6.6 Noise and vibration

This section summarises the results of the noise and vibration technical report prepared for the proposal which is provided in Appendix M.

6.6.1 Methodology

The assessment involved a quantitative assessment of construction noise and vibration and operational noise, prepared with consideration of the following key guidelines:

- *Construction Noise and Vibration Guidelines* (CNVG) (Roads and Maritime 2016)
- *Interim Construction Noise Guideline* (ICNG) (DECC 2009)
- *Assessing Vibration: a technical guideline* (NSW Department of Environment and Conservation (DEC) 2006a)
- DIN 4150:Part 2-1999 Structural vibration – Effects of vibration on structures (Deutsches Institut für Normung 1999)
- DIN 4150:Part 3-1999 Structural vibration – Effects of vibration on structures (Deutsches Institut für Normung 1999)
- Evaluation and Measurement for Vibration in Buildings Part 2, (British Standard (BS) 7385:Part 2-1993) (BS 7385).
- *NSW Road Noise Policy* (RNP) (DECCW 2011)
- *Noise Criteria Guideline* (NCG) (Roads and Maritime 2015a)
- *Noise Mitigation Guideline* (NMG) (Roads and Maritime 2015b)
- *Noise Model Validation Guideline* (Roads and Maritime 2018)
- *Application Notes – Noise Criteria Guideline* (Roads and Maritime 2015a)
- *Environmental Noise Management Manual* (ENMM) (Roads and Maritime 2001)
- *Procedure for Preparing an Operational Noise and Vibration Assessment* (Roads and Maritime 2011b)
- *Draft At-Receiver Treatment Guideline* (ARTG) (Roads and Maritime 2017).
- *NSW Road Noise Policy* (RNP) (DECCW 2011)
- *Noise Policy for Industry* (NPfI) (NSW Environment Protection Authority (NSW EPA) 2017).

The assessment involved:

- Identification of sensitive receivers
- Monitoring of background noise levels including traffic counts for background road traffic noise
- Establishment of noise and vibration assessment criteria
- Prediction of potential construction noise and vibration and operational noise
- Assessment of potential noise and vibration impacts by comparing predictions against relevant criteria
- Providing mitigation, where required.

6.6.2 Existing environment

Sensitive receivers

Noise sensitive receivers to the proposal have been identified. Construction noise sensitive receivers have been grouped into noise catchment areas (NCAs). Receivers within each NCA are expected to experience

similar existing background noise levels based on the results of site observations and background noise monitoring. The NCAs are described in Table 6-23 and shown in Figure 6-15.

The existing noise environment in NCA 1 and NCA 5 at the southern and northern extent of the proposal is generally influenced by the operation of the nearby New England Highway and Main North railway line. Mining activities contribute to the existing noise environment in the north for NCA 5. The noise environment in NCA 2, NCA 3 and NCA 4 is generally characteristic of a rural/suburban environment. The primary sources of noise in this area include local traffic and rail movements on the Main North railway line.

Non-residential receivers sensitive to the proposal are identified in Table 6-24 and shown in Figure 6-15

Table 6-23: Noise catchment areas

Noise catchment area	Description
NCA 1	NCA 1 is located around the southern connection and includes suburban residential properties in the northern section of the NCA and semi-rural properties in the south.
NCA 2	NCA 2 is located north and south of the Main North railway line around Putty Road and includes suburban and semi-rural residential properties to the north and south of the Main North railway line respectively.
NCA 3	NCA 3 is located to directly to the east of the Main North railway line at Singleton Heights and includes suburban residential properties.
NCA 4	NCA 4 is located east of the New England Highway around McDougalls Hill and includes suburban residential properties.
NCA 5	NCA is located around the northern connection at Rixs Creek and includes semi-rural residential properties located to the east of the New England Highway.

Table 6-24: Non-residential receivers

Receiver	Receiver type[1]	Address
Australian Christian College – Singleton (including Rainbows Early Learning Centre)	School	109-219 Kelso Street, Singleton
Wyland Caravan Park Singleton	Passive recreation	20 Carrington Street, Glenridding
Country Acres Caravan Park	Passive recreation	58 Maison Dieu Road, McDougalls Hill
Majestic Cinemas Singleton	Commercial property	21 Ryan Avenue, Singleton
Charbonnier Motor Inn Singleton	Commercial property	44 Maitland Road, Singleton

Table note 1: As defined in the ICNG

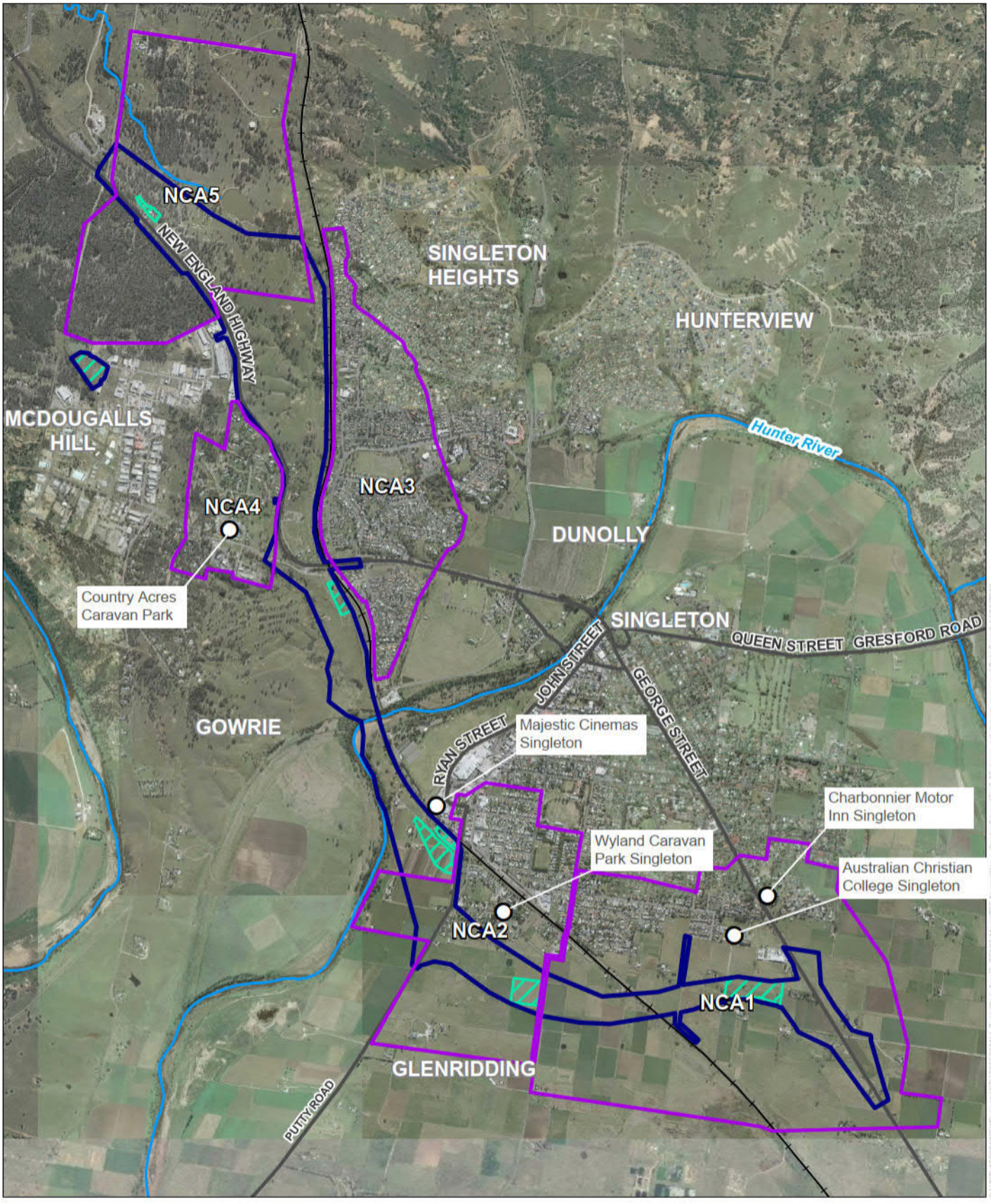

FIG. 6-15 Noise catchment areas

N

0 400 800 Meters

Legend

Proposal features

- Proposal area
- Modelled representative non-residental receivers
- Construction ancillary facilities
- NCA

Other features

- State roads
- Watercourse
- Main North railway line

Source: LPMA 2016, LPI 2019 and AECOM 2019
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Background noise levels

Noise monitoring was carried out for each NCA to measure the existing the background and ambient noise and road traffic noise in the vicinity of the proposal area. Noise monitoring was carried out at seven locations considered to be representative of the local noise environment. Noise logger locations are show in Figure 6-15. The monitoring was carried out between 2 and 15 March 2018.

A summary of background noise levels is provided in Table 6-25 and indicate that the noise environment at the measurement locations are typical of those located along major transport corridors in rural/suburban areas.

Table 6-25: Background noise levels

Noise catchment area	Background noise level $L_{A90, 15min}$ dB(A)		
	Day (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
NCA 1	34	34	34
NCA 2	35	35	30
NCA 3	36	36	32
NCA 4	36	36	32
NCA 5	39	39	31

Table 6-26: Measured road traffic noise levels

Noise logger	Road traffic noise level dB(A)	
	Day (7am-10pm) $L_{Aeq, 15hr}$	Night (10pm to 7am) $L_{Aeq, 9hr}$
1	71	67
5	64	63
6	50	48
7	62	60

6.6.3 Criteria

Construction noise

Construction noise criteria were developed in accordance with the ICNG for each noise catchment area. Standard construction hours defined in the ICNG are:

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

The proposed construction activities are expected to generally occur during standard construction hours, however some activities would be required to be carried out outside of standard hours. Refer to Section 3.3.2 for further information.

Construction noise management levels (NMLs) have been developed for standard construction hours (day) and outside of standard construction hours (evening and night) based on the background noise levels in Table 6-25. The NML represents the point above which there may be some community reaction to noise. The NMLs are summarised in Table 6-27.

A receiver is considered to be highly noise affected where predicted noise levels exceed 75 dB(A). The highly noise affected level represents the point above which there may be strong community reaction to noise.

Table 6-27: Noise management levels

Noise catchment area	Construction NML dB(A)		
	Day (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
NCA 1	44	39	39
NCA 2	45	40	35
NCA 3	46	41	37
NCA 4	46	41	37
NCA 5	49	44	36

The construction noise management levels that apply to other sensitive receivers (when in use) include:

- Schools, hospital and places of worship – 45 dB(A) internal noise level
- Active recreation – 65 dB(A) external noise level
- Passive recreation – 60 dB(A) external noise level
- Industrial properties – 75 dBA(A) external noise level
- Commercial properties – 70 dB(A) external noise level.

Construction road traffic noise

In accordance with the *Road Noise Policy* a screening test has been carried out to evaluate whether existing road traffic noise levels would increase by more than 2 dB(A) as a result of the construction of the proposal.

Based on the *Road Noise Policy* it is considered that where road traffic noise levels already exceed the assessment criteria, an increase of less than 2 dB(A) represents a minor impact that is barely perceptible to the average person.

Construction vibration

The *German Standard Structural Vibration Part 3: Effects of vibration on structures, DIN 4150-3 -1999* (DIN 4150) is the relevant standard for construction vibration and is summarised in Table 6-28. DIN 4159 includes minimum safe levels of vibration at different frequencies for residential, commercial and heritage listed buildings.

Table 6-28: Vibration criteria for structural damage

Type of structure	Vibration velocity in millimetres per second		
	1 – 10 hertz	10 – 50 hertz	50 – 100 hertz
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20
Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10

Humans are sensitive to vibration such that they can detect vibration levels well below those required to cause any risk of damage to a building or its contents. Criteria to avoid annoyance for intermittent and continuous vibration are provided in *Assessing Vibration: A Technical Guideline* and detailed discussion regarding criteria for human comfort is provided in Appendix M.

Ground-borne noise

Vibration generated by activities such as piling may enter buildings via the ground. This may cause the floors, walls and ceilings to vibrate and to radiate noise. This noise is commonly referred to as ground-borne noise. Ground-borne noise is typically low frequency and if audible, is perceived as a 'rumble'.

In general, ground-borne noise level values are relevant only where they are higher than the airborne noise, such as where construction works are being carried out within a cutting which would provide shielding to airborne noise. Ground-borne noise from construction would typically be masked by airborne noise associated with construction activities and/or traffic.

The ground-borne noise management levels as outlined in the ICNG are presented in Table 6-29. These levels are applicable during the evening and night-time periods only in residential properties, as the objective is to protect the amenity and sleep of people when they are at home.

Table 6-29: Ground-borne noise goals

Time	Ground-borne noise goals dB(A) $L_{Aeq(15\ min)}$
Evening (6pm-10pm)	40
Night (10pm-7am)	35

Sleep disturbance

Guidance provided in the *Road Noise Policy* for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10pm to 7am), the noise level outside a bedroom window should not exceed the background noise level by more than 15 dB(A). Construction noise sleep disturbance criteria have been developed in accordance with the *Road Noise Policy* and are summarised in Table 6-30.

The *Road Noise Policy* contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that, 'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions'. Therefore, given that a closed window provides around 10 dB(A) in noise attenuation from outside to inside, external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Table 6-30: Summary of environmental safeguards to minimise impacts to soils and contamination

NCA	Sleep disturbance screening criteria – $L_{A1(1min)}$ dB(A)	Sleep disturbance awakening reaction criteria – $L_{A1(1min)}$ dB(A)
NCA 1	49	65
NCA 2	45	65
NCA 3	47	65
NCA 4	47	65
NCA 5	46	65

Operational road traffic noise criteria

Operational road traffic noise criteria are assigned to sensitive receivers using the Roads and Maritime's *Noise Criteria Guideline*. The *Noise Criteria Guideline* provides guidance on how to apply the *Road Noise Policy*. Criteria are based on the road development type which is affecting the residential receiver. The operational criteria for residential land use are summarised in Table 6-31.

In some instances residential receivers may be exposed to noise from both new and redeveloped roads. Where this occurs, the proportion of noise from each road is used to establish transition zone criteria. Noise contours were developed to calculate transition zones in accordance with the *Noise Criteria Guideline* (refer to Appendix E of Appendix M). The contours identified that due to the relatively low level of noise from the new road segment, transition zone criteria do not apply to any sensitive receivers.

Table 6-31: Operational criteria for residential land use

Road category	Road development and land use types	Assessment criteria dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial /sub-arterial	Existing residences affected by noise from new freeways/arterial/sub-arterial road corridors	$L_{Aeq(15\ hr)}$ 55 (external)	$L_{Aeq(9\ hr)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeways/arterial/sub-arterial roads	$L_{Aeq(15\ hr)}$ 60 (external)	$L_{Aeq(9\ hr)}$ 55 (external)
	Existing residences affected by both new roads and the redevelopment of existing freeway/arterial/sub-arterial roads in a Transition Zone	Between $L_{Aeq(15\ hr)}$ 55-60 (external)	Between $L_{Aeq(9\ hr)}$ 50-55 (external)
	Existing residences affected by increases in traffic noise of 12 dB(A) or more from new freeway/arterial/sub-arterial roads	Between $L_{Aeq(15\ hr)}$ 42-55 (external)	Between $L_{Aeq(15\ hr)}$ 42-50 (external)

The criteria of non-residential sensitive receivers is summarised in Table 6-32. For schools, places of worship and childcare facilities, the *Noise Criteria Guideline* criteria are based on internal noise levels when in use.

Table 6-32: Operational criteria for non-residential land use

Land use	Assessment criteria	
	Day (7am-10pm)	**Night (10pm-7am)**
School classrooms	$L_{Aeq(1\ hr)}$ 40 (internal)	n/a
Hospital wards	$L_{Aeq(1\ hr)}$ 35 (internal)	$L_{Aeq(1\ hr)}$ 35 (internal)
Places of worship	$L_{Aeq(1\ hr)}$ 40 (internal)	$L_{Aeq(1\ hr)}$ 40 (internal)
Open space (active use)	$L_{Aeq(15\ hr)}$ 60	n/a
Open space (passive use)	$L_{Aeq(15\ hr)}$ 55	n/a
Child care facilities	Sleeping rooms $L_{Aeq(1\ hr)}$ 35 Indoor play areas $L_{Aeq(1\ hr)}$ 40 (internal) Outdoor play areas $L_{Aeq(1\ hr)}$ 55 (external)	n/a
Aged care facilities	Residential land use noise assessment criteria should be applied to these facilities.	

6.6.4 Potential impacts

Construction noise

Construction activities with the potential to generate noise would be carried out within the ancillary facilities described in Section 3.4 and throughout the proposal area. Noise associated with the following construction scenarios have been considered for the ancillary facilities as relevant:

- Vegetation clearing
- Establishment of site offices, amenities and temporary infrastructure including fencing
- Laydown, storage and delivery of materials and plant
- Stockpiling
- Demobilisation.

Noise associated with the following construction scenarios have been considered for the construction activities along the proposal area:

- Vegetation clearing
- Earthworks
- Drainage
- Bridge and viaduct construction
- Pavement works
- Finishing works.

For each ancillary facility and along the proposal area, predicted noise levels for each construction scenario have been assessed against the relevant noise criteria. A summary of the results of the assessment is provided below and detailed noise predictions are provided in Section 4 of Appendix M.

Potential noise impacts from construction activities during standard hours include:

- Potential exceedances of NMLs at residential receivers in all NCAs. Activities along the proposal area and activities at the Waterworks Lane construction compound are likely to affected the greatest number of residential receivers. Receivers closest to the proposal have the highest potential for impact
- NML exceedances are generally less than 10 dB(A). The pavement and earthworks activities along the proposal area are likely to cause the largest number of exceedances of the NMLs. During these activities exceedances of NMLs by greater than 20 dB(A) are predicted at up to eight receivers in NCA 1, 14 receivers in NCA 2 and 26 receivers in NCA 3
- Residential receivers in NCA 1 and NCA 2 have the greatest potential for impact. Up to six receivers in NCA 1 are predicted to be highly noise affected during earthworks along the proposal area. Up to eight receivers in NCA 2 are predicted to be highly noise affected during pavement works along the proposal area
- Construction activities are predicted to result in minor exceedances of NMLs at the Australian Christian College – Singleton and Wyland Caravan Park Singleton by 5 dB(A) and 10 dB(A) respectively. No exceedances are predicted at the other non-residential land uses.

Potential noise impacts from construction activities outside of standard hours include:

- Construction activities have the potential to exceed NMLs at residential receivers outside of standard hours in all NCAs. Consistent with the activities during standard hours, activities outside of standard hours along the proposal area and activities at the Waterworks Lane construction compound are likely to affected the greatest number of residential receivers
- NML exceedances are generally less than 15 dB(A), however a number of exceedances of greater than 25 dB(A) are predicted. The pavement and earthworks activities along the proposal area and laydown and storage activities at the Waterworks Lane construction compound are likely to cause the largest number of exceedances of the NMLs
- Construction activities are predicted to result in minor exceedances at Wyland Caravan Park (less than 5 dB(A)). No exceedances are predicted at the other non-residential land uses.

It is important to consider that the predicted noise levels are representative of the worst case 15 minute period of construction activity, while the construction equipment is at the nearest location to each sensitive receiver location. The assessed scenario does not represent the ongoing day to day noise impact at noise sensitive receivers for an extended period of time.

Particularly noisy activities, such as piling and use of concrete saws, would not persist for the entire construction period. In addition, the predictions use the shortest separation distance to each sensitive receiver, however in reality separation distances would vary between plant and sensitive receivers.

For linear works (works that move along the road alignment, rather than works located at a construction ancillary facility) noise exposure at each receiver would reduce due to increases in distance loss as the works progress along the alignment.

The reported maximum noise level is for the highest noise level during that construction scenario. The reported number of receivers where noise levels are expected to exceed the noise management levels is based on the reported maximum noise level. Typically the number of sensitive receivers exceeding the noise management levels will be reduced substantially depending instantaneous operating conditions.

A range of safeguards and management measures would be implemented to manage potential noise impacts during and outside of standard hours. The measures are outlined in Section 0.

Construction sleep disturbance

Exceedances of the sleep disturbance and awakening reaction criteria are predicted at a number of properties in each NCA. The largest numbers of exceedances are associated with bridge and viaduct and pavement works along the proposal area in the vicinity of NCA 1, NCA 2 and NCA 3. Sleep disturbance exceedances are predicted for up to about 1231 properties in total during these activities and awakening reactions are predicted for up to about 184 properties in total.

As described in Section 3.3.2, construction would largely be carried out during standard construction working hours.

A range of safeguards and management measures would be implemented to manage potential sleep disturbance impacts. The measures are outlined in Section 0.

Construction road traffic noise

The numbers of construction vehicle movements have been estimated to be up to 80 light and 140 heavy vehicles per day (up to 12 per hour) during peak construction periods across all ancillary facilities. Vehicles would access the site primarily by the New England Highway. Heavy vehicles would only access the site from approved heavy vehicle routes.

The existing traffic flows on the New England Highway are substantially greater than the proposed construction traffic numbers (there are currently over 1000 heavy vehicles between 7 am and 10 pm and over 300 heavy vehicles between 10pm and 7 am each day on the New England Highway). Therefore the additional traffic would have a minor impact on existing road traffic noise in the area, road traffic noise levels during construction are expected to increase by less than 2 dB(A).

Construction vibration

Construction activities would result in a short-term increase in localised vibration levels. Vibration impacts focus on potential structural damage in close proximity to construction activities. Furthermore, it is possible that local sensitive receivers may perceive construction vibration at times. The level of annoyance, however, will depend on individuals.

Plant and equipment needed for the proposal would be determined during the construction planning phase. Table 6-27 provides safe working buffer distances required to comply with the human comfort, cosmetic damage, standard dwelling and heritage building structural damage criteria for equipment likely to be used for the proposal. Other equipment may be used however it is anticipated that they would produce similar vibration levels. It is considered unlikely that vibration intensive plant would be operated within the minimum safe working distances for heritage structures and cosmetic damage outlined below.

Table 6-33: Recommended minimum working distances for vibration intensive plant

Plant	Rating	Minimum safe working distance (metres)		
		Heritage structures[1]	Cosmetic damage	Human response
Vibratory roller	< 50 kN (typically 1-2t)	8	5	15
	< 100 kN (typically 2-4t)	10	6	20
	< 200 kN (typically 4-6t)	20	12	40
	< 300 kN (typically 7-13t)	25	15	100
	> 300 kN (typically 13-18t)	30	20	100
	> 300 kN (>18 t)	38	25	100
Drop hammer	3t enclosed (30kJ per blow assumed)	40	23	100
	5kJ per blow	17	10	35
Vibratory rig	50kJ per cycle	50	30	100
	10kJ per cycle	23	15	100
Pile boring	≤ 800 mm	4	2 nominal	N/A
Jack hammer	Handheld	1 nominal	Avoid contact with structure	Avoid contact with structure

Table note:

1 More stringent conditions may apply to heritage or other sensitive structures. Any heritage property would need to be considered on a case by case basis and assessed in accordance with *DIN4150:3 Structural vibration - Effects of vibration on structures*.

Operational road traffic noise

The *Road Noise Policy* requires the assessment of road traffic noise at the year of opening (2026 indicative) and at the design year (2036 indicative) for daytime and night time periods. The operational noise scenarios that have been assessed therefore include:

- 'Do Minimum' (2026 and 2036), which represents the future road network if the proposal was not to be built
- Design (2026 and 2036), which incorporates the proposal design alignment, including the ramps and the future road network.

The relevant 'Do Minimum' and Design scenarios are compared to identify the operational noise impact of the proposal.

A noise barrier assessment has been carried out as part of the operational road traffic noise assessment in accordance with the *Road Noise Policy.* Six noise barriers have been recommended as part of the proposal, subject to detailed design. The dimensions of the barriers are described in full in Section 5.1.5 of

Appendix M and outlined in Table 6-34 below. The dimensions would generally be between three and 3.5 metres in height.

Table 6-34: Design noise barrier heights

Location	Height (m)	Length (m)
Bridge over the floodplain (east)	3	700
Bridge over the floodplain (central)	3	880
Bridge over the floodplain (west)	3.5	950
North of the Hunter River	3.5	540
South of Gowrie Gates	3.5	370
North of Gowrie Gates	3.5	720

Operational road traffic noise assessments were completed for scenarios with and without the noise reduction associated with the barriers (refer to Appendix M for further detail). Considering the impacts in both Year 2026 and Year 2036 during the daytime and night-time periods with the noise barriers the impacts are summarised as follows:

- Road traffic noise levels are predicted to exceed the L_{Aeq} noise criterion at a total of 93 sensitive receivers
- Of these 93 noise sensitive receivers:
  - Noise levels are predicted to increase by more than 2 dB(A) at 61 sensitive receivers
  - Noise levels are predicted to exceed the cumulative limit at 6 sensitive receivers. (ie ≥ $L_{Aeq(15\ hr)}$ or $L_{Aeq(9\ hr)}$ noise criterion + 5 dB(A))
  - Noise levels are predicted to exceed the relative increase criterion at 22 sensitive receivers (the difference between 'no build' and 'build' noise levels is ≥ 12 dB)
  - One receiver is identified as being acute (ie the proposal contributes less than 2.0 dB(A) to the overall level and noise levels are equal to or greater than $L_{Aeq(15\ hr)}$ 65 dB(A) or $L_{Aeq(9\ hr)}$ 60 dB(A)
- 89 sensitive receivers are considered to be eligible for the consideration of feasible and reasonable noise mitigation measures. A list of these receivers is provided in Table 5-4 of Appendix M.

Summary maps for operational road noise contours for the proposal with the noise barriers are shown in Figure 6-16 to Figure 6-18. Detailed maps are included in Appendix M.

Operational sleep disturbance

The *Road Noise Policy* includes a review of international sleep arousal research and concludes that at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance.

The *Environmental Noise Management Manual* considers a maximum noise level event to be defined as a vehicle pass-by event for which the $L_{A,max}$ noise level is equal to or greater than 15 dB(A) above the $L_{Aeq(1hr)}$. Maximum noise level events have been considered at 4294 New England Highway, Whittingham and 4850 New England Highway, McDougalls Hill. These locations are considered to be representative of receivers along the future proposed alignment.

An assessment of maximum noise level events was completed for the proposal and is provided in Section 5.1.7 of Appendix M. The assessment identified that the area is already exposed to maximum noise level events that have the potential for awakening reactions.

One of the main goals of this proposal is to reduce heavy vehicle traffic through Singleton town centre. It is expected that the maximum noise events would decrease in both number and duration due to reduced congestion, better alignments and gradients. Maximum noise events are most likely to occur between Gowrie Gates and the northern connection.

FIG. 6-16 Operational noise contours (1 of 5)

Legend

Proposal features

- Proposal area

Other features

- Roads
- Watercourse
- Main North railway line

Proposed noise wall height (m)

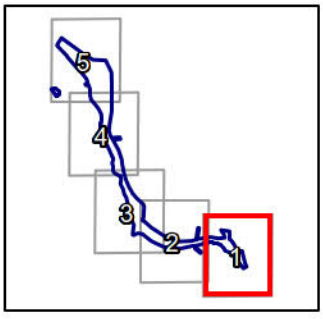
- 3
- 3.5

Free field sound pressure level, LAeq dBA

- 55
- 60
- 65

Facade corrected sound pressure level, LAeq dBA

< 55, 55, 57, 59, 61, 63, >65



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Source: LPMA 2016, LPI 2019 and AECOM 2019
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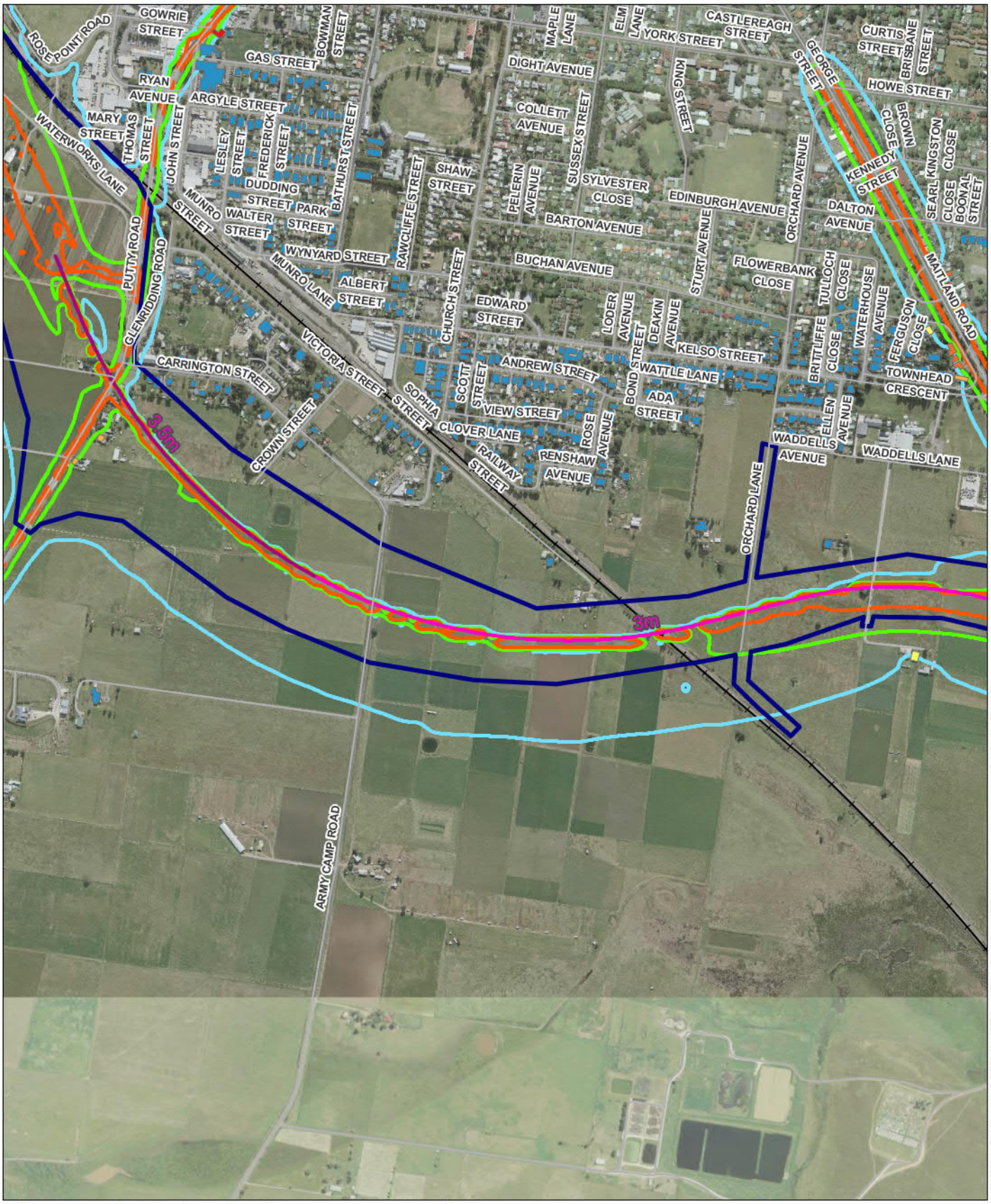


FIG. 6-17 Operational noise contours (2 of 5)

Legend

Proposal features

- Proposal area

Other features

- Roads
- Watercourse
- Main North railway line

Proposed noise wall height (m)

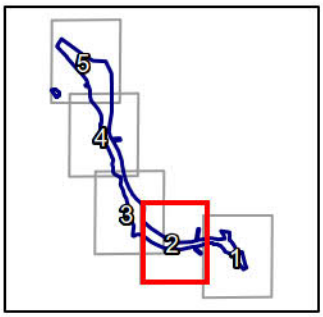
- 3
- 3.5

Free field sound pressure level, LAeq dBA

- 55
- 60
- 65

Facade corrected sound pressure level, LAeq dBA

< 55, 55, 57, 59, 61, 63, >65



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Source: LPMA 2016, LPI 2019 and AECOM 2019
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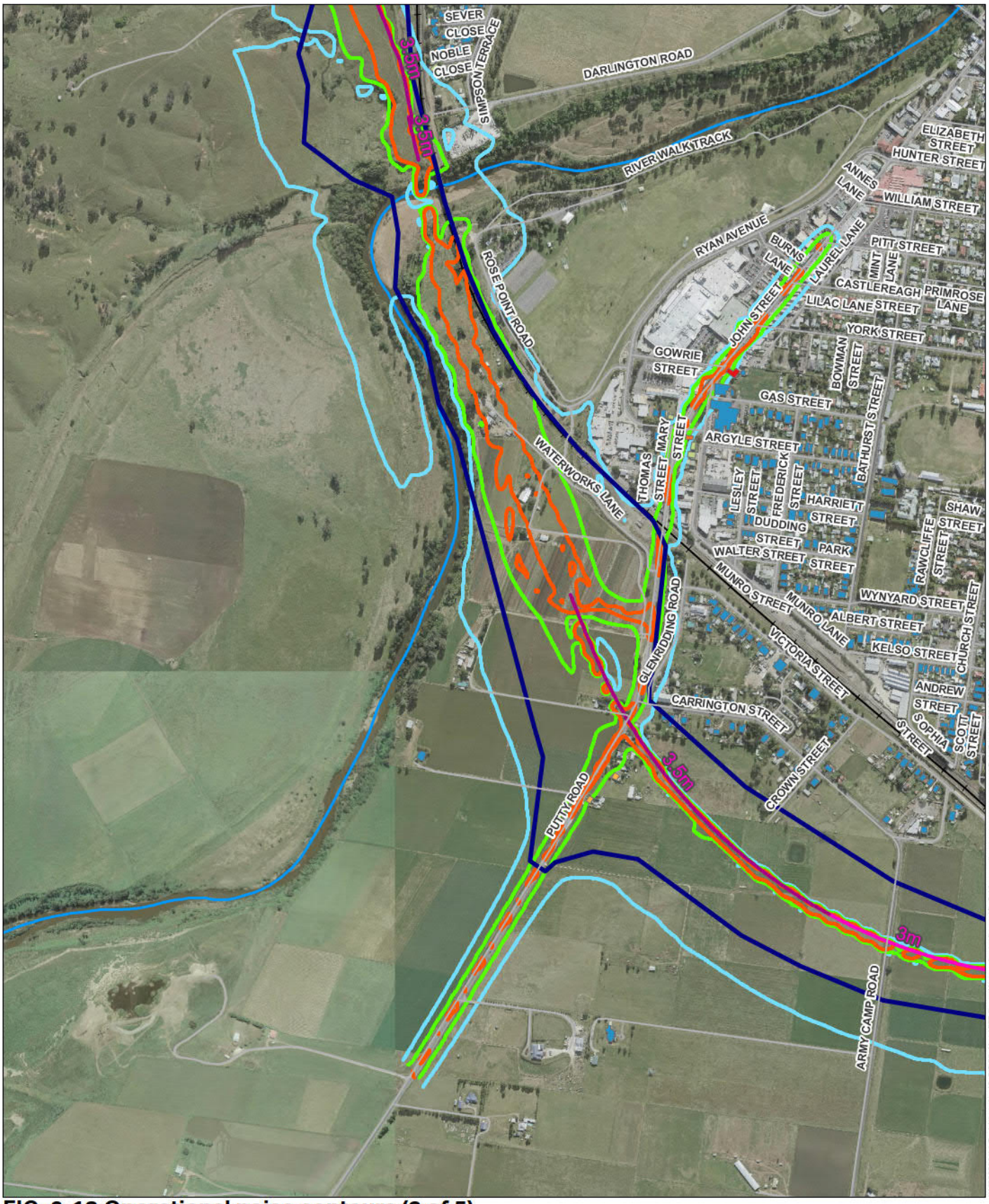


FIG. 6-18 Operational noise contours (3 of 5)

Legend

Proposal features

- Proposal area

Other features

- Roads
- Watercourse
- Main North railway line

Proposed noise wall height (m)

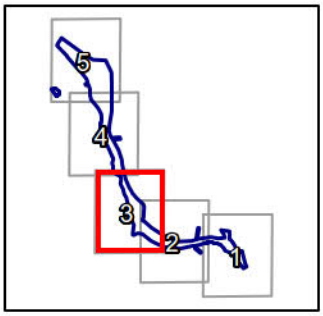
- 3
- 3.5

Free field sound pressure level, LAeq dBA

- 55
- 60
- 65

Facade corrected sound pressure level, LAeq dBA

< 55, 55, 57, 59, 61, 63, > 65



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0 150 300 Meters

Source: LPMA 2016, LPI 2019 and AECOM 2019
Imagery credit: © 2011 Spatial Services 2019, © 2017 AAM Pty Ltd 2019 and © 2008 SKM 2019

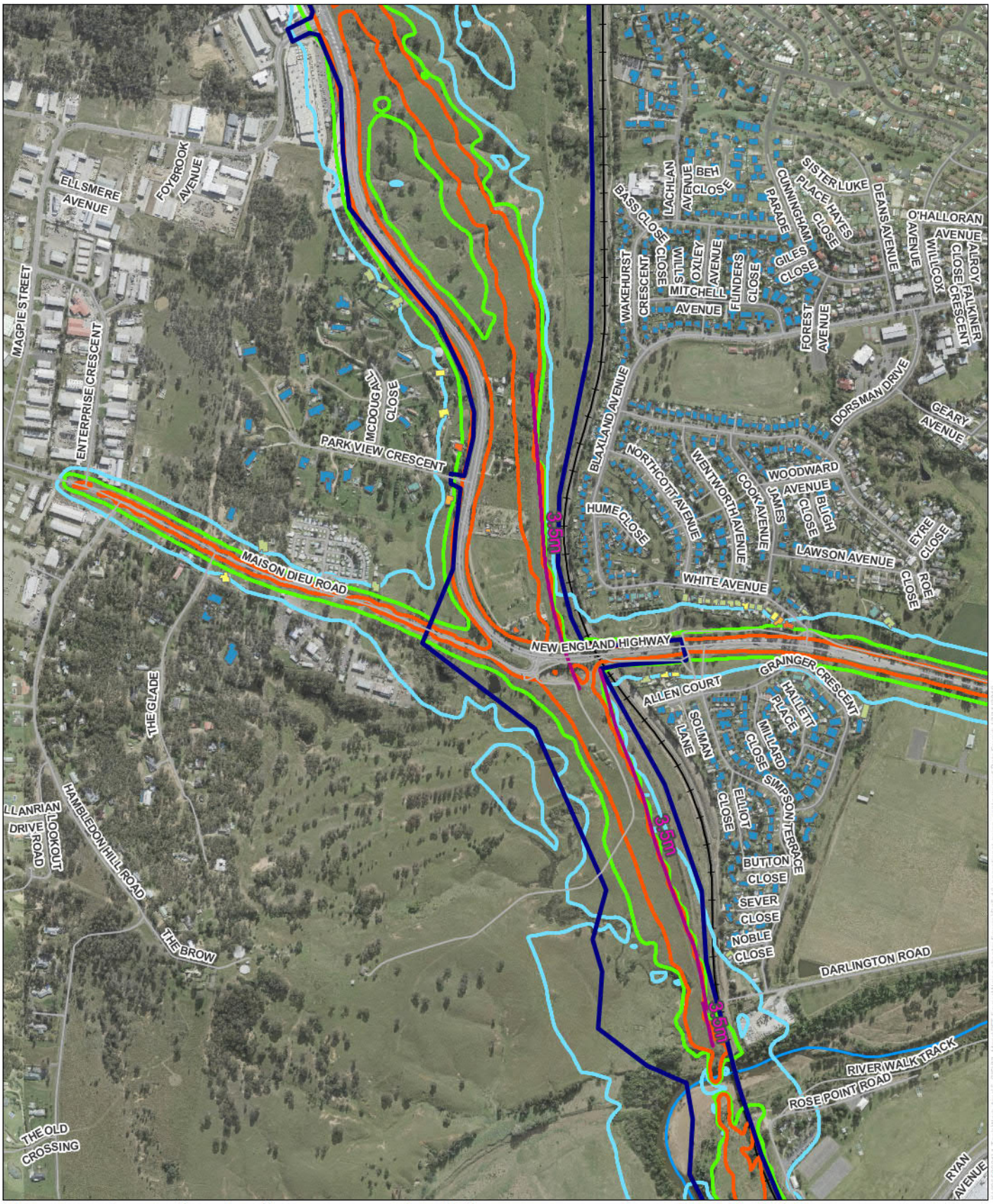


FIG. 6-19 Operational noise contours (4 of 5)

Legend

Proposal features

- Proposal area

Other features

- Roads
- Watercourse
- Main North railway line

Proposed noise wall height (m)

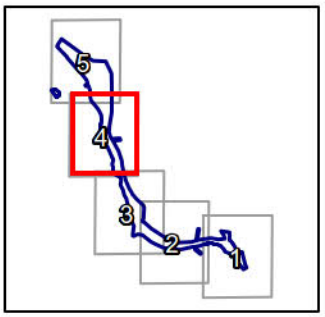
- 3
- 3.5

Free field sound pressure level, LAeq dBA

- 55
- 60
- 65

Facade corrected sound pressure level, LAeq dBA

< 55, 55, 57, 59, 61, 63, >65



N

0 150 300 Meters

Source: LPMA 2016, LPI 2019 and AECOM 2019
Imagery credit: © 2011 Spatial Services 2019, © 2017 AAM Pty Ltd 2019 and © 2008 SKM 2019

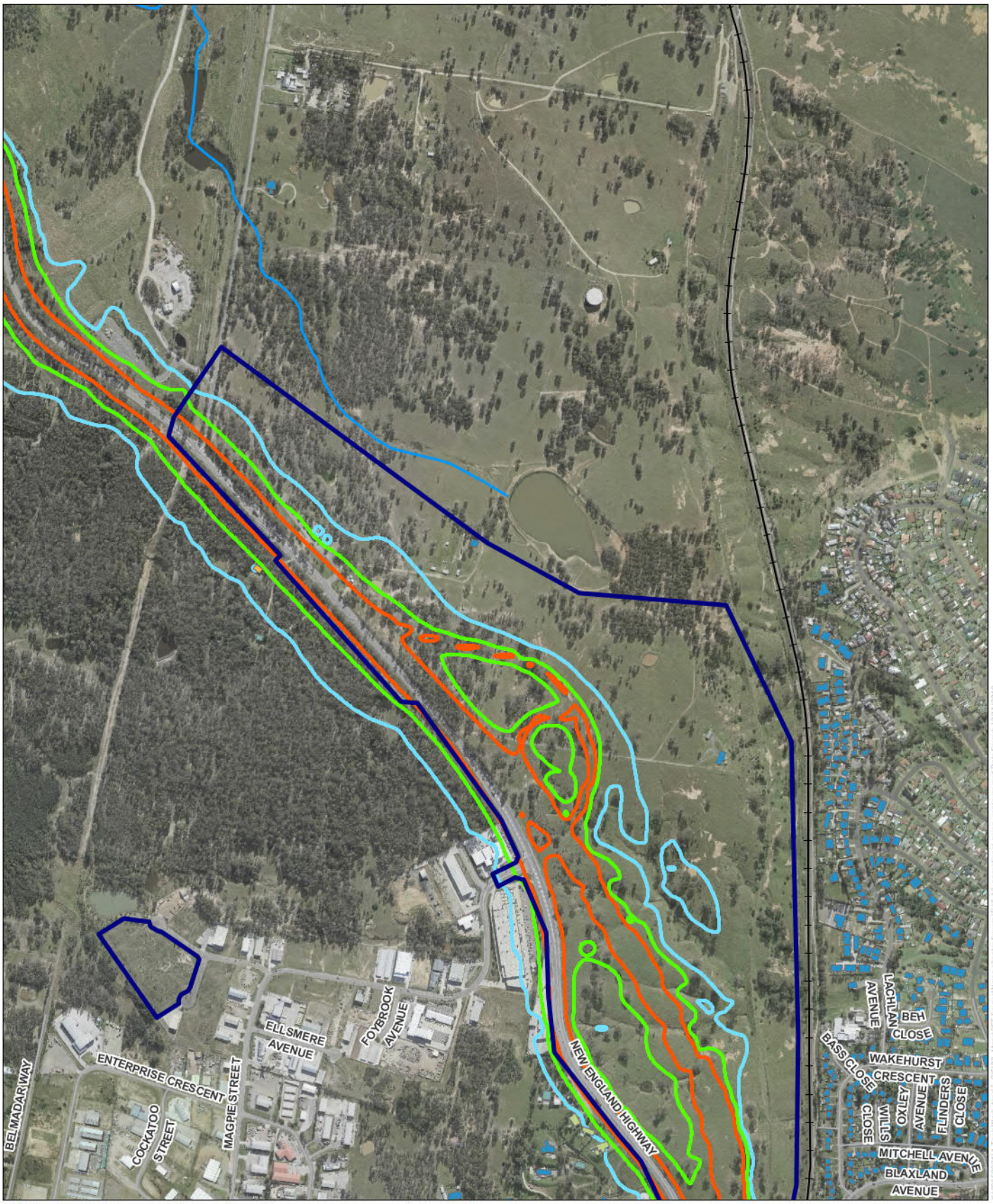


FIG. 6-20 Operational noise contours (5 of 5)

Legend

Proposal features

- Proposal area

Other features

- Roads
- Watercourse
- Main North railway line

Proposed noise wall height (m)

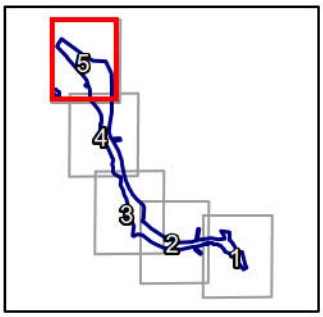
- 3
- 3.5

Free field sound pressure level, LAeq dBA

- 55
- 60
- 65

Facade corrected sound pressure level, LAeq dBA

< 55, 55, 57, 59, 61, 63, >65



N

0 150 300 Meters

Source: LPMA 2016, LPI 2019 and AECOM 2019
Imagery credit: © 2011 Spatial Services 2019, © 2017 AAM Pty Ltd 2019 and © 2008 SKM 2019

6.6.5 Safeguards and management measures

Environmental safeguards provided in Table 6-13 would be implemented to minimise potential impacts related to noise and vibration. Additional mitigation measures are identified in Section 6.4 of Appendix M.

Table 6-35: Summary of environmental safeguards to minimise impacts to noise and vibration

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	A Construction Noise and Vibration Management Plan (CNVMP) would be prepared as part of the Construction Environmental Management Plan. The CNVMP would identify: • all potential significant noise and vibration generating activities associated with the activity • noise and vibration sensitive receptors • measures to be implemented during construction to minimise noise and vibration impacts, such as restrictions on working hours, staging, placement and operation of work compounds, parking and storage areas, temporary noise barriers, haul road maintenance, and controlling the location and use of vibration generating equipment • feasible and reasonable mitigation measures to be implemented, taking into account the Roads and Maritime's Beyond the Pavement urban design policy, process and principles. • a monitoring program to assess performance against relevant noise and vibration criteria • arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • an out of hours works procedure, including approval process and proposed mitigation measures.	Contractor	Pre-construction and Construction
Noise and vibration	All sensitive receivers likely to be affected will be notified at least five days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will include details of: • the project • construction period and construction hours • contact information for project management staff • complaint and incident reporting and how to obtain further information	Contractor	Construction
Noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least 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	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	• Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.		
Noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods. Any variations to the standard construction hours will follow the approach RTA Environmental Facts Sheet - Noise Management and Night Works, including consultation with the affected local community	Contractor	Construction
Noise and vibration	Where reasonable ad feasible, high noise generating activities (75dB(A)L_{eq} at receiver) be used during standard construction hours and in continuance blocks of no more than 3 hours with at least one hour respite between each block of work generating high noise impact, where the location of the work is likely to impact the same receiver.	Contractor	Construction
Noise and vibration	Where high noise generating activities (75 dB(A) L_{eq} at receiver) are required out of hours the following will be implemented: • The equipment will be used prior to 10pm where reasonable and feasible • Where the above cannot be achieved the equipment will be used prior to midnight where reasonable and feasible It is not proposed to apply a three hour on and a one hour off respite approach in an effort to ensure that the use of such equipment is completed as early in the night as possible.	Contractor	Construction
Noise and vibration	Where properties have been identified for architectural treatment and these properties would be impacted by noise from construction works, Roads and Maritime would consult with those property owners on the early installation of treatments to provide noise mitigation during the construction of the proposal.	Roads and Maritime	Pre-Construction
Noise and vibration	The following will be implemented for deliveries the and from the proposal • Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. • Dedicated loading/unloading areas to be shielded if close to sensitive receivers. • Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Construction sites would be arranged to limit the need for reversing associated with regular/repeatable movements	Contractor	Construction
Noise and vibration	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	any out of hours work.		
Noise and vibration	The noise associated with the operation of construction ancillary facilities would primarily result from the operation of fixed and mobile plant and truck movements. Consideration would be given to the layout of the site in order to maximise distance and shielding to nearby receivers.	Contractor	Pre-construction and Construction
Noise and vibration	Where practicable, work should be scheduled to avoid major student examination periods such as before or during Higher School Certificate and at the end of higher education semesters.	Contractor	Construction
Noise and vibration	At compound sites, consider positioning site sheds, earth bunds and hoarding to maximise shielding to residential receivers	Contractor	Construction
Noise and vibration	In circumstances where the noise levels are predicted to exceed construction noise management levels after implementation of the general work practices, additional mitigation measures are required. These measures include the following: • Monitoring • Notification (letterbox drop or equivalent) • Specific notifications • Phone calls • Individual briefings • Respite Offers • Respite Periods • Duration Respite. • Alternative Accommodation	Contractor	Construction
Noise and vibration	Vibration intensive equipment size would be selected to avoid working within the structural damage minimum working distances The use of less vibration intensive methods of construction or equipment would be considered where feasible and reasonable.	Contractor	Construction
Noise and vibration	Where the use of vibration intensive equipment within the relevant minimum working distances cannot be avoided, prior to the commencement of vibration intensive work, a detailed inspection will be carried out and a written and photographic report prepared to document the condition of buildings and structures within the minimum working distances. A copy of the report will be provided to the relevant land owner or land manager.	Contractor	Pre-Construction
Noise and vibration	To confirm that the noise level targets are achieved, a post-construction noise monitoring program be carried out in accordance with the Noise Mitigation Guideline (Roads and Maritime 2014d).	Roads and Maritime	Operation