Botany Rail Duplication

Operational Noise & Vibration Review

Jacobs
Level 7, 177 Pacific Highway
North Sydney NSW 2060

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1 EXECUTIVE SUMMARY

To increase rail traffic capacity along the Botany Rail corridor, the Botany Rail Duplication project will implement a new rail track within the existing rail corridor between the Botany Yard and the Cooks River Loop.

As part of the Conditions of Approval (CoAs), it is required that an Operational Noise and Vibration Review (ONVR) be prepared based on the latest rail design. The aims of this ONVR report are to address the acoustic requirements stated in the CoA. The CoAs and how these are addressed within the report, is discussed in detail in Section 4.1.

In summary, this report discusses the following:

- Project description. Section 2 of this report discusses in detail the components of the Botany Rail Duplication project, such as new rail track features, track realignments,

- Scope areas which are subject to the ONVR acoustic assessment. These scope areas are categorised into noise catchment areas (NCAs). A detailed description of these NCAs, as well as potential affected receivers within each NCA; is discussed in Section 3.1.1.

- Existing acoustic environment and findings from acoustic survey conducted along the rail corridor (refer to Section 3). The purpose of the survey was to assist in validating the noise and vibration model of the duplicated rail track. This noise and vibration model would then predict the acoustic impacts when the Botany Rail Duplication project is finally implemented.

  Additionally, the report also discusses the existing condition of track lubricators. This is important since the current operation of the lubricators can influence the noise emissions from the rail corridor.

- Operational acoustic criteria and assessment objectives. The assessment criteria are obtained from the NSW "Rail Infrastructure Noise Guideline". (NSW RING) and document titled "Assessing Vibration – A Technical Guideline" (AVTG). These documents include criteria for airborne noise levels, ground-borne noise levels; as well as vibration levels. Assessment procedures and methodologies are also discussed (refer to Section 4).

- Operational noise modelling conducted to predicted airborne noise levels onto nearest affected receivers (refer to Section 5). The methodology employed to predict noise emissions from rail traffic is discussed; as well as the validation process used to calibrate the model to existing rail traffic conditions.

  Section 5 also includes the noise modelling results for typical operational scenarios which consider the following timeline:

  - Year 2024, prior to the implementation of the EPA licensing regime. This regime will require operators to eliminate wheel squeal from their rolling stock.
  - Year 2034, after the implementation of the EPA licensing regime.

  It is noted that the number of residential exceedances reduce significantly between before and after the implementation of the EPA licensing regime. This generally occurs because exceedances related to L_{Amax} noise emissions from wheel squeal; are mitigated by the implementation of the licensing regime.

  However, to achieve this outcome, it is also advised that an effective and thorough coverage of top-of-rail-friction-modifier (TORFM) and gauge face lubricators (GFL) is achieved along the rail corridor.

- Operational modelling of vibration and ground noise levels are given in Section 6 and indicate that there are no regenerated noise exceedances in spaces that that are orientated away from the rail line.

- Mitigation recommendations for acoustic impacts; such as airborne noise impacts are given in Section 7. The number or receiver locations that are identified for the consideration of further noise attenuation treatments are limited to 16 for 2034 (see Table 36 for specific locations).

- Strategy for ongoing consultation with stakeholders is given in Section 8.

- Post-operational testing and validation requirements and suggested methodology is given in Section 9.

2 INTRODUCTION

2.1 Overview

The Botany Rail Duplication project has been proposed so as to increase rail traffic capacity along the Botany Rail corridor, by implementing a new rail track within the existing rail corridor, between the Botany Yard and the Cooks River Loop.

The project is considered a Critical State Significant Infrastructure (CSSI) project. Consequently, approval conditions have been prepared specifically for the project, and are the Planning Secretary's Environmental Assessment Requirements (SEARs).

To address these planning requirements, an acoustic assessment was undertaken to accompany the environmental impact statement (EIS). This acoustic assessment is discussed in detail in report titled *"Botany Rail Duplication, Technical Report 2 – Noise and Vibration Technical Report, Construction and Operation"* (dated 30 September 2019, version v1.5, issued by SLR Consulting). This report is referred herein as the *EIS Technical Report 2*.

Subsequent to the issue of the EIS, a Submissions Report was issued that contained changes to certain operational conditions, such as speed profiles, which were varied from the initial design considered in the EIS Technical Report 2. The findings of the updated acoustic assessment are discussed in Appendix D of this Submissions Report (referred herein as the *Submissions Report – Appendix D*). These updated operational conditions are considered current and are used in our acoustic assessment. These operational conditions are summarised in Section 5.1 of our report.

The Infrastructure Approval for the project is given in CSSI 9714, dated 28th July 2020. This document describes the projects as:

Duplication of the Botany Rail Line including:

- construction of approximately 3 kilometres of track within the existing Botany Line rail corridor between Mascot and Botany;
- realignment of section of the existing track between Mascot and Botany;
- construction of rail crossovers;
- construction of new rail bridges and associated structures adjacent to existing rail bridges at Mill Stream, Southern Cross Drive, O'Riordan Street and Robey Street;
- reconstruction of existing rail bridges and associated structures at Robey Street and O'Riordan Street;
- construction of a new embankment and retaining structures adjacent to Qantas Drive between Robey Street and O'Riordan Street and an embankment between the bridges at Mill Stream and Botany Road;
- Ancillary work including signalling upgrades

This ONVR has been prepared in compliance with Project Approval CSSI 9714 Condition of Approval E32.

Since the project is now at the detailed design stages, the SEARs requires an Operational Noise and Vibration Review (ONVR) to be prepared based on the latest rail design (i.e. ONVR rail design). Pulse White Noise Acoustics (PWNA) has been engaged to undertake this ONVR acoustic assessment of the detailed design for the Botany Rail Duplication project.

This ONVR report discusses the findings from the operational acoustic assessment, and the updated mitigation measures which have been determined in coordination with the design team.

A glossary of acoustic terminology used in this report, is provided in Appendix A.

2.2 Project Brief

The Australian Rail Track Corporation (ARTC) proposes to operate a new second rail track within the existing Botany Line rail corridor, between Mascot and Botany.

As part of the implementation of the new rail track, the following key components will be constructed (refer to Figure 1):

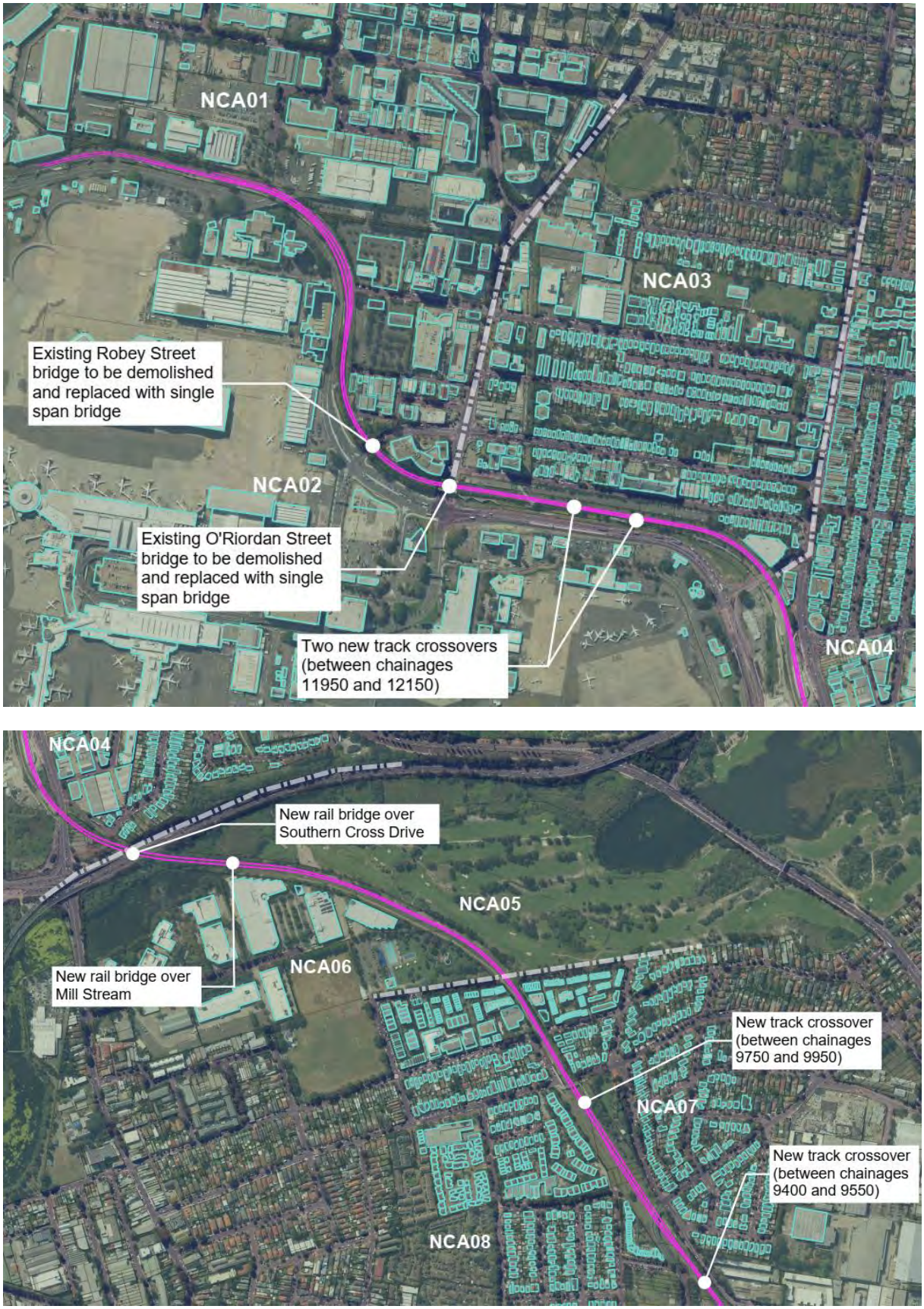
- Track duplication: Construction of a new rail track within the rail corridor.
- Track realignment (slewing) and upgrading: Sections of existing rail track to be shifted sideways (slewing) to improve the alignment of rail tracks.
- Four new rail crossovers. These crossovers are indicated in Figure 1.
- New bridge works: Existing rail bridges at Robey Street and O'Riordan Street will be demolished and replaced with single span bridges at each location to accommodate the existing and duplicated track. Additionally, new two-span rail bridges will be constructed over Southern Cross Drive and Mill Stream (refer to Figure 1).
- Embankment / retaining structures: new embankment and retaining structures to be constructed at the following locations:
    - Along Qantas Drive, between Robey Street and O'Riordan Street.
    - Between new bridges over Southern Cross Drive and Mill Stream.

In referencing the rail traffic direction, "Down Track" refers to rail traffic heading away from Port Botany (i.e. north bound), and "Up Track" refers to rail track heading towards Port Botany (i.e. south bound).

Ancillary works includes upgrades to bi-directional signalling, drainage works, and protection / relocation of utilities. The construction stage for the project is expected to last approximately three years, with commissioning and opening stages scheduled for 2024.

The rail track features listed above are shown in detail in drawing package titled *"Botany Rail Duplication, Trackworks, Detailed Design"* (Design Stage 3, revision D, referred herein as the *ONVR design package*). The features in this drawing package are implemented in the "Build" scenario of the rail noise model (refer to discussion in Section 5).

Figure 1 Key components of the project



3 EXISTING ACOUSTIC ENVIRONMENT

3.1 EIS Technical Report 2 & Submission Report – Appendix D

To determine the existing acoustic environment and keep consistency with the findings of the EIS assessment, the following background information discussed in the EIS Technical Report 2, is used in our assessment:

- Noise catchment areas (NCAs)

The following sub-sections summarise this information from the EIS Technical Report 2.

3.1.1 Assessment Area

The assessment area, as considered for the EIS assessment, is shown in Figure 2. Since the issue of the EIS Technical Report 2 and the Submissions Report – Appendix D, there has been some changes implemented in the assessment area. Therefore, a currently updated site layout is included in Appendix B. This updated layout shows the following modifications:

- Additional hotel developments (such as the Holiday Inn Express Sydney Airport).
- Future hotel developments, such as those to be located at 133-137 Baxter Road and 40-56 Baxter Road, Mascot.

Note: Only developments that received Development Consent prior to the Botany Rail Duplication (BRD) Approval need to be considered in the noise and vibration assessment. The BRD project received approval on 28 July, 2020.

The hotel development at 40-56 Baxter Road received Development Consent for DA-2019/233 on 8 October 2020. The future development at 133-137 Baxter Road (DA-2021/450) had its application lodged on 27 September 2020 and is still currently under assessment. Neither of these developments will be considered further in this assessment.

The Botany Line rail corridor is currently only used by freight trains; and connects Port Botany to the Metropolitan Freight Network.

The assessment area extends through the suburbs of Mascot, Botany and Pagewood. It is close to major road corridors such as:

- Joyce Drive, Qantas Drive, and O'Riordan Street in the north-western section.
- Southern Cross Drive and Botany Road in the south-eastern section.

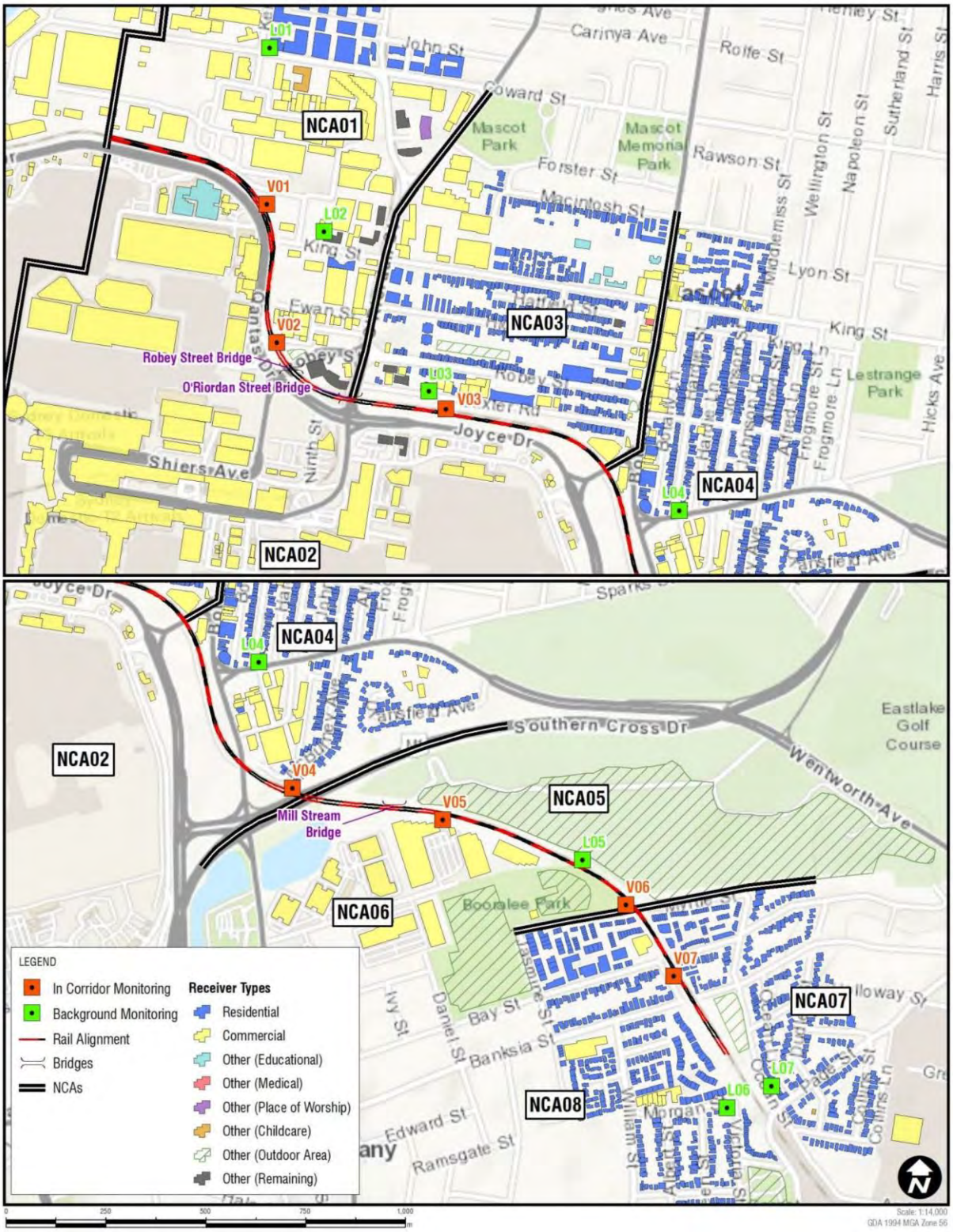
Additionally, the assessment area is also close to major infrastructure facilities, such as Sydney Kingsford Smith Airport; and other major rail corridors such as the Airport Line (which is located underground).

For the purpose of the acoustic assessment, the assessment area has been sub-divided into noise catchment areas (NCAs). These are briefly summarised in Table 1.

Table 1 Description of noise catchment areas

NCA	Minimum Distance from Rail Track, m	Description
1	10	Catchment is located north of the rail corridor, extending between O'Riordan Street and north-western extent. The NCA mostly comprises commercial premises with some residential receivers along Coward Street, and some hotels including the Stamford Plaza Hotel.
2	40	Catchment is located south of the rail corridor. It mostly comprises the Sydney Airport facilities, including the Qantas Flight Training Facility, and hotel facilities such as the Ibis Budget and Mantra Hotel. Note: We understand that the New Qantas Training Centre will no longer be proceeding at this location
3	20	Catchment is located north of the rail corridor, between O'Riordan Street and Botany Road. This mostly comprises residential receivers, and also includes hotel facilities such as the Quest Mascot and Felix Hotel (i.e. Citadines Connect Sydney Airport).
4	10	Catchment is located east of the rail corridor, extending between Botany Road and Southern Cross Drive. This comprises residential receivers, and some commercial premises located along Botany Road, between Wentworth Avenue and Southern Cross Drive.
5	30	Catchment comprises the Eastlake golf course, north of the rail corridor.
6	25	Catchment is located south of the rail corridor, extending between Southern Cross Drive and Myrtle Street. This comprises commercial receivers.
7	15	Catchment is located east of the rail corridor, extending between Myrtle Street and south-eastern extent. It comprises residential receivers.
8	15	Catchment is located west of the rail corridor, extending between Myrtle Street and south-eastern extent. It comprises residential receivers, and some dispersed commercial premises.

Figure 2 Assessment area (extracted from Figure 3 of the EIS Technical Report 2)



3.2 Unattended Noise Monitoring

To validate our noise model, PWNA has conducted an additional unattended noise survey for typical freight train pass-bys. The measured noise levels were only analysed for the time period between 12:00 am and 6:00 am. This period was chosen in order to exclude noise emissions from the following extraneous noise sources:

- Aircraft flight activities. It is noted that the survey period analysed is within the operational curfew for Sydney Kingsford Smith Airport.
- Construction work. During our site visits conducted along the rail corridor it was noted that construction works were being undertaken in the vicinity of the rail corridor during the daytime and evening periods, but are outside the analysed survey time period.
- Vehicular traffic along major road corridors (these major road corridors are listed in Section 3.1.1).

The noise survey was conducted at the locations shown in Appendix B. The instrumentation and dates the survey was conducted for each monitoring location, are listed in Table 2. In most instances, the measurement locations were selected to be as close as possible to the measurement locations considered by SLR Consulting (as discussed in the EIS Technical Report 2).

Table 2 Survey break-down and instrumentation

Measurement Locations	Distance From Nearest Track, m	Instrumentation	Survey Dates	Number of Analysed Freight Train Pass-Bys
M02	6m	Svan 971, S/N: 74365	15 April – 19 April	20
M03	8m	Rion NL-42, S/N: 396932	15 April – 19 April	20
M03b	4m	Svan 971, S/N: 61521	15 April – 19 April	20
M04	8m	Rion NL-42, S/N: 396932	21 April – 27 April	39
M06	18m	Svan 971, S/N: 61521	21 April – 27 April	39
M07	9m	Svan 971, S/N: 74365	21 April – 27 April	39

Calibration of the noise loggers was checked prior to and following measurements using a Bruel & Kjaer Type 4230 sound calibrator (serial number 1275644). The calibrator emitted a calibration tone of 94 dB at 1 KHz. The drift in calibration did not exceed ±0.5 dB. All equipment carries appropriate and current NATA (or manufacturer) calibration certificates.

A summary of the measured noise levels obtained during the survey, is provided in Table 3 below.

Table 3 Summary of measured noise levels

Measurement Location	Distance From Nearest Track, m	Measured Noise Levels, dB	
		L_{AE}	L_{Amax} [1]
M02	6	100	98
M03	8	94	94
M03b	4	107	107
M04	8	111	93
M06	18	88	85
M07	9	96	91

Notes:

1. Maximum noise levels not exceeded by 95% of individual train pass-by events

3.3 Existing Condition of Track Lubricators

A site inspection of the rail track was later undertaken on 23 June to confirm the operational conditions of the track lubricators and other track infrastructure devices. A summary of these devices is provided in Table 4.

Table 4 Summary of existing devices

Chainage	Rail Serviced	Type	Observations
10247	Both rails	LWS SmartLube	Solar powered TORFMA unit (not a lubricator)
10400	Up rail only	Whitmore	-
12840	Both rails but on the Down Track only	RTE-25	Mechanical lubricator

With respect to the gauge face lubricator, at the time of the inspection it was observed that its grease application is not currently reaching the first curve after the unit in the "Down" direction. A swipe test was also taken near the curves at chainage 10247 and 12840. The swipe test results at the time of the inspection appears to indicate diminished lubrication coverage through the rail corridor.

However, as commented by ARTC, it is noted that the existing lubricators are being operated and maintained as per manufacturers' specifications.

3.4 Attended Vibration Measurements

Vibration measurements of trains passbys were performed between 20nd and 23rd June 2022 in 4 locations with the aid of 2-3 accelerometers located at various distance from the railway. The measuring equipment consisted of:

- Apollo Sinus Samurai (3.2) 4 Channel Data acquisition and Analyser s/n 11386
- Accelerometers: AC102-1A s/n 181193 (Ch 1), AC102-1A s/n 181192 (Ch 2), AC102-1A s/n 181191 (Ch 3)
- Microphone: GRAS 46AE, s/n 476603 (Ch 4)

Ch1 and Ch2 were always connected to the accelerometers with CH1 being located closest to the railway. Ch2 was located further away and in some locations where the terrain allowed and the cable length was sufficient, Ch3 accelerometer was also connected at an even more distant location.

The microphone signal was not used for the ground borne analysis and the following work is based only on the 2 or 3 vibration signals measured by the accelerometers.

Ideally the sample size of train passbys for each location is 20 however, since no reliable train schedule was able to be provided, the number of valid train passbys was 4-6 for each location.

Table 5 Measurement locations and accelerometers distances

Locations	Address	Distances to the railway [m]		
		Ch1	Ch2	Ch3
#1	Qantas Training Centre, Ewan St, Mascot	8.0	12.0	16.0
#2	142 Banksia St, Pagewood	15.0	30.0	
#3	Baxter Road / Joyce Drive, Mascot	14.0	25.0	
#4	1 Myrtle St, Pagewood	15.0	30.0	22.5

Note: We have been advised by Qantas that Loc#1, which corresponds with Qantas Training Centre, is no longer a location of interest since the construction of this development at this location has been cancelled and it will be moved to Burrows Road. While the analysis at this location had been performed before this information was known, no further analysis is presented for this location in this report.

The analysis methodology and the results are presented in Section 6.1.

4 OPERATIONAL ACOUSTIC CRITERIA

4.1 Conditions of Approval

The following Conditions are from Part D and E of Project Approval CSSI 9714:

D1. Conditions D2 and D3 apply where an active noise mitigation system such as a track lubrication system is installed to mitigate operational rail noise.

D2. A Validation Program must be developed to validate the performance of the active noise mitigation system in meeting the noise level reductions (Lmax) anticipated in the Operational Noise and Vibration Review. The program must:

(a) facilitate the ongoing review of the effectiveness of the active noise mitigation;

(b) include regular noise monitoring at a location where Lmax is expected to be elevated;

(c) demonstrate how data collected translates to noise impacts at affected residences using the methodology set out in the Rail Infrastructure Noise Guideline; and

(d) include a monitoring, recording and reporting process that will facilitate measuring of compliance and reporting.

The validation program must be reviewed and endorsed by the AA as being able to meet the above requirements and be submitted to the Planning Secretary before the commencement of operation. The validation program must be able to demonstrate that the system is achieving the relevant noise reductions. The validation program may cease after 5 years with the approval of the Planning Secretary. Any request to cease monitoring must demonstrate that the active mitigation system and monitoring system has been maintained and is effective.

Notwithstanding, the performance of the active monitoring system must be submitted to the Planning Secretary on an annual basis and within three months of the end of each year. Regardless, the results of monitoring must be made available to the Planning Secretary on request.

D3. Where monitoring shows that the active noise mitigation system is not effective in achieving the noise level reductions in the Operational Noise and Vibration Review, the Proponent must implement further practicable measures to ensure the noise level reductions are achieved.

E30. The project must be designed to comply with the ground-borne noise trigger levels in the Rail Infrastructure Noise Guideline (EPA, 2013). Where the ground-borne noise trigger levels cannot be achieved the Proponent must implement management and/or mitigation measures to minimise exceedances.

E31 Baseline ground-borne noise monitoring must be completed before the commencement of construction where ground-borne noise is predicted to exceed the trigger level for Ground borne noise in the Rail Infrastructure Noise Guideline.

E32 The Proponent must prepare an Operational Noise and Vibration Review (ONVR) to confirm noise and vibration control measures that would be implemented for the operation of the CSSI. The ONVR must be prepared as an iterative design development and in consultation with relevant council(s) and other relevant stakeholders and must:

(a) confirm the appropriate operational noise and vibration objectives and levels for surrounding development, including existing sensitive land uses;

(b) confirm the operational noise predictions (including ground-borne noise) based on the final design. Confirmation must be based on an appropriately calibrated noise model (which has incorporated data obtained from noise monitoring and traffic counts where necessary for calibration purposes);

(c) confirm the operational noise and vibration impacts at sensitive receivers based on the final design of the CSSI, including operational daytime LAeq,15 hour and night-time LAeq, 9 hour traffic noise contours;

(d) examine all noise and vibration mitigation measures that could be applied to address the impacts identified in (c), with a focus on source control and design;

(e) identify specific physical and other mitigation measures that will be installed for controlling noise and vibration impacts at the source and at the receiver (if relevant) including location, type and timing of their installation;

(f) where noise and vibration objectives cannot be achieved, the ONVR must present an analysis of all noise and vibration mitigation measures, the 'best practice' achievable noise and vibration outcome and justification for the measure decided upon based upon the analysis;

(g) fully describe the design, assumptions, calculation process, mitigation strategy, and other relevant factors (including the procedures in place to ensure trains do not stop within the Botany Rail Duplication and details of exceptions that may result in trains stopping).

(h) include a consultation strategy to seek feedback from directly affected landowners on the noise and vibration mitigation measures; and

(i) procedures for the management of operational noise and vibration complaints.

The ONVR must be verified by the AA. The ONVR must be prepared at the Proponent's expense and submitted to the Planning Secretary for approval before the implementation of mitigation measures. The ONVR must be made publicly available consistent with the requirements of Condition B10.

The Proponent must implement the identified noise and vibration control measures no later than 6 months after the commencement of construction, unless otherwise agreed with the Planning Secretary.

E33 Where operational noise mitigation measures (that also assist in reducing construction noise impacts) cannot be installed within six months of commencement of construction in accordance with Condition E32, the Proponent must submit to the Planning Secretary a report providing justification as to why. The report must include details of temporary measures that would be implemented to reduce construction noise impacts, until such time that the operational noise mitigation measures identified in Condition E32 are implemented. The report must be endorsed by the AA and submitted to the ER for approval within six (6) months of the commencement of construction which would affect the identified sensitive land uses.

E34 Within 12 months of the commencement of operation of the CSSI, the Proponent must undertake monitoring of operational noise (including ground borne noise) to compare actual noise performance of the CSSI against the noise performance predicted in the review of noise mitigation measures required by Condition E32.

The Proponent must prepare an Operational Noise Compliance Report to document this monitoring. The Report must include, but not necessarily be limited to:

(a) airborne and ground-borne noise monitoring to assess compliance with the operational noise levels predicted in the review of operational noise mitigation measures required under Condition E32; NSW Government 31 Department of Planning, Industry and Environment Conditions of Approval for the Botany Rail Duplication SSI-9714 July 2020

(b) a review of the operational noise levels in terms of noise trigger levels established in the Rail Infrastructure Noise Guideline (EPA, 2013);

(c) methodology, location and frequency of noise monitoring undertaken, including monitoring sites at which CSSI noise levels are ascertained, with specific reference to locations indicative of impacts on receivers;

(d) details of any complaints and enquiries received in relation to operational noise generated by the CSSI between the date of commencement of operation and the date the report was prepared;

(e) any required recalibrations of the noise model taking into consideration factors such as noise monitoring and actual traffic numbers and proportions;

(f) an assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of mitigation measures; and

(g) identification of additional measures to those identified in the review of noise mitigation measures required by Condition E32, that are to be implemented with the objective of meeting the trigger levels outlined in the Rail Infrastructure Noise Guideline (EPA, 2013) and Noise Policy for Industry (EPA, 2017), when these measures are to be implemented and how their effectiveness is to be measured and reported to the Planning Secretary and the EPA.

The Operational Noise Compliance Report must be submitted to the Planning Secretary and the EPA, following review by the AA and within 60 days of completing the operational noise monitoring and made publicly available.

These conditions of approval are addressed in this report as summarised in Table 6 below.

Table 6 Summary of conditions of approval and relevant report sections

Condition	Section of This Report Addressing Condition of Approval
D1-D3	These Conditions will also be addressed in the Operational Noise Compliance Report (not this ONVR). Refer To Section 9
E30	Refer to Section 6
E32 (a)	Refer to Sections 3.1.1 and 0
E32 (b), (c)	Refer to Sections 5, 6
E32 (d), (e), (f)	Refer to Sections 7
E32 (g)	Refer to Section 7.3.5
E32 (h), (i)	Refer to Sections 8, 9

4.2 Airborne Noise Criteria

The airborne noise criteria are obtained from document titled *"Rail Infrastructure Noise Guideline"* (issued by NSW EPA, referred herein as the *NSW RING*).

Since the proposed development is considered as a redevelopment of an existing rail line, the NSW RING states that rail noise levels should be predicted at the following timelines: at opening year (i.e. 2024) and 10 years after opening (i.e. 2034).

For each timeline, a "Build" scenario and "No Build" scenario are considered. The "Build" scenario accounts for the assessment of rail noise levels assuming the proposed development is implemented. The "No Build" scenario includes the assessment of rail noise levels assuming the proposed development is not implemented. The difference in noise levels between the "Build" and "No Build" scenarios, determines the noise level increase generated by the proposed rail project.

The airborne noise assessment criteria in accordance with the NSW RING are summarised in Table 7 for residential receivers, and Table 8 for non-residential receivers.

Table 7 Airborne heavy rail noise criteria for residential receivers

Development Type	External Noise Trigger Level, dBA	
	Day time (7:00 am – 10:00 pm)	Night-time (10:00 pm – 7:00 am)
Redevelopment of existing rail line	RING Increase Trigger Levels Development increases existing $L_{Aeq(period)}$ rail noise levels by 2 dB or more, or existing L_{Amax} rail noise levels by 3 dB or more and predicted rail noise levels exceed:	
	RING Absolute Trigger Levels	
	65 dB L_{Aeq} (15 hours) OR 85 dB L_{AFmax} [1]	60 dB L_{Aeq} (9 hours) OR 85 dB L_{AFmax} [1]

Notes:

1. *L_{Amax} refers to the maximum noise level not exceeded for 95% of rail pass-by events*

Table 8 Airborne rail noise criteria for non-residential receivers

Development Type	External Noise Trigger Level, dBA (when in use)
	Redevelopment of existing rail line
	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2 dB or more for that period and resulting rail noise levels exceed:
Schools, educational institutions & childcare centres	70 dB L_{Aeq} (1 hour) [1]
Places of worship	55 dB L_{Aeq} (1 hour) [1]
Hospital - wards	50 dB L_{Aeq} (1 hour) [1]
Hospital – other uses	65 dB L_{Aeq} (1 hour) [1]
Open space – passive use	65 dB L_{Aeq} (1 hour)
Open space – active use	65 dB L_{Aeq} (1 hour)

Notes:

1. *Assuming a 25 dB noise reduction between external and internal noise levels for non-openable windows to be used or currently in use at educational facilities*

4.3 Ground-Borne Noise Criteria

The assessment criteria for ground-borne noise are obtained from Section 2.5 of the NSW RING. These are summarised in Table 9. These criteria are only applicable when internal ground-borne noise levels are higher than airborne noise generated by rail traffic.

Table 9 Ground-borne noise trigger levels

Development Type	Time Period	Internal Noise Trigger Levels, dBA
		Development increases existing $L_{Aeq(period)}$ rail noise levels by 3 dB or more for that period and resulting rail noise levels exceed:
Residential	Day time (7:00 am – 10:00 pm)	40 dB L_{ASmax} [1]
	Night-time (10:00 pm – 7:00 am)	35 dB L_{ASmax} [1]
Schools, educational institutions, places of worship	When in use	40 – 45 dB L_{ASmax} [1]

Notes:

1. L_{ASmax} *refers to the maximum noise level, in "slow" time response, not exceeded for 95% of rail pass-by events*

4.4 Ground-Borne Vibration Criteria

The NSW RING refers to document titled *"Assessing Vibration – A Technical Guideline"* (AVTG), for ground-borne vibration criteria. These criteria are expressed in terms of vibration dose values (VDVs). These are summarised in Table 10.

Table 10 Vibration dose values for intermittent vibration

Development Type	Daytime (7:00 am – 10:00 pm)		Night-time (10:00 pm – 7:00 am)	
	Preferred Values ($m/s^{1.75}$)	Maximum Values ($m/s^{1.75}$)	Preferred Values ($m/s^{1.75}$)	Maximum Values ($m/s^{1.75}$)
Critical areas (such as operating theatres and laboratories)	0.1	0.2	0.1	0.2
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

5 OPERATIONAL NOISE MODELLING

5.1 Methodology

The rail noise model has been developed using SoundPLAN 8 modelling software by selecting the modelling algorithms included in the Nordic Rail Traffic Noise Prediction (Kilde 1984).

The SoundPlan rail noise model developed by SLR Consulting for the EIS Assessment has been provided to us (referred herein as the *EIS rail noise model*). This model corresponds to the assessment discussed in the Submissions Report – Appendix D. The noise model accounts for background features such as local terrain and buildings. The model also includes track features and parameters which relate to the following scenarios:

- EIS "No Build" scenario: This includes current track and operational features such as crossovers, bridges, level crossings and train speeds (i.e. without the works for the rail duplication).

- EIS "Build" scenario: This comprises track and operational features which correspond to the rail duplication design as discussed in the EIS Technical Report 2 and *more specifically* the Submissions Report – Appendix D.

Using the latest operational conditions as discussed in the Submissions Report – Appendix D and track features shown in the ONVR design package; PWNA has developed a separate rail noise model which includes the following scenarios:

- "No Build" scenario: This has been developed from the background information included in the EIS "No Build" scenario; and validated to the measured noise levels discussed in Section 3.2. Based on the observations discussed in Section 3.3 (i.e. no effective coverage for track lubrication along the rail corridor), no correction for track lubricators are included in this scenario.

- "Build" scenario - prior to EPA licensing regime: Future scenario has been developed considering the effective and thorough coverage of top-of-rail-friction-modifier (TORFM) and gauge face lubricators (GFL) along the rail corridor. However, this scenario does not account for the implementation of the EPA license regime which directs rolling stock operators to reduce the noise impact of wheel squeal from freight wagons.

- "Build" scenario - after EPA licensing regime for rolling stock operator, has been implemented.

5.2 Base Source Noise Levels

Base source noise levels used for the noise model are summarised in Table 11. These noise levels are obtained directly from the algorithms discussed in the Nordic Rail Traffic Noise Prediction methods, based on the reference conditions stated in Table 11.

In order to adjust these base noise source levels to the measured noise levels included in the NSW Rail Noise Database (NSW RND), corrections have been applied as indicated in Table 11.

These base noise parameters are later modified to operational conditions discussed in Section 5.3 (such as medium notch, speed profile shown in Figure 3 and Figure 4, etc).

Table 11 Source noise levels

Train Type	Reference Conditions	Source Noise Level, dBA		Corrections from Kilde to Rail Noise Database for standard conditions	
		L_{AE}	L_{Amax} [2]	$L_{Aeq\ (24\ hours)}$	L_{Amax}
Freight wagon rolling noise	1000 m of wagons	96 [1]	90 [1]	-7.4	-0.6
Freight locomotive rolling noise	1 locomotive, 20 m long	89 [1]	94 [1]	-5.5	0.6
Freight locomotive engine and exhaust noise (high notch)	1 locomotive, 20 m long	90 [1, 3]	94 [1, 3]	-2.4	7.6

Notes:

1. *Based on a train speed of 80 km/hour, with rail roughness in accordance with standard ISO 3095. Measurement location is 15m from rail track and at 1.5 m above the rail track*
2. *Representative for 95% of train pass-bys*
3. *Based on a source height of 4 m.*

5.3 Operational Conditions

In accordance with latest speed profiles discussed in the Submissions Report – Appendix D, the ONVR noise model allows for the speed profiles shown in Figure 3 and Figure 4 (refer to "revised" curves).

For the "No Build" scenario, the rail speed remains at 30 km/hour throughout the assessed rail corridor, both for the "Up Track" and "Down Track" (similar to that assumed for the EIS Technical Report 2). As indicated in Section 5.4, train speeds during the noise monitoring period, were often very much slower through the alignment than the current speed limit of 30 km/hr.

The following noise modelling inputs have been used for a typical train make-up following completion of the Botany Rail Duplication Project:

- One locomotive with a typical length of 20m.
- Wagons with a typical length of 650m (current lengths can extend up to 1300m).

Figure 3 **Speed profile, Up Track (refer to "Revised Up" curve)**

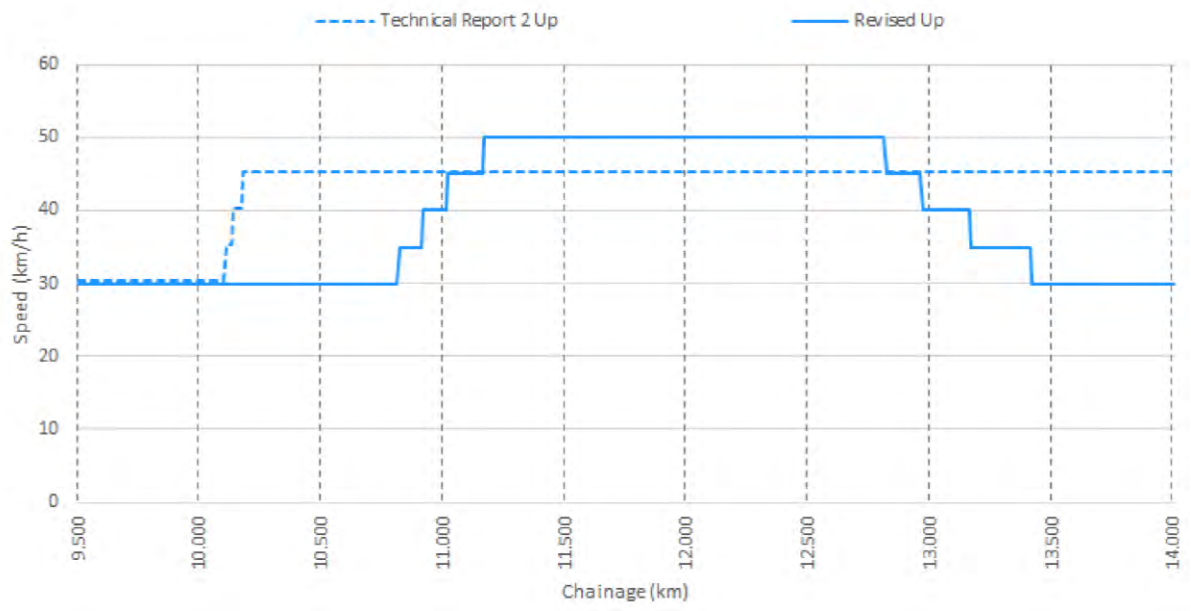
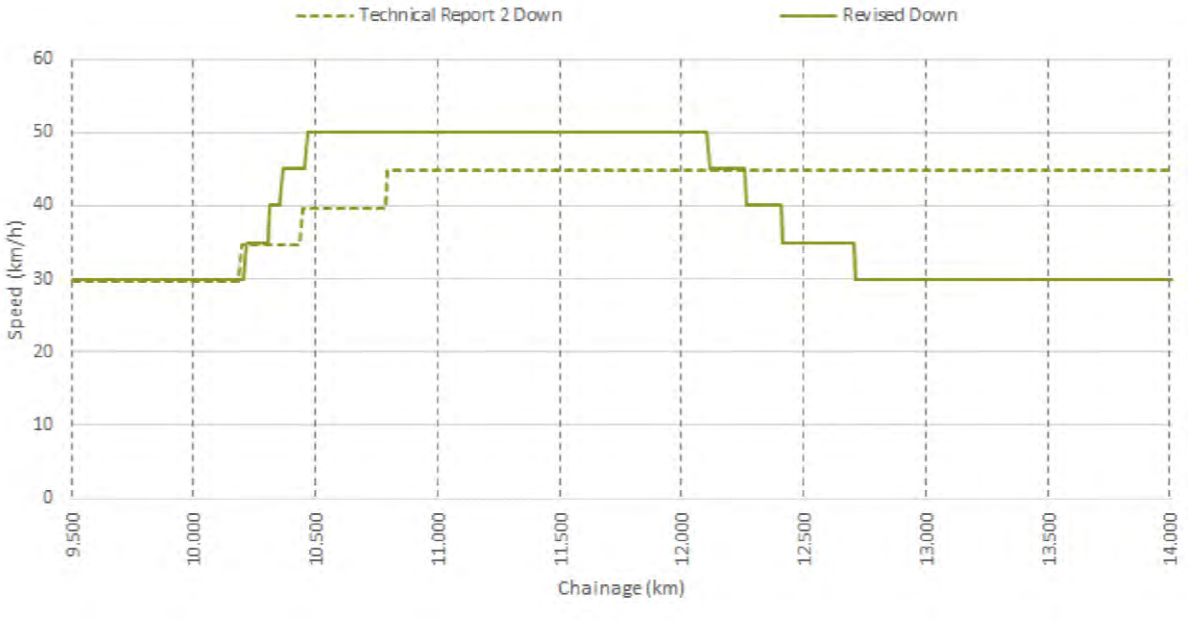


Figure 4 **Speed profile, Down Track (refer to "Revised Down" curve)**



Rail traffic volumes, as summarised in Table 12, have been used for this ONVR assessment. These rail traffic volumes are also representative of those used in the EIS assessment.

Table 12 Rail traffic volume

Year	Scenario	Train Movements			
		Daytime [1]		Night-time [1]	
		To Port Botany (Up Track)	From Port Botany (Down Track)	To Port Botany (Up Track)	From Port Botany (Down Track)
2024 (opening year)	No Build	24	24	14	14
	Build	24	24	14	14
2034	No Build	28	28	17	17
	Build	35	35	21	21

Notes:

1. Daytime period extends from 7:00 am to 10:00 pm. Night-time period extends from 10:00 pm to 7:00 am

5.4 Rail Track Feature Corrections

Corrections used for track features in the noise model, are summarised in Table 13. The standard corrections listed in this table are obtained from the NSW RND and the "Noise Prediction and Mitigation Guideline" (issued by ARTC, version 1.1, dated October 2020, referred herein as the *NP & MG*).

In an attempt to validate the standard corrections for track curves, corrections were determined from the difference between the unattended noise measurements and the predicted levels. As noted in Table 13, the measured corrections do not generally match the standard corrections. An analysis of the train volumes and times provided by ARTC, and train speeds inferred by our noise monitoring pass-by data, indicated the likely reason for the differences between the standard curve corrections and those observed from our measurements. These reasons are as follows:

- Train velocity: It is noted that trains were very often travelling at speeds lower than 30 km/hr. In accordance with the NSW RND, L_{Aeq} noise levels emitted by wagons could vary by 5 dB between 20 and 30 km/hr. Unfortunately, due to limitations of the modelling algorithm, train speeds lower than 30 km/hr cannot be modelled.

- The train speed issue for current rail movements is further compounded when it is noted on site that trains also do not keep a constant speed along curves.

An analysis of the measured curve corrections and a comparison against the standard modelling corrections, is given in in Table 13 below.

Table 13 Track feature corrections

Track Feature	Speed Range	Noise Corrections, dB									
		L_{Aeq}					L_{Amax}				
		Standard Correction	Measured On Site	2024 No Build Scenario	2024 (Prior to EPA Licensing) Build Scenario	2025-2034 (During EPA Licensing) Build & No Build Scenario	Standard Correction	Measured On Site	2024 No Build Scenario	2024 (Prior to EPA Licensing) Build Scenario	2025-2034 (During EPA Licensing) Build & No Build Scenario
Track radius greater than 500m	≥ 30	0	N/A	0	0	0	0	N/A	0	0	0
Track radius between 400m and 500m	≥ 30	+ 8	N/A	+ 8	+ 7 [1]	0	+ 21	N/A	+ 21	+ 13 [1]	0
Track radius between 300m and 400m	≥ 30	+ 8	-	+ 8	+ 7 [1]	0	+ 21	-	+ 21	+ 13 [1]	0
	10-25	-	0	-	-	-	-	+ 10	-	-	-
Track radius less than 300m	≥ 30	+ 9	-	+ 9	+ 8 [1]	0	+ 23	-	+ 23	+ 15 [1]	0
	20-30	-	+ 12	-	-	-	-	+ 21	-	-	-
	15-28	-	+ 6	-	-	-	-	+ 17	-	-	-
	15-25	-	+ 3.5	-	-	-	-	+ 4	-	-	-
Turnouts	-	+ 6	-	+ 6	+ 6	+ 6	+ 6	-	+ 6	+ 6	+ 6
Level crossings	-	+ 3	-	+ 3	+ 3	+ 3	+ 3	-	+ 3	+ 3	+ 3

Notes

1. *Correction accounts for track lubricator correction of -1 dB for L_{Aeq} noise levels; and -8 dB for L_{Amax} noise levels*

It can be seen in Table 13 above, when approaching a speed of 30 km/hr, the corrections for track curves approximates the standard corrections. Therefore, the standard corrections for track curves are adopted **for the "No Build" scenario** for 2024.

In the "Build" scenario prior to EPA licensing, curve track corrections are implemented by considering the thorough and effective coverage of TORFMs and GFLs. The relevant correction for these devices is -1 dB for L_{Aeq} noise levels, and -8 dB for L_{Amax} noise levels.

In the "Build" and "No Build" scenario during EPA licensing (after 2025), curve track correction are no longer required, since the license regime will require operators to eliminate wheel squeal from their rolling stock.

Track corrections for bridges are listed in Table 14. These corrections account for structure-radiated noise generated when trains pass over these bridges. These are also standard corrections obtained from the NSW RND and NP & MG.

Table 14 Rail bridge corrections

Bridge	Track	Bridge Details		
		Construction	Track Form	Correction, dB
Robey Street Bridge	New Up Track New Down Track	Concrete span and deck	Ballast track	0
O'Riordan Street Bridge	New Up Track New Down Track	Concrete span and deck	Ballast track	0
Wentworth Avenue Bridge	Existing Up & Down Tracks	Concrete span and deck	Ballast track	0
Botany Road Bridge	Existing Up Track Existing Down Track	Steel span and deck	Direct fix	+ 8
Southern Cross Drive Bridge	Existing Up Track New Down Track	Concrete span and deck Precast concrete span, concrete deck	Ballast track	0
Mill Stream Bridge	Existing Up Track New Down Track	Concrete span and deck Precast concrete span, concrete deck	Ballast track	0

5.5 Model Validation

For reasons discussed in Section 5.4, the noise model could not be validated for track curves. However, a model validation was conducted for a straight section of track corresponding to position M03.

By considering the standard track corrections discussed in Table 13, and assuming a locomotive operating at 30 km/hr, in medium notch (which implies a correction of + 5.9 dB for L_{Aeq} noise levels, and + 14.6 dB for L_{Amax} noise levels); then the predicted noise levels summarised in Table 15 are obtained.

As noted in this table, the predicted noise levels match the measured noise levels. Consequently, the locomotive corrections for medium notch have been adopted in the ONVR noise model.

Table 15 Validation results for straight section of track

Measurement Location	Measured Noise Levels, dB		Predicted Noise Levels, dB		Difference Between Predicted & Measured Noise Levels	
	$L_{Aeq(24\ hrs)}$	L_{Amax}	$L_{Aeq(24\ hrs)}$	L_{Amax}	$L_{Aeq(24\ hrs)}$	L_{Amax}
M03	57	94	57	94	0	0

5.6 Predicted Airborne Noise Levels

The predicted airborne noise levels obtained from the ONVR noise model, are listed as follows:

- Table 16 and Table 17 summarise the predicted noise levels at residential receivers. The listed noise levels correspond to the highest predicted noise level in each NCA. Table 16 includes noise levels for the "Build" and "No Build" scenarios prior to the implementation of the EPA licensing regime (i.e. year 2024); and Table 17 considers the implementation of the EPA licensing regime in year 2034.

- Table 18 and Table 19 summarise the number of total exceedances in residential receivers. Table 18 lists the residential exceedances prior to the implementation of the EPA licensing regime (i.e. year 2024); and Table 19 corresponds to after the implementation of the EPA licensing regime in year 2034.

- Table 20 summarises the predicted noise levels for other noise sensitive non-residential receivers (i.e. hotels and educational facilities). The listed noise levels correspond to the maximum predicted noise level at each premise. This corresponds to prior to the implementation of the EPA licensing regime (i.e. year 2024).

- Table 21 is the same as Table 20, except that Table 21 accounts for the EPA licensing regime.

- Table 22 summarises the predicted noise levels for other non-residential receivers (i.e. educational facilities, places of worship, medical centres and open spaces). The predicted noise levels correspond to year 2034 and to the time period these facilities are likely to be used (i.e. day time period).

From Table 18 and Table 19, it is noted that the implementation of the EPA licensing regime for rolling stock operators will have a significant impact on the number of residential exceedances.

The residential airborne exceedances listed in Table 18 and Table 19 are also shown in Appendix C.

Please note Appendix C also indicates residential and commercial exceedances for a "no mitigation" scenario (whereby no track lubrication and no implementation of EPA licensing regime has been implemented). This scenario is considered for years 2024 and 2034. However, noise results and exceedances for this "no mitigation" scenario, are not tabulated in this section of the report. It is noted that the exceedances are much higher than those obtained when effective track lubrication is obtained throughout the rail corridor; and when the EPA licensing regime is implemented. Therefore, this outcome reinforces the need to implement mitigation measures in the form of track lubrication and the EPA licensing regime.

Finally, from Table 22 it is noted that the non-residential receivers listed in this table achieve compliance with the relevant criteria.

Table 16 Summary of predicted airborne rail noise levels at residential receivers (**"No Build" & "Build" scenarios** without implementation of **EPA's** licensing regime)

NCA	Predicted Noise Levels											
	Daytime, dB $L_{Aeq, 15\ hrs}$				Night-time, dB $L_{Aeq, 9\ hrs}$				Maximum, dB L_{Amax}			
	Opening Year: 2024		Design Year: 2034		Opening Year: 2024		Design Year: 2034		Opening Year: 2024		Design Year: 2034	
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build
NCA01	59	59	59	61	59	59	59	61	91	87	91	87
NCA02 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA03	67	70	67	72	67	70	68	72	100	100	100	100
NCA04	67	68	68	69	67	68	68	69	103	98	103	98
NCA05 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA06 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA07	69	68	69	69	69	68	69	69	104	99	104	99
NCA08	68	68	68	69	68	68	69	70	102	99	102	99

Notes:

1. *Predicted noise levels are representative of receivers with the highest predicted noise level at each NCA*
2. *L_{Amax} noise level applies to both daytime and night-time period (criteria is 85 dB LAFmax)*
3. *Noise level criterion for daytime 65 dB LAeq(15hr) and night-time period is 60 dB LAeq(9hr)*
4. *NCA does not contain residential receivers*

Table 17 Summary of predicted airborne rail noise levels at residential receivers (**"No Build" & "Build" scenarios** with implementation of **EPA's licensing** regime)

NCA	Predicted Noise Levels											
	Daytime, dB $L_{Aeq, 15\ hrs}$				Night-time, dB $L_{Aeq, 9\ hrs}$				Maximum, dB L_{Amax}			
	EPA Licensing in force: 2025		Design Year: 2034		EPA Licensing in force: 2025		Design Year: 2034		EPA Licensing in force: 2025		Design Year: 2034	
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build
NCA01	52	53	52	55	52	53	53	55	79	81	79	81
NCA02 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA03	60	63	60	65	60	63	60	65	91	93	91	93
NCA04	60	62	61	64	60	62	61	64	93	94	93	94
NCA05 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA06 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA07	63	63	64	64	63	63	64	65	96	97	96	97
NCA08	62	62	62	64	62	62	63	64	94	97	94	97

Notes:

1. *Predicted noise levels are representative of receivers with the highest predicted noise level at each NCA*
2. *L_{Amax} noise level applies to both daytime and night-time period (criteria is 85 dB LAFmax)*
3. *Noise level criterion for daytime 65 dB LAeq(15hr) and night-time period is 60 dB LAeq(9hr)*
4. *NCA does not contain residential receivers*

Table 18 Number of exceedances in residential receivers (year 2024, scenarios with track lubrication and without considering implementation of **EPA's** licensing regime)

NCA	Number of Exceedances in Residential Receivers, year 2024						
	Above RING Absolute Trigger Level (Build scenario)			Above RING Increase Trigger Level (Comparison of no-build to build)			Total Triggers
	Day	Night	LAmax	Day	Night	LAmax	
NCA01	0	0	1	0	0	0	0
NCA02	-	-	-	-	-	-	-
NCA03	7	19	38	318	318	4	19
NCA04	5	13	32	456	456	7	10
NCA05	-	-	-	-	-	-	-
NCA06	-	-	-	-	-	-	-
NCA07	2	12	54	1	1	5	0
NCA08	2	14	84	68	68	0	0
						Total:	29

Notes:

1. *Except for "Total Triggers" each column lists the number of exceedances for a particular assessment condition. These assessment conditions are discussed in Table 7. By considering all these conditions, the number of total triggers per NCA is derived.*

Table 19 Number of exceedances in residential receivers (year 2034, **"No Build" & "Build" scenarios** with implementation of **EPA's licensing regime)**

NCA	Number of Exceedances in Residential Receivers, year 2034						
	Above RING Absolute Trigger Level (Build scenario)			Above RING Increase Trigger Level (Comparison of no-build to build)			Total Triggers
	Day	Night	LAmax	Day	Night	LAmax	
NCA01	0	0	0	3	3	0	0
NCA02	-	-	-	-	-	-	-
NCA03	0	11	17	330	330	15	11
NCA04	0	5	13	466	466	21	5
NCA05	-	-	-	-	-	-	-
NCA06	-	-	-	-	-	-	-
NCA07	0	10	48	69	64	6	0
NCA08	0	11	73	81	77	0	0
						Total:	16

Notes:

1. *Except for "Total Triggers" each column lists the number of exceedances for a particular assessment condition. These assessment conditions are discussed in Table 7. By considering all these conditions, the number of total triggers per NCA is derived.*

Table 20 Summary of predicted airborne rail noise levels and assessment at noise sensitive non-residential receivers, year 2024 (**"No Build" & "Build"** scenarios without implementation of **EPA's licensing regime)**

NCA	Receiver	Predicted Noise Level, dBA			Change in Noise Level **(between "Build" & "No Build"** scenarios)			Overall Assessment [1]	Is additional façade treatment required? [3]
		Day	Night	Max.		Night	Max.		
Hotels									
Criteria		*65*	*60*	*85*	*2.0*	*2.0*	*3.0*		
NCA01	Ibis Sydney Airport	50	50	80	0.4	0.4	0	Non-exceedance	-
	Travelodge Sydney Airport	57	57	85	0.5	0.5	0	Non-exceedance	-
	Stamford Plaza Hotel	71	71	103	3.5	3.5	0.2	Exceedance	No
	Holiday Inn Express Sydney Airport [2]	57	57	87	2	2	0	Non-exceedance	-
	Holiday Inn Sydney Airport [2]	46	46	73	2.5	2.5	0	Non-exceedance	-
	Pullman Sydney Airport Hotel [2]	47	47	78	0	0	0	Non-exceedance	-
NCA02	Mantra Hotel	61	61	87	3.2	3.2	0	Exceedance	No
	Ibis Budget Hotel	61	61	87	3.2	3.2	0	Exceedance	No
NCA03	Quest Mascot	58	58	86	3.4	3.4	1.1	Non-exceedance	-
	Citadines Hotel	61	61	89	3.5	3.5	0.6	Exceedance	No
Educational									
Criteria		*70*	*70*	*N/A*	*2.0*	*2.0*	*N/A*		
NCA01	New Qantas Training Centre [1]	67	67	-	0.3	0.3	-	Non-exceedance	-
NCA06	UTS Tech Labs	62	62	-	3.1	3.1	-	Non-exceedance	-

Notes:

1. *Assessment based on criteria as per Table 8 although we understand that the New Qantas Training Centre will no longer be proceeding at this location*
2. *New receiver not included in the Submissions Report – Appendix D*
3. *See Section 7.3.3.3 for evaluation of whether any additional façade treatment is required.*

Table 21 Summary of predicted airborne rail noise levels and assessment at noise sensitive non-residential receivers, year 2034 (**"No Build" & "Build"** scenarios with implementation of **EPA's licensing regime)**

NCA	Receiver	Predicted Noise Level, dBA			Change in Noise Level (between **"Build" & "No Build" scenarios)**			Overall Assessment [1]	Is additional façade treatment required? [3]
		Day	Night	Max.	Day	Night	Max.		
Hotels									
Criteria		*65*	*60*	*85*	*2.0*	*2.0*	*3.0*		
NCA01	Ibis Sydney Airport	46	47	75	3.0	3.0	1.5	Non-exceedance	-
	Travelodge Sydney Airport	53	53	80	2.4	2.3	1.4	Non-exceedance	-
	Stamford Plaza Hotel	66	66	97	4.5	4.4	2.8	Exceedance	No
	Holiday Inn Express Sydney Airport [2]	53	53	82	3.5	3.4	1.9	Non-exceedance	-
	Holiday Inn Sydney Airport [2]	43	43	67	4.0	3.9	1.5	Non-exceedance	-
	Pullman Sydney Airport Hotel [2]	46	46	72	2.5	2.4	2.0	Non-exceedance	-
NCA02	Mantra Hotel	60	60	84	4.1	4.0	1.7	Non-exceedance	-
	Ibis Budget Hotel	60	60	84	3.0	3.0	1.5	Non-exceedance	-
NCA03	Quest Mascot	59	59	86	4.0	4.0	2.0	Non-exceedance	-
	Citadines Hotel	62	62	87	4.5	4.4	2.0	Exceedance	No
Educational									
Criteria		*70*	*70*	*N/A*	*2.0*	*2.0*	*N/A*		
NCA01	New Qantas Training Centre [1]	63	63	-	2.2	2.1	-	Non-exceedance	-
NCA06	UTS Tech Labs	64	64	-	4.2	4.1	-	Non-exceedance	-

Notes:

1. *Assessment based on criteria as per Table 8 although we understand that the New Qantas Training Centre will no longer be proceeding at this location*
2. *New receiver not included in the Submissions Report – Appendix D*
3. *See Section 7.3.3.3 for evaluation of whether any additional façade treatment is required.*

Table 22 Summary of predicted airborne rail noise levels and assessment at other non-residential receivers (year 2034)

NCA	Receiver	Predicted L_{Aeq} Noise Level [2]	Change in Noise Level **(between "Build" & "No Build" scenarios)**	Overall Assessment [1]
Educational				
Criteria		*55*	*2.0*	
NCA01	Aero Kids Early Learning Centre	51	0.6	Compliance
NCA03	Mascot Public School	47	3.4	Compliance
	Mascot Library	45	3.0	Compliance
NCA07	Pagewood Kindergarten	55	0.8	Compliance
Place of Worship				
Criteria		*55*	*2.0*	
NCA01	Citygate Fellowship Church	47	2.3	Compliance
Hospital Other Uses				
Criteria		*65*	*2.0*	
NCA03	Mascot Medical & Dental Centre	60	1.0	Compliance
Open Spaces (passive & active)				
Criteria		*65*	*2.0*	
NCA01	Colemans Reserve	67	1.9	Compliance
NCA03	Robey St Reserve	55	3.9	Compliance
	John Curtin Reserve	48	1.6	Compliance
NCA05	Eastlake Golf Course	66	1.6	Compliance
NCA06	Botany Aquatic Centre	63	1.6	Compliance
	Booralee Park	53	1.8	Compliance
NCA07	Galarine Gardens	64	0.9	Compliance
	Garnet Jackson Reserve	60	1.0	Compliance

Notes:

1. *Assessment based on criteria listed on Table 8.*
2. *Noise levels are predicted for the time period the listed facilities are in use: day time period (7:00 am – 10:00 pm).*

6 OPERATIONAL VIBRATION & GROUND-BORNE NOISE MODELLING

For calibrating the model used in the following sections the methodology described below was employed.

6.1 Methodology

The methodology is divided in several parts and sub activities:

1 Calculate the LAvSmax,95% at the nearest measurement point for each location.

   a. Calculate the 95 percentile LAvSmax from the train passbys samples by calculating the average and the standard deviation (STDEV) and adding 1.645 STDEV to the average.

2 Calculate the Vibration Attenuation to the closest building edge contain relevant potentially sensitive receivers (on the ground – under foundation).

   a. Estimate the distance from the new rail line to the closest building containing a sensitive receiver.

   b. Calculate the vibration attenuation between Ch1 and Ch2 (and if relevant (Ch3) measurement locations. The averaged measured attenuation minus 1.645 STDEV was used as a lower limit of expected attenuation.

   c. Compare results to one or more vibration transmission models.

   d. Adjust (calibrate) the selected model to give same results as the calculated lower limit of attenuation (95%).

   e. Calculate the attenuation to the nearest point of the building foundation.

3 Calculate vibration attenuation from the ground (including foundation coupling losses) to the sensitive receiver inside the building.

4 Calculate the expected Ground Borne noise LASmax,95% from the LAVSmax,95% and compare against the limits.

The conversion from ground-borne vibration levels to ground-borne noise levels is based on the corrections discussed in the publication titled "Measurement & Assessment of Ground borne Noise & Vibration" (issued by The Association of Noise Consultants, 2nd Edition, 2012). This conversion is defined as follows:

$$Lp = Lv - 27 \text{ dB } (-32\text{dB})$$

where:

- Lp is the sound pressure level
- Lv is the vibration level (dB re 10^{-9} m/s). The above formula is called the Kurtzweil Formula and it was found to provide more realistic results of the sound level Lp radiated by the vibrating floors by replacing -27 dB with -32 dB.

6.2 Models of Vibration Attenuation with the Distance

The geometrical attenuation due to distance (spreading loss) for a Point source is:

$$20 \log_{10}(\text{Distances ratio}),$$

while for a Line Source it is:

$$10 \log_{10}(\text{Distances Ratio})$$

Other models include internal losses in the soil and between layers of solid with different elastic properties, but given that this information was not available, those models were not used.

The US Federal Transit Administration - Transit Noise and Vibration Impact Assessment Manual (TN&VIAM) provides a Generalized Ground Surface Vibration Attenuation with Distance Curves graph (Figure 6-4) and formulae for locomotive powered freight trains is given by the following equation (see in a Table (6-10) of the NV&VIA):

- $Lv = 92.28 + 14.81 \log(D) - 14.17 \log(D)^2 + 1.65 \log(D)^3$

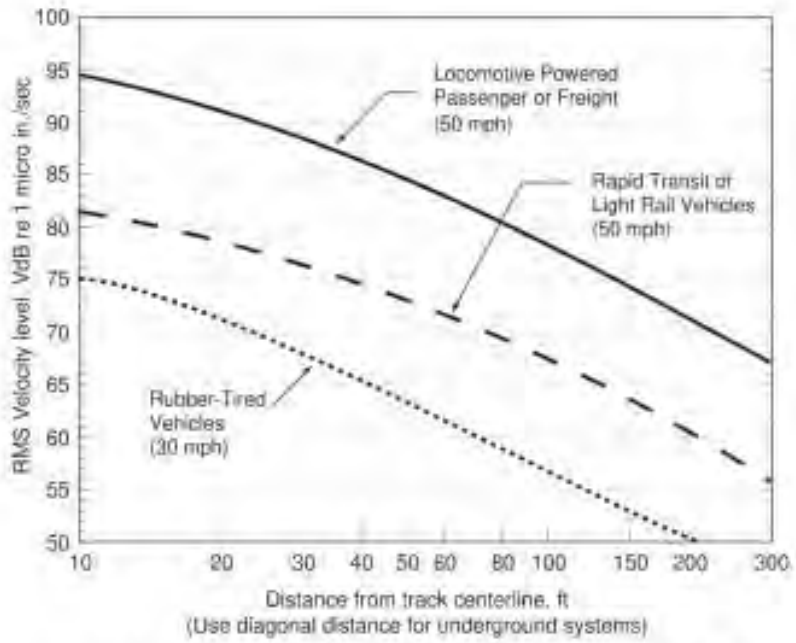


Figure 6-4 Generalized Ground Surface Vibration Curves

Vibration velocity level in decibels is defined as:

$$L_v = 20 \log\left(\frac{v}{v_{ref}}\right) \qquad \text{Eq. 5-1}$$

where:

L_v = velocity level, VdB
v = rms velocity amplitude
v_{ref} = 1 x 10^{-6}in/sec in the USA
= 1 x 10^{-8}m/sec internationally*

*Because of the variations in the reference quantities, it is important to be clear about what reference quantity is being used when specifying velocity levels. All vibration levels in this manual are referenced to 1x10^{-6} inches/second.

1 m=39.37 in and the reference value for Lv in m/sec is 10^{-9} therefore Lv expressed in meter/sec is:

- Lv in inches/sec + 20 log (1000/39.37) i.e. + 28.1 dB.

6.3 Models' calibration

For calibrating the model a factor k2 was added to the TN&VIAM equations and its value was adjusted so as to provide the observed attenuation measured on site.

- $Lv = 92.28 + k2*14.81\log(D) - k2*14.17\log(D)^2 + k2*1.65\log(D)^3$

Converting the formula above to metric units and rearranging the terms the formula becomes:

- $Lv = 120.38 + k2*(14.81\log(D*3.28) - 14.17\log(D*3.28)^2 + 1.65\log(D*3.28)^3)$

The formula above was used for estimating the vibration level at the required distances after calibrating it with the measured data. The calibration consists of finding the k2 value that gives the same attenuation between two measurement points (usually Ch1 and Ch2 locations), as was calculated from the measurements.

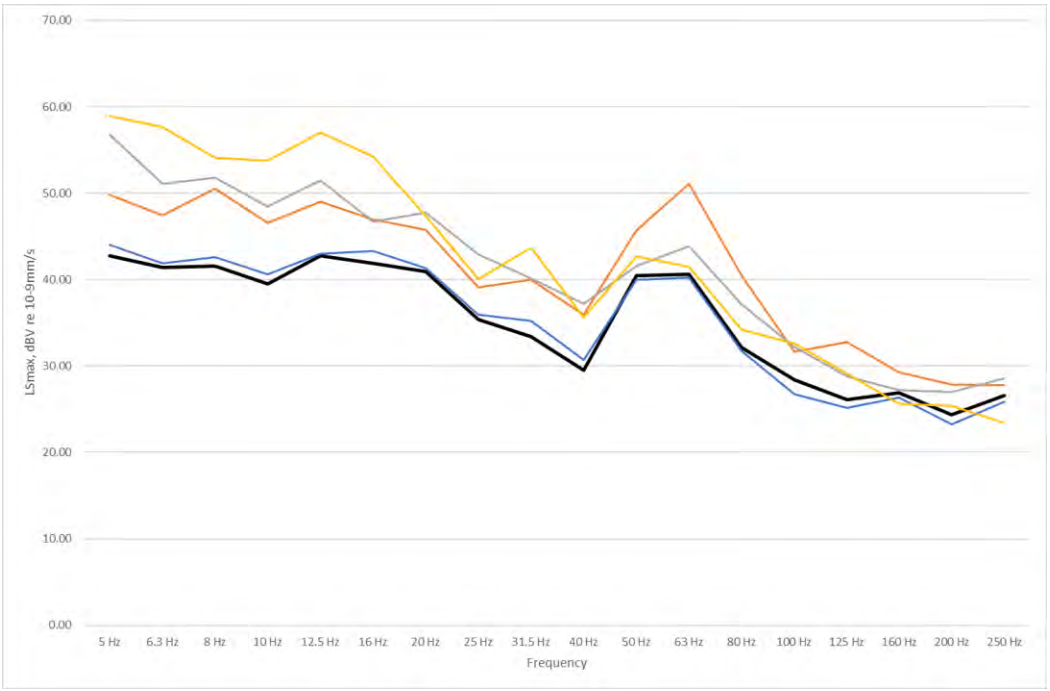
Note: The constant (120.38) in the formula above can be also adjusted so the predicted Lv match the measured vibration levels, however for predicting vibration levels at various distance, the calculated propagations are based only on the level differences - which are not dependent on the constant in the formula.

6.4 Validation

On Monday 24 October, 2022 validation noise measurements were undertaken at the Stamford Plaza Hotel adjacent to the existing line. Simultaneous ground-borne noise and vibration measurements were undertaken. The ambient noise levels without air-conditioning operating within the room were measured at L_{Aeq} 32 dB(A). All ground-borne noise measurements were undertaken with air-conditioning turned off.

For all measurements the ground-borne noise was inaudible at the measurement location. A small increase in low frequencies was identified in the one-third octave bands of the measured noise levels. Presented below Figure 5 is a summary of the measured ground-borne noise levels. Only the relevant frequencies from 5 Hz to 250 Hz have been included. Note that the black line is the measured ambient level. Given the signal only slightly emerges above the ambient level for 80 Hz – 200 Hz (the typical dominant range for ground-borne noise), there is not enough signal strength to certify that the measurements are a true signal.

Figure 5 Measured ground-borne noise levels



Presented below is a summary of the measured levels, and the corresponding predicted level at the measurement point.

Table 23 Stamford Plaza ground-borne noise levels

Measurement	Ground-borne noise level, LASmax
Train 1	18 dB(A)
Train 2	27 dB(A)
Train 3	22 dB(A)
Train4	21 dB(A)
Predicted level	22 dB(A)

The measurements identify that the model accurately predicts the typical ground-borne noise level at the measurement location. However the second train was measured 5 dB higher than the predicted level. It is noted that the rail condition is very poor throughout this area. The project will be rectifying this and with appropriate maintenance the ground-borne noise levels are expected to reduce further. Poor track condition can increase ground-borne noise and vibration levels by as much as 10 dB, so a significant decrease can be expected with an improved future rail condition. Given the poor rail condition and difficulty in measuring the very low levels, the model appears to be accurately predicting ground-borne noise levels.

However to account for wheel and rail condition variability a +5dB correction has been applied to all ground-borne noise predictions to provide certainty for future impacts and the 95th percentile of passbys.

6.5 NSW RING Ground Borne Noise Limits

Ground-borne noise level values are relevant only where they are higher than the airborne noise from railways (such as in the case of an underground railway) and where the ground-borne noise levels are expected to be, or are, audible within habitable rooms.

Additionally, there should be an increase in the existing rail noise levels by 3 dB(A) or more; and the resulting rail noise levels to exceed 35 dBA during the night and 40 dBA during the day time inside residential properties.

The metric used for ground borne calculations and limits is the $L_{ASmax,95\%}$ which refers to the maximum noise level not exceeded for 95 per cent of rail pass-by events and is measured using the 'Slow' (S) response setting on a sound-level meter.

6.6 Increase Ground Noise and Vibration Levels with Trains Speed

The trains speeds are predicted to increase from 30 km/h to 50 km/hr which will most likely increase the noise and vibration levels. While in some cases the level increase can be as low as 15 times the logarithm (base 10) of the speed ratio increase, the TN&VIAM recommends using 20 times the logarithmic ratio unless a different specific data for vibration has been obtained. The increase is not frequency dependant and in our case for the corresponding increase in the speed ratio of 1.667 the expected increase in the level of noise and vibration is 4.4 dB.

6.7 Measuring Equipment

- Sinus Apollo Samurai s/n 11386 – 4 Channels Signal Analyser and Recorder
- CTC AC102-1A s/n 181191/3– accelerometers
- Gras 46AE s/n 476603 – microphone
- B&K type 4230 s/n 1275644 – sound calibrator

6.8 Measurement Loc#3- NC03: Baxter Road / Joyce Drive, Mascot

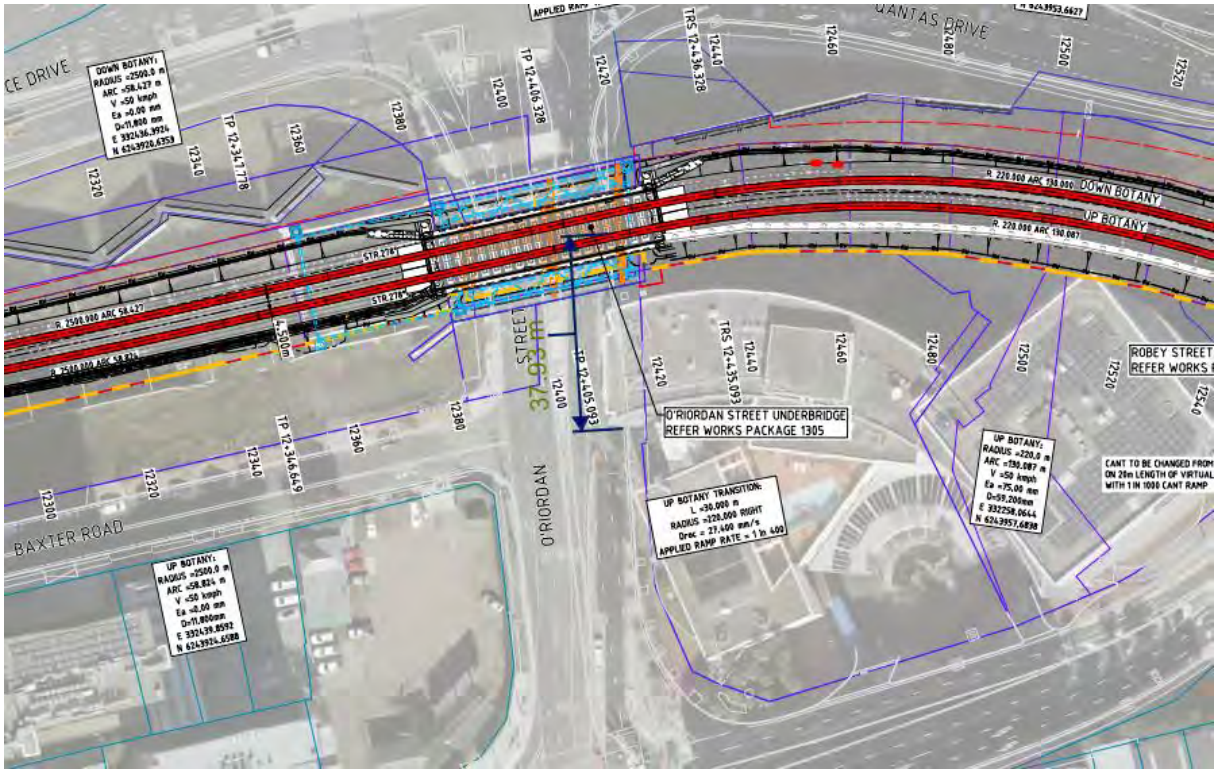
The vibration level expressed as $L_{AvSmax,95\%}$ at the closest measurement location, 9 m away from the current rail was calculated from 5 train passes by adding 1.645 STDEV to the average value. The results are shown below:

Table 24 LAvSmax,95% vibration level at the 9 m from the rails

Parameter	Total dBA	31.5 dB	63 dB	125 dB	250 dB	500 dB	1k dB	2k dB
LAvSmax,95%	90.6	107.6	110.9	105.4	72.6	48.8	41.1	37.2

6.8.1 Stamford Plaza Hotel, Mascot

Figure 6 Stamford Plaza Hotel and the nearby railway corridor



The new rail is planned to be closer than the existing one, which is 18 m away from the railway facing façade, by 4.5 m and the expected noise increase was calculated to be 1.7 dB. However the expected increase due to the speed increase is 4.4 dB therefore the total increase is estimated as 6.1 dB.

The calculated value for k2 in Loc#3 was 0.7 which was used in the TN&VIAM formula

The front of the hotel will be subjected to high level of direct airborne noise which will exceed the ground borne noise, therefore the ground borne noise was calculated at the back of the hotel which is shielded from the airborne noise at a distance of 38m from the rail line.

Table 37 in Appendix E: Operational vibration & Ground-Borne Noise Modelling shows the calculations for the expected noise levels on the ground floor (where no bedroom or residential receiver are expected) as 36 dBA, and at the lowest bedrooms floor, the level is 30 dBA. Compliance is achieved at the assessable location.

6.9 Measurement Loc#2 NCA07-08: Banksia St, Pagewood & Botany

The vibration levels LAvSmax,95% at the closest measurement location, 15 m away from the current rail were calculated from 6 train passes by adding 1.645 STDEV to the average value. The results are shown below:

Table 25 LAvSmax,95% vibration level at the 14 m from the rails

Parameter	Total dBA	31.5 dB	63 dB	125 dB	250 dB	500 dB	1k dB	2k dB
LAvSmax,95%	78.5	102.8	104.4	79.0	60.6	43.2	37.5	33.7

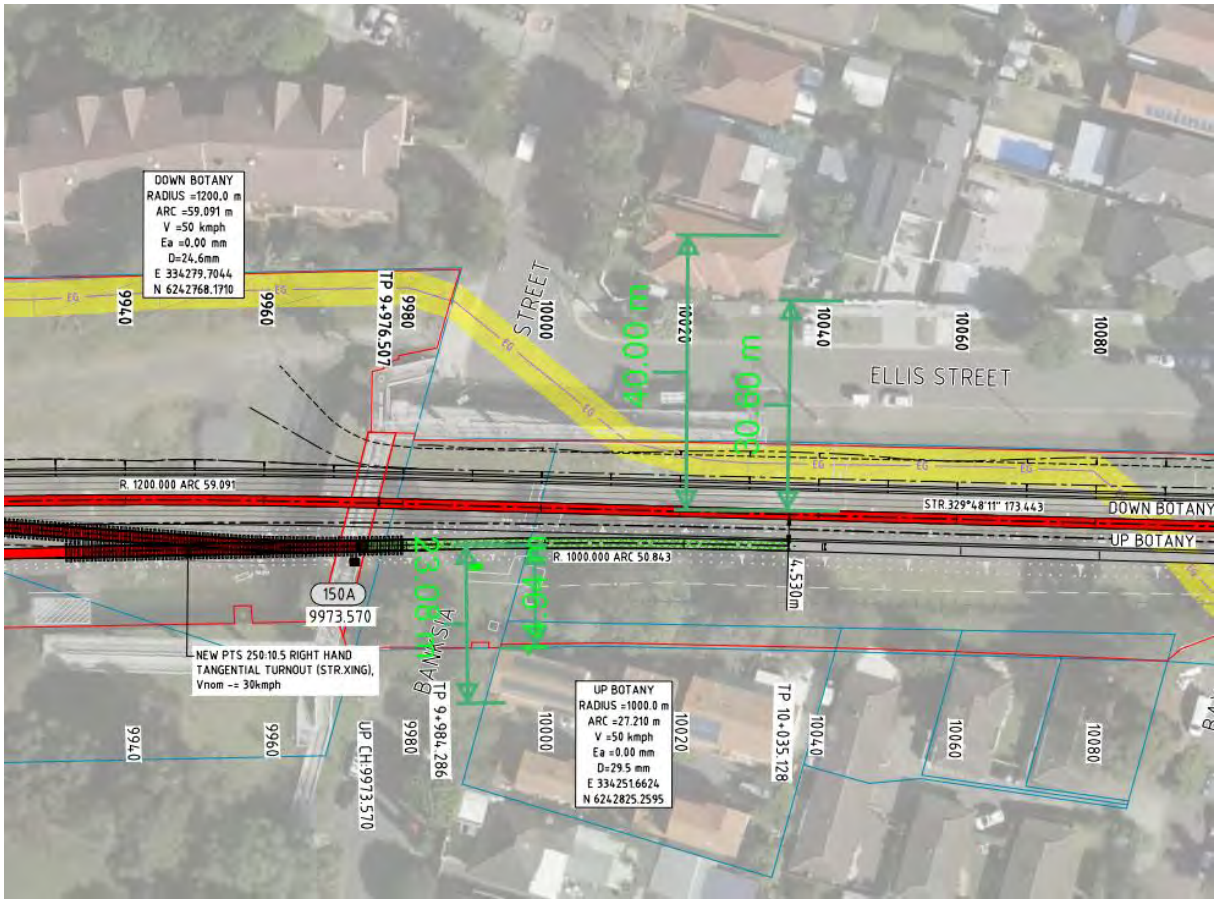
6.9.1 142 Banksia Street, Pagewood

Figure 7 142 Banksia Street, closest building distance from the existing rails

The measurement point (CH1) was the same distance from the railway as the edge of the sensitive residence at 142 Banksia St as shown in the figure above.

The new rail will be located 4.5 m further away than current location therefore an attenuation of 1.1 dB in the ground borne noise levels is expected and therefore of no concern, however the speed increase of the passing trains on the existing rail will increase the noise by 4.4 dB.

Figure 8 142 &140 Banksia Street residences, showing distance from the rail to the front and back façades



The attenuation in this location was 6 dB for a distance increase from 15 m to 30 m and k2 was calculated to have a value of 0.96. The estimated ground borne noise at the back of the house (23 m distance to the nearest railway), where the air borne noise may be lower than the ground borne noise, is estimated to be 46 dBA (assuming the foundations are "Large masonry on piles"), which exceeds the night-time limit. The predicted ground borne sound level on the first level is 34 dBA and therefore complies with both the day and night noise limits.

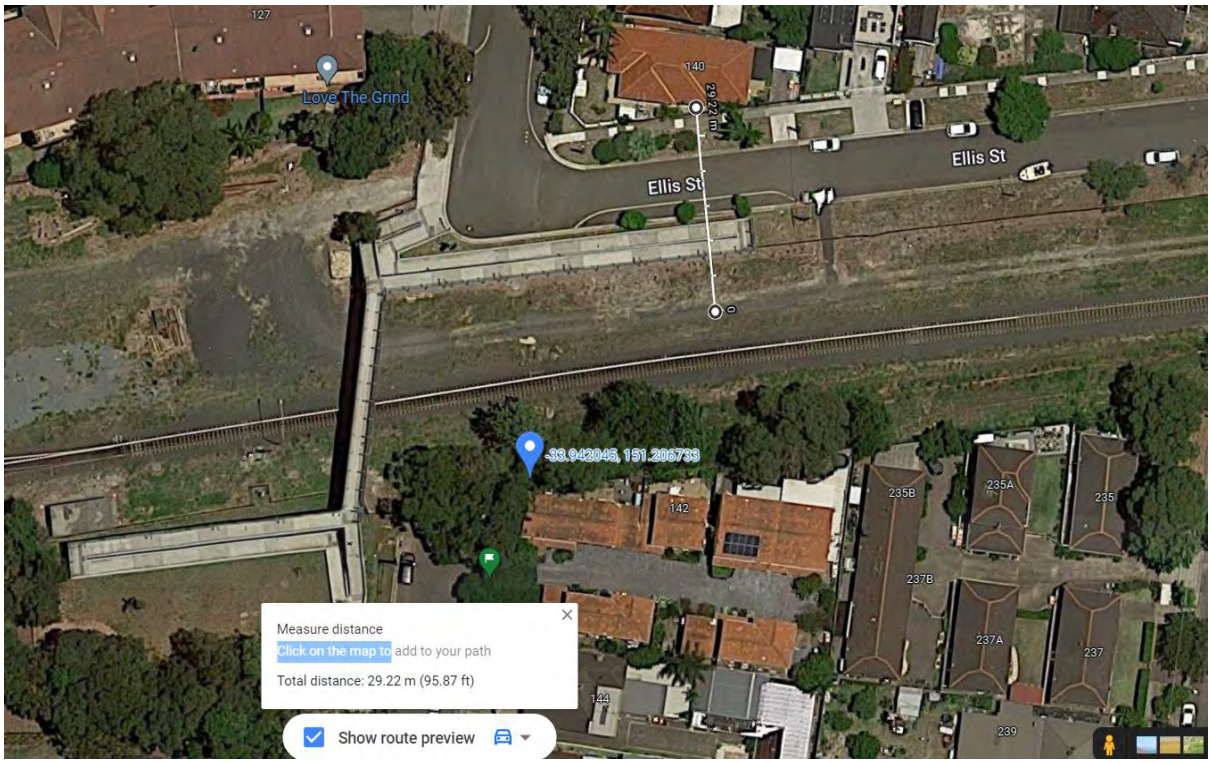
If foundation is a typical "single family residence, then estimated ground borne noise at the back of the house will be 46 dBA which exceeds the day and night ground-borne noise trigger levels.

However the calculation of the air borne noise at this location in front of the house is LASmax=95 dBA and assuming a noise reduction of 15 dB to the back of the house, plus a 20 dB noise reduction from outside to inside (closed windows) results in an estimated noise of 51 dBA airborne noise inside the residence, which exceeds the ground borne noise and therefore the ground borne noise levels are compliant with the trigger levels and requirements of the RING.

6.9.2 140 Banksia Street & Ellis St, Botany

On the other side of the railway the residents of Ellis Street may experience higher regenerated noise levels from the new railway line to be located 30 m away (see also Figure 8), which will be closer by 4.5 m than the existing one.

Figure 9 Ellis Street Residences, Botany (140 Banksia St.)



Using the same vibration attenuation (k2=0.96) and adding the effect of the increase in the train speed, the move is estimated to increase the noise to nearby Ellis St residents by 6 dB.

The estimated ground borne noise at the back of the house (40 m distance to the nearest railway), where the air borne noise is likely to be lower than the ground borne noise, is estimated to be 35 dBA (if the foundation is “Large masonry on piles”) and therefore complies with the RING ground-borne noise trigger levels.

6.10 Other Residential Receiver Locations

The site-specific distance attenuation measurements show that for other receiver locations on facades further than approximately 20-25 m from the nearest rail line (and facing away from the rail line), will result in regenerated noise levels below 35 dBA and will not be considered further in this document.

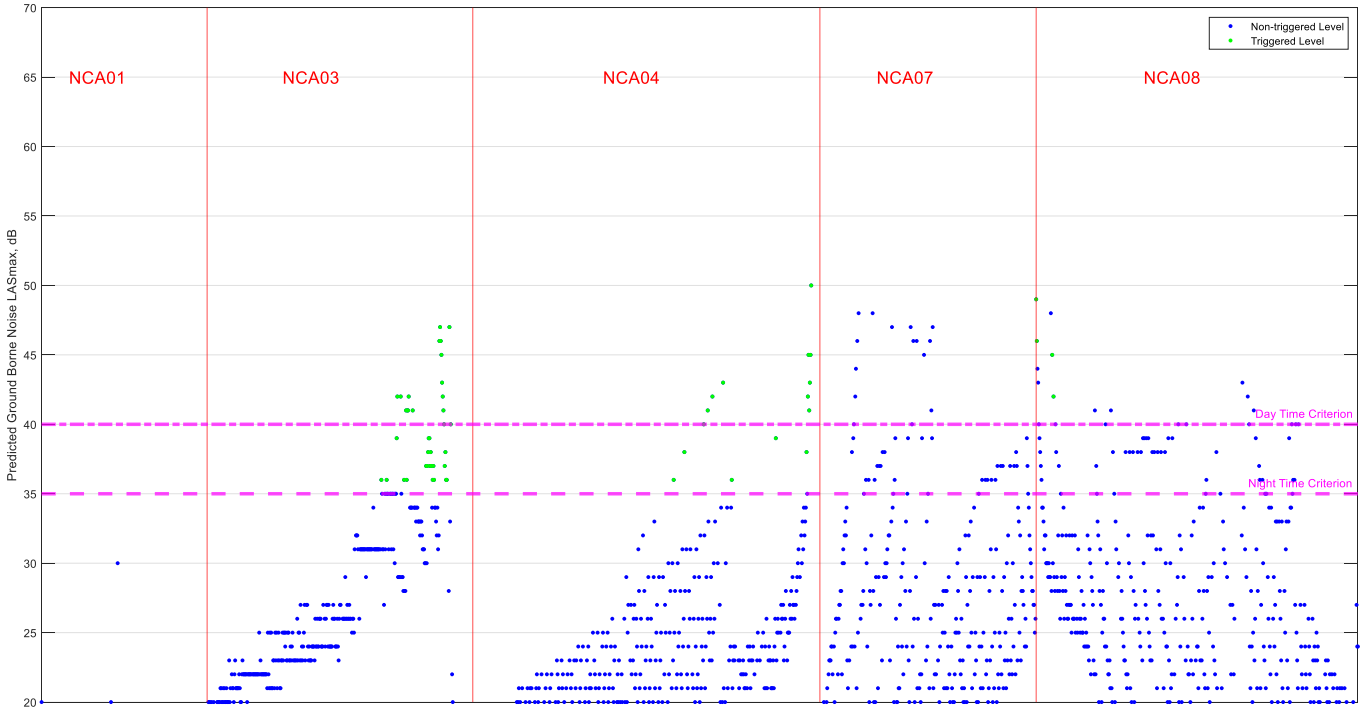
6.11 Operational Ground-Borne Noise Assessment

6.11.1 Residential Receivers

A computer model has been used to predict vibration levels for typical operational scenarios for the proposed rail project. The model is based on the calculation procedures discussed in document titled "Transit Noise and Vibration Impact Assessment" (issued by the Federal Transit Administration, dated September 2018, FTA Report No. 0123).

The predicted ground-borne noise levels at residential receivers, are summarised in the scatter plot shown in Figure 10. The distribution of predicted ground-borne noise levels is shown for each NCA which contains residential receivers. Those indicated in blue correspond to non-triggered levels (i.e. compliances with criteria discussed in Section 4.3), and those shown in green correspond to triggered levels (i.e. non-compliances with the absolute level criteria in Section 4.3).

Figure 10 Scatter plot of predicted ground-borne noise levels at residential receivers



However, for those exceedances summarised above, it is also predicted that the internal airborne L_{AFmax} noise levels (assuming a 25 dB noise reduction between external and internal noise levels), will be approximately 20 dB higher than the ground-borne L_{ASmax} noise levels. As discussed in Section 4.3, the ground-borne noise levels L_{ASmax} are relevant in the assessment provided these are higher than the airborne L_{AFmax} noise levels.

A preliminary assessment has determined that a minimum noise reduction of 40 - 45 dB would be required for the ground-borne noise levels to be higher than the airborne noise levels at certain residential receivers. A façade construction that achieves such sound insulation performance would generally exclude external windows and comprise masonry façade components. Noting from a preliminary visual inspection of the nearest affected residences, such façade construction are currently not installed. Furthermore, most of these facades include windows. Therefore, the overall acoustic assessment at the residences is influenced by the airborne noise assessment discussed in Section 5.

6.11.2 Non-Residential Receivers

Table 27 summarises the predicted ground-borne noise levels for noise sensitive, non-residential, receivers. To compare ground-borne noise levels with internal airborne noise levels, the sound insulation performances tabulated in Table 26 have been considered.

It is noted that the airborne noise component will be higher than the ground-borne noise component. Therefore, the overall acoustic environment at the hotels will be mostly influenced by the airborne noise assessment discussed in Section 5.

Table 26 Summary of assessed façade constructions for hotel rooms

Receiver	Façade Location	Approximate Glazed Area, m^2	Glazed Construction	Estimated Sound Insulation Performance
Mantra Hotel [1]	North	6	10.38mm lam/ 23mm airgap/ 6.38mm lam	Rw 42
Ibis Budget Hotel [1]	North	3	6.38mm lam/ 23mm airgap/ 5mm mono	Rw 41
Citadines Hotel [1]	South	3.5	10.38mm lam	Rw 35
Quest Mascot [1]	South	3	10.38mm lam	Rw 35
Stamford Hotel [1]	South	6	10mm mono/ 50mm airgap/ 10mm mono	Rw 47
Travelodge Sydney Airport [1]	South	4	10.38mm lam	Rw 35

Notes:

1. *Information obtained from report titled "Sydney Gateway – Hotel Façade Acoustic Performance Review", dated 14 April 2021, issued by Renzo Tonin & Associates*

Table 27 Summary of predicted ground-borne noise levels at noise sensitive, non-residential, receivers

NCA	Receiver	Predicted Noise Level, dB LASmax		Change in Noise Level dB	Predicted Noise Intrusion Levels From Train Pass-Bys, dB LASmax				Comparison with Internal Airborne L_{AFmax} Noise Levels [1]
		Day	Night		Prior To EPA Licensing		During EPA Licensing		
					Room closest to rail corridor	Room farthest from rail corridor	Room closest to rail corridor	Room farthest from rail corridor	
Hotels									
Criteria		*40*	*35*	*3.0*					
	Stamford Plaza Hotel	30	30	6.3	66	51	60	45	Lower
NCA02	Mantra Hotel [3]	29	29	4.4	46	31	41	Less than 30	Lower
	Ibis Budget Hotel [3]	33	32	4.4	47	32	41	Less than 30	Lower
NCA03	Quest Mascot [3]	33	32	4.4	47	32	47	32	Lower
	Citadines Hotel [3]	31	31	4.4	50	35	48	33	Lower
Educational									
Criteria		*40 - 45*	*40 - 45*	*3.0*					
NCA01	New Qantas Training Centre [2]				-	-	-	-	

Notes:

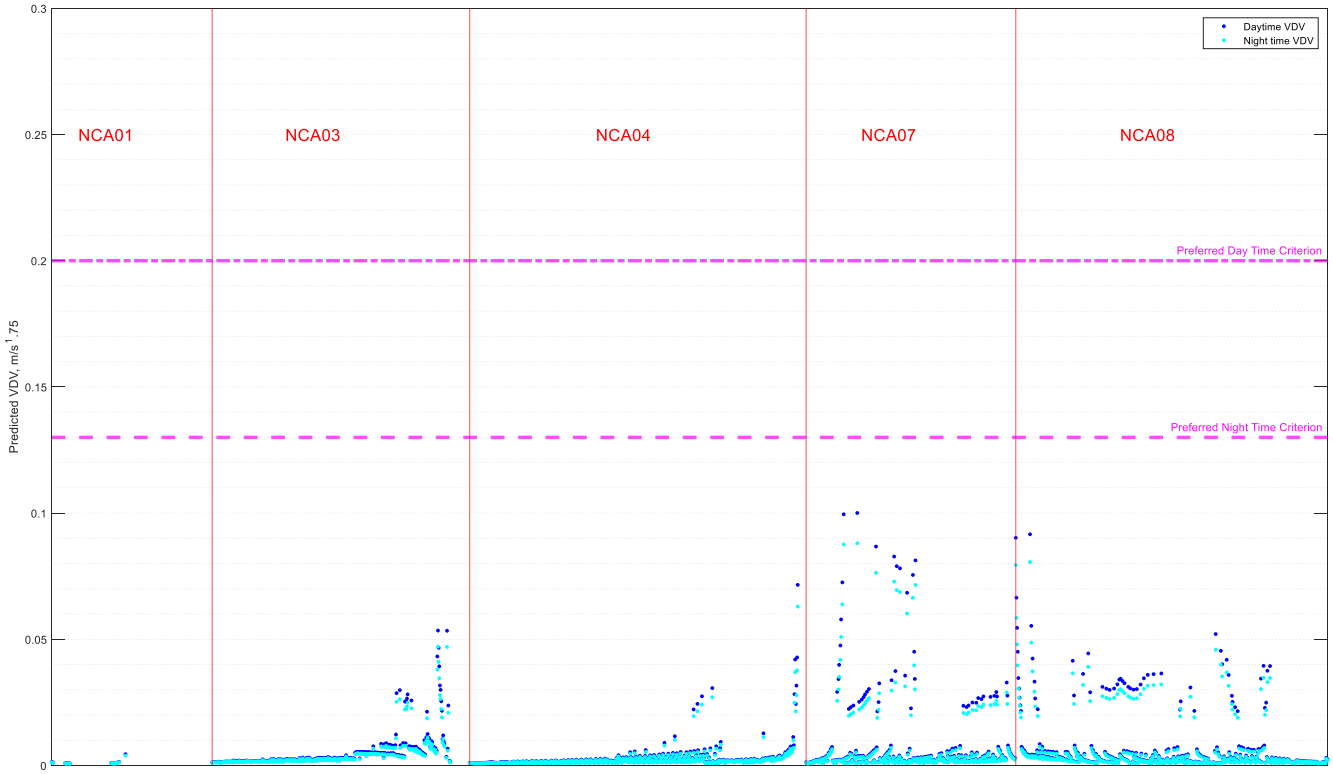
1. *Façade construction and performance could only be found for those hotels which are closest to the rail corridor. No façade information could be found for those buildings further away from the rail corridor; therefore no noise intrusion level could be predicted for the latter buildings*
2. *We understand that the New Qantas Training Centre will no longer be proceeding at this location*
3. *Rooms located along the façade which is facing away from the railways line (shielded from airborne noise) are located further than 20-25m from the closest rails line and will have regenerated internal noise levels lower than the criterion of 35 dB LASmax (for 95% of train passbys).*

The new Qantas Training Centre, was proposed to be a future educational facility. As discussed in Section 3.4, we have been advised that this project will not be proceeding at this location but will be moved to a location in Burrows Road. No further consideration with therefore be given to this proposed development.

6.12 Operational Vibration Assessment

The predicted vibration levels, in terms of VDVs, are summarised in Figure 11. As discussed for Figure 10, the scatter plot represents the distribution of predicted VDVs for each NCA which includes residential receivers. VDV values predicted for the daytime period are shown in blue, and night time predicted VDV values are indicated in cyan.

Figure 11 Scatter plot of predicted VDVs



From the information presented in Figure 11, it is observed that predicted VDV values comply with the human comfort vibration criteria discussed in Section 4.4.

Since the human comfort vibration criteria is complied with, it is also very unlikely that any building will be subject to cosmetic damage vibration levels (which are higher than the human comfort criteria).

7 NOISE AND VIBRATION MITIGATION RECOMMENDATIONS

The RING nominates in Section 3.5.1 that noise and vibration impacts from railway operations follow three main control strategies:

- by reducing noise and vibration at the source
- in transmission to the receiver
- at the receiver.

These control strategies should be considered in a hierarchical way so that all the measures which reduce noise for a large number of receivers are exhausted before more localised mitigation measures are considered. These measures discussed below are for the project as a whole, and does not apply only to the new rail (i.e. they apply to both the existing and duplicated rail lines).

7.1 Feasible and Reasonable Noise Mitigation

It is acknowledged that applying feasible and reasonable mitigation measures to existing railway corridors, as is the case Botany Rail Duplication, is generally more limited and potentially more costly than for new rail developments.

The interpretation of "feasible and reasonable" mitigation measures, as they apply to noise, is summarised in Table 28 below.

Table 28 Feasible and reasonable noise mitigation considerations

Terminology	Noise mitigation evaluation considerations	
"Feasible" (possible and practical to implement)	"Feasible" rail noise and vibration mitigation includes measures that are technically possible and generally well proven methods of reducing noise generation or reduction in transmission or at-receiver locations.	
"Reasonable" (when balanced with other relevant project considerations)	When considering whether a noise mitigation measure is "reasonable" the implementation of the measure needs to be evaluated against other relevant project considerations and implementation effects. Some of these considerations are provided below:	
	Effectiveness and efficiency	The resultant noise reduction needs to be significant enough to warrant the implementation of the mitigation measure. If the noise reduction is largely imperceptible (either in level or character) then its implementation is unlikely to be warranted.
	Safety	Any reasonable noise reduction measure must not result in an appreciable increased risk to safety to either rolling stock or members of the public.
	Maintenance implications	The ongoing maintenance implications need to be considered. For example, the installation of rail dampers may impact other inspection or maintenance protocols. The noise controls are also required to be durable and suitable for the environmental conditions of their location.
	Cost	The cost of the mitigation measures must be commensurate with the anticipated benefit. This is sometimes quantified in a cost per dB of noise reduction and must consider the number of receivers that are subject to the benefit (i.e. $/dB per receiver)
	Community preferences and considerations	The community's views on the proposed noise mitigation are also required to be considered when determining the reasonableness of the mitigation measures. For example, residents may prefer to have slightly higher noise levels than be overshadowed by a high noise barrier on their property boundary.

7.2 Noise Mitigation Hierarchy

7.2.1 Controlling Noise And Vibration At The Source

The RING notes:

> *"Keeping rail vehicles and tracks well maintained is important and this should be given high priority in any mitigation strategy. Other types of sources that should be given high priority are those with annoying characteristics (e.g. tonality, impulsiveness). These include wheel squeal, brake squeal and the noise from track joints and turnouts as they generally evoke a strong community reaction. Noise mitigation that reduces these annoying characteristics would provide a benefit to the community, even where there may be no measurable changes in noise levels".*

Examples of controlling noise and vibration at source include:

Track measures

- Including designing the rail alignment to avoid sharp radius bends, rail grinding and other measures to ensure a good quality smooth running surface, minimising rail discontinuities by using continuously welded rail and minimising turnouts (or using quiet swing-nose turnouts), use of rail lubrication systems to minimise rail squeal on curves, use of resilient rail fasteners to increase vibration isolation and the use of rail dampers to reduce airborne noise production.

Rolling stock measures

- Including use of high attenuation exhaust mufflers on locomotives, use of disc brakes and low squeal brake blocks, on-board wheel lubrication, use of wheel dampers and ensuring wheels are correctly aligned (monitored through the implementation of an angle-of-attack monitoring system).

7.2.2 Rolling Stock Operator Licensing Regime From 2025

The NSW EPA has adopted the requirements of the new standard in their Rolling Stock Operator Licensing regime (NSW Environment Protection Authority, 2020). The EPA has set a date of 2025 for all wagons to be compliant and rolling stock operators are required to report each year on their progress (the public records indicate that around 100 wagons (<5% of the total requiring modification) have been upgraded).

The change in regulation follows an amendment to the Protection of the Environment Operations Act 1997 (POEO Act) to include rolling stock operators. While railway infrastructure operators and railway construction projects have previously required licences, this is the first time that rolling stock operators have required a licence. This makes all rail operators directly accountable for their environmental performance and provides a consistent approach to regulating the potential impacts of railway activities.

On 5 August 2020, the EPA issued new licences to rolling stock operators. The licences seek to reduce air and noise impacts on the community:

- by requiring new locomotives in NSW to comply with noise and air emission limits;
- through operating conditions and pollution studies relating to wheel squeal, idling, braking, bunching and stretching and horn use; and
- through monitoring and reporting requirements to allow the progress of the rail industry in reducing emissions to be determined over time.

The licences also require the rolling stock operators to provide the community with a way to report complaints.

As an example, Environment Protection License No. 21364, held by Pacific National Pty Ltd for rolling stock operations, includes the following Condition:

> *Licence number: 21364*

Title: *Pollution Study - Freight wagon steering performance rectification program*

Start date: *05 Aug 2020*

Licence review: *Due date 05 Aug 2025*

Licence Condition

To reduce the noise impacts associated with wheel squeal from freight wagons, the licensee must ensure within five years of the date of issue of this licence, or otherwise as agreed by the EPA, that the wheelsets of any non-compliant freight wagons of priority wagon classes operated by the licensee have an acceptable Angle of Attack.

The licensee must, within six months of the date of issue of this licence, provide a list of all non-compliant freight wagons of priority wagon classes operated by the licensee to the EPA together with a report that outlines the licensee's proposed measures and progressive milestones, including timeframes, for achieving Condition U5.1.

The licensee must notify the EPA within 21 days of any changes to the list of non-compliant freight wagons of priority wagon classes operated by the licensee as required under Condition U5.2.

The consequence of the change in regulation following the amendment to the Protection of the Environment Operations Act 1997 (POEO Act) to include rolling stock operators that ensures that the wheelsets of any non-compliant freight wagons of priority wagon classes operated by the licensee to be modified to have an acceptable Angle of Attack (AoA), is that rail squeal will be effective removed from the Botany Rail Line from 2025 (and perhaps almost entirely compliant by project opening).

In the situation where the introduction of these AoA requirements are not entirely effective in removing all rail squeal from the BRD area, then a possible consequence is that the curve gain corrections for the operating line could be determined by measurements carried out 1 year after project opening (i.e. 2025 when the POEO Act amendments are fully in force) as part of the compliance assessment, or conservatively assumed by adopting the Schall '03 correction of minus 8 dBA to the L_{Amax} levels for the effect of rail lubrication from Gauge Face Lubricator (GFL) and Top Of Rail Friction Modifiers (TORFM). Since these curve gains will however be essentially identical for the both the build and no-build scenarios, there is unlikely to be an impact on the number of triggered receiver locations.

7.2.3 Controlling Noise And Vibration Transmission

Controlling the transmission of noise and vibration typically includes measures such as the use of noise barriers to mitigate noise and using resilient rail fasteners or ballast mats to reduce the transmission of vibration into the ground.

The effectiveness of noise barriers is influenced by their location relative to either the noise source or the receiver. They may include low height noise barriers located close to the rail track that provide effective shielding of the rolling noise from the wheel-rail interaction or it may include boundary fences at the residential property boundary.

Upgrading property boundary fences in conjunction with facade treatments may be a potential option for some properties which addresses this concern, where the existing fence is low or has gaps. The property fence then forms a noise barrier to the rail noise providing useful sound attenuation. In this situation an upgrading of property boundary fences in conjunction with facade treatments could be beneficial. The suitability and height of a property fence would be determined on a case-by-case basis, in consultation with the resident, taking account of adverse impacts such as access, shadowing and loss of view. Upgrades to property fences would be subject to Council approval.

7.2.4 Controlling Noise At The Receiver

Even after the implementation of feasible and reasonable noise mitigation at source and on the transmission path, some residual noise treatment may be required at the point of impact.

Where the proposed rail duplication results in residual noise levels exceeding the criteria at existing or developments approved before the project approval, the treatment of buildings at the property (e.g. insulation, window-glazing for noise reduction, upgrading construction) will need to be assessed and treatment negotiated in consultation with the residents. When treating building facades, consideration of the ventilation required will also need to be considered.

A disadvantage of facade treatments is that for houses of light construction (e.g. weatherboard), the effectiveness can be limited by the transmission through the walls. This is a particular problem for low frequency noise such as that from freight exhausts (whereas noise from passenger trains is typically more broadband). Another disadvantage to facade treatments in isolation is there is no effect on the noise levels outside the dwelling in the front yards.

The scope of property facade treatments would depend on the existing conditions at each property and consultation with the affected receivers. The cost of property treatments will vary from case to case.

A number of documents provide guidance on noise mitigation for infrastructure projects, including:

- ARTC's *"Noise Prediction and Mitigation Guideline"* (ARTC, 2018)
- RMS's *"At-Receiver Noise Treatment Guideline"* (RMS, 2017)

At-receiver acoustic treatment recommendations will vary based on the exceedances above the noise criteria.

7.2.4.1 At-Receiver Noise Treatment Guideline (Draft) 2017

A guiding principle of this guideline is that the internal noise level at sensitive receivers with at-receiver treatment should be similar to the internal noise levels at a sensitive receiver where the external criterion has been met (where it is assumed the windows are closed in both instances).

At-receiver noise mitigation should only be applied where it has not been feasible or reasonable to apply at source noise control or transmission path noise reduction, or where residual exceedances remain after applying these feasible and reasonable noise controls.

At- receiver noise control treatments may include the following:

- Ventilation systems that meet Building Code of Australia fresh air requirements with the windows and doors shut (air conditioning may also be considered)
- Upgraded windows, glazing and solid core doors on the exposed façades of substantial structures only (e.g. masonry or insulated board cladding each with sealed underfloor)
- Upgrading window and door seals
- The sealing of wall vents
- The sealing of the underfloor below the bearers and appropriately treating sub-floors ventilation
- Roof insulation
- The sealing of eaves
- Courtyard screens may be chosen by the owner as an alternative to architectural treatment where feasible and reasonable.

Table 29 below outlines treatment packages for residential dwellings for different level of required noise reduction.

Table 29 Architectural treatment package types

Exceedance, dBA	Noise mitigation level required				
	1-5 dBA	6-8 dBA	9-11 dBA	12-14 dBA	>14 dBA
Treatment package type	1	2	3	4	5

Treatment packages should only be recommended and considered feasible and reasonable where they are predicted to provide a noticeable improvement in noise reduction (3 dBA or greater) than the existing window, door and façade system.

Table 30 below outlines the recommended constructions for the relevant treatment package types indicated above.

Table 30 Architectural treatment package types – Deemed to comply mitigation packages (Based on R_w+C_{tr})

Construction	Treatment package type				
	1	2	3	4	5
Exceedance, dBA	1-5 dBA	6-8 dBA	9-11 dBA	12-14 dBA	>14 dBA
All	• Optional ceiling fans[1] • Mechanical ventilation (MV)[2] • New acoustic seals for windows • Seal around window architraves / door jambs • Seal all vents and openings	• As per Category 1 treatments • External solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals			
Brick veneer or double brick Window area less than or equal to 20% floor area	• 6.38mm lam, or equivalent	For 6 dBA exceedance: • 6.38mm laminate and roof insulation (R4.0 215mm thick) or 6.5mm lam with acoustic interlayer For 7 dBA exceedance: • 8.5mm lam with acoustic interlayer or 10.38mm lam For 8 dBA exceedance: • 8.5mm lam with acoustic interlayer or 10.5mm lam with acoustic interlayer or 10mm acrylic panel with nominally 100mm gap or >4mm secondary window with 100mm gap or equivalent	• Roof insulation (R4.0 215mm thick) For 9 dBA exceedance: • 8.5mm lam with acoustic interlayer or 10.38mm lam Otherwise: • 10.5mm lam with acoustic interlayer or 10mm acrylic panel with nominally 100mm gap or >4mm secondary window with 100mm gapor equivalent	• >4mm secondary window with 100mm gap, or equivalent • Roof insulation (R4.0 215mm thick)	• >6mm secondary window with nominally 100mm gap, or equivalent • Roof insulation (R4.0 215mm thick)
Brick veneer or double brick Sliding door area less than or equal to 50% wall area	• Seal subfloor • Roof insulation (R4.0 215mm thick)	• 6.5mm lam with acoustic interlayer, or equivalent • Roof insulation (R4.0 215mm thick) Or • 8.5mm lam with acoustic interlayer, or equivalent	• 8.5mm lam with acoustic interlayer or >4mm secondary window with nominally 100mm gap, or equivalent • Roof insulation (R4.0 215mm thick)	• >6mm secondary window with nominally 100mm gap, or equivalent • Roof insulation (R4.0 215mm thick)	• >6mm secondary window with nominally 100mm gap, or equivalent • Roof insulation (R4.0 215mm thick)

Construction	Treatment package type				
	1	2	3	4	5
Exceedance, dBA	1-5 dBA	6-8 dBA	9-11 dBA	12-14 dBA	>14 dBA
Lightweight Window area less than or equal to 20% floor area	• Seal subfloor • Roof insulation (R4.0 215mm thick)	• As per Category 1 treatments For 8 dBA exceedance • 10mm acrylic panel with nominally 100mm gap, or equivalent • Re-sheet wall lining (1x 6mm fibre cement sheeting with nominal board weight of 11 kg/m^2 and 1 x 13mm plasterboard with nominal board weight of 10.5 kg/m^2 to finish, or equivalent) • Wall insulation (R2.7 90mm thick) • Otherwise: • 10mm acrylic panel with 100mm gap, or equivalent • Additional wall lining (1 x 13mm plasterboard with nominal board weight of 10.5 kg/m^2 to finish, or equivalent)	• As per Category 1 treatments • 10mm acrylic panel with nominally 100mm gap, or equivalent • Re-sheet wall lining (1x 6mm fibre cement sheeting with nominal board weight of 11 kg/m^2 and 1 x 13mm plasterboard with nominal board weight of 10.5 kg/m^2 to finish, or equivalent) • Wall insulation (R2.7 90mm thick) • Resilient mount to isolate wall lining and stud	• As per Category 1 treatments • >4mm secondary • window with nominally 100mm gap, or equivalent • Re-sheet wall lining (1x 6mm fibre cement sheeting with nominal board weight of 11 kg/m2 and 1 x 13mm plasterboard with nominal board weight of 10.5 kg/m^2 to finish, or equivalent) • Wall insulation (R2.7 90mm thick) • Resilient mount to isolate wall lining and stud	• As per Category 1 treatments • >6mm secondary window with nominally 100mm gap, or equivalent • Re-sheet wall lining (1x 6mm fibre cement sheeting with nominal board weight of 11 kg/m^2 and 1 x 13mm plasterboard with nominal board weight of 10.5 kg/m^2 to finish, or equivalent) • Wall insulation (R2.7 90mm thick) • Resilient mount to isolate wall lining and stud

Notes:

1. *Ceiling fans should have Direct Current (DC) electric motors to minimise noise.*
2. *Mechanical ventilation (MV) should be installed so that fresh air is ducted from an unaffected building facade. Mechanical fan noise should meet the recommended noise levels in AS2107.*

7.3 Recommended Acoustic Treatments

The following recommendations are made in the context of a new EPA Licensing regime coming into effect from 2025, which is only one year after opening. The EPA issued new licences to rolling stock operators in 2020 giving them a date of 2025 (i.e. a 5 year time frame) to have all rolling stock compliant with new noise emission requirements. It is anticipated that over the next couple of years (i.e. prior to the 2024 rail line opening) much of the rolling stock will be modified to be compliant with the new regulations.

The impact of the introduction of this EPA Rolling Stock Operator Licensing regime is that the track feature corrections given in Section 5.4 to account for rail squeal are effectively removed and the number of exceedances of the rail noise criteria is reduced from 44 (see Table 18) to 16 (see Table 19) for the 2034 scenario.

7.3.1 Mitigation At Source

7.3.1.1 Track Lubrication

As noted from Sections 5 and 6, to minimise the number of impacted receivers, track lubrication is to be implemented and will need to ensure adequate coverage for all curved sections of rail track.

A site visit on the 24 June 2022 of the current rail alignment indicated that in terms of GFL, there is only one unit servicing the BRD project area at present. It is on the UP rail only and its grease application is not currently reaching the first curve after the unit in the DOWN direction (we did not inspect curves in the UP direction as these are not in the BRD project area).

A swipe-test sheet from the two curves shows that there is no effective lubrication coverage through the project area at present.

The location of these current lubricators is listed in Table 31 below. It is recommended that the project implements a new friction management scheme throughout the project area and in doing so consider the consolidation and/or removal of existing lubricators based on their type and current condition.

As mentioned in Section 5.4, the no-build scenario assumes no effective rail lubrication throughout the current rail alignment.

Considering the hierarchy of controls as outlined in the RING, which favours mitigation at the source, it is recommended that the project implement a friction management scheme throughout the project area to appropriately manage wheel rail interface noise at-source.

Considering current industry practices the new lubrication scheme is to utilise modern, electronic GFL and TORFMA units. Compared to previously available technologies such as mechanical units that exist in the current scheme, modern electronic units represents a significant improvement in reliability, performance and maintainability.

The proposed future track lubrication system is to be installed in accordance with "ARTC Code of Practice, Rail Section 1" (authored by ARTC, dated 15 June 2016). The implementation of this friction management scheme may be optimised through a staged approach, to be detailed in a Validation Program which shall be prepared in accordance with CoA D2.

Table 31 Summary of existing track lubricators

Chainage	Rail Location	Type
10247	Both rails	LWS SmartLube
10400	Up rail only	Whitmore
12840	Both rails	RTE

7.3.1.2 Angle of Attack Monitoring System

Curve squeal cannot be eliminated by rail lubrication alone. To ensure that wheel squeal "curve gain" correction can be appropriately mitigated and accounted for in the noise model for the "Build" scenario for year 2034, it is also necessary to remove defective rolling stock from the freight network.

It is conventional to account for wheel squeal by adding a "curve gain" factor in rail noise modelling. The most commonly accepted values of curve gain are defined in the German rail noise prediction methodology. They are:

- +8dB for curves of less than 300m radius; and
- +3dB for curves between 300 and 500m radius.

More recent work by TfNSW has shown that curve gains in NSW can be significantly higher than those in the German method and recommends a value of +21dB for curves less than 500m radius (see Table 13).

Anecdotally it is considered that approximately 5 to 10% of freight trains on the NSW network generate severe squeal (over 100dBA at 25m) and that this is caused by poor steering of a relatively small number (less than 3%) of wagons.

Poor steering of rolling stock is the primary cause of severe wheel squeal on the NSW freight network. This finding is based on results from a sophisticated trackside detection system installed at Beecroft, in Sydney, in 2007. The system measures the steering performance of each passing wheel, the "angle of attack" (AoA), and also reads the associated wagon identification number.

Some wagon bogie designs cannot always effectively steer around curves and the subsequent high lateral creep create wheel squeal. Effective wagon steering is known to almost eliminate wheel squeal.

The importance of wagon steering has resulted in the creation of a wagon steering standard which was released on 1 January 2018 (*T HR RS 00400 ST RSU 400 Series – Minimum Operating Standards for Rolling Stock – Freight Vehicle Specific Interface Requirements,* Version 2.0 Issued date: 24 August 2017, section 2.7.1).

Section 2.7.1 of this *Minimum Operating Standards for Rolling Stock – Freight Vehicle Specific Interface Requirements* Standards states:

> *Acceptable AoA is defined as being less than a value given by the following equation:*
>
> *AoA = 2.5 x Bwb / R*
>
> *Where,*
>
> *AoA - angle of attack (Rad)*
>
> *Bwb - bogie wheel base (m)*
>
> *R - radius of track curvature (m)*
>
> *Note: At the Beecroft AoA detector on the Up Main North at 26.675 km (310 m radius curve), for a typical freight bogie, this corresponds to an acceptable AoA of <15 mrad. This limit will be applied from 01 January 2018. Any wagon that exceeds the AoA limit at any wayside detection system on the RailCorp network from this date shall be held in breach and TfNSW will issue a notification of breach to the operator.*
>
> *The operator shall, within 12 months from the day TfNSW has notified the breach to the operator, either:*
>
> *• Rectify the performance of the wagon; or,*
>
> *• Submit a plan to rectify the performance of the wagon to the satisfaction of the Lead Rolling Stock Engineer, ASA. The timeline for rectification shall be no longer than the next scheduled overhaul of the bogies on the wagon.*

If the operator fails to satisfy these requirements, then the affected wagon shall not be operated on the RailCorp Network until its steering performance has been rectified to the satisfaction of the Lead Rolling Stock Engineer, ASA.

ASA reserve the right to restrict wagons from entering, or returning to service, onto the RailCorp Network, where the performance of the wagon's steering is clearly noncompliant, or any corrective actions and assurance is ambiguous.

Wagon bogies need to rotate under the wagon in order to steer effectively. High rotational resistance at the centre bowl (the bearing that connects the bogie and the wagon) is a key cause of poor steering. Bogies with the basic "three-piece" design are particularly sensitive to the effects of high rotational resistance because of the lack of rigidity in this type of bogie compared to other designs.

Analysis of a very large data set carried out in NSW identified that severe squeal only occurs when the angle of attack is high (significantly above 10milliRadians) and that the probability of squeal increases significantly when the angle of attack exceeds approximately 20milliRadians.

The analysis also confirmed that basic "three-piece" freight bogies were the only bogies to exhibit high angle of attack, due to poor steering. Other freight bogie types such as the "one-piece" freight bogies, three-piece freight bogies fitted with cross-bracing or steering arms, all steered well around the curve and did not squeal. It has also been established that three-piece bogies can also steer well if the elements that control bogie rotational resistance (the centre bowl and side bearers) are maintained to appropriate specifications.

Research carried out in Australia has established that wheel squeal can be effectively controlled at source. Solving the poor steering performance of three-piece freight bogies that are not properly set up and maintained, by replacement with other bogie types or improved maintenance, can virtually eliminate wheel squeal.

Monitoring rail noise and angle of attack on curves enables the identification of bogies that are not steering well, so that remedial action can be taken.

Recommendation

ARTC has a Wayside Strategy that identifies the need for Wayside Monitoring Systems across the freight rail network, including among others, Angle of Attack systems. Whilst not a direct recommendation of this ONVR, ARTC could review the existing Wayside Strategy in consultation with the broader industry if additional monitoring systems are required to support ensuring rolling stock operators are compliant under their licensing regimes. Angle of Attack systems do not necessarily need to be installed within the BRD project area if a more suitable location is preferred as part of ARTC's overarching Wayside Strategy.

7.3.2 Noise Transmission Mitigation Measures

Close to rail noise barriers have been assessed for "feasible" and "reasonable" considerations (when balanced with other relevant project considerations).

An example of low height noise barriers is shown in Figure 12 below. This example is of a "bolt-on" close-to-rail noise barriers is the Soundim (https://www.soundim.fi/) product but others also manufacture these products.

Figure 12 Close-to-rail noise barriers

Although this type of mitigation measure is feasible, it is not effective at reducing the maximum noise level from the diesel locomotive. It is however effective in mitigating the noise of rail squeal.

Since the EPA's Rolling Stock Operator Licensing regime (NSW Environment Protection Authority, 2020) requires all rolling stock to be compliant by 2025, which is one year after opening, and it is likely that much of the rolling stock will be made compliant in advance of this date, it is not considered reasonable on the grounds of cost effectiveness to mitigate rail squeal in this manner for such a short period of time.

It is also noted that currently there is no effective rail lubrication through the current rail alignment and the introduction of electronic rail lubricators, as recommended in Section 7.3.1 above, will significantly reduce the current level of rail squeal at project opening in 2024.

For this project, the rail line is being duplicated on the southern side of the existing rail line. The majority of the residential receiver locations located in close proximity to the rail alignment are located north of the existing rail line (with the exception of the eastern end of the project where residences are located on both sides of the alignment). Even if the effects of rail lubrication were to be ignored, since the existing track is generally located closer the receiver locations of interest, little benefit can be derived by installing low height noise barriers close to the rail track for the new line. The implementation of noise transmission reduction measures in the form of noise barrier is therefore not considered to be reasonable or cost efficient.

Additionally, these barriers can impact on the ongoing maintenance of the track and are not recommended for installation on this basis also.

7.3.3 Noise Mitigation Measures At The Receiver

7.3.3.1 Residential Boundary Fence Upgrades

Upgrading property boundary fences to provide noise screening to the residences may be feasible but may not be practical or desirable from the resident's perspective. This type of treatment would need to be discussed as a potential option with the 16 property owners of the noise sensitive receiver locations which will exceed the noise criteria for the 2034 build scenario (i.e. those shown in Appendix C), and will otherwise require architectural mitigation measures (see Section 7.3.3.1 below).

7.3.3.2 Architectural Treatments - Residences

We have identified that in the absence of the EPA Rolling Stock Operator Licensing Regime, 44 premises would exceed the noise criteria (see Table 18) for the build scenario.

Since the EPA's Rolling Stock Operator Licensing regime (NSW Environment Protection Authority, 2020) requires all rolling stock to be compliant by 2025, which is one year after opening, and it is likely that much of the rolling stock will be made compliant in advance of this date, it is not considered reasonable on the grounds of cost effectiveness to implement architectural treatments to mitigate noise criteria exceedances for such a short period of time (i.e. 2024-2025).

It is also noted that currently there is no effective rail lubrication through the current rail alignment and the introduction of electronic rail lubricators, as recommended in Section 7.3.1 above, will significantly reduce the current level of rail squeal at project opening in 2024 (i.e. at opening, noise levels from rail squeal will be reduced by approximately 8 dB).

With the full introductions of the Rolling Stock Operator Licensing Regime from 2025, we have predicted that only 16 noise sensitive receivers will exceed the noise criteria for the 2034 build scenario (i.e. those shown in Appendix C), and will require architectural mitigation measures. Number of exceedances is also shown in Table 18 for opening year 2024, prior to implementation of EPA licensing scheme; and in Table 19 for year 2034 when EPA licensing scheme is implemented.

To treat these residences, the noise exposed building envelope of these residences should be treated as per the Treatment Package Type indicated in Table 30 above. It should be noted that all architectural treatments are subject to agreement with the owner and subject to a property condition assessment.

For year 2034 (after the implementation of the EPA licensing regime), the required architectural treatments for the airborne exceedances listed in Table 19, have been categorised. This is summarised in Table 32.

For year 2024 (before the implementation of the EPA licensing regime), the required architectural treatments for the airborne exceedances listed in Table 19, have been categorised and summarised in Table 36. Table 36 is included in Appendix C.

The addresses for the receiver locations identified in Table 32 and Table 36; are provided in Appendix C.

Table 32 Summary of architectural treatments at residential receivers (year 2034, after implementation of EPA licensing scheme)

Exceedance, dBA	Noise Mitigation Level Required				
	1-5 dBA	6-8 dBA	9-11 dBA	12-14 dBA	>14 dBA
Treatment package type	1	2	3	4	5
Receiver Location Per NCA					
Building number in NCA03	2575 2577 2578 2579 2585	2625 2626 2627 2628 2629 2640			
Building number in NCA04	3034 3177	3050 3178	3182		

Notes

1. For addresses corresponding to the building numbers listed above, refer to the back of Appendix C.

Treatment packages should only be recommended and considered feasible and reasonable where they are predicted to provide a noticeable improvement in noise reduction (3 dBA or greater) than the existing window, door and façade system.

Due to the proximity of these residences to Sydney Airport, it is likely the recommended acoustic treatments have already been implemented to mitigate against aircraft noise intrusion. It is recommended that each residential receiver should be individually assessed to confirm whether the advised treatments are required.

7.3.3.3 Architectural Treatments – Non-Residential Receivers

From Table 20 and Table 21, it is noted that non-compliances are influenced by exceedances in daytime $L_{Aeq\ (15\ hours)}$ noise levels and night time $L_{Aeq\ (9\ hours)}$ noise levels. By accounting façade sound insulation performances listed in Table 26, typical noise intrusion levels inside the affected hotels have been predicted, these are summarised in Table 33 below.

Table 33 Predicted noise intrusion levels for affected hotels

Hotel	Predicted Noise Intrusion Levels, dBA Year 2024 - Prior to EPA Licensing Scheme & Excluding Track Lubrication		Predicted Noise Intrusion Levels, dBA Year 2024 - Prior to EPA Licensing Scheme		Predicted Noise Intrusion Levels, dBA Year 2034 - After EPA Licensing Scheme	
	Day	Night	Day	Night	Day	Night
Stanford Plaza	31	31	30	30	25	25
Mantra Hotel	N/A	25	25	25	N/A	N/A
Ibis Budget Hotel	N/A	26	25	25	N/A	N/A
Citadines Hotel	N/A	33	30	30	33	33

For residential developments near rail corridors, Clause 87 of the State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) requires that the following L_{Aeq} levels are not exceeded (with windows and doors closed):

- In any bedroom in the building – 35 dBA $L_{Aeq(9hour)}$ between 10:00 pm and 7:00 am
- Anywhere else in the building (other than a garage, kitchen, bathroom or hallway) – 40 dBA L_{Aeq} at any time (i.e. $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$).

From Table 33, it is noted that the predicted noise intrusion levels for the affected hotels will be compliant with these guidelines. Therefore, it is concluded that the current facade constructions for these hotels already sufficiently provide all feasible and reasonable acoustic treatments that can be implemented.

7.3.4 Vibration Attenuation Measures

As noted from Sections 6.11 despite the fact a number of receivers will be subject regenerated noise levels that exceed the relative increase limit 3 dB, mostly due the speed increase along the rail alignment from 30 km/hr to 50 km/hr, all assessed receivers have assessed regenerated noise levels at the building façade facing away from the rail line, of less than 35 dB L_{ASmax} for 95 % of train passbys.

As a result, no vibration mitigation measures are required in order to limit the transmission of ground borne noise and vibration from the project.

7.3.5 **Ensuring Trains Don't Stop** Within the BRD Project Area

The primary objective of the project is to increase freight capacity and operational flexibility by providing duplicated bi-directional tracks in place of the existing single line. This will enable train movements in the Up and Down directions concurrently, removing the need for freight trains to stop and idle at the existing passing loops, which is currently required to facilitate passing movements with the existing single line arrangement.

Upon completion of the project, during normal operations there will be no reason or purpose for trains to stop and idle. As such, conditions under which trains may be required to stop is expected to be limited to breakdown scenarios or emergency incidents such as unauthorised personnel within the rail corridor, signalling failure or adverse weather events.

8 CONSULTATION STRATEGY

This section outlines the strategy for ongoing consultation with stakeholders about measures proposed to manage operational noise and vibration associated with the project. This is a requirement of the Conditions of Approval for as outlined in Section 4.1.

8.1 Purpose

The project aims to balance the benefits of growing the rail transport network with the effects such developments can have on residents living adjacent to railway lines. This report has identified a number of sensitive receivers that will be affected by increased operational noise. A discussion of the approaches that have been considered to minimise train noise is outlined in Section 7.

The project will continue to engage with the community through a process that aims to ensure affected stakeholders feel they have had an opportunity to be informed and provide feedback about the project's operational noise and vibration management strategy.

8.2 Objectives

The objectives of the operational noise and vibration management consultation strategy are to:

- Inform stakeholders about the modelling results, which provide the rationale for operational noise and vibration mitigation measures proposed in the ONVR.
- Inform stakeholders about the operational noise management measures, including the consideration of source controls, noise walls and receiver controls.
- Provide information to assist stakeholders understanding how operational noise and vibration management measures have progressed since the Environmental Assessment.
- Provide accessible information to enable stakeholders affected by noise management measures to engage with the project team from an informed position.
- Inform stakeholders about the planning, design and construction processes of operational noise management measures, including the rationale for key decisions and decisions on alternative noise management measures.
- Engage directly with affected stakeholders in relation to the location, impact, construction staging, property access and look of property treatments where applicable.

8.3 Consultation Approach

8.3.1 General

ONVR consultation will address the affected receivers and inform the wider community.

8.3.2 One-On-One Consultation

Stakeholders directly affected by proposed mitigation measures will be engaged in detail about the impact of, and process for, undertaking these activities. This process will include consultation on property specific issues and accommodating the requirements (e.g. access times) of individual property owners and tenants.

For tenanted properties, consultation directly with the tenants will only be undertaken with the agreement of the owner or owner's agent.

Meetings will take place after feedback on proposed noise management measures has been received.

8.3.3 Stakeholder Consultation & Approval of Plans

The ONVR is required to be prepared in consultation with the relevant council(s) and other relevant stakeholders as per CoA – E32. Consultation details are included in document titled *"Community Communication Strategy"* (Revision 6, dated 17 August 2022, issued by John Holland Group).

Comments received on the ONVR will be considered and, where relevant, incorporated into the plan and recorded as per Table 34. .

Table 34 Record of stakeholder consultation details

Condition of Approval SSI-9714	Document	Agency	Consultation Details	Response Comments
E32	ONVR	Bayside Council	27/10/2022 - ONVR (Rev 6) provided to Bayside Council (one contact) for review 31/10/2022 – Response from Council including comments 04/11/2022 – ONVR summary email provided to Council including comments provided by ARTC 07/11/2022 – Response from Council including additional questions 07/11/2022 – Additional information provided to Council from ONVR.	Comments received 31/10/2022 and 07/11/2022 (refer Appendix F)

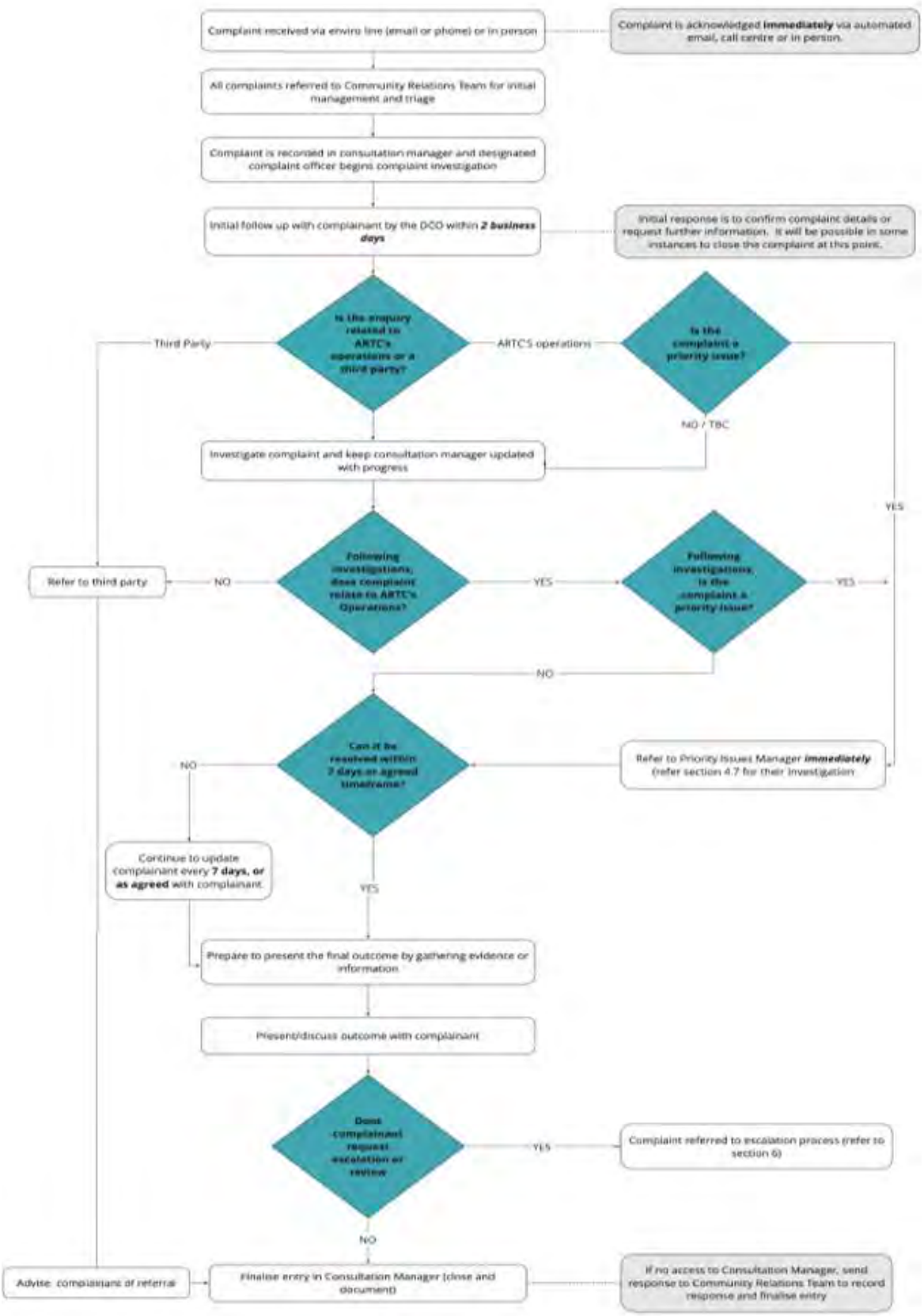
8.4 Complaints Management Procedures

ARTC will be responsible for operational complaints management via the existing ARTC Enviroline phone number (1300 550 402) or email address enviroline@artc.com.au.

CoA E32i requires a procedure for the management of operational noise and vibration complaints. To address this requirement, an indicative ARTC operational complaints management process is shown in Figure 13.

Complaints management procedures have also been established for the duration of construction activities with complaints pathways displayed on site hoarding and included in all community notifications. All construction complaints are logged within the ARTC Consultation Manager Database.

Figure 13 Complaints management procedures



9 POST-OPERATIONAL TESTING & VALIDATION

After implementation of acoustic mitigation measures, it is required by the Conditions of Approval, specifically D1, D2 and D3, that a post-operational noise and vibration compliance survey is undertaken to confirm mitigation measures have been correctly implemented.

Figure 14 provides a flowchart illustrating an example of the post operational noise process and validation which could be adopted in the Operational Noise Compliance Report. An experienced and qualified acoustic consultant should undertake the acoustic monitoring, which will generally involve:

- Validation of the model inputs (action B in Figure 14): A review of the inputs to and assumptions for the noise model, i.e. the number of trains, mix of trains, speed of trains and track alignment. If these inputs are consistent with the assumptions made within the ONVR, this indicates that the noise increase component will be consistent with the predictions.

  If it is observed that one or more of the above design inputs have changed, then additional calculations will be undertaken to determine the variance generated and whether any additional mitigation measures need to be considered.

- Validation of the predicted noise levels (action A in Figure 14): On site noise monitoring will be undertaken at representative locations for the purpose of validating the predictions from the ONVR noise model. Representative locations will be chosen to provide a cross section of different conditions, e.g. bridge locations, varying landforms, locations with and without new noise walls.

  The monitoring results will then be compared against the airborne noise criteria (refer to Section 4.2) and prediction from the ONVR noise model, to determine any variance in noise levels between actual noise levels and ONVR predictions. At this point potential outcomes include:

  - Monitoring results indicate levels consistent with predictions, (i.e. within 2 dB). Mitigation measures remain as described in this report.

  - The measured noise levels are higher than the airborne noise criteria and outside normal measurement tolerances and daily noise level variations at individual (specific) locations (i.e. 2 dBA or more above the ONVR predictions). In this situation the source of the exceedance will be identified, and the reason investigated.

    If the exceedance is due to a defect (typically track or the wheel/rail interface), the investigation will explore rectification measures. If this cannot resolve the issue, additional mitigation measures may need to be considered.

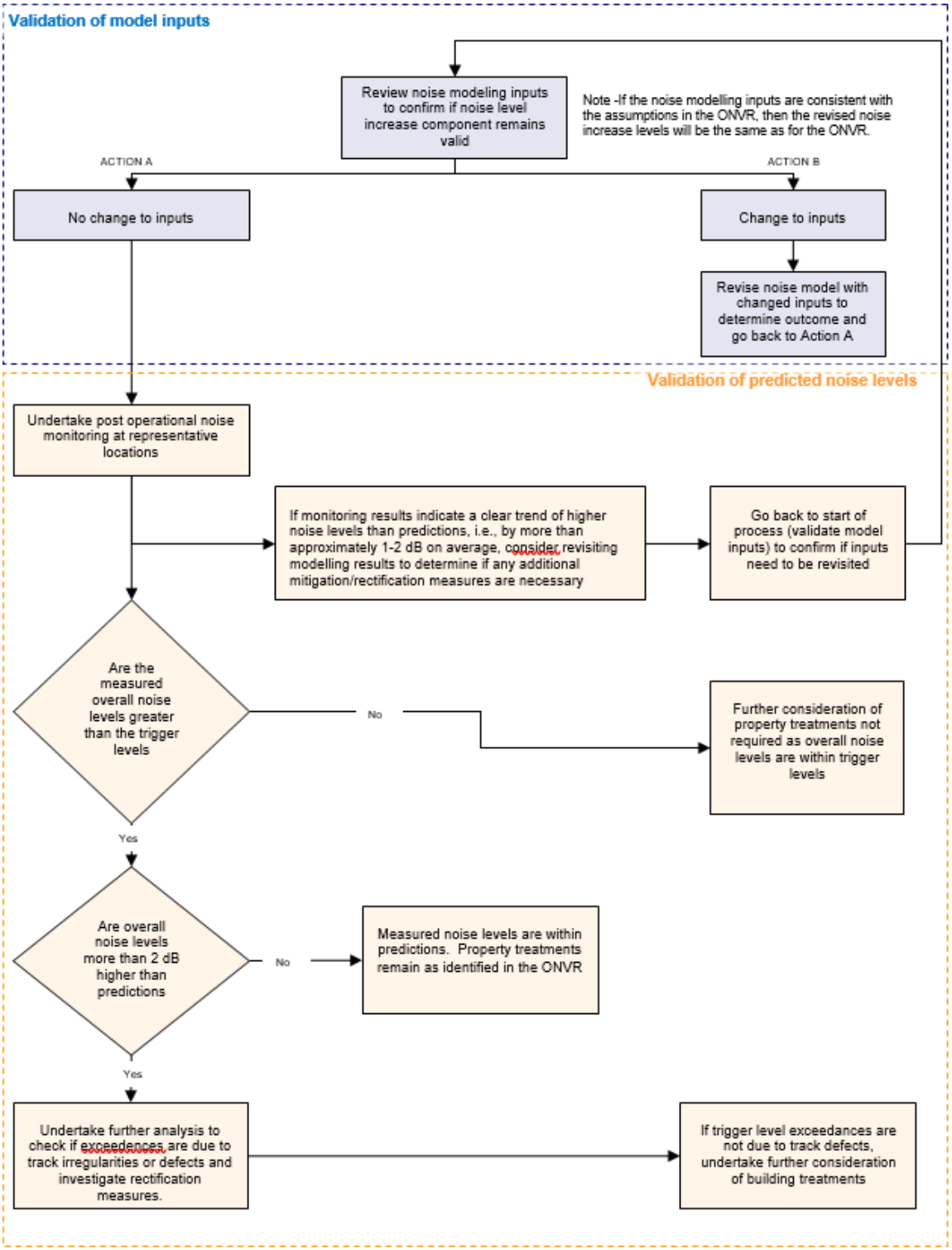
  - Monitoring results indicate a clear trend of higher noise levels than predictions, (i.e. by more than 1-2 dBA on average. In this situation consideration will be given to revisiting modelling results to determine if additional management measures are necessary.

- Validation of vibration predictions: On site vibration monitoring will be undertaken at representative locations along the project corridor. The purpose of the monitoring is to determine the change in vibration levels (by comparing the vibration levels from trains operating on new and existing tracks) and comparing the overall vibration levels with the ONVR predictions.

If the operational testing confirms that the operational noise and vibration levels during operations exceed those predicted in the ONVR noise model, then investigation of further reasonable and feasible mitigation or rectification measures should be undertaken in consultation with affected property owners, stakeholders and local authorities.

The post-operational testing and validation should be undertaken by a professional acoustic practice which is a member of the Association of Australasian Acoustical Consultants (AAAC). Staff involved with the testing and validation works should be members of the Australian Acoustical Society (AAS).

Figure 14 Example of post operational noise testing & validation process



Survey equipment should comprise the following:

- For attended noise measurements, equipment should include Class 1 sound level meters in accordance with standard IEC 61672-1:2002 (or equivalent current standard).
- For unattended noise measurements, equipment can include Class 1 or Class 2 sound level meters in accordance with standard IEC 61672-1:2002 (or equivalent current standard).

As part of the reporting, current calibration certificates should be provided for all used equipment.

Survey measurement should be conducted at residential locations indicated in Table 35. These measurements should be compared against the baseline noise levels summarised in Table 35.

Table 35 Recommended locations for post-operational survey, with baseline noise levels

Measurement Locations	Noise Level At Measurement Locations Yr 2024 Before Implementation of EPA Licensing Scheme			Noise Level At Measurement Locations Yr 2034 After Implementation of EPA Licensing Scheme		
	L_{Aeq} (15 hours)	L_{Aeq} (9 hours)	L_{Amax}	L_{Aeq} (15 hours)	L_{Aeq} (9 hours)	L_{Amax}
105 Baxter Road, Mascot	61	61	88	61	61	88
34 Baxter Road, Mascot	70	70	100	65	65	93
1285 Botany Road, Mascot	68	68	98	62	63	90
40 McBurney Avenue, Mascot	66	66	96	61	61	88

APPENDIX A: ACOUSTIC TERMINOLOGY

The following is a brief description of the acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/Subway train 110 dB(A) Rock Concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Ambient sound	The all-encompassing sound at a point composed of sound from all sources near and far.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
Reverberation	The persistence of sound in a space after the source of that sound has been stopped (the reverberation time is the time taken for a reverberant sound field to decrease by 60 dB)
Air-borne sound	The sound emitted directly from a source into the surrounding air, such as speech, television or music
Impact sound	The sound emitted from force of one object hitting another such as footfalls and slamming cupboards.
Air-borne sound isolation	The reduction of airborne sound between two rooms.
Sound Reduction Index [R] (Sound Transmission Loss)	The ratio the sound incident on a partition to the sound transmitted by the partition.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.
Level difference [D]	The difference in sound pressure level between two rooms.

Normalised level difference [D_n]	The difference in sound pressure level between two rooms normalised for the absorption area of the receiving room.
Standardised level difference [D_{nT}]	The difference in sound pressure level between two rooms normalised for the reverberation time of the receiving room.
Weighted standardised level difference [$D_{nT,w}$]	A single figure representation of the air-borne sound insulation of a partition based upon the level difference. Generally used to present the performance of a partition when measured in situ on site.
C_{tr}	A value added to an R_w or $D_{nT,w}$ value to account for variations in the spectrum.
Impact sound isolation	The resistance of a floor or wall to transmit impact sound.
Impact sound pressure level [L_i]	The sound pressure level in the receiving room produced by impacts subjected to the adjacent floor or wall by a tapping machine.
Normalised impact sound pressure level [L_n]	The impact sound pressure level normalised for the absorption area of the receiving room.
Weighted normalised impact sound pressure level [$L_{n,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in a laboratory.
Weighted standardised impact sound pressure level [$L'_{nT,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in situ on site.
C_I	A value added to an L_{nW} or $L'_{nT,w}$ value to account for variations in the spectrum.
Energy Equivalent Sound Pressure Level [$L_{A,eq,T}$]	'A' weighted, energy averaged sound pressure level over the measurement period T.
Percentile Sound Pressure Level [$L_{Ax,T}$]	'A' weighted, sound pressure that is exceeded for percentile x of the measurement period T.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*

APPENDIX B: SITE LAYOUT, RECEIVERS & NOISE MONITORING LOCATIONS

Site Layout, Receivers & Noise Monitoring Locations

Legend

- Residences
- Hotels
- Educational facilities
- Commercial premises

NCA01

NCA02

NCA03

Holiday Inn Sydney Airport

Pullman Sydney Airport Hotel

New Qantas Flight Training Centre (under construction)

Travelodge Sydney Airport

Ibis Sydney Airport

Holiday Inn Express Sydney Airport

Quest Mascot

Citadines Hotel

Mascot Public School

Stamford Plaza

133-137 Baxter Road, Mascot (under DA assessment)

Mantra Hotel

Ibis Budget Hotel

Baxter Road crossovers (between chainages 11950 & 12150)

40-56 Baxter Road, Mascot (under construction)

M02

M03

M03b

13100 13000 12900 12800 12700 12700 12600 12600 12500 12400 12300 12200 12100 12000 11900 11800 11800 11700 11700 11600 11500

0 100 200 m

Site Layout, Receivers & Noise Monitoring Locations

Legend

- Residences
- Hotels
- Educational facilities
- Commercial premises

Mascot Public School

NCA03

NCA04

NCA02

NCA05

NCA06

M04

UTS Tech Labs

11800 11700 11600 11500 11400 11300 11200 11100 11000 10900 10800 10700 10600 10500

0 100 200 m

Site Layout, Receivers & Noise Monitoring Locations

Legend

- Residences
- Hotels
- Educational facilities
- Commercial premises

NCA05

NCA06

NCA07

NCA08

M06

M07

Stephen Road crossovers (between chainages 9400 & 9950)

10600 10500 10400 10300 10200 10100 10000 9900 9800 9700 9600 9500 9400 9300 9200

0 100 200 m

APPENDIX C: LOCATION OF AIRBORNE NOISE TRIGGER EXCEEDANCES

Table 36 Summary of architectural treatments at residential receivers (year 2024, before implementation of EPA licensing scheme)

Exceedance, dBA	Noise Mitigation Level Required				
	1-5 dBA	6-8 dBA	9-11 dBA	12-14 dBA	>14 dBA
Treatment package type	1	2	3	4	5
Receiver Location Per NCA					
Building number in NCA03	2575 2577 2578 2579	2611 2612 2632 2634	2608 2609 2610 2631	2628 2629 2630	2625 2626 2627 2640
Building number in NCA04		3063 3180	2992 3021 3027 3129 3177 3181	3034 3050	

Notes

1. For addresses corresponding to the building numbers listed above, refer to the back of Appendix C.

Year 2024 Build Scenario - No Mitigation
Sensitive Receivers Exceeding Noise Criteria

Year 2024 Build Scenario - No Mitigation
Sensitive Receivers Exceeding Noise Criteria

Year 2024 Build Scenario - No Mitigation
Sensitive Receivers Exceeding Noise Criteria

Year 2024, Build Scenario, No Mitigation
Residential Exceedances

NCA	Building No	Address
1	2143	338 KING STREET MASCOT 2020
3	2355	UNIT 2 330 KING STREET MASCOT 2020
3	2484	UNIT 18 104-110 HIGH STREET MASCOT 2020
3	2500	109 ROBEY STREET MASCOT 2020
3	2502	111 ROBEY STREET MASCOT 2020
3	2503	107 ROBEY STREET MASCOT 2020
3	2505	UNIT 15 22 HIGH STREET MASCOT 2020
3	2542	UNIT 2 1-3 ELIZABETH AVENUE MASCOT 2020
3	2558	31 ROBEY STREET MASCOT 2020
3	2567	131 BAXTER ROAD MASCOT 2020
3	2569	9 ROBEY STREET MASCOT 2020
3	2575	107 BAXTER ROAD MASCOT 2020
3	2577	103 BAXTER ROAD MASCOT 2020
3	2578	105 BAXTER ROAD MASCOT 2020
3	2579	109 BAXTER ROAD MASCOT 2020
3	2588	36 ROBEY STREET MASCOT 2020
3	2589	34 ROBEY STREET MASCOT 2020
3	2590	28 ROBEY STREET MASCOT 2020
3	2591	30 ROBEY STREET MASCOT 2020
3	2592	32 ROBEY STREET MASCOT 2020
3	2593	26 ROBEY STREET MASCOT 2020
3	2594	22 ROBEY STREET MASCOT 2020
3	2595	24 ROBEY STREET MASCOT 2020
3	2596	16 ROBEY STREET MASCOT 2020
3	2597	20 ROBEY STREET MASCOT 2020
3	2598	18 ROBEY STREET MASCOT 2020
3	2599	14 ROBEY STREET MASCOT 2020
3	2600	12 ROBEY STREET MASCOT 2020
3	2602	10 ROBEY STREET MASCOT 2020
3	2604	4 ROBEY STREET MASCOT 2020
3	2606	2 ROBEY STREET MASCOT 2020
3	2608	29 BAXTER ROAD MASCOT 2020
3	2609	33 BAXTER ROAD MASCOT 2020
3	2610	31 BAXTER ROAD MASCOT 2020
3	2611	23 BAXTER ROAD MASCOT 2020
3	2612	25 BAXTER ROAD MASCOT 2020
3	2613	21 BAXTER ROAD MASCOT 2020
3	2614	13 BAXTER ROAD MASCOT 2020
3	2615	15 BAXTER ROAD MASCOT 2020
3	2616	19 BAXTER ROAD MASCOT 2020
3	2617	17 BAXTER ROAD MASCOT 2020
3	2618	9 BAXTER ROAD MASCOT 2020
3	2619	11 BAXTER ROAD MASCOT 2020

NCA	Building No	Address
3	2620	5 BAXTER ROAD MASCOT 2020
3	2621	3 BAXTER ROAD MASCOT 2020
3	2622	7 BAXTER ROAD MASCOT 2020
3	2624	1 BAXTER ROAD MASCOT 2020
3	2625	32 BAXTER ROAD MASCOT 2020
3	2626	34 BAXTER ROAD MASCOT 2020
3	2627	30 BAXTER ROAD MASCOT 2020
3	2628	28 BAXTER ROAD MASCOT 2020
3	2629	28 BAXTER ROAD MASCOT 2020
3	2630	26 BAXTER ROAD MASCOT 2020
3	2631	22 BAXTER ROAD MASCOT 2020
3	2632	18 BAXTER ROAD MASCOT 2020
3	2633	8 BAXTER ROAD MASCOT 2020
3	2634	12 BAXTER ROAD MASCOT 2020
3	2635	4 BAXTER ROAD MASCOT 2020
3	2636	2 BAXTER ROAD MASCOT 2020
3	2639	988 BOTANY ROAD MASCOT 2020
3	2640	36 BAXTER ROAD MASCOT 2020
3	2642	59 BAXTER ROAD MASCOT 2020
4	2905	UNIT 13 1 HOLLINGSHED STREET MASCOT 2020
4	2923	1239 BOTANY ROAD MASCOT 2020
4	2930	1243 BOTANY ROAD MASCOT 2020
4	2946	58 HARDIE STREET MASCOT 2020
4	2947	UNIT 3 1247 BOTANY ROAD MASCOT 2020
4	2974	66 HARDIE STREET MASCOT 2020
4	2982	68 HARDIE STREET MASCOT 2020
4	2986	67 HARDIE STREET MASCOT 2020
4	2989	70 HARDIE STREET MASCOT 2020
4	2992	1271 BOTANY ROAD MASCOT 2020
4	2995	72 HARDIE STREET MASCOT 2020
4	3001	74 HARDIE STREET MASCOT 2020
4	3010	76 HARDIE STREET MASCOT 2020
4	3016	78 HARDIE STREET MASCOT 2020
4	3020	76 ALFRED STREET MASCOT 2020
4	3021	1279 BOTANY ROAD MASCOT 2020
4	3022	80 HARDIE STREET MASCOT 2020
4	3025	79 HARDIE STREET MASCOT 2020
4	3027	1281 BOTANY ROAD MASCOT 2020
4	3028	82 HARDIE STREET MASCOT 2020
4	3032	81 HARDIE STREET MASCOT 2020
4	3034	UNIT 2 1283 BOTANY ROAD MASCOT 2020
4	3036	83 HARDIE STREET MASCOT 2020
4	3038	84 HARDIE STREET MASCOT 2020
4	3042	85 HARDIE STREET MASCOT 2020
4	3045	90 JOHNSON STREET MASCOT 2020

NCA	Building No	Address
4	3047	86 HARDIE STREET MASCOT 2020
4	3050	UNIT 26 1285 BOTANY ROAD MASCOT 2020
4	3054	87 HARDIE STREET MASCOT 2020
4	3056	86 HARDIE STREET MASCOT 2020
4	3061	34 WENTWORTH AVENUE MASCOT 2020
4	3062	3 WENTWORTH AVENUE MASCOT 2020
4	3063	1 WENTWORTH AVENUE MASCOT 2020
4	3064	UNIT 19 52 WENTWORTH AVENUE MASCOT 2020
4	3066	38 WENTWORTH AVENUE MASCOT 2020
4	3068	36 WENTWORTH AVENUE MASCOT 2020
4	3077	3 MCBURNEY AVENUE MASCOT 2020
4	3079	5 MCBURNEY AVENUE MASCOT 2020
4	3080	2 MCBURNEY AVENUE MASCOT 2020
4	3081	44 DRANSFIELD AVENUE MASCOT 2020
4	3082	42 DRANSFIELD AVENUE MASCOT 2020
4	3084	9 MCBURNEY AVENUE MASCOT 2020
4	3087	4 MCBURNEY AVENUE MASCOT 2020
4	3089	9 MCBURNEY AVENUE MASCOT 2020
4	3094	13 MCBURNEY AVENUE MASCOT 2020
4	3101	13 MCBURNEY AVENUE MASCOT 2020
4	3108	15 MCBURNEY AVENUE MASCOT 2020
4	3113	17 MCBURNEY AVENUE MASCOT 2020
4	3127	19 MCBURNEY AVENUE MASCOT 2020
4	3128	16 MCBURNEY AVENUE MASCOT 2020
4	3129	1297 BOTANY ROAD MASCOT 2020
4	3131	21 MCBURNEY AVENUE MASCOT 2020
4	3132	18 MCBURNEY AVENUE MASCOT 2020
4	3133	52 DRANSFIELD AVENUE MASCOT 2020
4	3136	23 MCBURNEY AVENUE MASCOT 2020
4	3137	20 MCBURNEY AVENUE MASCOT 2020
4	3138	25 MCBURNEY AVENUE MASCOT 2020
4	3140	22 MCBURNEY AVENUE MASCOT 2020
4	3143	27 MCBURNEY AVENUE MASCOT 2020
4	3144	24 MCBURNEY AVENUE MASCOT 2020
4	3150	29 MCBURNEY AVENUE MASCOT 2020
4	3151	56 DRANSFIELD AVENUE MASCOT 2020
4	3152	26 MCBURNEY AVENUE MASCOT 2020
4	3154	28 MCBURNEY AVENUE MASCOT 2020
4	3155	31 MCBURNEY AVENUE MASCOT 2020
4	3159	33 MCBURNEY AVENUE MASCOT 2020
4	3160	35 MCBURNEY AVENUE MASCOT 2020
4	3161	37 MCBURNEY AVENUE MASCOT 2020
4	3162	30 MCBURNEY AVENUE MASCOT 2020
4	3163	32 MCBURNEY AVENUE MASCOT 2020
4	3165	39 MCBURNEY AVENUE MASCOT 2020

NCA	Building No	Address
4	3167	34 MCBURNEY AVENUE MASCOT 2020
4	3168	41 MCBURNEY AVENUE MASCOT 2020
4	3169	38 MCBURNEY AVENUE MASCOT 2020
4	3170	43 MCBURNEY AVENUE MASCOT 2020
4	3171	38 MCBURNEY AVENUE MASCOT 2020
4	3172	47 MCBURNEY AVENUE MASCOT 2020
4	3173	49 MCBURNEY AVENUE MASCOT 2020
4	3174	49 MCBURNEY AVENUE MASCOT 2020
4	3175	40 MCBURNEY AVENUE MASCOT 2020
4	3176	51 MCBURNEY AVENUE MASCOT 2020
4	3177	40 MCBURNEY AVENUE MASCOT 2020
4	3178	42 MCBURNEY AVENUE MASCOT 2020
4	3179	57 MCBURNEY AVENUE MASCOT 2020
4	3180	59 MCBURNEY AVENUE MASCOT 2020
4	3181	61 MCBURNEY AVENUE MASCOT 2020
7	3268	UNIT 1 15 BEGONIA STREET PAGEWOOD 2035
7	3277	UNIT 1 15 BEGONIA STREET PAGEWOOD 2035
7	3304	237 BAY STREET PAGEWOOD 2035
8	3519	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3528	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3529	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3530	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3532	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3533	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3535	2 MYRTLE STREET BOTANY 2019
8	3536	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3538	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3542	3 MYRTLE STREET BOTANY 2019
8	3544	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3546	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3547	3 MYRTLE STREET BOTANY 2019
8	3551	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3554	3 MYRTLE STREET BOTANY 2019
8	3555	3 MYRTLE STREET BOTANY 2019
8	3558	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3559	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3561	UNIT 3 30 JASMINE STREET BOTANY 2019
8	3563	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3564	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3565	5 MYRTLE STREET BOTANY 2019
8	3567	UNIT 162 26 JASMINE STREET BOTANY 2019
8	3568	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3569	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3570	5 MYRTLE STREET BOTANY 2019
8	3571	UNIT 8 1 MYRTLE STREET BOTANY 2019

NCA	Building No	Address
8	3573	92 BAY STREET BOTANY 2019
8	3574	5 MYRTLE STREET BOTANY 2019
8	3575	UNIT 162 26 JASMINE STREET BOTANY 2019
8	3583	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3587	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3590	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3592	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3596	92 BAY STREET BOTANY 2019
8	3614	217 BAY STREET BOTANY 2019
8	3615	UNIT 4 219-225 BAY STREET BOTANY 2019
8	4001	UNIT 1 76 BAY STREET BOTANY 2019

Year 2034 Build Scenario - No Mitigation
Sensitive Receivers Exceeding Noise Criteria

Year 2034 Build Scenario - No Mitigation
Sensitive Receivers Exceeding Noise Criteria

Year 2034 Build Scenario - No Mitigation
Sensitive Receivers Exceeding Noise Criteria

Year 2034, Build Scenario, No Mitigation
Residential Exceedances

NCA	Building No	Address
1	2143	338 KING STREET MASCOT 2020
3	2355	UNIT 2 330 KING STREET MASCOT 2020
3	2484	UNIT 18 104-110 HIGH STREET MASCOT 2020
3	2500	109 ROBEY STREET MASCOT 2020
3	2502	111 ROBEY STREET MASCOT 2020
3	2503	107 ROBEY STREET MASCOT 2020
3	2505	UNIT 15 22 HIGH STREET MASCOT 2020
3	2542	UNIT 2 1-3 ELIZABETH AVENUE MASCOT 2020
3	2558	31 ROBEY STREET MASCOT 2020
3	2567	131 BAXTER ROAD MASCOT 2020
3	2569	9 ROBEY STREET MASCOT 2020
3	2575	107 BAXTER ROAD MASCOT 2020
3	2577	103 BAXTER ROAD MASCOT 2020
3	2578	105 BAXTER ROAD MASCOT 2020
3	2579	109 BAXTER ROAD MASCOT 2020
3	2585	93 BAXTER ROAD MASCOT 2020
3	2588	36 ROBEY STREET MASCOT 2020
3	2589	34 ROBEY STREET MASCOT 2020
3	2590	28 ROBEY STREET MASCOT 2020
3	2591	30 ROBEY STREET MASCOT 2020
3	2592	32 ROBEY STREET MASCOT 2020
3	2593	26 ROBEY STREET MASCOT 2020
3	2594	22 ROBEY STREET MASCOT 2020
3	2595	24 ROBEY STREET MASCOT 2020
3	2596	16 ROBEY STREET MASCOT 2020
3	2597	20 ROBEY STREET MASCOT 2020
3	2598	18 ROBEY STREET MASCOT 2020
3	2599	14 ROBEY STREET MASCOT 2020
3	2600	12 ROBEY STREET MASCOT 2020
3	2602	10 ROBEY STREET MASCOT 2020
3	2604	4 ROBEY STREET MASCOT 2020
3	2606	2 ROBEY STREET MASCOT 2020
3	2608	29 BAXTER ROAD MASCOT 2020
3	2609	33 BAXTER ROAD MASCOT 2020
3	2610	31 BAXTER ROAD MASCOT 2020
3	2611	23 BAXTER ROAD MASCOT 2020
3	2612	25 BAXTER ROAD MASCOT 2020
3	2613	21 BAXTER ROAD MASCOT 2020
3	2614	13 BAXTER ROAD MASCOT 2020
3	2615	15 BAXTER ROAD MASCOT 2020
3	2616	19 BAXTER ROAD MASCOT 2020
3	2617	17 BAXTER ROAD MASCOT 2020
3	2618	9 BAXTER ROAD MASCOT 2020

NCA	Building No	Address
3	2619	11 BAXTER ROAD MASCOT 2020
3	2620	5 BAXTER ROAD MASCOT 2020
3	2621	3 BAXTER ROAD MASCOT 2020
3	2622	7 BAXTER ROAD MASCOT 2020
3	2624	1 BAXTER ROAD MASCOT 2020
3	2625	32 BAXTER ROAD MASCOT 2020
3	2626	34 BAXTER ROAD MASCOT 2020
3	2627	30 BAXTER ROAD MASCOT 2020
3	2628	28 BAXTER ROAD MASCOT 2020
3	2629	28 BAXTER ROAD MASCOT 2020
3	2630	26 BAXTER ROAD MASCOT 2020
3	2631	22 BAXTER ROAD MASCOT 2020
3	2632	18 BAXTER ROAD MASCOT 2020
3	2633	8 BAXTER ROAD MASCOT 2020
3	2634	12 BAXTER ROAD MASCOT 2020
3	2635	4 BAXTER ROAD MASCOT 2020
3	2636	2 BAXTER ROAD MASCOT 2020
3	2639	988 BOTANY ROAD MASCOT 2020
3	2640	36 BAXTER ROAD MASCOT 2020
3	2642	59 BAXTER ROAD MASCOT 2020
4	2905	UNIT 13 1 HOLLINGSHED STREET MASCOT 2020
4	2923	1239 BOTANY ROAD MASCOT 2020
4	2930	1243 BOTANY ROAD MASCOT 2020
4	2946	58 HARDIE STREET MASCOT 2020
4	2947	UNIT 3 1247 BOTANY ROAD MASCOT 2020
4	2974	66 HARDIE STREET MASCOT 2020
4	2982	68 HARDIE STREET MASCOT 2020
4	2986	67 HARDIE STREET MASCOT 2020
4	2989	70 HARDIE STREET MASCOT 2020
4	2992	1271 BOTANY ROAD MASCOT 2020
4	2995	72 HARDIE STREET MASCOT 2020
4	3001	74 HARDIE STREET MASCOT 2020
4	3010	76 HARDIE STREET MASCOT 2020
4	3016	78 HARDIE STREET MASCOT 2020
4	3020	76 ALFRED STREET MASCOT 2020
4	3021	1279 BOTANY ROAD MASCOT 2020
4	3022	80 HARDIE STREET MASCOT 2020
4	3025	79 HARDIE STREET MASCOT 2020
4	3027	1281 BOTANY ROAD MASCOT 2020
4	3028	82 HARDIE STREET MASCOT 2020
4	3032	81 HARDIE STREET MASCOT 2020
4	3034	UNIT 2 1283 BOTANY ROAD MASCOT 2020
4	3036	83 HARDIE STREET MASCOT 2020
4	3038	84 HARDIE STREET MASCOT 2020
4	3042	85 HARDIE STREET MASCOT 2020

NCA	Building No	Address
4	3045	90 JOHNSON STREET MASCOT 2020
4	3047	86 HARDIE STREET MASCOT 2020
4	3050	UNIT 26 1285 BOTANY ROAD MASCOT 2020
4	3054	87 HARDIE STREET MASCOT 2020
4	3056	86 HARDIE STREET MASCOT 2020
4	3061	34 WENTWORTH AVENUE MASCOT 2020
4	3062	3 WENTWORTH AVENUE MASCOT 2020
4	3063	1 WENTWORTH AVENUE MASCOT 2020
4	3064	UNIT 19 52 WENTWORTH AVENUE MASCOT 2020
4	3066	38 WENTWORTH AVENUE MASCOT 2020
4	3068	36 WENTWORTH AVENUE MASCOT 2020
4	3077	3 MCBURNEY AVENUE MASCOT 2020
4	3079	5 MCBURNEY AVENUE MASCOT 2020
4	3080	2 MCBURNEY AVENUE MASCOT 2020
4	3081	44 DRANSFIELD AVENUE MASCOT 2020
4	3082	42 DRANSFIELD AVENUE MASCOT 2020
4	3084	9 MCBURNEY AVENUE MASCOT 2020
4	3087	4 MCBURNEY AVENUE MASCOT 2020
4	3089	9 MCBURNEY AVENUE MASCOT 2020
4	3094	13 MCBURNEY AVENUE MASCOT 2020
4	3101	13 MCBURNEY AVENUE MASCOT 2020
4	3108	15 MCBURNEY AVENUE MASCOT 2020
4	3113	17 MCBURNEY AVENUE MASCOT 2020
4	3127	19 MCBURNEY AVENUE MASCOT 2020
4	3128	16 MCBURNEY AVENUE MASCOT 2020
4	3129	1297 BOTANY ROAD MASCOT 2020
4	3131	21 MCBURNEY AVENUE MASCOT 2020
4	3132	18 MCBURNEY AVENUE MASCOT 2020
4	3133	52 DRANSFIELD AVENUE MASCOT 2020
4	3136	23 MCBURNEY AVENUE MASCOT 2020
4	3137	20 MCBURNEY AVENUE MASCOT 2020
4	3138	25 MCBURNEY AVENUE MASCOT 2020
4	3140	22 MCBURNEY AVENUE MASCOT 2020
4	3143	27 MCBURNEY AVENUE MASCOT 2020
4	3144	24 MCBURNEY AVENUE MASCOT 2020
4	3150	29 MCBURNEY AVENUE MASCOT 2020
4	3151	56 DRANSFIELD AVENUE MASCOT 2020
4	3152	26 MCBURNEY AVENUE MASCOT 2020
4	3154	28 MCBURNEY AVENUE MASCOT 2020
4	3155	31 MCBURNEY AVENUE MASCOT 2020
4	3159	33 MCBURNEY AVENUE MASCOT 2020
4	3160	35 MCBURNEY AVENUE MASCOT 2020
4	3161	37 MCBURNEY AVENUE MASCOT 2020
4	3162	30 MCBURNEY AVENUE MASCOT 2020
4	3163	32 MCBURNEY AVENUE MASCOT 2020

NCA	Building No	Address
4	3165	39 MCBURNEY AVENUE MASCOT 2020
4	3167	34 MCBURNEY AVENUE MASCOT 2020
4	3168	41 MCBURNEY AVENUE MASCOT 2020
4	3169	38 MCBURNEY AVENUE MASCOT 2020
4	3170	43 MCBURNEY AVENUE MASCOT 2020
4	3171	38 MCBURNEY AVENUE MASCOT 2020
4	3172	47 MCBURNEY AVENUE MASCOT 2020
4	3173	49 MCBURNEY AVENUE MASCOT 2020
4	3174	49 MCBURNEY AVENUE MASCOT 2020
4	3175	40 MCBURNEY AVENUE MASCOT 2020
4	3176	51 MCBURNEY AVENUE MASCOT 2020
4	3177	40 MCBURNEY AVENUE MASCOT 2020
4	3178	42 MCBURNEY AVENUE MASCOT 2020
4	3179	57 MCBURNEY AVENUE MASCOT 2020
4	3180	59 MCBURNEY AVENUE MASCOT 2020
4	3181	61 MCBURNEY AVENUE MASCOT 2020
7	3268	UNIT 1 15 BEGONIA STREET PAGEWOOD 2035
7	3277	UNIT 1 15 BEGONIA STREET PAGEWOOD 2035
7	3304	237 BAY STREET PAGEWOOD 2035
8	3519	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3520	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3521	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3522	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3523	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3524	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3525	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3526	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3527	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3528	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3529	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3530	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3531	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3532	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3533	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3534	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3535	2 MYRTLE STREET BOTANY 2019
8	3536	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3538	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3542	3 MYRTLE STREET BOTANY 2019
8	3543	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3544	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3545	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3546	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3547	3 MYRTLE STREET BOTANY 2019
8	3548	UNIT 7 21-23 MYRTLE STREET BOTANY 2019

NCA	Building No	Address
8	3551	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3553	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3554	3 MYRTLE STREET BOTANY 2019
8	3555	3 MYRTLE STREET BOTANY 2019
8	3556	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3558	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3559	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3560	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3561	UNIT 3 30 JASMINE STREET BOTANY 2019
8	3563	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3564	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3565	5 MYRTLE STREET BOTANY 2019
8	3567	UNIT 162 26 JASMINE STREET BOTANY 2019
8	3568	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3569	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3570	5 MYRTLE STREET BOTANY 2019
8	3571	UNIT 8 1 MYRTLE STREET BOTANY 2019
8	3573	92 BAY STREET BOTANY 2019
8	3574	5 MYRTLE STREET BOTANY 2019
8	3575	UNIT 162 26 JASMINE STREET BOTANY 2019
8	3583	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3587	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3590	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3592	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3596	92 BAY STREET BOTANY 2019
8	3614	217 BAY STREET BOTANY 2019
8	3615	UNIT 4 219-225 BAY STREET BOTANY 2019
8	4001	UNIT 1 76 BAY STREET BOTANY 2019

Year 2024 Build Scenario - With Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2024 Build Scenario - With Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2024 Build Scenario - With Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2024, Build Scenario, With Track Lubrication
Residential Exceedances

NCA	Building No	Address
3	2575	107 BAXTER ROAD MASCOT 2020
3	2577	103 BAXTER ROAD MASCOT 2020
3	2578	105 BAXTER ROAD MASCOT 2020
3	2579	109 BAXTER ROAD MASCOT 2020
3	2608	29 BAXTER ROAD MASCOT 2020
3	2609	33 BAXTER ROAD MASCOT 2020
3	2610	31 BAXTER ROAD MASCOT 2020
3	2611	23 BAXTER ROAD MASCOT 2020
3	2612	25 BAXTER ROAD MASCOT 2020
3	2625	32 BAXTER ROAD MASCOT 2020
3	2626	34 BAXTER ROAD MASCOT 2020
3	2627	30 BAXTER ROAD MASCOT 2020
3	2628	28 BAXTER ROAD MASCOT 2020
3	2629	28 BAXTER ROAD MASCOT 2020
3	2630	26 BAXTER ROAD MASCOT 2020
3	2631	22 BAXTER ROAD MASCOT 2020
3	2632	18 BAXTER ROAD MASCOT 2020
3	2634	12 BAXTER ROAD MASCOT 2020
3	2640	36 BAXTER ROAD MASCOT 2020
4	2992	1271 BOTANY ROAD MASCOT 2020
4	3021	1279 BOTANY ROAD MASCOT 2020
4	3027	1281 BOTANY ROAD MASCOT 2020
4	3034	UNIT 2 1283 BOTANY ROAD MASCOT 2020
4	3050	UNIT 26 1285 BOTANY ROAD MASCOT 2020
4	3063	1 WENTWORTH AVENUE MASCOT 2020
4	3129	1297 BOTANY ROAD MASCOT 2020
4	3177	40 MCBURNEY AVENUE MASCOT 2020
4	3180	59 MCBURNEY AVENUE MASCOT 2020
4	3181	61 MCBURNEY AVENUE MASCOT 2020

Year 2034 Build Scenario - With Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2034 Build Scenario - With Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2034 Build Scenario - With Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2034, Build Scenario, With Track Lubrication
Residential Exceedances

NCA	Building No	Address
3	2575	107 BAXTER ROAD MASCOT 2020
3	2577	103 BAXTER ROAD MASCOT 2020
3	2578	105 BAXTER ROAD MASCOT 2020
3	2579	109 BAXTER ROAD MASCOT 2020
3	2585	93 BAXTER ROAD MASCOT 2020
3	2608	29 BAXTER ROAD MASCOT 2020
3	2609	33 BAXTER ROAD MASCOT 2020
3	2610	31 BAXTER ROAD MASCOT 2020
3	2611	23 BAXTER ROAD MASCOT 2020
3	2612	25 BAXTER ROAD MASCOT 2020
3	2613	21 BAXTER ROAD MASCOT 2020
3	2625	32 BAXTER ROAD MASCOT 2020
3	2626	34 BAXTER ROAD MASCOT 2020
3	2627	30 BAXTER ROAD MASCOT 2020
3	2628	28 BAXTER ROAD MASCOT 2020
3	2629	28 BAXTER ROAD MASCOT 2020
3	2630	26 BAXTER ROAD MASCOT 2020
3	2631	22 BAXTER ROAD MASCOT 2020
3	2632	18 BAXTER ROAD MASCOT 2020
3	2634	12 BAXTER ROAD MASCOT 2020
3	2635	4 BAXTER ROAD MASCOT 2020
3	2636	2 BAXTER ROAD MASCOT 2020
3	2640	36 BAXTER ROAD MASCOT 2020
4	2947	UNIT 3 1247 BOTANY ROAD MASCOT 2020
4	2992	1271 BOTANY ROAD MASCOT 2020
4	3021	1279 BOTANY ROAD MASCOT 2020
4	3027	1281 BOTANY ROAD MASCOT 2020
4	3034	UNIT 2 1283 BOTANY ROAD MASCOT 2020
4	3050	UNIT 26 1285 BOTANY ROAD MASCOT 2020
4	3062	3 WENTWORTH AVENUE MASCOT 2020
4	3063	1 WENTWORTH AVENUE MASCOT 2020
4	3129	1297 BOTANY ROAD MASCOT 2020
4	3172	47 MCBURNEY AVENUE MASCOT 2020
4	3174	49 MCBURNEY AVENUE MASCOT 2020
4	3175	40 MCBURNEY AVENUE MASCOT 2020
4	3176	51 MCBURNEY AVENUE MASCOT 2020
4	3177	40 MCBURNEY AVENUE MASCOT 2020
4	3178	42 MCBURNEY AVENUE MASCOT 2020
4	3179	57 MCBURNEY AVENUE MASCOT 2020
4	3180	59 MCBURNEY AVENUE MASCOT 2020
4	3181	61 MCBURNEY AVENUE MASCOT 2020
8	3528	UNIT 7 21-23 MYRTLE STREET BOTANY 2019
8	3529	UNIT 42 9-19 MYRTLE STREET BOTANY 2019

NCA	Building No	Address
8	3530	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3532	UNIT 42 9-19 MYRTLE STREET BOTANY 2019
8	3533	UNIT 42 9-19 MYRTLE STREET BOTANY 2019

Year 2024 Build Scenario - With EPA Licencing and Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2024 Build Scenario - With EPA Licencing and Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2024 Build Scenario - With EPA Licencing and Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2024, Build Scenario, With EPA Licensing Scheme & Track Lubrication
Residential Exceedances

NCA	Building No	Address
3	2579	109 BAXTER ROAD MASCOT 2020
3	2625	32 BAXTER ROAD MASCOT 2020
3	2626	34 BAXTER ROAD MASCOT 2020
3	2627	30 BAXTER ROAD MASCOT 2020
3	2628	28 BAXTER ROAD MASCOT 2020
3	2640	36 BAXTER ROAD MASCOT 2020
4	3050	UNIT 26 1285 BOTANY ROAD MASCOT 2020
4	3178	42 MCBURNEY AVENUE MASCOT 2020
4	3182	63 MCBURNEY AVENUE MASCOT 2020

Year 2034 Build Scenario - With EPA Licencing and Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2034 Build Scenario - With EPA Licencing and Lubrication
Sensitive Receivers Exceeding Noise Criteria

Year 2034 Build Scenario - With EPA Licencing and Lubrication
Sensitive Receivers Exceeding Noise Criteria

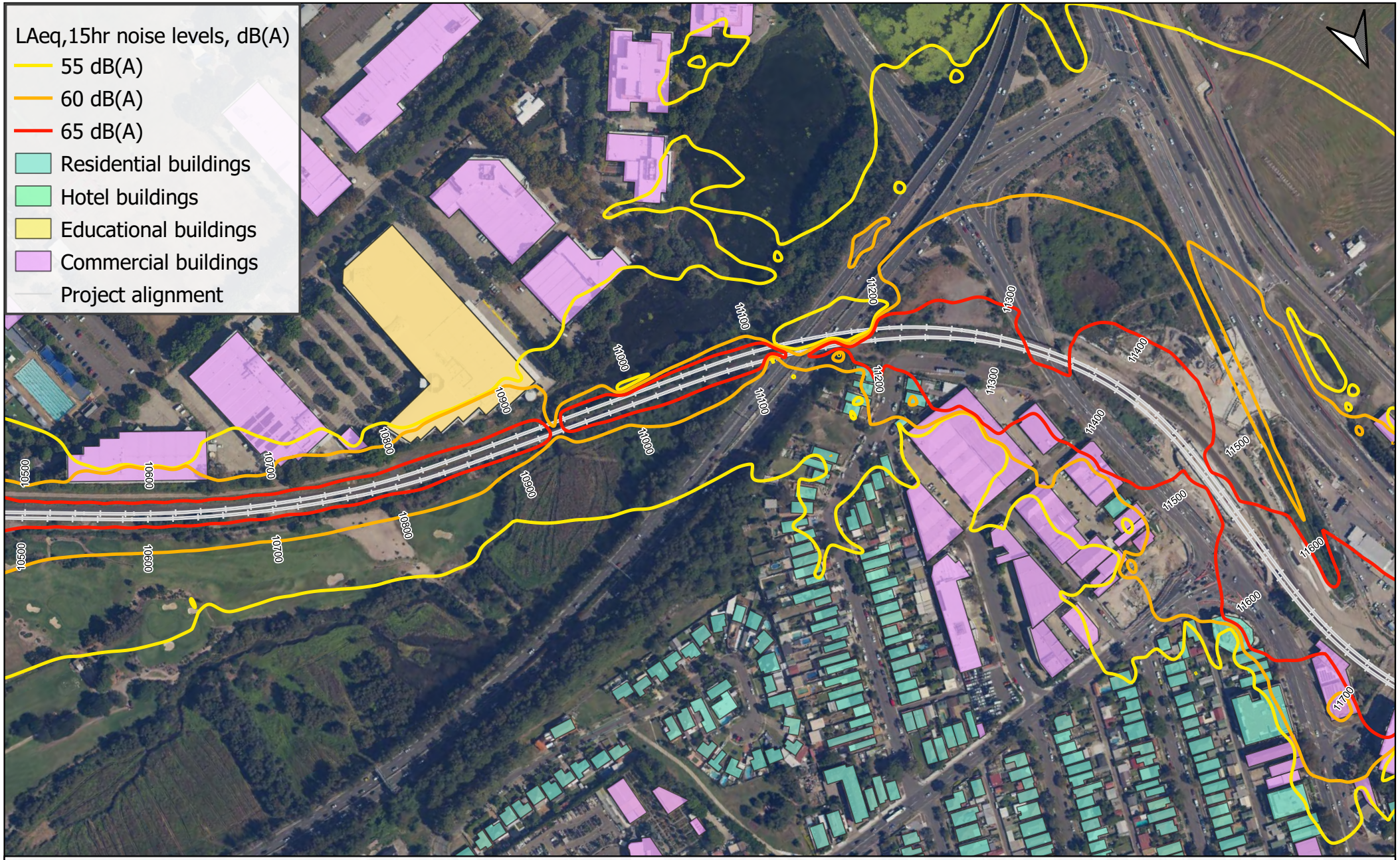
Year 2034, Build Scenario, With EPA Licensing Scheme & Track Lubrication
Residential Exceedances

NCA	Building No	Address
3	2575	107 BAXTER ROAD MASCOT 2020
3	2577	103 BAXTER ROAD MASCOT 2020
3	2578	105 BAXTER ROAD MASCOT 2020
3	2579	109 BAXTER ROAD MASCOT 2020
3	2585	93 BAXTER ROAD MASCOT 2020
3	2625	32 BAXTER ROAD MASCOT 2020
3	2626	34 BAXTER ROAD MASCOT 2020
3	2627	30 BAXTER ROAD MASCOT 2020
3	2628	28 BAXTER ROAD MASCOT 2020
3	2629	28 BAXTER ROAD MASCOT 2020
3	2640	36 BAXTER ROAD MASCOT 2020
4	3034	UNIT 2 1283 BOTANY ROAD MASCOT 2020
4	3050	UNIT 26 1285 BOTANY ROAD MASCOT 2020
4	3177	40 MCBURNEY AVENUE MASCOT 2020
4	3178	42 MCBURNEY AVENUE MASCOT 2020
4	3182	63 MCBURNEY AVENUE MASCOT 2020

APPENDIX D: NOISE CONTOURS – "BUILD" SCENARIOS

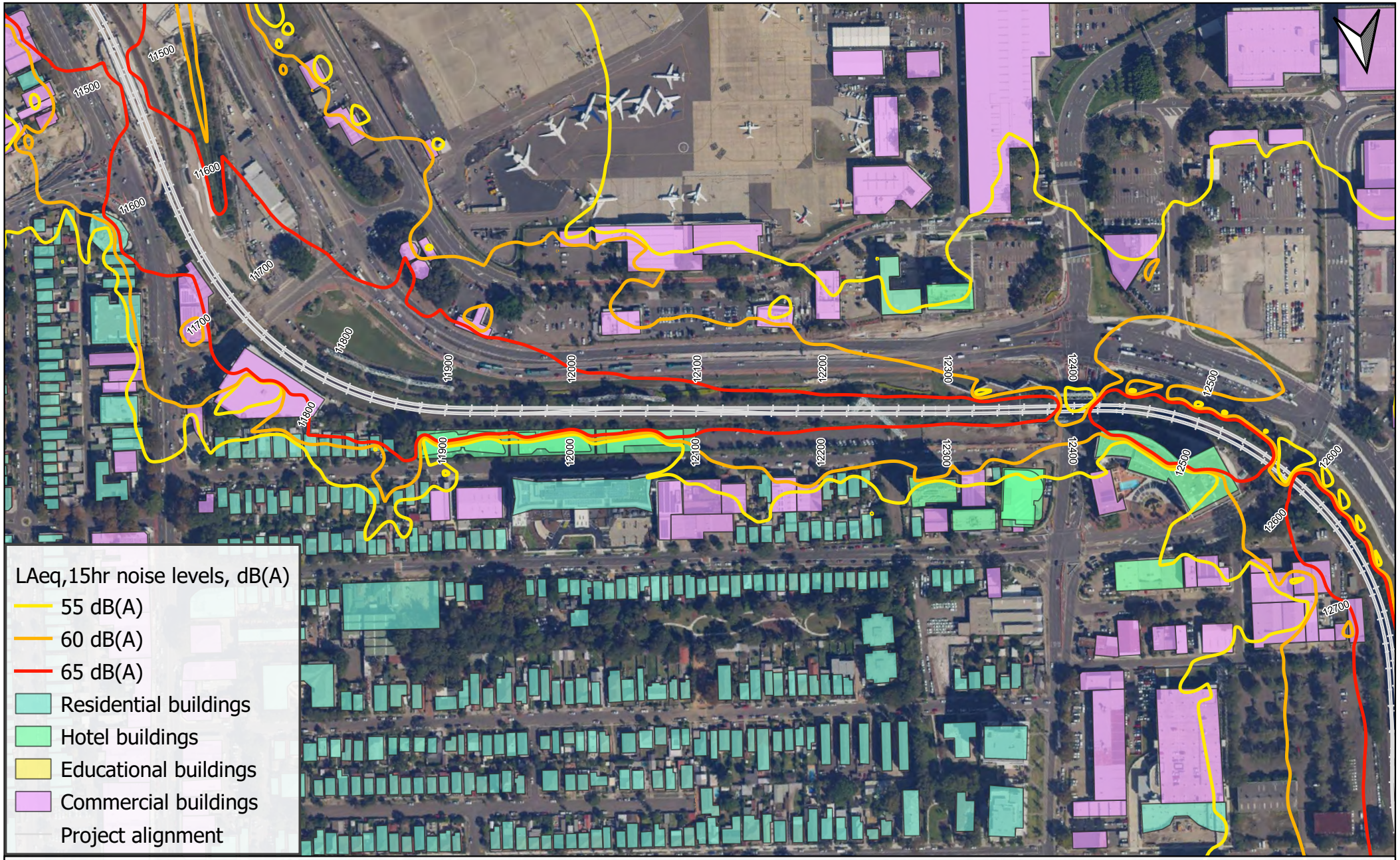
Year 2024 Build Scenario - with lubrication

$L_{Aeq,15hour}$ noise contours



Year 2024 Build Scenario - with lubrication

$L_{Aeq,15hour}$ noise contours

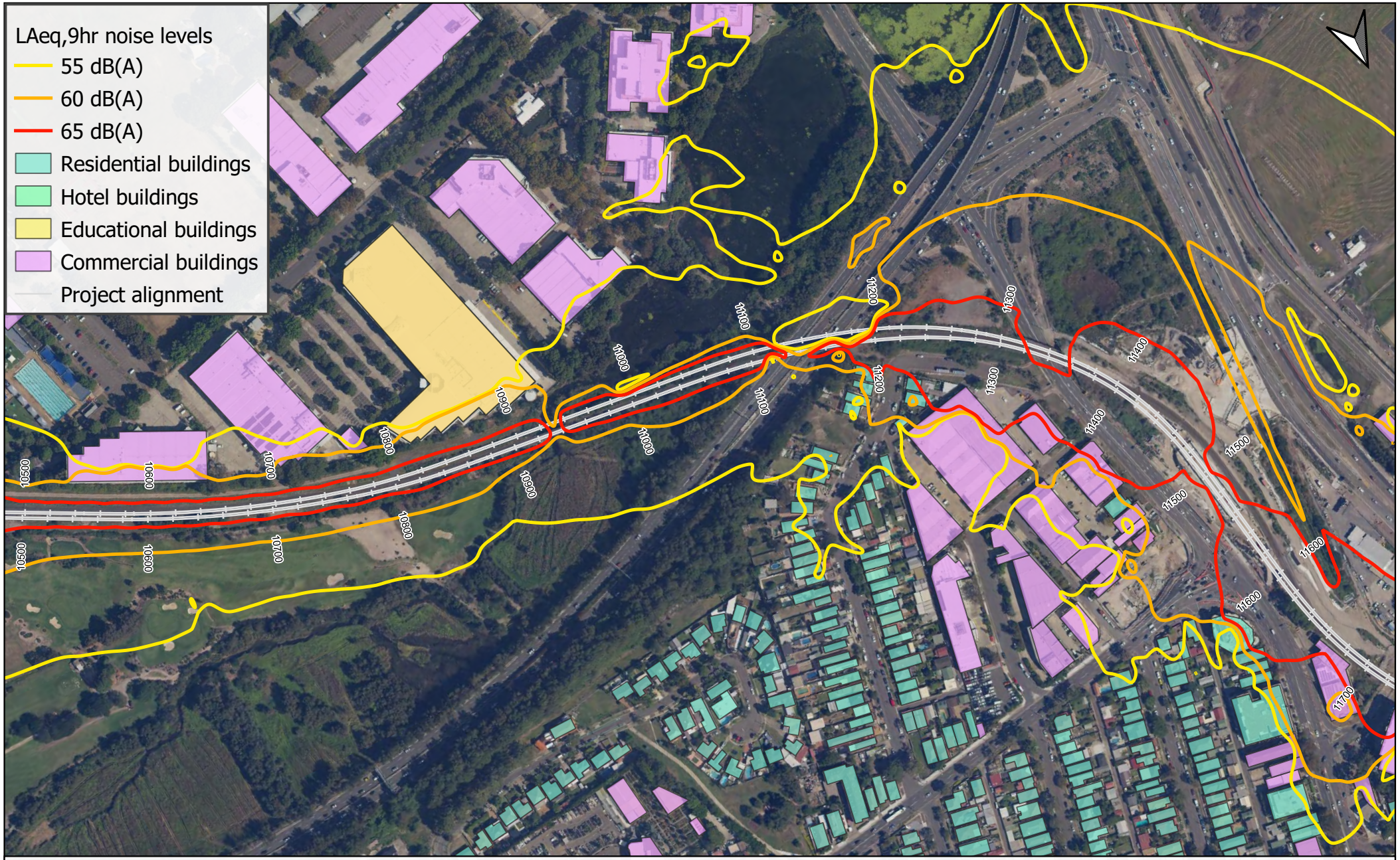


Year 2024 Build Scenario - with lubrication

$L_{Aeq,15hour}$ noise contours

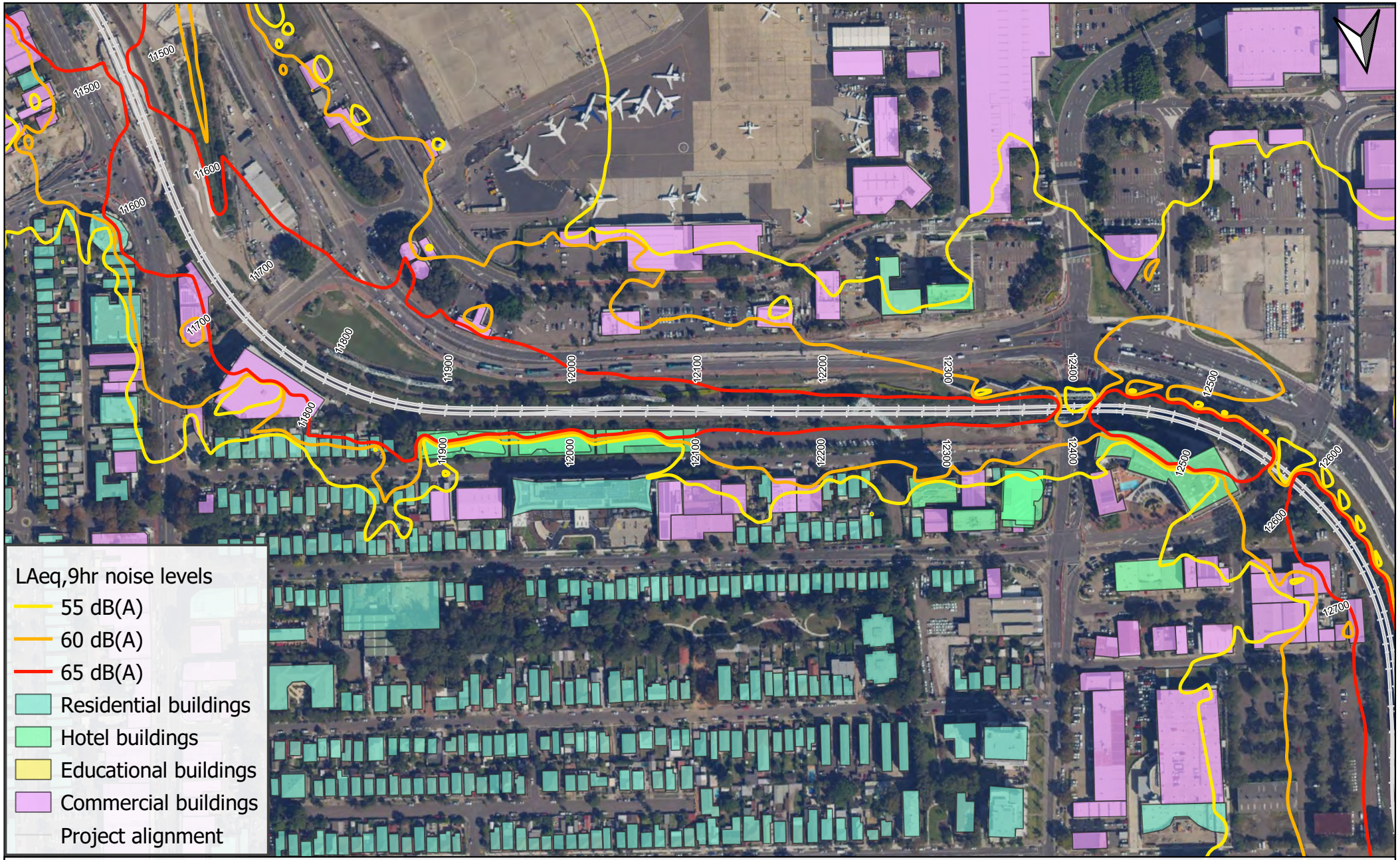
Year 2024 Build Scenario - with lubrication

$L_{Aeq,9hour}$ noise contours



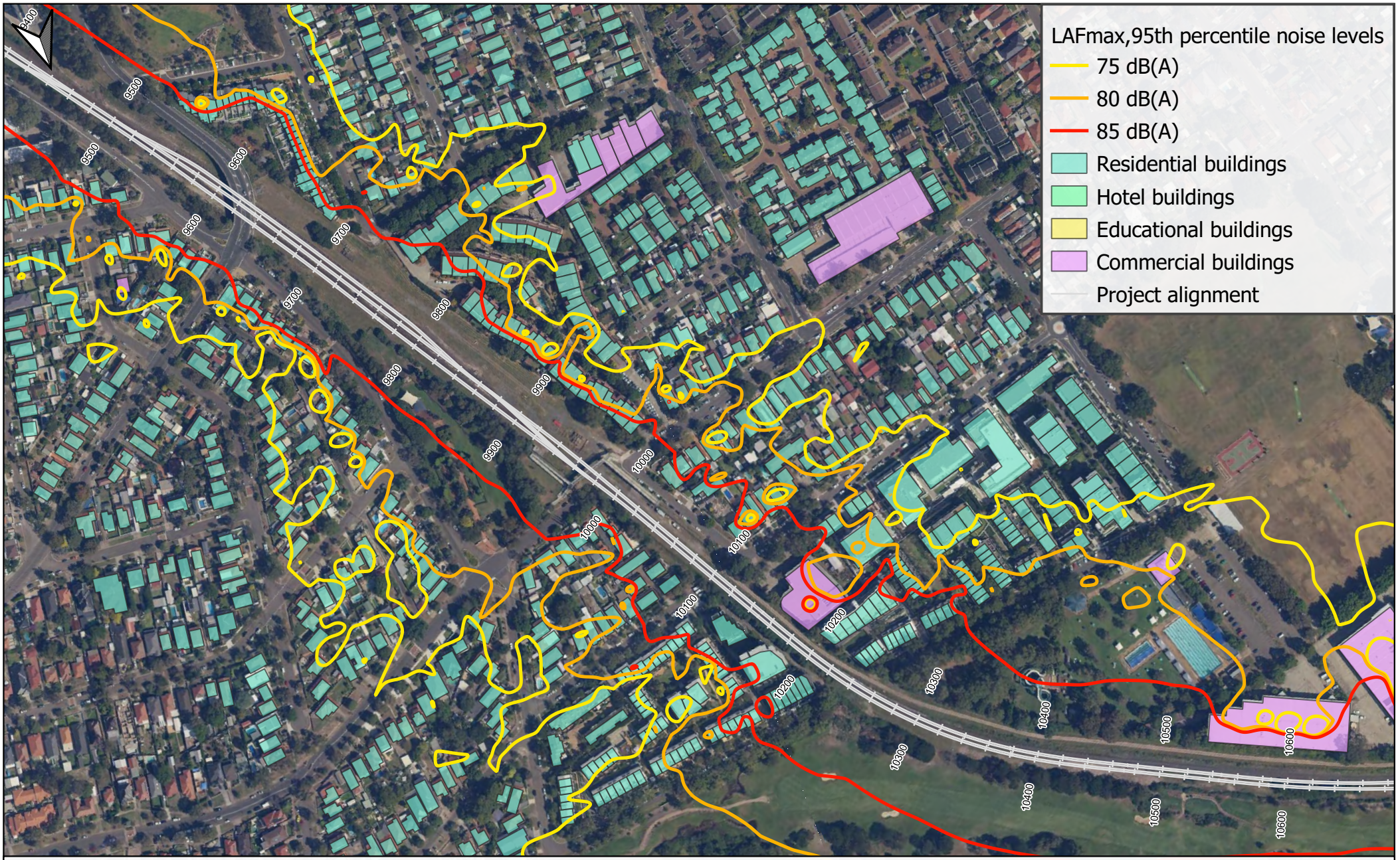
Year 2024 Build Scenario - with lubrication

$L_{Aeq,9hour}$ noise contours



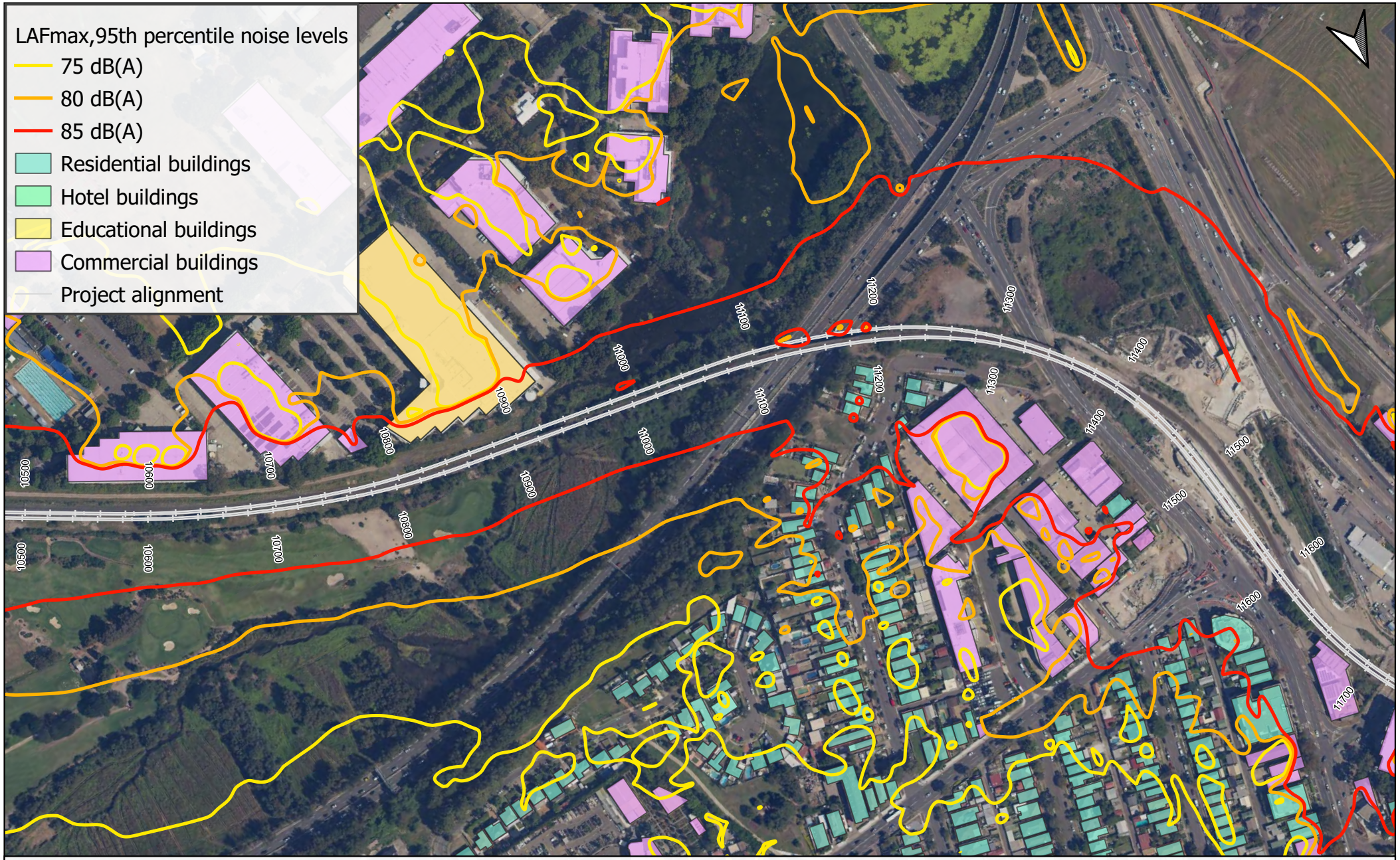
Year 2024 Build Scenario - with lubrication

$L_{Aeq,9hour}$ noise contours



Year 2024 Build Scenario - with lubrication

$L_{AFmax,95th\ percentile}$ noise contours



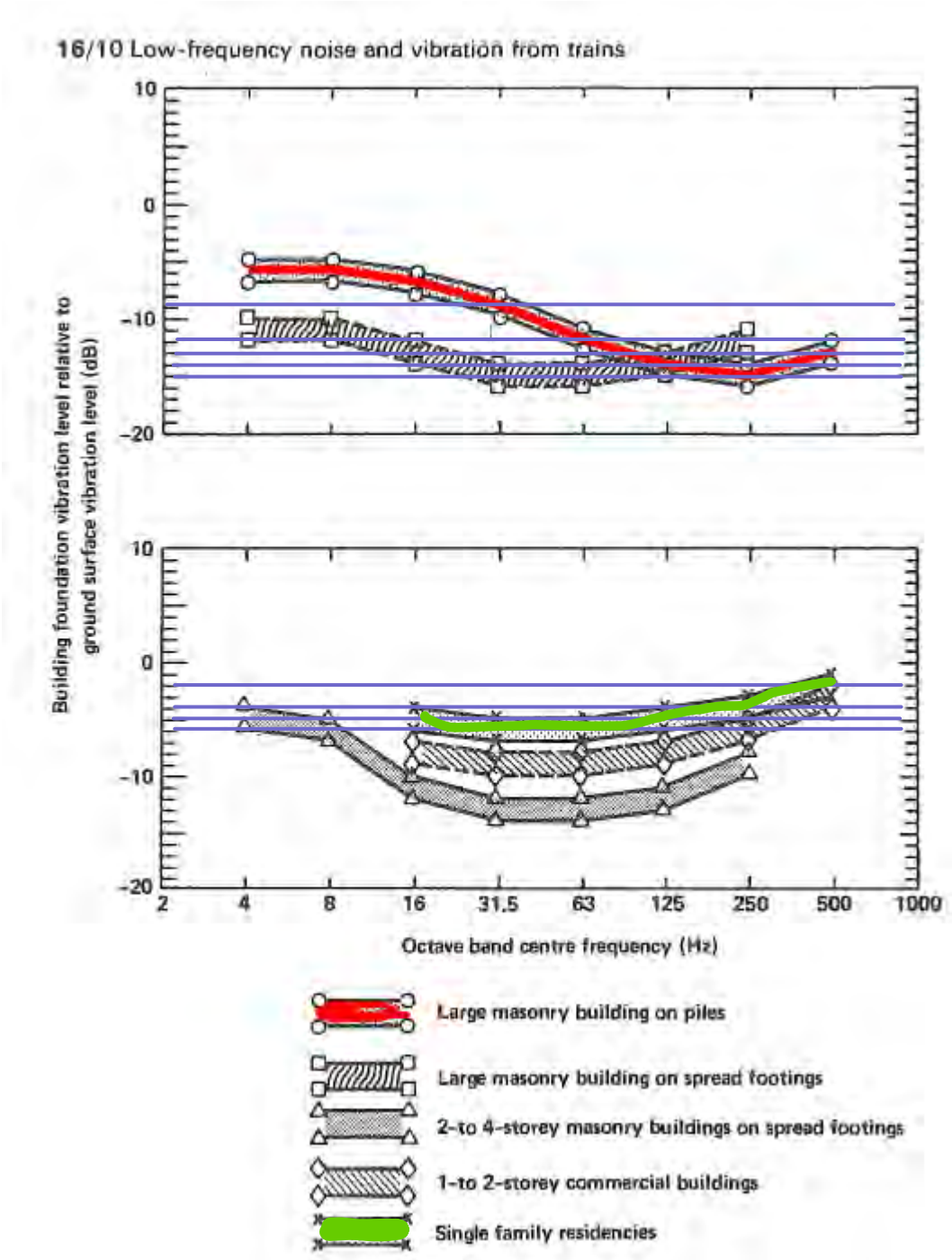
Year 2024 Build Scenario - with lubrication

$L_{AFmax,95th\ percentile}$ noise contours

Year 2024 Build Scenario - with lubrication

$L_{Aeq,9hour}$ noise contours

APPENDIX E: OPERATIONAL VIBRATION & GROUND-BORNE NOISE MODELLING



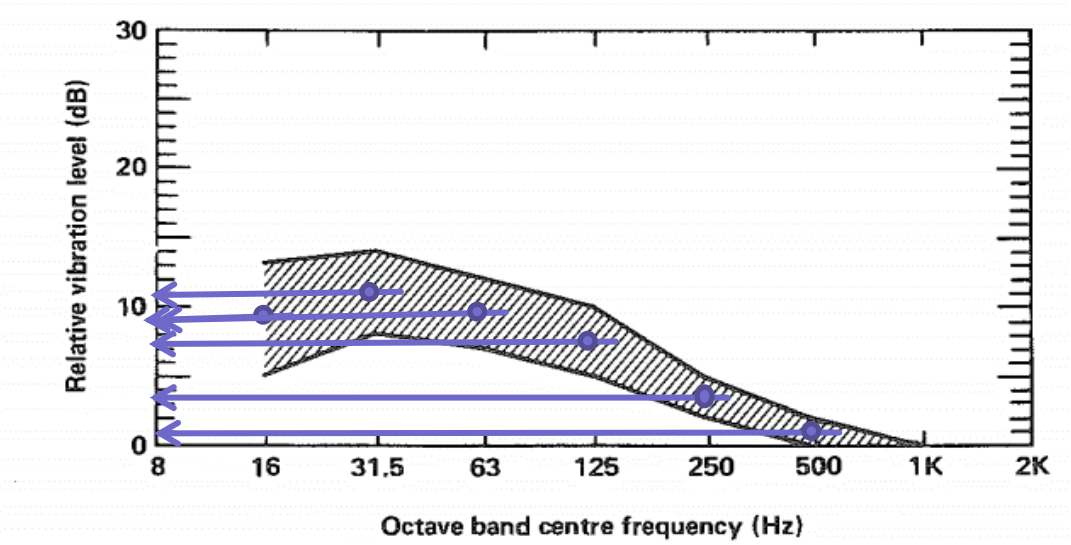


Figure 16.11 Range of amplification of vibration due to resonances of floor slabs supported on columns[25]

Table 16.2 Point source below building—attenuation of acceleration level per floor in dB

Frequency (Hz)	*Floor level above grade*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Floor-to-floor distance: 3 m (10 ft)										
31	2	2	2	1	1	1	1	1	1	1
63	3	2	2	2	2	1	1	1	1	1
125	3	3	2	2	2	2	2	1	1	1
250	3	3	3	3	3	3	3	2	2	2
500	4	4	3	3	3	3	3	3	3	3
1K	5	5	4	4	4	4	4	3	3	3
Floor-to-floor distance: 3.7 m (12 ft)										
31	2	2	2	2	1	1	1	1	1	1
63	3	2	2	2	2	1	1	1	1	
125	3	3	3	2	2	2	2	1	1	1
250	4	4	3	3	3	2	2	2	2	2
500	4	4	4	4	4	3	3	3	3	3
1K	5	5	5	4	4	4	4	4	4	4

Table 37 Stamford Plaza Hotel: LASmax,95% calculation to sensitive receivers on Level 5

Parameter	Total dBA	31.5 dB	63 dB	125 dB	250 dB	500 dB	1k dB	2k dB
LAvSmax,95%	90.6	107.6	110.9	105.4	72.6	48.8	41.1	37.2
Distance attenuation		-8.7	-8.7	-8.7	-8.7	-8.7	-8.7	-8.7
Embankment		-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0
Speed Increase		4.4	4.4	4.4	4.4	4.4	4.4	4.4
Large masonry on piles		-8.0	-11.0	-14.0	-15.0	-14.0	-10.0	0.0
LASmax,95% -ground floor	31.4	53.4	53.6	45.2	11.4	-11.4	-15.1	-9.0
Level 1		2.0	3.0	3.0	3.0	4.0	5.0	0.0
Level 2		2.0	2.0	3.0	3.0	4.0	5.0	0.0
Level 3		2.0	2.0	2.0	3.0	3.0	4.0	0.0
Level 4		1.0	2.0	2.0	3.0	3.0	4.0	0.0
Atten to Level 5		-7.0	-9.0	-10.0	-12.0	-14.0	-18.0	0.0
LASmax,95% to first bedroom floor	21.9	46.4	44.6	35.2	-0.6	-25.4	-33.1	-9.0

Table 38 LASmax,95% calculation to the residences on 142 Banksia Street

Parameter	Total dBA	31.5 dBA	63 dBA	125 dBA	250 dBA	500 dBA	1k dBA	2k dBA
LAvSmax,95%	78.5	63.4	78.2	62.9	52.0	40.0	37.5	34.9
Distance attenuation		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foundation attenuation		0.0	0.0	0.0	0.0	0.0	0.0	0.0
LASmax,95% at ground level	46.5	31.4	46.2	30.9	20.0	8.0	5.5	2.9
Level 1 attenuation		2.0	3.0	3.0	4.0	4.0	5.0	0.0
LASmax,95% at Level 1	43.5	29.4	43.2	27.9	17.0	4.0	0.5	2.9

APPENDIX F: STAKEHOLDER CONSULTATION WITH LOCAL COUNCIL

From: Rachael Labruyere-JHG
Sent: Monday, 7 November 2022 10:16 AM
To: Colin Mable <Colin.Mable@bayside.nsw.gov.au>
Subject: RE: ONVR Additional Information

Thanks Colin – To validate the noise model, PWNA (acoustic consultants) carried out unattended and attended noise and vibration monitoring was carried out during April and June 2022 to assess background noise levels prior to construction/duplication. Further details of background monitoring is included in Section 3.2 and 3.4 of the ONVR. Following completion of construction and during the first five years of operation validation monitoring will be carried out to ensure effectiveness of the mitigation system and predicted noise levels.

Should post construction monitoring show that the noise mitigation system is not effective in achieving the noise levels detailed in the ONVR, further practicable measures will be implemented to ensure the required noise level reductions are achieved. Further details are included in Section 9 of the ONVR.

Regards

Rachael

From: Colin Mable <Colin.Mable@bayside.nsw.gov.au>
Sent: Monday, 7 November 2022 9:16 AM
To: Rachael Labruyere-JHG <Rachael.Labruyere@jhg.com.au>
Subject: RE: ONVR Additional Information

Rachael,

Thanks for your call last week and your email below clarifying my concerns at possible increased noise from trains near Bay, Banksia, Myrtle and Ocean Streets Botany.

All I can say is I hope the modelling is correct and noise levels stay the same or even reduce otherwise the residents will certainly be raising complaints if they consider noise levels have increased.

In this regard will noise monitoring units be installed pre and post completion of the duplication in the above areas to confirm if noise levels have changed.

Cheers

Colin Mable Executive Engineer
444 – 446 Princes Highway Rockdale
M 0412 915 287
E colin.mable@bayside.nsw.gov.au W www.bayside.nsw.gov.au

From: Rachael Labruyere-JHG
Sent: Friday, 4 November 2022 1:59 PM
To: Colin Mable <colin.mable@bayside.nsw.gov.au>

Cc: Loretta Mihaljek-JHG <Loretta.Mihaljek@jhg.com.au>
Subject: ONVR Additional Information

Hi Colin – As discussed this morning, predicted airborne noise levels included within the ONVR are detailed in Section 5.6.

The Bay, Banksia, Myrtle and Ocean Street areas are located in NCA07 and NCA08 (as detailed in the map below).

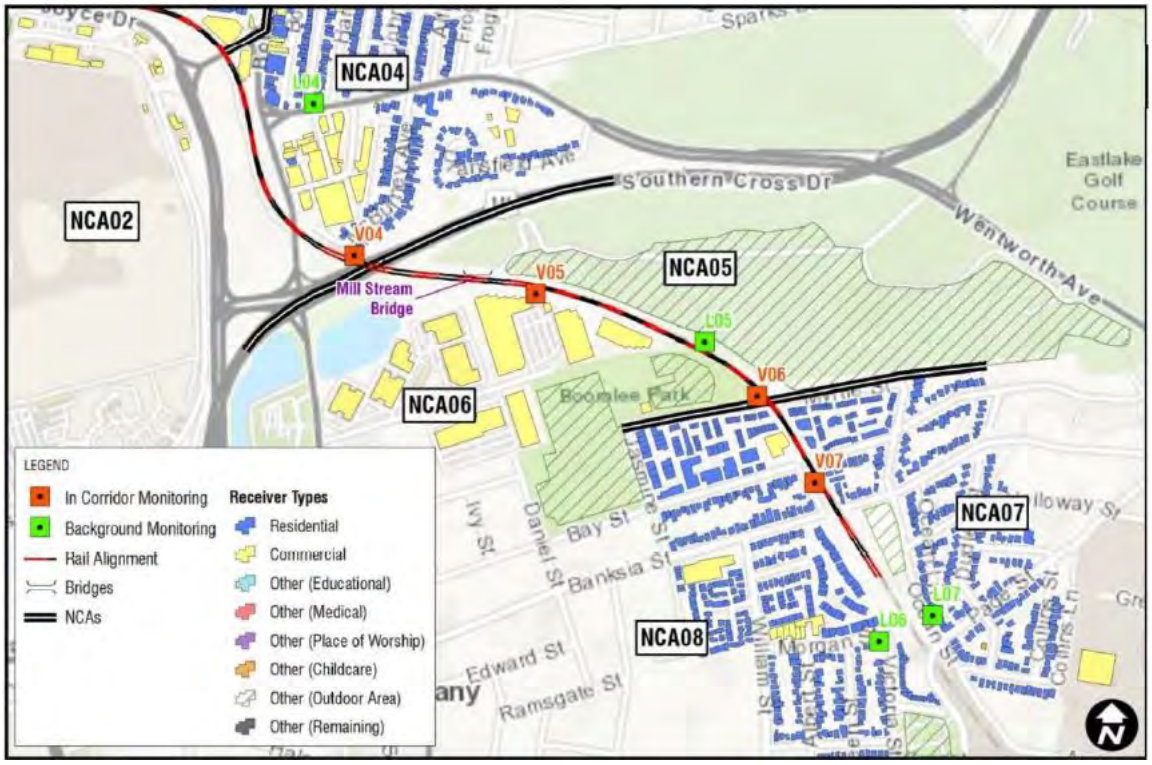


Table 16, within the ONVR presents the predicted noise levels for build and no-build scenarios in the absence of the EPA's licensing regime and I have highlighted in the table the LAeq and LAmax predictions for each scenario. As you can see in the table, noise levels in NCA07 and NCA08 are predicted to remain the same or decrease slightly with the build scenario.

Table 16 Summary of predicted airborne rail noise levels at residential receivers ("No Build" & "Build" scenarios without considering implementation of EPA's licensing regime)

NCA	Predicted Noise Levels											
	Daytime, dB $L_{Aeq,\ 15\ hrs}$				Night-time, dB $L_{Aeq,\ 9\ hrs}$				Maximum, dB L_{Amax}			
	Opening Year: 2024		Design Year: 2034		Opening Year: 2024		Design Year: 2034		Opening Year: 2024		Design Year: 2034	
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build
NCA01	59	59	59	61	59	59	59	61	91	87	91	87
NCA02 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA03	67	70	67	72	67	70	68	72	100	100	100	100
NCA04	67	68	68	69	67	68	68	69	103	98	103	98
NCA05 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA06 [3]	-	-	-	-	-	-	-	-	-	-	-	-
NCA07	69	68	69	69	69	68	69	70	104	99	104	99
NCA08	68	68	68	69	68	68	69	70	102	99	102	99

Notes:
1. *Predicted noise levels are representative of receivers with the highest predicted noise level at each NCA*
2. *L_{Amax} noise level applies to both daytime and night-time period (criteria is 85 dB LAFmax)*
3. *Noise level criterion for daytime 65 dB LAeq(15hr) and night-time period is 60 dB LAeq(9hr)*
4. *NCA does not contain residential receivers*

Table 19, presents the exceedances of residential receivers and requiring at property treatment, with no triggers in NCA07 or NCA08.

Table 19 Number of exceedances in residential receivers (year 2034, "No Build" & "Build" scenarios with considering implementation of EPA's licensing regime)

NCA	Number of Exceedances in Residential Receivers, year 2034						
	Above RING Absolute Trigger Level (Build scenario)			Above RING Increase Trigger Level (Comparison of no-build to build)			Total Triggers
	Day	Night	LAmax	Day	Night	LAmax	
NCA01	0	0	0	3	3	0	0
NCA02	-	-	-	-	-	-	-
NCA03	0	11	17	330	330	15	11
NCA04	0	5	13	466	466	21	5
NCA05	-	-	-	-	-	-	-
NCA06	-	-	-	-	-	-	-
NCA07	0	10	48	69	64	6	0
NCA08	0	11	73	81	77	0	0
						Total:	16

Notes:
1. *Except for "Total Triggers" each column lists the number of exceedances for a particular assessment condition. These assessment conditions are discussed in Table 7. By considering all these conditions, the number of total triggers per NCA is derived.*

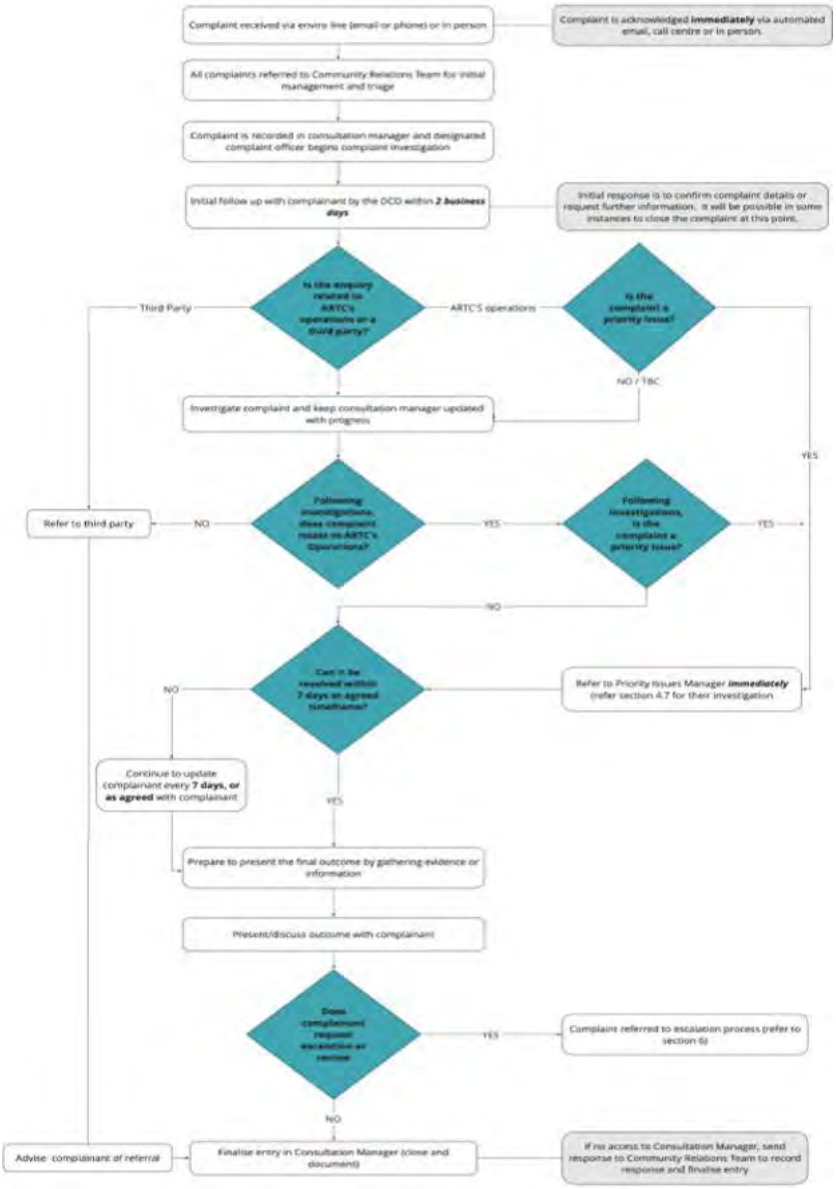
Where properties have triggered mitigation, the mitigation includes:

- Controlling noise at source – Including track lubrication, wehll dampers, wheel lubrication and high attenuation exhaust mufflers
- Controlling transmission of noise – Including ballast mats and noise resilient rail fasteners
- Controlling noise at the receiver – Including insulation and window glazing

Details are further provided in Section 7 of the ONVR regarding the treatment options available and the reasonable and feasible assessment to be applied.

For the other questions, ARTC has provided the following:

- Rectification of rolling stock is not an ARTC compliance requirement, however the effectiveness of track lubrication will be monitored by ARTC in accordance with the CSSI approval conditions through operational noise compliance monitoring to ensure the relevant operational noise goals are achieved. The requirement to rectify non-compliant freight wagons to ensure reduced noise impact from wheel squeal is derived from the rolling stock operator's Environmental Protection Licence (EPL), which forms a statutory obligation that is to be monitored and regulated by the EPA.
- Section 8.4 has been revised and complaints management will be implemented according to Figure 13 (presented below) of the ONVR via the existing ARTC Enviroline phone number and email address, and in compliance with the relevant statutory requirements under ARTC's EPL 3142 as monitored and regulated by the EPA.



If you have any questions or would like further clarification on the above please feel free to call or email.

Regards

Rachael

Rachael Labruyere
Environment Manager
Botany Rail Duplication

BOTANY
RAIL DUPLICATION
ARTC JOHN HOLLAND

Building D, 10 Bourke Road
Mascot NSW 2020
M. +61 439464796
W. johnholland.com.au

From: Colin Mable <Colin.Mable@bayside.nsw.gov.au>
Sent: Monday, 31 October 2022 11:03 AM
To: Loretta Mihaljek-JHG <Loretta.Mihaljek@jhg.com.au>
Subject: RE: Botany Rail Duplication - Operational Noise and Vibration Report (for review)

Loretta,

I refer to your email in which you have forwarded the Noise and Vibration Report for the above Project. Council does not have any experts in Noise & Vibration Assessments and assumes this Report has been conducted by an Accredited Company in this Field.

In viewing the Report Council's main concerns would be in addressing potential noise and vibration issues where residential properties are the closest the new rail line. This is the case with properties along Myrtle Street, Bay Street, Banksia Street, Ocean Street and Page Street Botany.

In the Report it seems to say noise levels near these streets could increase from 59 – 72 Decibels to 87 – 100 Decibels. If this is the case then measures need to be implemented to manage these increased noise levels at these streets. So can you please advise what measures will be implemented to manage the noise levels adjacent to these streets.

Also the Report states rolling stock is required to be modified to reduce noise and vibration by 2025 to comply with EPA Licencing and the tracks to be regularly lubricated to reduce noise. What guarantee does Council have that ARTC will comply with these requirements to reduce the potential noise and vibration issues associated with the new track.

Finally Section 8 (Consultation) and in particular section 8.4 (Complaints Management) indicates a 24 hour service will be established to address resident issues when the new track is operational. Again what guarantee does Council have that ARTC will provide this service and will act on any issues raised by Residents affected by the increased noise and vibration.

If you have any questions with the above comments please come back to me.

Regards

Colin Mable Executive Engineer
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M 0412 915 287
E colin.mable@bayside.nsw.gov.au W www.bayside.nsw.gov.au

From: Loretta Mihaljek-JHG <Loretta.Mihaljek@jhg.com.au>
Sent: Thursday, 27 October 2022 2:18 PM
To: Colin Mable <Colin.Mable@bayside.nsw.gov.au>
Subject: Botany Rail Duplication - Operational Noise and Vibration Report (for review)

Dear Colin,

As part of the Botany Rail Duplication projects "*Conditions of Approvals*" (CoAs) it is required that the project prepare an "*Operational Noise and Vibration Report*" (ONVR). In summary, the report discusses the project description, scope, acoustic environment and noise modelling.

Another requirement of the CoAs is that the ONVR is required to be issued to Bayside Council for comments/review. I have sent you a copy of the ONVR via onedrive as the document was too big to attach to this email.

Would you mind forwarding the ONVR to the relevant person within your organisation for review and comments please. We would require the comments/review back by **Thursday 3 November.** Apologies for the quick turnaround time but we have had a slight overlap with the recent departure of the projects Interface Manager.

Alternatively, if your team require further explanation and understanding of the ONVR, the project's environmental team would be more than happy to run a workshop to discuss the reports contents.

Any issues, please contact me anytime.

Thank you in advance and have a nice afternoon

Loretta Mihaljek
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