO	
1	2A Doncaster	1	65	58	66	59	65	58	66	59	60	55	YES	YES	0.9	0.9	1.0	1.0	YES	NO	YES	At-property treatments already implemented at some acute properties during previous intersection upgrade project. This project does not significantly increase noise levels therefore additional nosie mitigation is not warranted for properties that are already treated. Reasonable and fesible noise mitigation would be considered for acute properties that are identified as having not received noise mitigation in the past.
1	2B Doncaster	G	61	54	62	54	61	54	62	55	60	55	YES	NO	0.5	0.5	0.5	0.5	NO	NO	NO	
1	2B Doncaster	1	64	57	64	57	64	57	64	57	60	55	YES	YES	0.5	0.6	0.5	0.6	NO	NO	NO	
1	2C Doncaster	G	63	56	63	56	63	56	63	56	60	55	YES	YES	0.5	0.4	0.4	0.4	NO	NO	NO	
1	2 Doncaster	G	58	51	59	51	59	52	59	52	60	55	NO	NO	0.1	0.1	0.0	0.0	NO	NO	NO	
1	4 Doncaster	G	57	50	57	50	57	50	58	50	60	55	NO	NO	0.1	0.1	0.1	0.0	NO	NO	NO	
													Total number of properties where further mitigation should be considered								1	
NCA 2 - Camden bypass to Wentworth Drive																						
2	1 Kokoda Circuit	G	67	60	67	60	69	61	69	61	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	YES	YES	
2	3 Kokoda Circuit	G	66	58	66	58	67	60	67	60	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	YES	YES	
2	5 Kokoda Circuit	G	66	58	66	58	67	59	67	59	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	NO	YES	
2	7 Kokoda Circuit	G	64	57	64	57	65	58	65	58	60	55	YES	YES	0.0	0.0	0.0	-0.1	YES	NO	YES	
2	9 Kokoda Circuit	G	68	60	67	60	69	61	69	61	60	55	YES	YES	-0.1	-0.1	0.0	0.0	YES	YES	YES	
2	11 Kokoda Circuit	G	66	59	66	59	67	60	67	60	60	55	YES	YES	0.0	-0.1	0.0	0.0	YES	YES	YES	
2	13 Kokoda Circuit	G	66	59	66	59	67	60	67	60	60	55	YES	YES	0.0	0.0	-0.1	0.0	YES	YES	YES	
2	15 Kokoda Circuit	G	68	61	68	61	69	62	69	62	60	55	YES	YES	0.0	0.0	-0.1	-0.1	YES	YES	YES	
2	17 Kokoda Circuit	G	68	61	68	61	70	62	70	62	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	YES	YES	
2	19 Kokoda Circuit	G	68	60	68	60	69	62	69	62	60	55	YES	YES	0.0	0.1	0.0	0.0	YES	YES	YES	
2	21 Kokoda Circuit	G	68	61	68	61	69	62	70	62	60	55	YES	YES	0.0	0.0	0.1	0.1	YES	YES	YES	
2	27 Kokoda Circuit	G	63	55	63	55	64	56	64	57	60	55	YES	YES	0.0	0.0	0.1	0.1	NO	NO	NO	
2	29 Kokoda Circuit	G	60	53	61	53	62	54	62	55	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
2	31 Kokoda Circuit	G	61	53	61	53	62	55	62	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
2	31 Kokoda Circuit	1	69	62	69	62	70	63	70	63	60	55	YES	YES	0.1	0.0	0.0	0.0	YES	YES	YES	Consider mitigation for Level 1 only
2	33 Kokoda Circuit	G	62	55	62	55	63	56	63	56	60	55	YES	YES	0.1	0.1	0.1	0.1	NO	NO	NO	
2	33 Kokoda Circuit	1	67	60	67	60	68	61	69	61	60	55	YES	YES	0.0	0.0	0.1	0.0	YES	YES	YES	Consider mitigation for Level 1 only
2	9 Ramsay Close	G	65	57	65	57	66	58	66	59	60	55	YES	YES	0.1	0.0	0.0	0.1	YES	NO	YES	
2	11 Ramsay Close	G	64	56	64	56	65	57	65	58	60	55	YES	YES	0.0	0.0	0.0	0.1	YES	NO	YES	
2	13 Ramsay Close	G	62	55	62	55	63	56	63	56	60	55	YES	YES	0.0	0.0	0.0	0.1	NO	NO	NO	
2	15 Ramsay Close	G	61	54	61	54	63	55	63	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
2	17 Ramsay Close	G	63	55	63	55	64	56	64	56	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
2	11 Blamey Place	G	61	54	62	54	63	55	63	55	60	55	YES	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
2	12 Blamey Place	G	65	58	66	58	67	59	67	59	60	55	YES	YES	0.1	0.1	0.1	0.2	YES	NO	YES	
2	57 Montgomery Street	G	59	52	60	52	61	53	61	53	60	55	YES	NO	0.1	0.0	0.0	0.0	NO	NO	NO	
2	29 Montgomery Street	G	61	53	61	53	62	54	62	55	60	55	YES	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
2	31 Montgomery Street	G	62	54	62	54	63	55	63	55	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
2	33 Montgomery Street	G	62	55	62	55	64	56	64	56	60	55	YES	YES	0.1	0.1	0.1	0.1	NO	NO	NO	
2	35 Montgomery Street	G	63	56	63	56	64	57	64	57	60	55	YES	YES	0.1	0.1	0.1	0.0	NO	NO	NO	

NCA	Receiver		Year of Opening 'No Build' Scenario dB(A)		Year of Opening 'Build' Scenario dB(A)		Design Year 'No Build' Scenario dB(A)		Design Year 'Build' Scenario dB(A)		RNP Criteria dB(A)		Are the RNP Criteria exceeded?		Change in noise level dB(A)				Acute Level of Noise?		Consider Noise Mitigation	Comments
															Year Opening		Design Year					
		Floor	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	(YES/NO)	
2	37 Montgomery Street	G	62	55	62	55	64	56	64	56	60	55	YES	YES	0.1	0.1	0.1	0.0	NO	NO	NO	
2	39 Montgomery Street	G	63	55	63	55	64	56	64	56	60	55	YES	YES	0.0	0.0	0.0	0.1	NO	NO	NO	
2	41 Montgomery Street	G	63	55	63	55	64	56	64	56	50	-	YES	-	0.1	0.1	0.1	0.0	NO	NO	NO	
2	43 Montgomery Street	G	62	55	62	55	63	56	63	56	60	55	YES	YES	0.1	0.1	0.1	0.1	NO	NO	NO	
2	45 Montgomery Street	G	62	54	62	54	63	55	63	56	60	55	YES	YES	0.1	0.1	0.0	0.1	NO	NO	NO	
2	47 Montgomery Street	G	62	54	62	54	63	55	63	56	60	55	YES	YES	0.0	0.1	0.1	0.1	NO	NO	NO	
2	49 Montgomery Street	G	61	54	61	54	62	55	62	55	60	55	YES	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
2	51 Montgomery Street	G	61	53	61	53	62	54	62	55	60	55	YES	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
2	53 Montgomery Street	G	61	54	61	54	62	55	62	55	60	55	YES	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
2	55 Montgomery Street	G	61	53	61	53	62	55	62	55	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
2	86 Tobruk Road	G	60	53	60	53	62	54	62	54	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
2	88 Tobruk Road	G	61	53	61	53	62	55	62	55	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
2	90 Tobruk Road	G	60	53	60	53	62	54	62	54	60	55	YES	NO	0.1	0.1	0.0	0.0	NO	NO	NO	
2	92 Tobruk Road	G	62	55	62	55	63	56	63	56	60	55	YES	YES	0.1	0.1	0.1	0.0	NO	NO	NO	
2	59 Liquidamober Drive	G	60	53	60	53	61	54	61	54	60	55	YES	NO	0.1	0.1	0.0	0.1	NO	NO	NO	
2	63 Liquidamober Drive	G	60	53	60	53	62	54	62	54	60	55	YES	NO	0.1	0.0	0.0	0.0	NO	NO	NO	
2	65 Liquidamober Drive	G	61	53	61	53	62	55	62	55	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
2	69 Liquidamober Drive	G	61	54	61	54	62	55	62	55	60	55	YES	NO	0.1	0.1	0.1	0.0	NO	NO	NO	
2	74 Narellan Road	G	62	54	62	54	63	55	63	55	60	55	YES	NO	0.0	0.0	0.1	0.0	NO	NO	NO	
2	1 Lae Place	G	59	52	59	52	60	53	60	53	60	55	NO	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
2	1 Lae Place	1	66	58	66	58	67	59	67	59	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	NO	YES	Consider mitigation for Level 1 only
2	3 Lae Place	G	60	52	60	52	61	54	61	54	60	55	YES	NO	0.0	0.0	0.0	0.1	NO	NO	NO	
2	3 Lae Place	1	66	58	66	58	67	59	67	59	60	55	YES	YES	0.0	0.0	0.1	0.1	YES	NO	YES	
2	5 Lae Place	G	60	53	60	53	62	54	62	54	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
2	5 Lae Place	1	66	58	66	59	67	60	67	60	60	55	YES	YES	0.1	0.1	0.0	0.0	YES	YES	YES	Consider mitigation for Level 1 only
2	12 Vale Circuit	G	59	52	59	52	60	53	60	53	60	55	NO	NO	0.0	0.1	0.0	0.1	NO	NO	NO	
2	14 Vale Circuit	G	59	52	59	52	60	53	60	53	60	55	NO	NO	0.0	0.1	0.0	0.0	NO	NO	NO	
2	16 Vale Circuit	G	59	52	59	52	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
2	18 Vale Circuit	G	60	53	60	53	61	54	61	54	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
2	60 Narellan Road	G	61	53	61	53	62	55	62	55	60	55	YES	NO	-0.1	0.0	0.0	-0.1	NO	NO	NO	
													Total number of properties where further mitigation should be considered								19	
								NCA 3 - School														
3	Magdalene Catholic High School	G	59	-	59	-	60	-	60	-	50	-	YES	-	0.0	-	0.0	-	N/A	-	NO	Existing noise levels already exceed the RNP goals and the Project does not increase noise levels, therefore no additinoal nosie mitigation is required
								NCA 4 - Hartley Road to Tramway Drive (Inc French Place & retirement village)														
4	1-359 Narellan Rd	G	68	62	68	62	69	63	69	63	60	55	YES	YES	-0.1	-0.1	-0.1	-0.1	YES	YES	YES	
4	2-359 Narellan Rd	G	68	63	68	63	69	64	69	64	60	55	YES	YES	0.0	0.0	0.0	-0.1	YES	YES	YES	
4	3-359 Narellan Rd	G	66	61	66	61	67	62	67	62	60	55	YES	YES	0.0	-0.1	-0.1	-0.1	YES	YES	YES	Retirement village appears currently unoccupied
4	6-359 Narellan Rd	G	70	64	70	64	71	65	70	65	60	55	YES	YES	-0.1	-0.1	-0.2	-0.2	YES	YES	YES	
4	10-359 Narellan Rd	G	67	62	67	62	68	62	68	62	60	55	YES	YES	-0.1	-0.1	-0.1	-0.1	YES	YES	YES	
4	61-359 Narellan Rd	G	66	60	66	60	66	61	66	61	60	55	YES	YES	-0.1	-0.1	-0.2	-0.2	YES	YES	YES	
4	62-359 Narellan Rd	G	58	53	58	53	59	53	59	53	60	55	NO	NO	0.0	-0.1	-0.1	0.0	NO	NO	NO	
4	63-359 Narellan Rd	G	69	64	69	64	70	65	70	64	60	55	YES	YES	-0.3	-0.4	-0.3	-0.3	YES	YES	YES	
4	1 French Pl	G	64	58	64	58	65	59	64	59	60	55	YES	YES	0.0	-0.1	-0.1	-0.1	NO	NO	NO	
4	3 French Pl	G	63	58	63	58	64	58	64	58	60	55	YES	YES	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	5 French Pl	G	63	57	63	57	64	58	64	58	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
4	25 Outram Pl	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
4	27 Outram Pl	G	61	56	61	56	62	56	62	56	60	55	YES	YES	0.0	0.1	0.0	0.1	NO	NO	NO	
4	29 Outram Pl	G	60	54	60	54	61	55	61	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
4	31 Outram Pl	G	62	57	62	57	63	57	63	57	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
4	33 Outram Pl	G	62	57	62	57	63	58	63	58	60	55	YES	YES	0.0	-0.1	0.0	-0.1	NO	NO	NO	
4	35 Outram Pl	G	62	56	62	56	63	57	63	57	60	55	YES	YES	-0.1	-0.1	-0.1	0.0	NO	NO	NO	
4	37 Outram Pl	G	62	57	62	57	63	57	63	57	60	55	YES	YES	-0.1	0.0	0.0	0.0	NO	NO	NO	
4	39 Outram Pl	G	62	56	62	56	62	57	62	57	60	55	YES	YES	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	41 Outram Pl	G	62	56	62	56	63	57	63	57	60	55	YES	YES	-0.1	-0.1	0.0	0.0	NO	NO	NO	
4	5 Cass St	G	63	57	63	57	64	58	64	58	60	55	YES	YES	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	7 Cass St	G	62	57	62	57	63	58	63	58	60	55	YES	YES	0.0	0.0	-0.1	-0.1	NO	NO	NO	
4	17 Paddy Miller Ave	G	62	56	62	56	63	57	63	57	60	55	YES	YES	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	19 Paddy Miller Ave	G	62	56	62	56	63	57	63	57	60	55	YES	YES	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	21 Paddy Miller Ave	G	62	56	62	56	63	57	63	57	60	55	YES	YES	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	23 Paddy Miller Ave	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	-0.1	0.0	-0.1	NO	NO	NO	

NCA	Receiver		Year of Opening 'No Build' Scenario dB(A)		Year of Opening 'Build' Scenario dB(A)		Design Year 'No Build' Scenario dB(A)		Design Year 'Build' Scenario dB(A)		RNP Criteria dB(A)		Are the RNP Criteria exceeded?		Change in noise level dB(A)				Acute Level of Noise?		Consider Noise Mitigation	Comments
															Year Opening		Design Year					
		Floor	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	(YES/NO)	
4	25 Paddy Miller Ave	G	62	57	62	57	63	58	63	57	60	55	YES	YES	0.0	0.0	-0.1	-0.1	NO	NO	NO	
4	27 Paddy Miller Ave	G	61	55	61	55	62	56	62	56	60	55	YES	YES	-0.1	0.0	-0.1	0.0	NO	NO	NO	
4	29 Paddy Miller Ave	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	31 Paddy Miller Ave	G	61	56	61	56	62	57	62	57	60	55	YES	YES	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	33 Paddy Miller Ave	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	-0.1	0.0	-0.1	NO	NO	NO	
4	35 Paddy Miller Ave	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	37 Paddy Miller Ave	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	39 Paddy Miller Ave	G	61	55	61	55	62	56	62	56	60	55	YES	YES	-0.1	0.0	0.0	0.0	NO	NO	NO	
4	41 Paddy Miller Ave	G	61	55	61	55	61	56	61	56	60	55	YES	YES	-0.1	0.0	0.0	-0.1	NO	NO	NO	
4	43 Paddy Miller Ave	G	60	54	60	54	61	55	61	55	60	55	YES	NO	0.0	-0.1	-0.1	0.0	NO	NO	NO	
4	45 Paddy Miller Ave	G	59	54	59	54	60	55	60	55	60	55	NO	NO	0.0	-0.1	-0.1	0.0	NO	NO	NO	
4	47 Paddy Miller Ave	G	60	54	60	54	61	55	61	55	60	55	YES	NO	0.0	-0.1	0.0	-0.1	NO	NO	NO	
4	49 Paddy Miller Ave	G	59	54	59	54	60	54	60	54	60	55	NO	NO	-0.1	0.0	-0.1	0.0	NO	NO	NO	
4	51 Paddy Miller Ave	G	59	53	59	53	60	54	60	54	60	55	NO	NO	-0.1	-0.1	0.0	-0.1	NO	NO	NO	
4	53 Paddy Miller Ave	G	59	53	59	53	60	54	60	54	60	55	NO	NO	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	55 Paddy Miller Ave	G	59	53	59	53	60	54	60	54	60	55	NO	NO	-0.1	0.0	-0.1	-0.1	NO	NO	NO	
4	57 Paddy Miller Ave	G	59	53	59	53	60	54	60	54	60	55	NO	NO	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	59 Paddy Miller Ave	G	58	52	58	52	59	53	59	53	60	55	NO	NO	-0.1	-0.1	0.0	-0.1	NO	NO	NO	
4	1 Kidd Ct	G	59	53	59	53	60	54	60	54	60	55	NO	NO	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	3 Kidd Ct	G	59	53	59	53	59	54	59	54	60	55	NO	NO	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	4 Kidd Ct	G	58	52	58	52	59	53	59	53	60	55	NO	NO	-0.1	0.0	-0.1	0.0	NO	NO	NO	
4	6 Kidd Ct	G	59	53	59	53	60	54	60	54	60	55	NO	NO	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	2 Jones Circuit	G	59	54	59	54	60	55	60	55	60	55	NO	NO	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	3 Jones Circuit	G	59	53	59	53	60	54	60	54	60	55	NO	NO	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	3 Jones Circuit	1	63	57	63	57	63	58	63	58	60	55	YES	YES	0.0	0.0	0.0	-0.1	NO	NO	NO	
4	4 Jones Circuit	G	59	54	59	54	60	54	60	54	60	55	NO	NO	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	5 Jones Circuit	G	59	54	59	53	60	54	60	54	60	55	NO	NO	-0.1	-0.1	0.0	-0.1	NO	NO	NO	
4	30 Charles Babbage Ave	G	59	54	59	54	60	55	60	54	60	55	NO	NO	0.0	0.0	0.0	-0.1	NO	NO	NO	
4	32 Charles Babbage Ave	G	59	54	59	54	60	54	60	54	60	55	NO	NO	-0.1	0.0	-0.1	0.0	NO	NO	NO	
4	34 Charles Babbage Ave	G	60	54	59	54	60	55	60	55	60	55	NO	NO	-0.1	0.0	0.0	0.0	NO	NO	NO	
4	36 Charles Babbage Ave	G	60	54	60	54	61	55	61	55	60	55	YES	NO	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	38 Charles Babbage Ave	G	60	54	60	54	61	55	61	55	60	55	YES	NO	-0.1	0.0	-0.1	0.0	NO	NO	NO	
4	40 Charles Babbage Ave	G	60	55	60	55	61	56	61	55	60	55	YES	NO	-0.1	-0.1	0.0	-0.1	NO	NO	NO	
4	42 Charles Babbage Ave	G	61	55	60	55	61	56	61	56	60	55	YES	YES	-0.1	-0.1	0.0	-0.1	NO	NO	NO	
4	44 Charles Babbage Ave	G	60	54	60	54	60	55	60	55	60	55	NO	NO	-0.1	0.0	-0.1	-0.1	NO	NO	NO	
4	46 Charles Babbage Ave	G	59	53	59	53	60	54	60	54	60	55	NO	NO	-0.1	0.0	-0.1	-0.1	NO	NO	NO	
4	1 Jacks Circuit	G	59	53	59	53	60	54	60	54	60	55	NO	NO	-0.1	0.0	-0.1	0.0	NO	NO	NO	
4	2 Jacks Circuit	G	60	54	60	54	61	55	61	55	60	55	YES	NO	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	3 Jacks Circuit	G	61	55	61	55	62	56	62	56	60	55	YES	YES	-0.1	-0.1	0.0	0.0	NO	NO	NO	
4	4 Jacks Circuit	G	60	54	60	54	61	55	61	55	60	55	YES	NO	0.0	-0.1	-0.1	0.0	NO	NO	NO	
4	5 Jacks Circuit	G	60	55	60	54	61	55	61	55	60	55	YES	NO	0.0	-0.1	-0.1	0.0	NO	NO	NO	
4	2 Baldwin Way	G	61	56	61	56	62	56	62	56	60	55	YES	YES	-0.1	-0.1	-0.2	-0.1	NO	NO	NO	
4	4 Baldwin Way	G	62	56	62	56	63	57	63	57	60	55	YES	YES	-0.2	-0.1	-0.1	-0.1	NO	NO	NO	
4	6 Baldwin Way	G	62	56	61	56	62	57	62	56	60	55	YES	YES	-0.2	-0.1	-0.1	-0.1	NO	NO	NO	
4	8 Baldwin Way	G	60	55	60	55	61	55	61	55	60	55	YES	NO	-0.1	-0.1	-0.2	-0.1	NO	NO	NO	
4	10 Baldwin Way	G	61	55	61	55	62	56	62	56	60	55	YES	YES	-0.2	-0.1	-0.1	-0.1	NO	NO	NO	
4	12 Baldwin Way	G	61	55	61	55	62	56	61	56	60	55	YES	YES	-0.1	-0.1	-0.2	-0.1	NO	NO	NO	
4	14 Baldwin Way	G	62	56	62	56	63	57	62	57	60	55	YES	YES	-0.1	-0.1	-0.2	-0.1	NO	NO	NO	
4	13 Manning Place	G	61	55	61	55	62	56	62	56	60	55	YES	YES	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	15 Manning Place	G	61	54	60	54	61	55	61	55	60	55	YES	NO	-0.1	-0.1	-0.1	-0.1	NO	NO	NO	
4	17 Manning Place	G	60	54	60	54	61	54	61	54	60	55	YES	NO	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	19 Manning Place	G	60	53	60	53	60	54	60	54	60	55	NO	NO	-0.1	0.0	0.0	0.0	NO	NO	NO	
4	21 Manning Place	G	60	54	60	54	61	54	61	54	60	55	YES	NO	-0.1	0.0	0.0	0.0	NO	NO	NO	
4	23 Manning Place	G	60	53	60	53	60	54	60	54	60	55	NO	NO	-0.1	0.0	-0.1	-0.1	NO	NO	NO	
4	25 Manning Place	G	59	53	59	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
4	27 Manning Place	G	59	53	59	53	60	53	60	53	60	55	NO	NO	0.0	-0.1	0.0	0.0	NO	NO	NO	
4	29 Manning Place	G	58	51	58	51	59	52	59	52	60	55	NO	NO	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	29 Manning Place	1	63	56	63	56	63	57	63	57	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
4	31 Manning Place	G	58	51	58	51	59	52	58	52	60	55	NO	NO	0.0	0.0	-0.1	0.0	NO	NO	NO	
4	33 Manning Place	G	59	52	59	52	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
4	35 Manning Place	G	60	52	60	52	60	53	60	53	60	55	NO	NO	-0.1	0.0	0.0	0.0	NO	NO	NO	
4	37 Manning Place	G	59	51	59	51	59	52	59	52	60	55	NO	NO	0.0	-0.1	0.0	0.0	NO	NO	NO	

Total number of properties where further mitigation should be considered 7

These nominated properties are all related to the retirement village

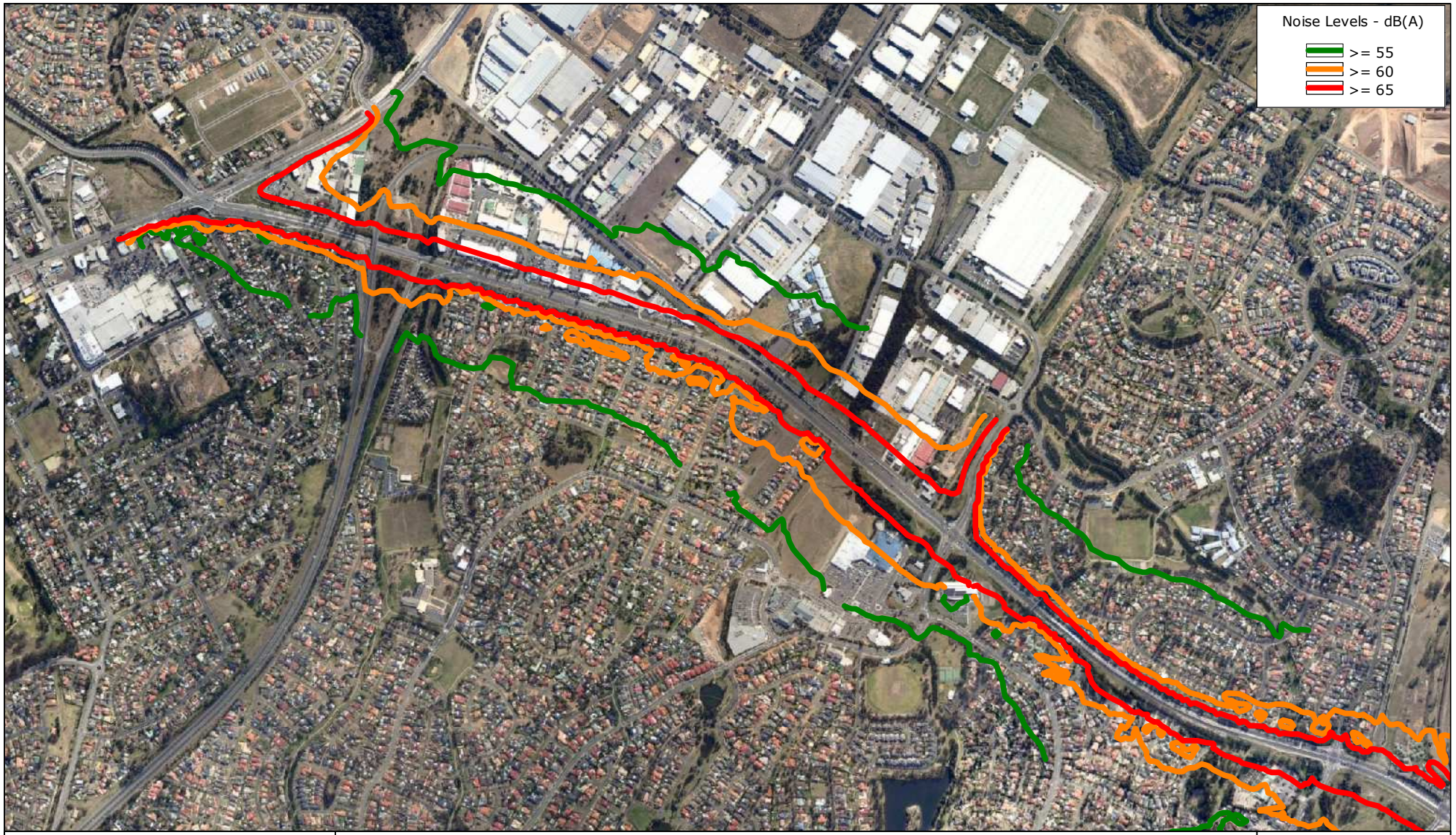
NCA	Receiver	Floor	Year of Opening 'No Build' Scenario dB(A)		Year of Opening 'Build' Scenario dB(A)		Design Year 'No Build' Scenario dB(A)		Design Year 'Build' Scenario dB(A)		RNP Criteria dB(A)		Are the RNP Criteria exceeded?		Change in noise level dB(A)				Acute Level of Noise?		Consider Noise Mitigation (YES/NO)	Comments
															Year Opening		Design Year					
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night		
NCA 5 - Wentworth Drive to Mount Annan Drive																						
5	18 Mt Annan Drive	G	61	56	61	55	62	56	62	56	60	55	YES	YES	-0.1	-0.1	0.0	0.0	NO	NO	NO	
5	2 Magnolia Mews	G	58	53	58	53	59	53	59	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	4 Magnolia Mews	G	60	54	60	54	61	55	61	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	6 Magnolia Mews	G	60	54	60	54	60	55	60	55	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	10 Magnolia Mews	G	58	52	58	52	59	53	59	53	60	55	NO	NO	-0.1	-0.1	0.0	0.0	NO	NO	NO	
5	5 Magnolia Mews	G	58	52	58	52	58	53	58	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	7 Harper Grove	G	58	52	58	52	59	53	59	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	2 Riverside Place	G	54	48	54	48	55	49	55	49	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	4 Riverside Place	G	55	49	55	49	56	50	56	50	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	6 Riverside Place	G	56	51	56	51	57	51	57	51	60	55	NO	NO	0.1	0.0	0.0	0.0	NO	NO	NO	
5	13 Collins Grove	G	63	57	63	57	64	58	64	58	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
5	15 Collins Grove	G	64	58	64	58	65	59	65	59	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	NO	YES	
5	17 Collins Grove	G	63	57	63	57	64	58	64	58	60	55	YES	YES	0.0	0.0	0.0	0.1	NO	NO	NO	
5	19 Collins Grove	G	64	58	64	58	65	59	65	59	60	55	YES	YES	0.1	0.1	0.1	0.1	YES	NO	YES	
5	2 Martin Place	G	64	58	64	58	65	59	65	59	60	55	YES	YES	0.0	0.0	0.1	0.0	YES	NO	YES	
5	4 Martin Place	G	65	59	65	59	66	60	66	60	60	55	YES	YES	0.0	0.1	0.0	0.0	YES	YES	YES	
5	6 Martin Place	G	66	60	66	60	67	61	67	61	60	55	YES	YES	0.1	0.0	0.1	0.1	YES	YES	YES	
5	8 Martin Place	G	66	60	66	60	67	61	67	61	60	55	YES	YES	0.1	0.1	0.1	0.1	YES	YES	YES	
5	10 Martin Place.	G	64	58	64	58	65	59	65	59	60	55	YES	YES	0.1	0.1	0.0	0.1	YES	NO	YES	
5	12 Martin Place	G	65	59	65	59	66	60	66	60	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	YES	YES	
5	1c Watson Road	G	62	56	62	56	63	57	63	57	60	55	YES	YES	0.0	-0.1	0.0	0.0	NO	NO	NO	
5	8 Watson Road	G	62	56	62	56	63	57	63	57	60	55	YES	YES	0.0	0.0	0.1	0.0	NO	NO	NO	
5	14 Watson Road	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
5	16 Watson Road	G	61	55	61	56	62	56	62	56	60	55	YES	YES	0.1	0.1	0.0	0.1	NO	NO	NO	
5	20 Watson Road	G	64	58	64	58	65	59	65	59	60	55	YES	YES	0.0	0.1	0.0	0.1	YES	NO	YES	
5	22 Watson Road	G	64	59	65	59	65	59	65	59	60	55	YES	YES	0.1	0.0	0.1	0.1	YES	NO	YES	
5	24 Watson Road	G	59	53	59	53	60	54	60	54	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	1 Kingston Road	G	63	57	63	57	64	58	64	58	60	55	YES	YES	0.0	0.1	0.0	0.1	NO	NO	NO	
5	1 Wood Circuit	G	61	56	62	56	62	56	62	56	50	-	YES	YES	0.1	0.0	0.0	0.0	NO	NO	NO	
5	2 Wood Circuit	G	62	56	62	56	63	57	63	57	50	-	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
5	2 Bransby Place	G	64	58	64	58	65	59	65	59	60	-	YES	YES	0.1	0.1	0.1	0.1	YES	NO	YES	
5	4 Bransby Place	G	66	60	66	60	66	60	67	61	60	55	YES	YES	0.1	0.1	0.1	0.1	YES	YES	YES	
5	6 Bransby Place	G	66	60	66	60	67	61	67	61	60	55	YES	YES	0.1	0.1	0.1	0.2	YES	YES	YES	
5	8 Bransby Place	G	65	59	65	59	66	60	66	60	60	55	YES	YES	0.1	0.1	0.1	0.0	YES	YES	YES	
5	10 Bransby Place	G	64	58	64	58	64	59	64	59	60	55	YES	YES	0.0	0.0	0.0	0.1	NO	NO	NO	
5	12 Bransby Place	G	64	58	64	58	65	59	65	59	60	55	YES	YES	0.1	0.1	0.1	0.0	YES	NO	YES	
5	12 Bransby Place	1	70	65	71	65	71	65	71	65	60	55	YES	YES	0.1	0.1	0.0	0.1	YES	YES	YES	
5	14 Bransby Place	G	63	57	63	57	63	58	63	58	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
5	16 Bransby Place	G	64	59	64	59	65	59	65	59	60	55	YES	YES	0.0	0.1	0.1	0.0	YES	NO	YES	
5	18 Bransby Place	G	62	56	62	56	63	57	63	57	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
5	18 Bransby Place	1	69	63	69	63	69	64	69	64	60	55	YES	YES	0.0	0.0	0.0	-0.1	YES	YES	YES	
5	20 Bransby Place	G	64	59	64	59	65	59	65	59	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	NO	YES	
5	22 Bransby Place	G	63	57	63	57	64	58	64	58	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
5	24 Bransby Place	G	62	56	62	56	63	57	63	57	60	55	YES	YES	-0.1	0.0	0.0	0.0	NO	NO	NO	
5	26 Bransby Place	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
5	25 Bransby Place	G	59	53	59	53	60	54	60	54	60	55	NO	NO	0.0	0.1	0.1	0.0	NO	NO	NO	
5	27 Bransby Place	G	59	53	59	53	60	54	60	54	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
5	29 Bransby Place	G	61	55	61	55	62	56	62	56	60	55	YES	YES	0.1	0.1	0.0	0.1	NO	NO	NO	
													Total number of properties where further mitigation should be considered								19	
NCA 6 - Tramway Drive to F5																						
6	4 Kenny Hill Rd	G	63	57	63	57	63	58	63	58	60	55	YES	YES	0.0	0.1	0.0	0.0	NO	NO	NO	
6	409 Narellan Rd	G	66	61	66	60	67	61	67	61	60	55	YES	YES	-0.1	-0.2	-0.1	-0.1	YES	YES	YES	
													Total number of properties where further mitigation should be considered								1	
NCA 7 - Mount Annan Drive to F5																						
7	410 Narellan Rd	G	64	59	65	59	65	59	65	59	60	55	YES	YES	0.1	0.2	0.1	0.1	YES	NO	YES	
													Total number of properties where further mitigation should be considered								1	
NCA 8 - F5 south to Substation																						
8	61 The Kraal Drive	G	60	54	60	54	60	54	60	54	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
8	1 St Luke Place	G	58	52	58	52	58	52	58	52	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
8	2 St Luke Place	G	60	53	60	53	60	54	60	54	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	

NCA	Receiver	Floor	Year of Opening 'No Build' Scenario dB(A)		Year of Opening 'Build' Scenario dB(A)		Design Year 'No Build' Scenario dB(A)		Design Year 'Build' Scenario dB(A)		RNP Criteria dB(A)		Are the RNP Criteria exceeded?		Change in noise level dB(A)				Acute Level of Noise?		Consider Noise Mitigation	Comments
															Year Opening		Design Year					
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	(YES/NO)	
8	2 St Luke Place	G	60	54	60	54	61	54	61	54	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
8	4 St Luke Place	G	59	53	59	53	59	53	59	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
8	5 St Luke Place	G	59	52	59	52	59	53	59	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
8	22 St Luke Place	G	59	53	59	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
8	24 St Luke Place	G	59	53	59	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	-0.1	NO	NO	NO	
8	Maryfields Recovery Centre	G	60	54	60	54	60	54	60	54	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	Main building shown on older maps no longer exists. Small builidng still remains and is assumed to be residential use
8	Maryfields Friary (residential)	G	61	54	61	54	61	55	61	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	Existing noise levels already exceed the RNP goals (as a Place of Worship) however the Project does not increase noise levels, therefore no additinoal nosie mitigation is required
8	Maryfields Friary (place of worship)	G	61	54	61	54	61	55	61	55	50	50	YES	YES	0.0	0.0	0.0	0.0	N/A	N/A	NO	
8	Bethlehem Monastery (residential)	G	58	52	58	52	58	52	58	52	60	55	NO	NO	0.0	0.0	0.0	-0.1	NO	NO	NO	
8	Bethlehem Monastery (place of worship)	G	58	52	58	52	58	52	58	52	50	50	YES	YES	0.0	0.0	0.0	-0.1	N/A	N/A	NO	
													Total number of properties where further mitigation should be considered								0	
	NCA 9 - Campbelltown TAFE College																					
9	Campbelltown College Building A	G	66	-	66	-	67	-	67	-	50	-	YES	-	-0.1	-	-0.1	-	N/A	-	NO	Existing noise levels already exceed the RNP goals however the Project does not increase noise levels, therefore no additinoal nosie mitigation is required
9	Campbelltown College Building B	G	64	-	64	-	65	-	65	-	50	-	YES	-	0.0	-	-0.1	-	N/A	-	NO	Existing noise levels already exceed the RNP goals however the Project does not increase noise levels, therefore no additinoal nosie mitigation is required
	NCA 10 - Narellan Road at Blaxland Road intersection																					
10	2 Pittman Steps Pl	G	60	53	60	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	4 Pittman Steps Pl	G	61	53	61	53	61	53	61	53	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	6 Pittman Steps Pl	G	60	53	60	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	8 Pittman Steps Pl	G	61	54	61	54	61	54	61	54	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	23 Pittman Steps Pl	G	62	55	62	55	62	55	62	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	23 Pittman Steps Pl	1	71	64	71	64	71	64	71	64	60	55	YES	YES	0.0	0.0	0.0	0.0	YES	YES	YES	Consider mitigation for Level 1 only
10	3 The Ark Ave	G	62	55	62	55	62	55	62	55	60	55	YES	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	6 The Ark Ave	G	58	52	58	52	59	52	59	52	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	4 Ager Cottage Cres	G	59	52	59	52	59	53	59	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	6 Ager Cottage Cres	G	59	53	59	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	-0.1	NO	NO	NO	
10	7 Ager Cottage Cres	G	59	53	59	53	60	53	60	53	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	8 Ager Cottage Cres	G	59	53	59	53	59	53	59	53	60	55	NO	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
10	9 Ager Cottage Cres	G	58	51	58	51	58	51	58	51	60	55	NO	NO	0.0	0.0	0.0	-0.1	NO	NO	NO	
10	10 Ager Cottage Cres	G	59	53	59	53	60	53	60	53	60	55	NO	NO	0.0	0.1	0.1	0.0	NO	NO	NO	
10	11 Ager Cottage Cres	G	58	52	58	52	59	52	59	52	60	55	NO	NO	0.0	0.0	0.0	0.0	NO	NO	NO	
10	12 Ager Cottage Cres	G	59	53	59	53	60	53	59	53	60	55	NO	NO	-0.2	-0.1	-0.2	-0.2	NO	NO	NO	
10	13 Ager Cottage Cres	G	58	52	58	52	58	52	58	52	60	55	NO	NO	0.0	0.0	0.0	-0.1	NO	NO	NO	
10	14 Ager Cottage Cres	G	59	53	59	53	59	53	59	53	60	55	NO	NO	0.1	0.1	0.0	0.1	NO	NO	NO	
10	15 Ager Cottage Cres	G	58	52	58	52	58	52	58	52	60	55	NO	NO	0.0	-0.1	0.0	0.0	NO	NO	NO	
10	16 Ager Cottage Cres	G	59	52	59	52	59	52	59	53	60	55	NO	NO	0.3	0.2	0.2	0.2	NO	NO	NO	
10	17 Ager Cottage Cres	G	58	51	58	51	58	52	58	52	60	55	NO	NO	0.0	0.0	0.0	0.1	NO	NO	NO	
10	18 Ager Cottage Cres	G	58	52	59	52	59	52	59	52	60	55	NO	NO	0.1	0.1	0.2	0.1	NO	NO	NO	
10	19 Ager Cottage Cres	G	58	51	58	51	58	52	58	52	60	55	NO	NO	0.0	0.0	0.0	0.1	NO	NO	NO	
10	20 Ager Cottage Cres	G	58	51	58	51	58	52	58	52	60	55	NO	NO	0.1	0.1	0.1	0.0	NO	NO	NO	
10	21 Ager Cottage Cres	G	58	52	58	52	59	52	59	52	60	55	NO	NO	0.1	0.0	0.0	0.0	NO	NO	NO	
10	22 Ager Cottage Cres	G	57	50	57	50	57	50	57	50	60	55	NO	NO	0.1	0.1	0.0	0.0	NO	NO	NO	
10	22 Ager Cottage Cres	1	61	55	61	55	62	55	62	55	60	55	YES	NO	0.0	-0.1	0.0	0.0	NO	NO	NO	
10	23 Ager Cottage Cres	G	59	52	59	52	59	53	59	53	60	55	NO	NO	0.1	0.0	0.1	0.0	NO	NO	NO	
10	24 Ager Cottage Cres	G	57	50	57	50	57	50	57	50	60	55	NO	NO	0.0	0.1	0.1	0.1	NO	NO	NO	
10	24 Ager Cottage Cres	1	61	55	61	55	62	55	62	55	60	55	YES	NO	0.0	-0.1	0.0	-0.1	NO	NO	NO	
10	26 Ager Cottage Cres	G	57	50	57	50	57	51	57	51	60	55	NO	NO	0.0	0.0	0.1	0.1	NO	NO	NO	
10	26 Ager Cottage Cres	1	62	55	62	55	62	56	62	56	60	55	YES	YES	0.0	0.0	0.0	0.0	NO	NO	NO	
10	28 Ager Cottage Cres	G	57	51	57	51	58	51	58	51	60	55	NO	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
10	28 Ager Cottage Cres	1	63	57	63	57	64	57	64	57	60	55	YES	YES	0.0	0.0	0.0	0.1	NO	NO	NO	
10	30 Ager Cottage Cres	G	58	52	58	52	58	52	58	52	60	55	NO	NO	0.1	0.1	0.1	0.0	NO	NO	NO	
10	32 Ager Cottage Cres	G	60	53	60	53	60	53	60	53	60	55	NO	NO	0.0	0.1	0.1	0.1	NO	NO	NO	
10	34 Ager Cottage Cres	G	60	53	60	53	60	54	60	54	60	55	NO	NO	0.0	0.0	0.1	0.0	NO	NO	NO	
10	36 Ager Cottage Cres	G	60	53	60	53	60	54	60	54	60	55	NO	NO	0.1	0.0	0.1	0.1	NO	NO	NO	
10	38 Ager Cottage Cres	G	61	55	61	55	62	55	62	55	60	55	YES	NO	0.1	0.1	0.0	0.0	NO	NO	NO	
10	41 Keighran Mill Drive	G	60	54	60	54	61	54	61	54	60	55	YES	NO	0.1	0.1	0.1	0.0	NO	NO	NO	

NCA	Receiver	Floor	Year of Opening 'No Build' Scenario dB(A)		Year of Opening 'Build' Scenario dB(A)		Design Year 'No Build' Scenario dB(A)		Design Year 'Build' Scenario dB(A)		RNP Criteria dB(A)		Are the RNP Criteria exceeded?		Change in noise level dB(A)				Acute Level of Noise?		Consider Noise Mitigation (YES/NO)	Comments
															Year Opening		Design Year					
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night		
10	43 Keighran Mill Drive	G	61	55	61	55	62	55	62	55	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
10	45 Keighran Mill Drive	G	61	54	61	54	61	54	61	55	60	55	YES	NO	0.1	0.1	0.1	0.1	NO	NO	NO	
10	47 Keighran Mill Drive	G	62	55	62	55	62	55	62	55	60	55	YES	NO	0.1	0.0	0.0	0.1	NO	NO	NO	
																					Total number of properties where further mitigation should be considered	1

Note: Red numbers identify acute noise levels

APPENDIX D - NOISE CONTOURS



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inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'Build Option'
LAeq,15h - Day

Description
Western Project Area

Date: 18/3/2013

Reference: TF888-01P01 (rev 1) Gr# 14

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4

RENZO TONIN & ASSOCIATES
inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'Build Option'
LAeq,15h - Day

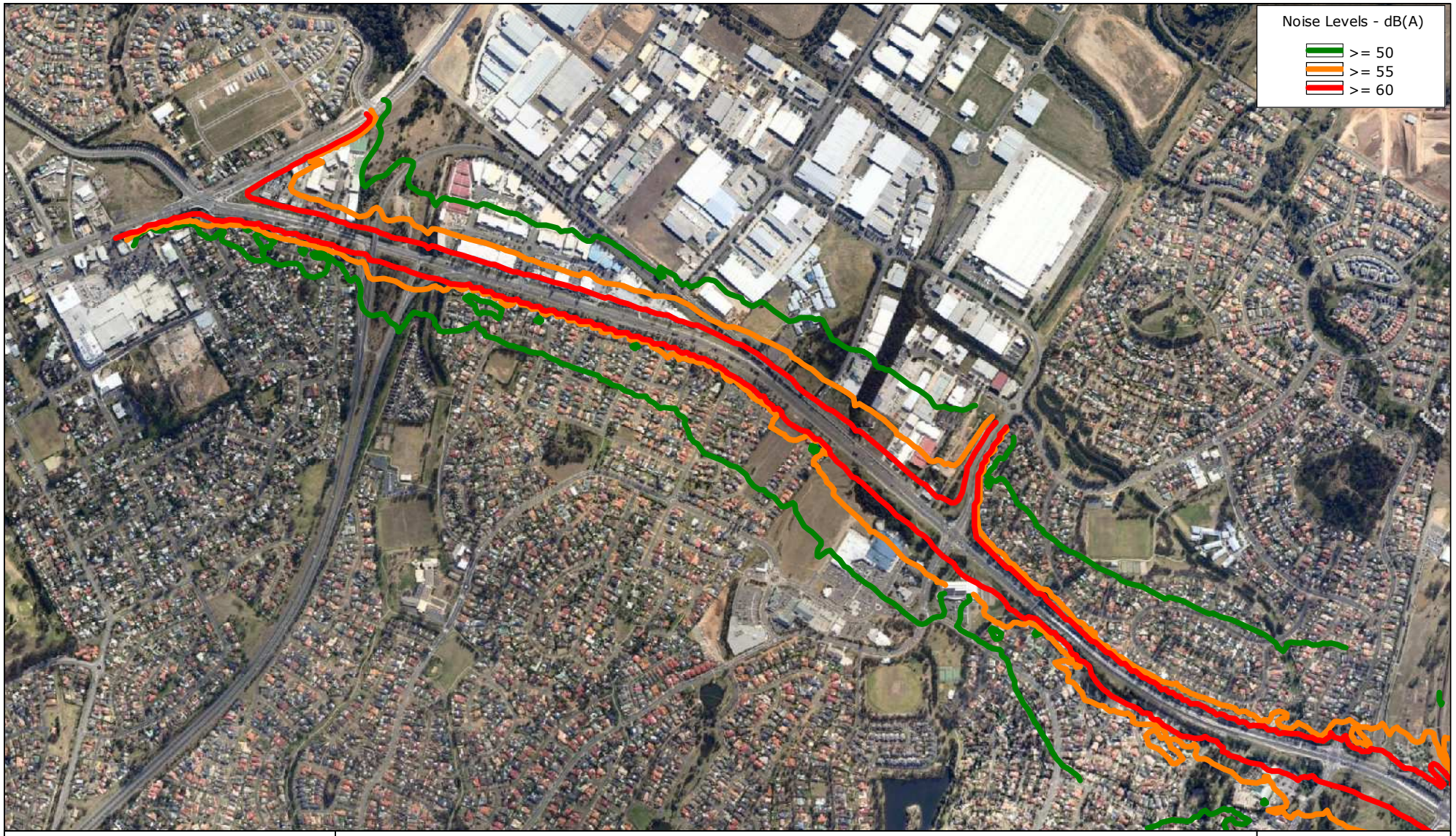
Description
Eastern Project Area

Date: 18/3/2013

Reference: TF888-01P02 (rev 1) Gr# 14

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4



RENZO TONIN & ASSOCIATES
inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'Build Option'
LAeq,9h - Night

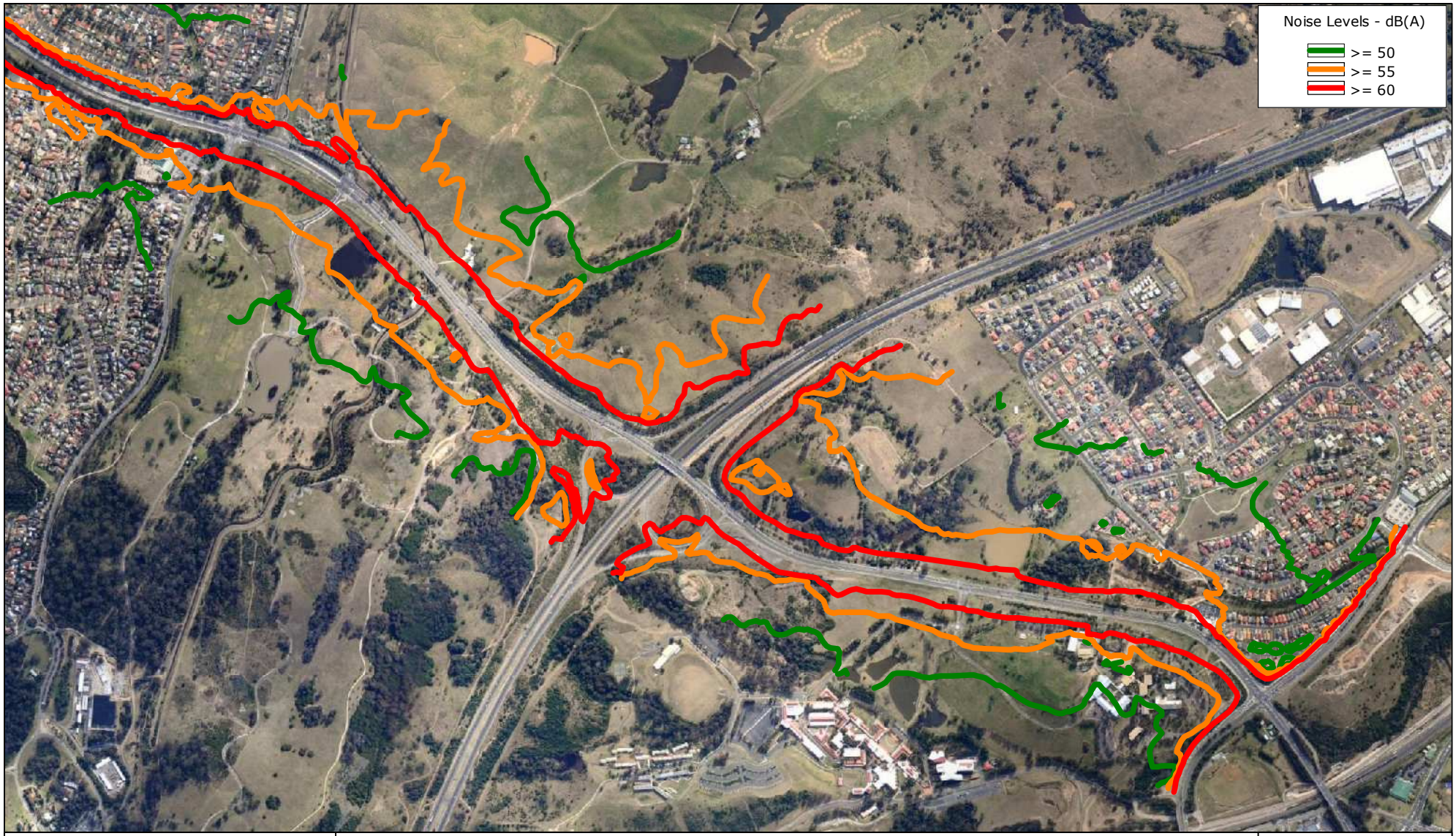
Description
Western Project Area

Date: 18/3/2013

Reference: TF888-01P03 (rev 1) Gr# 16

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4



RENZO TONIN & ASSOCIATES
inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'Build Option'
LAeq,9h - Night

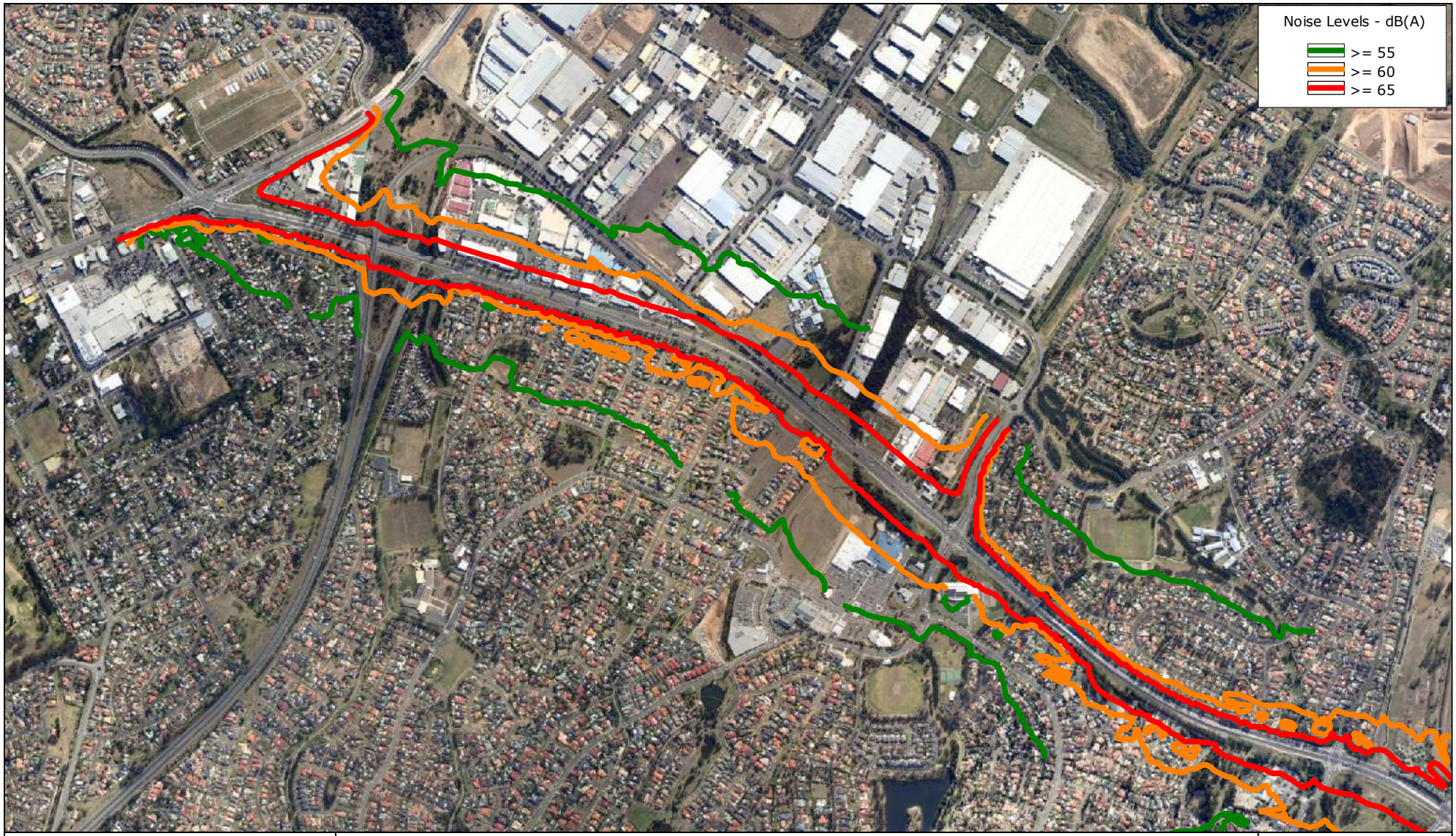
Description
Eastern Project Area

Date: 18/3/2013

Reference: TF888-01P04 (rev 1) Gr# 16

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4



RENZO TONIN & ASSOCIATES
inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'No Build Option'
LAeq,15h - Day

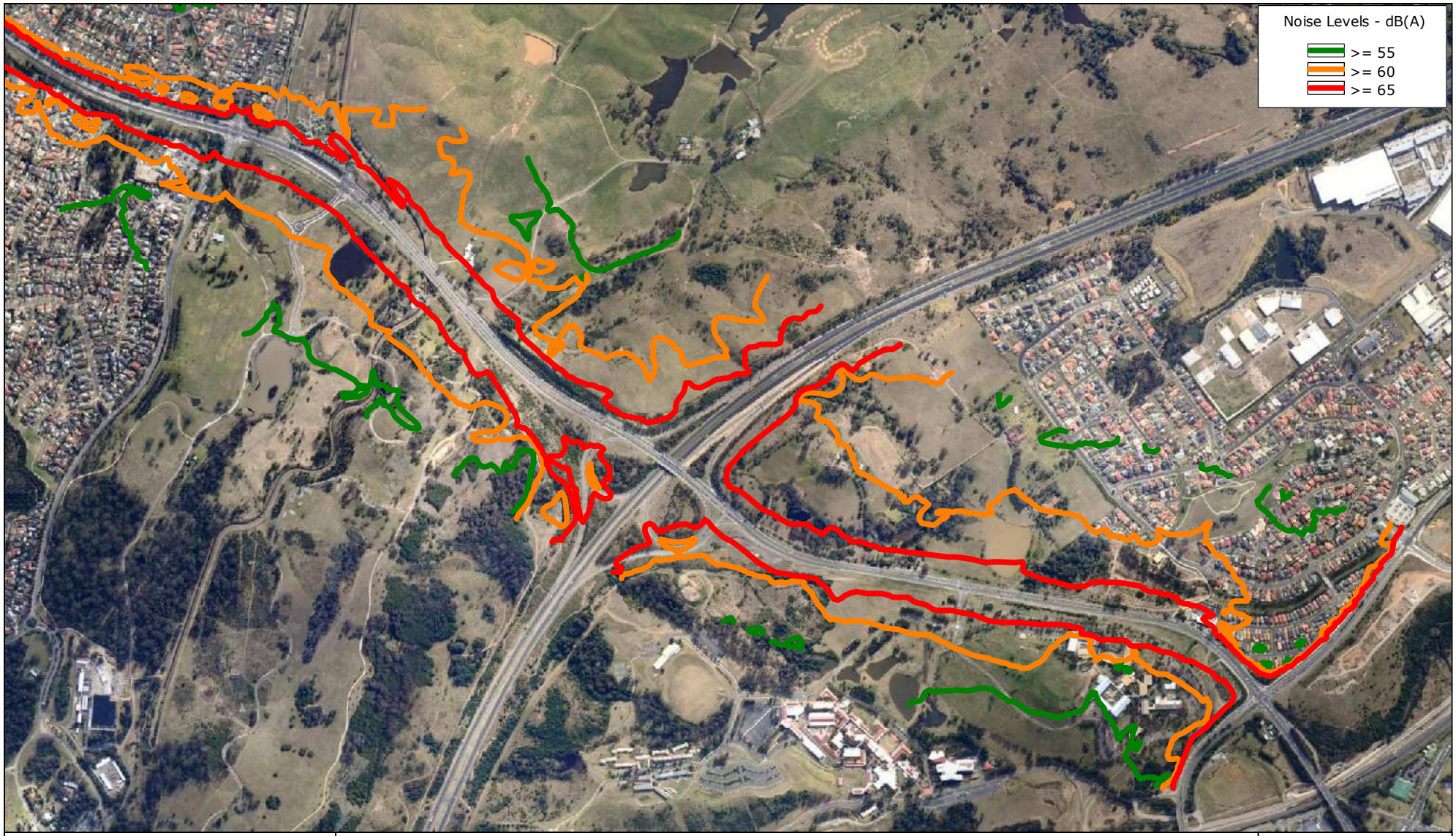
Description
Western Project Area

Date: 18/3/2013

Reference: TF888-01P05 (rev 1) Gr# 18

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4



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inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'No Build Option'
LAeq,15h - Day

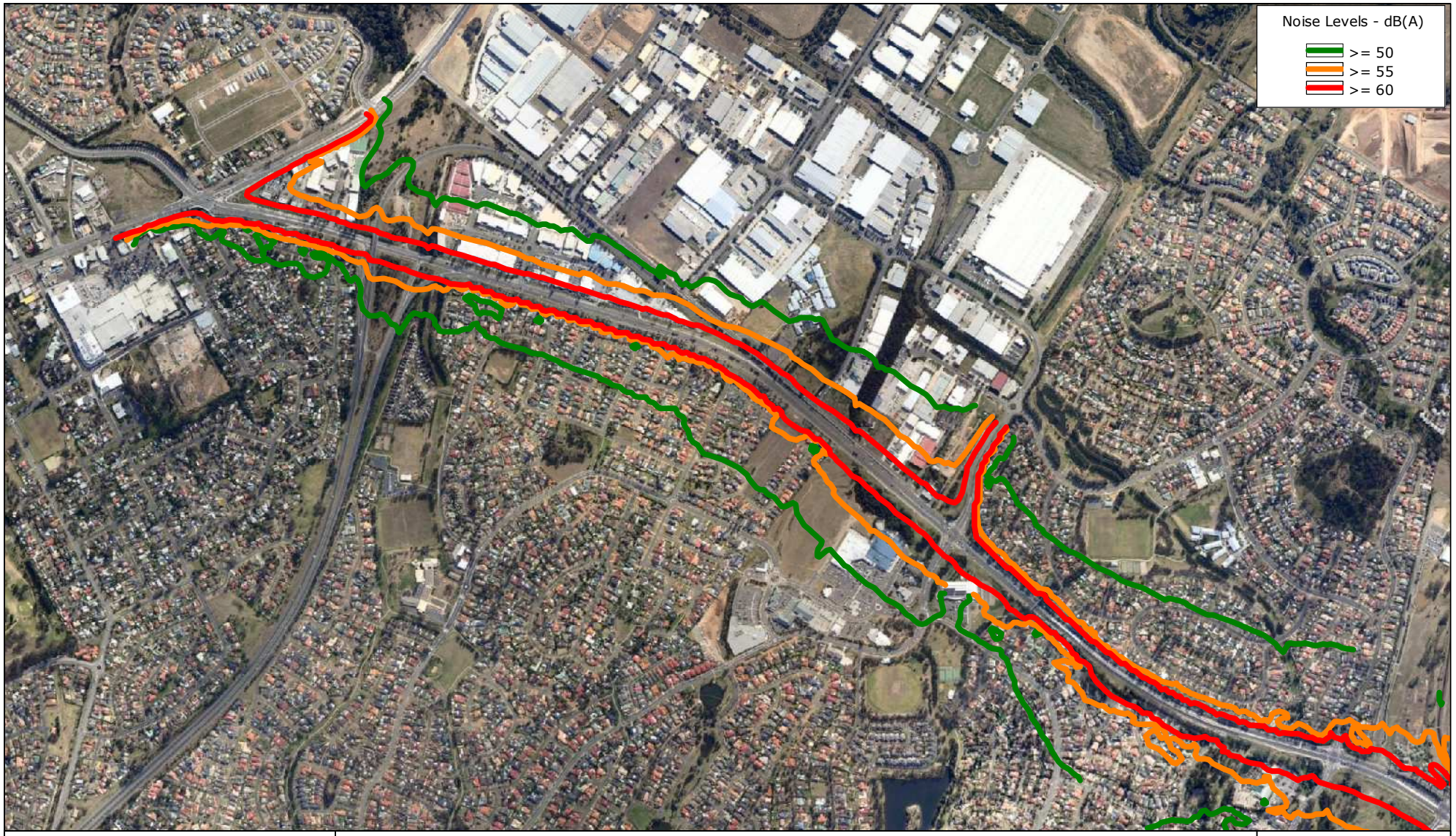
Description
Eastern Project Area

Date: 18/3/2013

Reference: TF888-01P06 (rev 1) Gr# 18

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4



RENZO TONIN & ASSOCIATES
inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'No Build Option'
LAeq,9h - Night

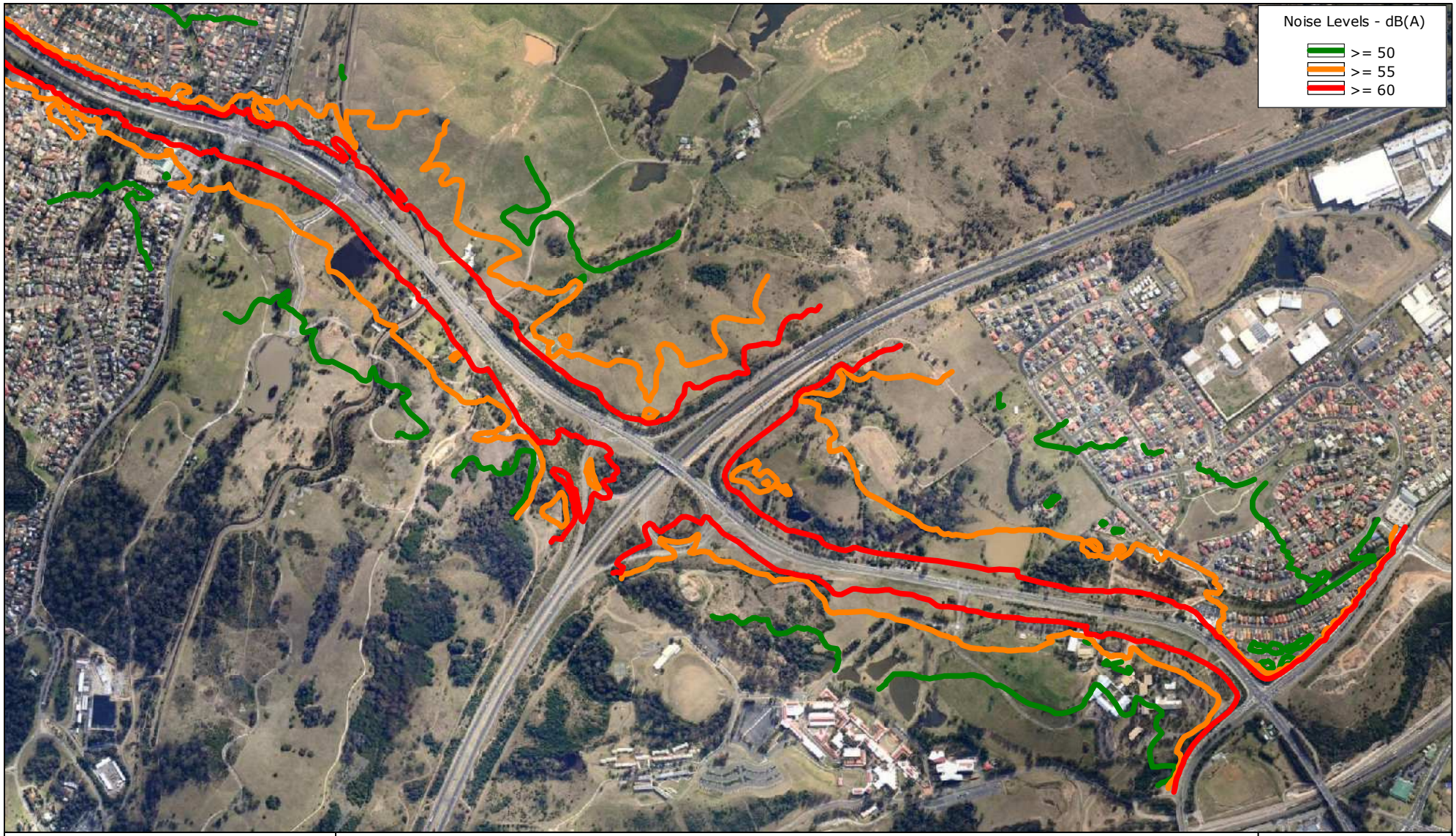
Description
Western Project Area

Date: 18/3/2013

Reference: TF888-01P07 (rev 1) Gr# 20

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4



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inspired to achieve

Project:
Narellan Road Upgrade

Scenario
Design Year 2026 - 'No Build Option'
LAeq,9h - Night

Description
Eastern Project Area

Date: 18/3/2013

Reference: TF888-01P08 (rev 1) Gr# 20

Client: Roads and Maritime Services (RMS)

Scale: 1: 15000 A4

APPENDIX E - MEASURED NOISE DATA