Report

Assessment of Noise and Vibration Emissions (SEARs)

QANTAS FLIGHT TRAINING & SIMULATOR CENTRE

Qantas Airways Ltd

Report

CONFIDENTIAL

Revision: 7.0 – Updated Issue
Issued: 28 May 2019

Norman Disney & Young
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1 INTRODUCTION

1.1 Introduction

NDY has been commissioned by Qantas Airways Ltd (Qantas) to prepare this report in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the SSD 10154 for the development of a new flight training centre at 297 King Street, Mascot.

1.1 Professional Accreditation

The noise calculation and reporting has been undertaken by acoustic engineers Marina Apfel, Thomas Warren and Akil Lau of Norman Disney & Young. Marina Apfel, Thomas Warren, and Akil Lau are certified members of the Australian Acoustical Society (MAAS).

Additionally, NDY Acoustics Sydney is a member firm of the Association of Australasian Acoustical Consultants (AAAC).

1.2 Revision History

Rev	Date Issued	Comment
1.0	01 February 2019	Draft
2.0	12 April 2019	For Review
3.0	14 April 2019	Initial Issue
4.0	15 April 2019	Updated Issue
5.0	15 April 2019	Updated Issue
6.0	27 May 2019	Updated construction noise assessment (Sections 9.3.3, 9.3.4)
7.0	28 May 2019	Minor updates

2 GLOSSARY

Term	Definition
The Site	Qantas Airways Limited owned land in Mascot to the north of Sydney Kingsford Smith Airport consisting of Lots 2 & 4 DP 234489, Lot 1 DP 202747, Lot B DP 164829 and Lot 133 DP 659434. Current site improvements include including at-grade car parking for Qantas staff, an industrial shed to store spare aviation parts, a substation, a disused gatehouse, a Sydney Water Asset with two driveways over it, the Qantas catering facility and Qantas tri-generation plant.
The Project	The construction of a new Flight Training Centre and ancillary uses to replace the existing facility on the Qantas Jetbase that will be impacted by RMS' Sydney Gateway Project.
Mascot Campus	Over 19ha of Qantas Airways Limited controlled land in Mascot to the north of Sydney Kingsford Smith Airport consisting of freehold and leased land. The following lots are owned by Qantas: Lot 133 DP 659434; Lots 4 & 5 DP 38594 Lot 23 DP 883548; Lots 1 & 2 DP 738342; Lot 3 DP 230355; Lot 4 DP 537339; Lots 2 & 4 DP 234489; Lot 4 234489; Lot 1 DP 81210; Lot 1 DP 202093; Lot 1 DP 721562; Lot 2 DP 510447; Lot 1 DP 445957; Lot B DP 164829 and Lot 1 DP 202747 and equates to 16.5ha of land. The following lots are leased by Qantas: Lot 14 DP 1199594 and Lot 2 DP 792885 and equates to 2.7ha of land.
Jetbase Qantas	Qantas leased land within the boundaries of Sydney Kingsford Smith Airport.
Sydney Gateway Project	A RMS Project including a road and rail component that is intended to increase capacity and improve connections to the ports to assist with growth in passenger, freight and commuter movements across the region, by expanding and improving the existing road and freight rail networks.
decibel, dB	The decibel scale is logarithmic. A doubling in loudness would subjectively be represented by an increase in noise levels of 10 decibels (dB). A small change of 3dB would be just noticeable to most listeners. Decibels are not actually a unit of sound pressure but are simply an expression of a ratio from a standardised sound pressure level representing zero decibels.
dB(A)	In most national and International environmental standards assessments adopt "A" weighted decibels. "A" weighted decibels are measured with a sound level meter which has been electronically adjusted to an international standard in an attempt to match the response of the human ear.
	The spread of noise over a time period can be expressed in a number of ways. The two methods used in the noise level targets are: **L_{10}** The sound level exceeded for 10 per cent of the time. **L_{95}:** The sound level exceeded for 95 per cent of the time. **L_{eq}:** The average sound pressure level over the measurement period. **L_{max}:** The loudest single event over the measurement period.
Ambient Sound	Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far. Usually taken to mean the L_{Aeq} value.
Background Sound Level	The average of the lowest levels of the sound levels measured in an affected area in the absence of noise from occupants and from unwanted external ambient noise sources. Usually taken to mean the L_{A90} value.

3 ABBREVATIONS

Acronym	Definition
ARTC	Australian Rail Track Corporation
BBLEP	Botany Bay Local Environmental Plan 2013
EP&A	Act Environmental Planning and Assessment Act 1979
FTE	Full-time Equivalent
Gateway	Sydney Gateway Project
ha	Hectares
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
LEP	Local Environmental Plan
LGA	Local Government Area
NSW	New South Wales
Qantas	Qantas Airways Limited
RMS	NSW Roads and Maritime Services
SACL	Sydney Airport Corporation Limited
SEPP	State Environmental Planning Policy
SEPP 55	State Environmental Planning Policy No. 55 - Remediation of Land
SEPP SRD	State Environment Planning Policy (State and Regional Development) 2011
Simulators	Full Motion Flight Simulators
sqm	Square Metres
SSD	State Significant Development
the Airport	Sydney Kingsford Smith Airport
the Department	Department of Planning and Environment
the District Plan	Eastern City District Plan (2018)
the Minister	the Minister for Planning
the Region Plan	Metropolis of Three Cities – the Greater Sydney Region Plan (2018)
the Strategy	The Future Transport Strategy 2056 (2018)
EPA	Environment Protection Authority
RMS	Roads and Maritime Services
NSW NPfI	NSW Noise Policy for Industry 2017
ICNG	Interim Construction Noise Guideline 2009
CNVG	Construction Noise and Vibration Guideline 2016
AVaTG	Assessing Vibration: a technical guideline
RNP	NSW Road Noise Policy 2011
RINP	NSW Rail Infrastructure Noise Policy 2013
AS2107	AS2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors*
AS2021	*AS2021:2015 – Aircraft Noise Intrusion – Building siting and construction*
AS2670	AS2670-2:1990 *Evaluation of human exposure to whole-body vibration - Part 2: CONTINUOUS AND SHOCKINDUCED VIBRATION IN BUILDINGS (1 to 80 Hz)*
BS7385	BS7385-2 1993 *Evaluation and measurement for vibration in buildings – Part 2 Guide to damage levels from ground-borne vibration*
PPV	Peak particle velocity
RBLs	Rating Background Levels
the Traffic Report	*Traffic Report for Proposed Relocation of Flight Training Centre (Mascot)* (REF: 11146/1) by Colston Budd Rogers & Kafes Pty Ltd, dated April 2019

Acronym	Definition
the Geotech Report	*Report on Geotechnical Investigation Proposed Flight Training Centre King Street, Mascot* (85777.15.R.001.Rev0.Geotechnical) by Douglas Partners, dated 8 February 2019
DEFRA Database	*Department for Environment Food and Rural Affairs UPDATE OF NOISE DATABASE FOR PREDICTION OF NOISE ON CONSTRUCTION AND OPEN SITES (2005)*
TUV Nord	TUV Nord *Ermittlung der Geräuschemission von Kfz im Straßenverkehr* (2005)
AS2436	AS2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*
BS5228	BS5228-1:2009 *Code of practice for noise and vibration control on construction and open sites*

4 EXECUTIVE SUMMARY

NDY has undertaken a Noise and Vibration Impact Assessment to address the following Secretary's Environmental Assessment Requirements (SEARs) in regard to the acoustic design:

- *a description of all potential noise and vibration sources during the construction and operational phases of the development, including on and off-site traffic noise;*
- *a noise impact assessment, including a cumulative noise impact assessment in accordance with relevant Environment Protection Authority guidelines;*
- *a detailed construction programme considering sensitive receivers and other nearby construction activities, with justification for any requested extended construction hours;* [In regards to this, the report provides: an initial assessment of typical construction activities expected to be carried out, considering activities with justification for any requested extended construction hours.]
- *consideration of the operational requirements of the development in relation to surrounding noise sources such as the proposed Sydney Gateway Project and the Botany Rail Duplication Project; and*
- *details of noise mitigation, management and monitoring measures.*

4.1 Description of the Site and Locality

The site is located at 297 King Street, Mascot and comprises land known as Lots 2 & 4 DP 234489, Lot 1 DP 202747, Lot B DP 164829 and Lot 133 DP 659434. The site is identified in Figure 1.

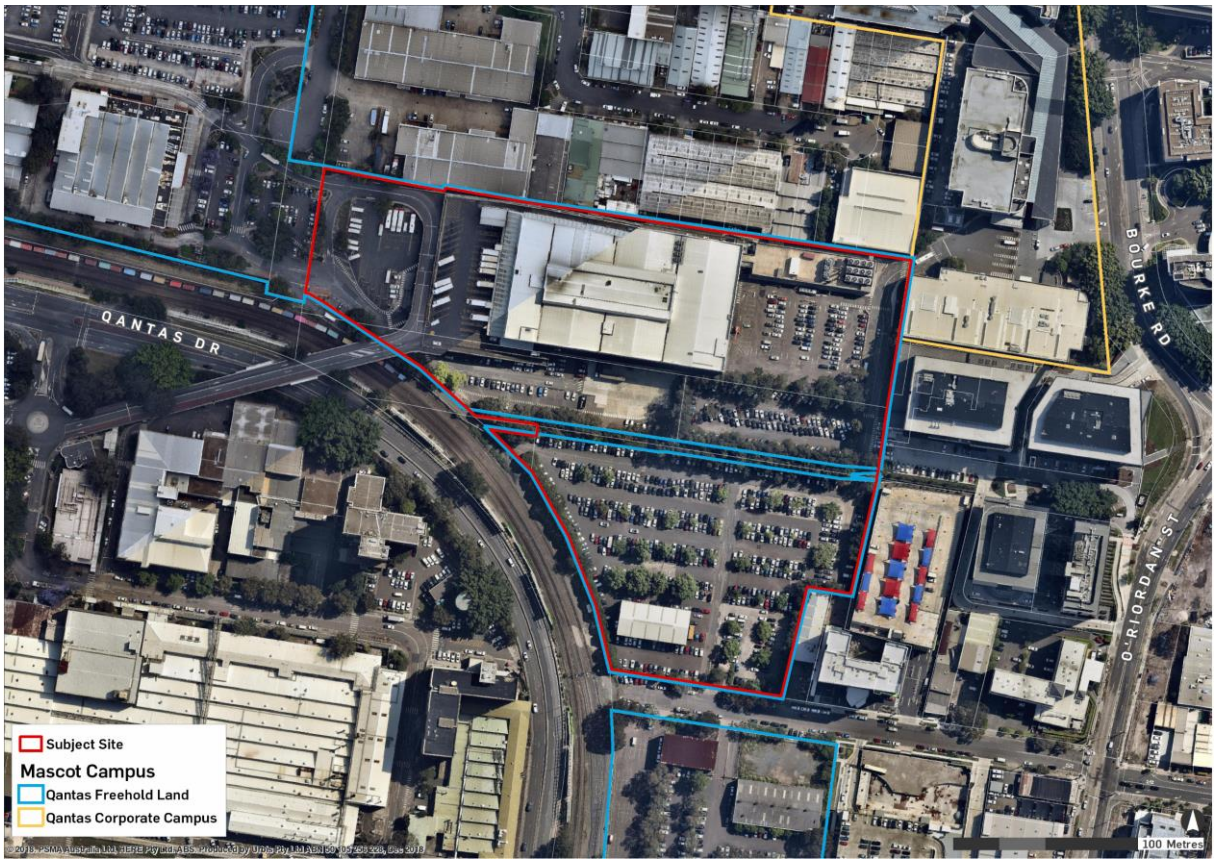

Figure 1: The Site

Key features of the site are as follows:

- The site is approximately 5.417ha and is an irregular shape. It is approximately 240m in length and maintains a variable width of between approximately 321m in the northern portion of the site and approximately 93m along the King Street frontage (refer to Figure 1).
- The site possesses a relatively level slope across the site. An open Sydney Water drainage channel bisects the northern portion of the site in an east-west direction. There are some isolated changes in level immediately adjacent to this channel. A Site Survey Plan accompanies the application which details the topographic characteristics of the site.
- Multiple mature Plane Trees are scattered throughout the site. A variety of native and exotic tress and vegetation also exist around the perimeter of the site which help screen the site from surrounding uses.
- Site improvements include at-grade car parking for Qantas staff, an industrial shed to store spare aviation parts, a substation, a disused gatehouse, a Sydney Water Asset with two driveways over it, the Qantas catering facility and Qantas tri-generation plant.
- The site forms part of a larger land holding under the ownership of Qantas that generally extends between Qantas Drive to the west, Ewan Street to the south, Coward Street to the north, with the Qantas "Corporate Campus" fronting Bourke Road.
- Vehicular access to the site from the local road network is available from King Street. The site has intra-campus connections along the northern boundary in the form of two connecting driveways in the north-eastern and north-western corner of the site along the northern boundary which link it to the broader Mascot Campus.
- The site is located within the Bayside LGA.

Key features of the locality are:

- **North:** The site is bounded to the north low scale industrial development, beyond which is Coward Street. Further north of the site is the Mascot Town Centre which is characterised by transport-oriented development including high density mixed-use development focussed around the Mascot Train Station.
- **East:** The site is bordered to the east by commercial development including a newly completed Travelodge hotel which includes a commercial car park. Additional commercial development to the east includes the Ibis Hotel and Pullman Sydney Airport fronting O'Riordan Street.
- **South:** The site is bounded to the south by King Street, beyond which is Qantas owned at-grade car parking and other industrial uses. Further south is the Botany Freight Rail Line and Qantas Drive beyond which is the Domestic Terminal at Sydney Airport.
- **West:** The site is bordered to the west by the Botany Freight Rail Line and Qantas Drive, beyond which lies Sydney Kingsford Smith Airport and the Qantas Jetbase (location of the current Flight Training Centre).

4.2 Project Description

Safety is Qantas' first priority. The flight training centre is a key pillar of this value. The facility enables pilots and flight crews to undertake periodic testing to meet regulatory requirements by simulating both aircraft and emergency procedural environments. The Project seeks consent for the construction and operation of a new flight training centre, and associated ancillary uses including a multi-deck car park. The Project is comprised of the following uses:

4.2.1 Flight Training Centre

The proposed flight training centre will occupy the southern portion of the site. It is a building that comprises 4 core elements as follows:

- An emergency procedures hall that contains;
  - cabin evacuation emergency trainers,
  - an evacuation training pool,
  - door trainers,
  - fire trainers
  - slide descent towers,
  - security room,
  - aviation medicine training and equipment rooms.
- A flight training centre that contains:
  - a flight training hall with 14 bays that will house aircraft simulators,
  - integrated procedures training rooms, computer rooms, a maintenance workshop, storerooms, multiple de-briefing and briefing rooms, pilot's lounge and a shared lounge.
- Teaching Space that contains
  - training rooms,
  - classrooms and two computer based exam rooms.
- Office Space
  - Office space for staff and associated shared amenities including multiple small, medium and large meeting rooms, think tank rooms, informal meeting spaces, a video room and lunch/tea room.
- Ancillary spaces including the reception area at the ground floor, toilets, roof plant and vertical circulation. The external ground floor layout will include a loading dock, at-grade car parking for approximately 39 spaces and a bus drop-off zone at the northern site boundary.

4.2.2 Car Park

The proposed multi-deck car park will be located to the north-east of the flight training centre and adjacent the existing Qantas catering facility and tri-generation plant. The car park is 13 levels and will provide 2059 spaces for Qantas staff. Vehicle access to the car park will be provided via King Street, Kent Road and from Qantas Drive via the existing catering bridge.

5 INFORMATION SOURCES

5.1.1 Protection of the Environment and Operations Act 1997

We understand the impacted lands are federal land. We however are not aware of any federal noise and vibration regulations and have therefore considered approved NSW State regulations. Under the Protection of the *Environment and Operations Act 1997* the Environment Protection Authority (EPA), now incorporated within the NSW Office of Environment and Heritage, has the responsibility to issue policy statements to set out criteria and methods of management for noise and vibration within the state.

5.1.1.1 NSW *Noise Policy for Industry 2017* (NPfI)

The external noise level criteria for nearest property boundaries have been derived in accordance with the NSW NPfI.

5.1.1.2 NSW Department of Environment & Climate Change – *Interim Construction Noise Guideline 2009* (ICNG)

Construction noise is a major environmental noise issue in NSW and it is well accepted that this activity can adversely affect, sleep, concentration, learning performance, mental and physical health. While construction noise is temporary in nature, its impacts need to be controlled.

The NSW ICNG is specifically aimed at managing noise from construction works. The guideline was developed by the NSW Department of Environment & Climate Change. The Guideline contains detailed procedures for the assessment and management of construction noise impacts.

5.1.1.3 NSW Roads and Maritime Services – *Construction Noise and Vibration Guideline 2016* (RMS CNVG)

The NSW RMS CNVG provides information about minimum working distances the for typical items of vibration intensive plant for cosmetic damage as per BS7385 and human comfort as per AVaTG.

5.1.1.4 NSW Department of Environment and Conservation - *Assessing Vibration: a technical guideline 2006* (AVaTG), includes reference to BS6841:1987, BS 6472:1992 and BS 6472:2008

The NSW AVaTG provides guidance around vibration assessment and criteria. The guideline was developed by the NSW Department of Environment and Conservation based on guidelines contained in BS 6472:1992. This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. It does not address motion sickness, occupational vibration, blasting vibration effects or vibration-induced damage to buildings or structures. The guideline references Standard BS6841:1987 *Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock*, BS 6472:1992 *Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)* and BS 6472:2008 *Guide to evaluation of human exposure to vibration in buildings*.

5.1.1.5 NSW *Road Noise Policy 2011* (RNP)

The NSW RNP provides noise assessment criteria for noise impact from road traffic.

Please note the *Development near rail corridors and busy roads – interim guideline* (Department of Planning 2008) references the *Environmental criteria for road traffic noise* (1999) which has now been replaced with the *Road Noise Policy* (2011).

5.1.1.6 NSW *Rail Infrastructure Noise Policy 2013* (RINP)

The NSW RINP provides noise assessment criteria for noise impact from rail traffic.

Please note the *Development near rail corridors and busy roads – interim guideline* (Department of Planning 2008) references the *Interim Guidelines for the Assessment of Noise from Rail Infrastructure Projects* (2007) which has now been replaced with the *Rail Infrastructure Noise Policy* (2013).

5.1.2 AS2107:2016 – Recommended Design Sound Levels

AS2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors* (AS2107) provides recommendations for background noise levels in different types of spaces. AS2107 gives recommendations for design sound levels for building interiors. These criteria are proposed to be applied to noise intrusion from external traffic and to the HVAC services noise design.

5.1.3 AS2021:2015 – Aircraft Noise Intrusion

AS2021:2015 – Aircraft Noise Intrusion – Building siting and construction (AS2021) provides guidance on the construction of buildings in the vicinity of airports to minimize aircraft noise intrusion and give internal $L_{max,s}$ level criteria for plane flyovers.

5.1.4 AS2670-2:1990 – Vibration Criteria regarding Human Comfort

AS2670-2:1990 *Evaluation of human exposure to whole-body vibration - Part 2: CONTINUOUS AND SHOCKINDUCED VIBRATION IN BUILDINGS (1 to 80 Hz)* (AS2670) provides vibration limits of building vibration with respect to human response.

5.1.5 BS7385-2: 1993 – Vibration Criteria regarding Structural Damage

The NSW AVaTG does not directly relate to damage levels of buildings however the NSW RMS CNG makes reference to British Standard BS7385-2:1993 *Evaluation and measurement for vibration in buildings – Part 2 Guide to damage levels from ground-borne vibration* (BS7385).

5.1.6 NDY Previous Project Experience

NDY references vibration limits that were used for vibration logging in a data centre next to a construction site.

5.1.7 Project Design Information Sources

- *Traffic Report for Proposed Relocation of Flight Training Centre (Mascot)* (REF: 11146/1) by Colston Budd Rogers & Kafes Pty Ltd, dated April 2019
- *Report on Geotechnical Investigation Proposed Flight Training Centre King Street, Mascot* (85777.15.R.001.Rev0.Geotechnical) by Douglas Partners, dated 8 February 2019
- Noxon Giffen - Architectural Drawings:
    - NGA-S1822-DWG-DA2.40, Site – Plan – Proposed, Revision A1, 12.04.2019
    - NGA-S1822-DWG-DA3.01, QGFT - GA - PLAN - SITE & GROUND FLOOR, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA3.02, QGFT - GA - PLAN - LEVEL 1, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA3.03, QGFT - GA - PLAN - LEVEL 2, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA3.04, QGFT - GA - PLAN - LEVEL 3, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA4.01, QGFT-C- GA- PLAN-SITE & GROUND FLOOR, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA4.02, QGFT-C- GA- PLAN- FIRST FLOOR, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA4.03, QGFT-C- GA- PLAN-TYPICAL FLOOR, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA4.11, QGFT- C- GA -PLAN - ROOF STAGE 02, Revision A1, 11.04.2019
    - NGA-S1822-DWG-DA3.10, QGFT - GA - PLAN - ROOF, Revision A1, 11.04.2019

- Data Sources:
    - TUV Nord *Ermittlung der Geräuschemission von Kfz im Straßenverkehr* (2005)
    - Department for Environment Food and Rural Affairs *UPDATE OF NOISE DATABASE FOR PREDICTION OF NOISE ON CONSTRUCTION AND OPEN SITES* (2005)
    - AS2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*
    - BS5228-1:2009 *Code of practice for noise and vibration control on construction and open sites*

6 ACOUSTIC SURVEY OF THE EXISTING ENVIRONMENT

6.1 Methodology

Unattended noise and vibration measurements were conducted to determine the existing ambient noise and vibration levels of the site and surrounding area.

The noise survey at a representative location for receivers in the Infrastructure zone to the West of the site at Qantas Jetbase (L1) was carried out between the 15th and 21st of May 2018.

The noise survey at the Eastern site boundary at 295 King Street (L2) was carried out between the 5th and 14th December 2018 and due to unfavourable weather conditions during the initial assessment period, additional measurements were carried out between the 9th and 12th of April 2109.

Handheld noise logging was carried out on 6th of February 2019 at the intersection of O'Riordan Street and King Street as well as on the 9th and 12th of April at 316 King Street at the nearest Residential receiver boundary (L3).

Figure 2 shows the noise logger measurement locations and City Of Botany area zoning in accordance with *Botany Bay Local Environmental Plan 2013* (BBLEP).

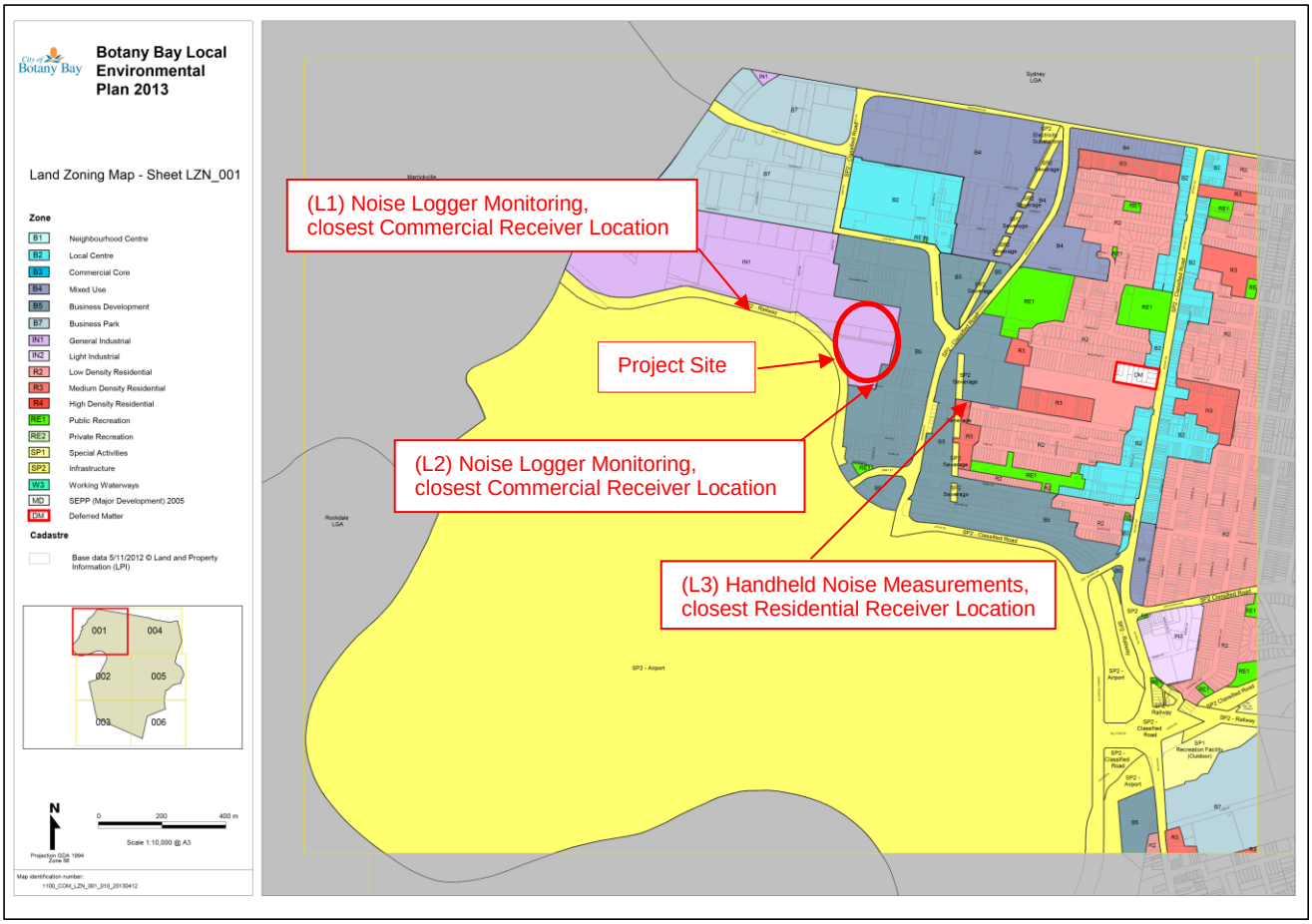

Figure 2: City of Botany Bay Area Zoning

6.2 Sensitive Receivers

The project site is zoned *General Industrial IN 1*, below are the zoning descriptions of the sensitive receivers in close proximity to the site:

- Northern site boundary – *Business Development B5* zoned land
- Eastern site boundary – *Business Development B5* zoned land including Travelodge Hotel site at approx. 6m from the Qantas site boundary
- Southern side – *Business Development B5* zoned at approx. 160m from the site boundary beyond Qantas owned carparking
- Western side – *Infrastructure zoned* (Qantas leased land) across the Botany Freight Rail Line and Qantas Drive at approx. 50m from the site boundary
- Closest residential receiver – zoned *Medium Density Residential R3* approx. 260m South East of site at 316 King Street

6.3 Instrumentation

Noise levels were measured using the Noise Logger listed in Table 1.

Table 1: Noise Logger Information

Noise Logger	Type	Serial Number	Date of Calibration
Rion NL-42	Class 1	00521656	20.02.2018
Ngara EL-316	Class 1	16306037	10.07.2017
B&K 2270 Sound Level Meter	Class 1	2650622	06.12.2018

The equipment calibration was checked prior to, and after the noise survey using a 94dB external calibration tone at 1 kHz. No significant drift was noted during the calibration procedure (i.e. less than 0.5dB).

The noise monitor was configured to record all relevant noise parameters including background noise (L_{A90}) and equivalent continuous noise levels L_{Aeq}. Samples were recorded at 15-minute A-weighted continuous intervals. The noise monitor responses were set to *fast* response.

6.4 Meteorological Data

In order to verify that the noise data was obtained during suitable meteorological conditions, weather data such as rain and wind speed was obtained from the Australian Bureau of Meteorology, Sydney Airport weather station and Kingsford Smith International weather station as representative sites.

Noise data is excluded (as per the NSW NPfI methodology) from the results if:

- Rain is observed during any 15 minute noise measurement period and/or;
- Wind speeds exceeded 5 m/s during any 15 minute noise measuring period.[1]

6.5 Handheld Traffic Noise Measurements at King Street Residential Receivers

The results of handheld noise measurements are listed in Table 2. The approximate measurement location L3 is shown in Figure 2. Noise levels at the closest residential receivers at 316 King Street are governed primarily by traffic from King Street and O'Riordan Street.

[1] The wind noise data has been corrected for the height difference between the meteorological station (10m) and the measurement position (1.5m) as per AS1170.2-1989. The procedure has been outlined and validated in *"CONVERTING BUREAU OF METEOROLOGY WIND SPEED DATA TO LOCAL WIND SPEEDS AT 1.5m ABOVE GROUND LEVEL" by Tracy Gowen, Peter Karantonis, and Tony Rofail*.

Table 2: Noise Level Measurement Results – Residential Receiver at closest Residential Receiver

Start Time (Date)	Elapsed Time	Lf,max [dBA]	Lf,eq [dBA]	Lf,90 [dBA]	Comments
17:05 (6/2/19)	15:01	81	63	60	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Lmax due to car horn ▪ Dry, no wind
17:21 (9/4/19)	15:00	85	65	60	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Lmax due to car horn ▪ Dry, slight breeze now and then
18:50 (9/4/19)	15:00	79	65	60	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Lmax due to car horn ▪ Dry, slight breeze now and then
21:42 (6/2/19)	15:00	77	61	56	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Lmax due to truck ▪ Dry, slight breeze
22:00 (6/2/19)	15:00	84	60	56	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Lmax due to bus horn ▪ Dry, slight breeze
22:19 (6/2/19)	15:00	77	61	55	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Lmax due to normal traffic movements ▪ Dry, slight breeze
22:37 (6/2/19)	15:00	74	61	55	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Lmax due to normal traffic movements ▪ Dry, slight breeze
09:00 (12/4/19)	15:00	77	63	56	▪ Noise levels driven by traffic from King St and O'Riordan St ▪ Some distant planes ▪ Some distant construction noise ▪ Lmax due to normal traffic movements ▪ Dry, no wind

7 ACOUSTIC CRITERIA

7.1 Operational Noise Criteria (Site Emissions to External Receiver)

7.1.1 Boundary Noise Criteria (as per NSW NPfI)

7.1.1.1 Assessment of existing Noise Environment

For the purpose of the assessment, the measured noise data was processed into the following time periods:

- Daytime: 0700 to 1800 hrs;
- Evening: 1800 to 2200 hrs;
- Night-time: 2200 to 0700 hrs.

The measured background (L_{A90}) and equivalent continuous (L_{Aeq}) noise levels during these defined time periods are presented in Table 3.

The L_{A90} noise levels presented are *Rating Background Levels* (RBLs), being the median of the background L_{A90} (i.e. of the lowest 10th percentile of samples) in each daytime, evening and night-time measurement period, for each 24 hour period during the noise survey.

The L_{Aeq} noise levels presented are the logarithmic average of all the L_{Aeq} samples taken in each of the daytime, evening and night-time periods.

Table 3 shows the existing ambient noise levels at the Eastern boundary noise monitoring location (L1 in Figure 2), the Western boundary noise monitoring location (L2 in Figure 2) and at the closest residential boundary (L3 in Figure 2). APPENDIX A shows the graphical data for the monitoring locations L1 and L2.

Table 3: Existing Ambient Noise Levels

Location	Noise Index	Noise Level, dB re 20 µPa		
		Daytime 07:00 to 18:00	Evening 18:00 to 22:00	Night-time 22:00 to 07:00
L1 Western Receiver (Qantas Jetbase)	L_{A90} (RBL)	63	58	50
	$L_{Aeq,period}$	71	71	68
L2 Eastern Site Boundary (295 King Street)	L_{A90} (RBL)	50	49	45
	$L_{Aeq,period}$	65	63	57
L3 Residential receiver (314 King Street)*	L_{A90} (RBL)	50	45	40
	$L_{Aeq,period}$	65	60	55

* RBLs and Period Noise Levels have been estimated based on handheld measurements (Section 6.5) and under consideration of estimated average background a-weighted sound pressure levels for different residences in Australia as per Appendix A in AS 1055:2-1997 for Noise Area R4 (*Areas with dense transportation or some commerce or industry*). We have elected to use background noise levels for noise area R4 which are higher than the levels for the R3 zoning as the handheld measurement results confirm significantly higher background noise levels than typically experienced in R2 zoned areas due to the close proximity to O'Riordan Street with high traffic volumes.

7.1.1.2 NSW NPfI Criteria

Based on the unattended noise survey discussed in Section 6 of this report, the external noise level criteria for the receiver location has been derived in accordance with the NSW Noise Policy for Industry (NSW NPfI).

The NSW NPfI provides assessment methodologies, criteria and detailed information on the assessment of environmental noise emissions in NSW.

The NSW NPfI criteria for noise sources consider two (2) components:

- Controlling **intrusive** noise impacts for residential receivers. Assessing intrusiveness generally requires noise measurements to quantify background (L_{A90}) noise levels at a location considered representative of the most potentially affected residential receiver(s). The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source(s) under consideration should be controlled to not exceed background noise levels by more than 5dB.

- Maintaining noise **amenity** for various categories of land use (including residential receivers and other sensitive receivers). The amenity criterion is based on the sensitivity of a particular land use to industrial-type noise. The recommended amenity noise levels detailed in Table 2.2 of NSW NPfI represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. This is to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area. The project amenity criteria for each new source of industrial noise is equalled to recommended amenity noise level minus 5dB(A). A +3dB(A) to be added to project amenity noise level for conversion from a period level to a 15-minutes level. Where the resultant project amenity noise level is 10dB or more below the existing industrial noise level, the project amenity noise levels can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

The noise sensitive receivers in the Business Development zones to the North and East have been assessed against criteria for commercial receivers outlined in the NPfI.

Occupational noise emissions to the receivers in the Infrastructure zone to the West have been assessed against criteria for industrial receivers outlined in the NPfI. Construction noise emissions have not been assessed to the Western boundary as the land is currently leased by Qantas and will be leased and occupied by Qantas during construction.

The closest *residential* receivers are located at 316 King Street approx. 260m from the proposed development which have been assessed against the Urban residential criteria outlined in the NPfI.

The NPfI notes "*Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2, only the amenity levels apply*." The project amenity and intrusive noise levels are listed in Table 4.

Table 4: NPfI Project Intrusiveness and Amenity Noise Criteria

Type of Receiver	Noise Level $L_{eq,15min}$ [dBA]		
	Daytime 0700 to 1800	Evening 1800 to 2200	Night-time 2200 to 0700
Industrial (West)	**Project Amenity Assessment**		
	68	68	68

Commercial (North/East/South)	**Project Amenity Assessment**		
	63	63	63
Urban Residential (316 King Street)	**Project Intrusiveness Assessment***		
	55	50	45
	Project Amenity Assessment		
	58	50	45
* Project Intrusiveness Noise Levels are based on the conservative estimates as per Table 3.			

7.1.1.3 'Modifying factor' Adjustments

Penalties may be applied if the noise from the development "... contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."

To take into account the potential annoying character of the noise an adjustment of +2dB(A) or +5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), may be added to the measured value to penalise the noise for its potential greater annoyance aspect.

Table C1 of the NSW NPfI provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Operational noise sources identified and assessed with the building are not expected to contain annoying characteristics that would require additional noise penalties for the assessment.

7.1.1.4 Project Trigger Noise Levels

The project trigger noise levels are the most stringent noise levels of the NSW NPfI project intrusiveness and project amenity noise levels for day, evening and night time periods and are project specific. Table 5 below presents the project trigger noise level (PTNL) for the closest receivers.

Table 5: External Project Trigger Noise Levels (PTNL)

Location	Time	Descriptor	External PTNL [dBA]
Industrial (West)	When in use	$L_{eq,\ 15min}$	**68**
Commercial (North/East/South)	When in use	$L_{eq,\ 15min}$	**63**
Urban Residential (316 King Street)	0700 to 1800	$L_{eq,\ 15min,\ day}$	55
	1800 to 2200	$L_{eq,\ 15min,\ evening}$	50
	2200 to 0700	$L_{eq,\ 15min,\ night}$	45

7.1.1.5 Sleep Disturbance Noise Limits

In accordance with NSW NPfI 2017, the potential for sleep disturbance from maximum noise level events to residential receivers needs to be considered during the night time. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

"*Where the subject development/premises night-time noise levels at a residential location exceed:*

- *$L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is the greater, and/or*
- *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*

a detailed maximum noise level event assessment should be undertaken."

Table 6 details the sleep disturbance noise limits for the nearest residential receivers adjacent to the proposed development.

Table 6: Sleep Disturbance Noise Limits

Location	Descriptor	Given Noise Limits [dBA]	Limits based on RBL* [dBA]	Project Noise Levels [dBA]
Urban Residential (316 King Street)	$L_{eq,15mins,\ night}$	40	45	**45**
	$L_{Fmax,\ night}$	52	55	**55**
* Project Intrusiveness Noise Levels are based on the RBL estimates as per Table 3.				

7.2 Noise Criteria for Traffic on Public Roads (as per NSW RNP)

The requirements of the NSW RNP are applicable to this assessment. Table 7 summarises the assessment criteria for residential zones based on the type of road and the land use for noise from public roads. The functional role for each type of road category is as follows:

- Freeways or motorways/arterial roads:
  - Support major regional and inter- regional traffic movement.
  - Freeways and motorways usually feature strict access controls via grade separated interchanges.
- Sub-arterial roads:
  - Provide connection between arterial roads and local roads.
  - May support arterial roads during peak periods.
  - May have been designed as local streets but can serve major traffic generating developments or support non-local traffic.
- Local roads:
  - Provide vehicular access to abutting property and surrounding streets.
  - Provide a network for the movement of pedestrians and cyclists and enable social interaction in a neighbourhood.
  - Should connect, where practicable, only to sub-arterial roads.

Table 7: Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project/Land Use	Assessment Criteria [dBA]	
		$L_{eq,15hour}$ Day (7am to 10pm)	$L_{Aeq,9hour}$ Night (10pm to 7am)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	55 (External)	$L_{Aeq,9hour}$ 50 (External)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	60 (External)	55 (External)
Local Roads	4. Existing residences affected by noise from new local road corridors 5. Existing residences affected by noise from redevelopment of existing local roads 6. Existing residences affected by additional traffic on existing local roads generated by land use developments	55 (External)	50 (External)

The noise assessment criteria for non-residential land uses are listed in Table 8. These criteria are applied when assessing the impact and determining mitigation measures in the following situations:

- When there is a new road or road development;
- When there is a land use development with the potential to generate additional traffic on local, sub-arterial or arterial roads.

Table 8: Road Traffic Noise Assessment Criteria for Non-residential Land Uses Affected by Proposed Road Project and Traffic Generating Development

Existing Land Uses	Assessment Criteria [dBA]	Additional Consideration
Isolated residences in commercial or industrial zones (applied to Hotel)	$L_{eq,1hr}$ 40 (Internal)	For isolated residences in industrial or commercial zones, the external ambient noise levels can be higher than those in residential areas. Internal noise levels in such residences are likely to be more appropriate in assessing any road traffic noise impacts, and the proponent should determine suitable internal noise level targets, taking guidance from Australian Standard 2107:2000 (Standards Australia 2000).
Office Buildings (General Office Areas)	$L_{eq,1hr}$ 45 (Internal) When in use	Guidance taken from Australian Standard 2107:2016

The NSW Road Noise Policy notes the following:

"Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and

reasonable mitigation measures, an increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person."

7.3 Construction Noise Criteria (as per ICNG)

The ICNG guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer term construction works and the qualitative method, which is generally suited to short term works (usually not more than 3 weeks) such as infrastructure maintenance.

It is expected that the length of the construction works associated with the development is more than 3 weeks and therefore a quantitative method has been used for this assessment.

Table 9 outlines standard construction hours as recommended by the ICNG and lists proposed standard and extended construction hours to be adopted for the Qantas site. The proposed standard hours for the Qantas site are based on the assumption that Monday to Friday operation is no different to Saturday, Sunday and Public Holiday operation for the Travelodge Hotel which is the most affected neighbouring site.

Table 9: Construction Hours

Period	Hours as per NSW ICNG	Hours Proposed for Qantas Site
Standard Hours	Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Monday – Sunday 07:00 – 20:00
Outside Standard Hours (i.e. extended hours)	Any time other than the recommended standard hours	Monday – Sunday 20:00 – 07:00

Table 10 and Table 11 set out the management levels for noise at residence and sensitive land uses, respectively. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected management level'.

Table 10: Noise Management Levels at Residence using Quantitative Assessment

Period	Hours Proposed for Qantas Site	External Management Level $L_{eq,15min}$ [dBA] (as per ICNG)
Standard Hours	Monday – Sunday 07:00 – 20:00	Noise Affected RBL + 10
		Highly noise affected 75
Outside Standard Hours (i.e. extended hours)	Monday – Sunday 20:00– 07:00	Noise Affected RBL + 5
Note: Noise Levels apply at the boundary that is most exposed to construction noise and at a height of 1.5m above ground level.		

Table 11: Noise Management Levels at Industrial and Commercial Premises (as per NSW ICNG)

Land Use	External Management Level, $L_{eq,15min}$ [dBA] (applies when properties are being used)
Industrial premises	75
Offices, retail outlets	70

Criteria for construction noise to the Travelodge receiver East of the site have been established based on the residential receiver criteria range considering the sensitivity of the receiver. The Travelodge however is located on *Business Development B5* zoned land and the boundary noise criteria to control operational noise emissions for commercial zones is 63dBA at all times (as per Section 7.1.1.4). It should also be considered that the building façade of the Travelodge hotel has been designed to attenuate noise from planes flying over the site to appropriate internal noise levels due to the close proximity to the airport and that the hotel has no balconies. We therefore propose External Noise Management Levels associated with the construction works are adjusted as outlined in Table 12. While the Construction Noise Guideline notes there may be some community reaction to noise when noise affected management levels are exceeded we believe higher management levels may be acceptable due to the location to aid with reducing the overall construction period.

Table 12: Construction Noise Management Levels – Proposed for Construction Works on the Qantas Site

Receivers	Recommended Hours	RBL $L_{eq,15mins}$ [dBA]	External Noise Management Level $L_{eq,15mins}$ [dBA] (as per ICNG)	Adjusted External Noise Management Levels proposed to be adopted for the Development $L_{eq,15mins}$ [dBA]
Industrial (West, Drilling-East)	All Hours (Standard Hours + Outside Standard Hours)	n/a	75	75
Commercial (North/East/South)	All Hours (Standard Hours + Outside Standard Hours)	n/a	70	70
Residential (Travelodge-East located in Business Development Zone)	Standard Hours (Monday – Sunday 07:00 – 20:00)	50	60 – 75 (noise affected to highly noise affected range)	63[1] – 75 (noise affected to highly noise affected range)
	Outside Standard Hours (Monday – Sunday 07:00 – 20:00)	50	55	63[1]
		49	54	63[1]
		45	50	63[1]
Residential[2] (316 King Street)	Standard Hours (Monday – Sunday 07:00 – 20:00)	50	60 – 75 (noise affected to highly noise affected range)	60 – 75 (noise affected to highly noise affected range)
	Outside Standard Hours (Monday – Sunday 07:00 – 20:00)	50	55	55
		45	50	50
		40	45	45
1) As per criteria for operational noise emissions outlined in Section 7.1.1.4. 2) Management Noise Levels are based on the RBL estimates as per Table 3.				

7.4 Internal Project Noise Criteria (to protect from the Impact of External Sources)

7.4.1 Summary of Internal Design Noise Criteria

Internal design noise criteria to protect the development from the impact of external noise sources as well as building services noise sources have been based on the *NSW ICNG*, the *NSW RNP*, the rail noise trigger levels for the *redevelopment* of existing rail lines as per the *NSW RING* and the background noise level recommendations of AS2107.

The internal design noise levels for the development are summarized in Table 13.

Table 13: Internal Design Noise Criteria

Qantas Training Centre Room Type	Internal Construction Noise Management Level[1], $L_{Aeq(15min)}$	Overall Internal Noise Level due to External Road & Rail Traffic Noise Intrusion & HVAC Noise[1], L_{Aeq}	Maximum Internal Noise Level due to Plane Flyovers[1], $L_{A, max, slow}$
IPT, classrooms	45 dB	40 dB	55 dB
Auditorium	40 dB	35 dB	55 dB
Open plan offices, Meeting room (small/med), think tank, lunch/breakout, Briefing, De-Briefing, lounges, CBT	45 dB	45 dz	65 dB
Sim Offices, Workshop Office, Visual Repair	50 dB	50 dB	65 dB
Meeting room (large)	45 dB	40 dB	65 dB[9]
Video[6]	40 dB	35 dB	55 dB
EP Pool[9]	58 dB	58 dB	65 dB
EP Hall	50 dB	50 dB	65 dB
EP Raft	50 dB	50 dB	65 dB
EP Door Trainer	45 – 50 dB	45 – 50 dB	65 – 50 dB
Maintenance Workshop	60 dB	60 dB	75 dB
Amenities: Toilets, Shower	See Note 5)	50 dB	n/a
Café, Kitchen, Corridor[7]	See Note 5)	50 dB	n/a
Simulator Bays[4]	See Note 5)	55 dB	Maintain performance from existing environment in B148.
Plant, IT Rooms	See Note 5)	85 dB[8]	n/a
Simulator Cabins	10dB below Qantas background airplane audio curves to not add to simulator induced noise and compliance with tone masking requirements for inaudibility of intruding noise.		Maintain performance from existing environment in B148.

Qantas Training Centre Room Type	Internal Construction Noise Management Level[1)], $L_{Aeq(15min)}$	Overall Internal Noise Level due to External Road & Rail Traffic Noise Intrusion & HVAC Noise[1)], L_{Aeq}	Maximum Internal Noise Level due to Plane Flyovers[1)], $L_{A, max, slow}$
1) Management levels apply to all day and night time periods. 3) Noise components for traffic noise intrusion and HVAC will each have to be design to below the nominated criteria for the combined noise not to exceed the criteria. 4) Note that the proposed background noise levels do not include noise emissions from IT equipment, the simulators or similar. 5) We have assumed that noise levels in these areas will be acceptable if the internal noise levels in the other areas are met where criteria have been specified. 7) We have assumed Green Star requirements for corridors to not apply to service corridors and have assumed slightly higher background noise levels are acceptable in the service corridors. 8) 85dBA should be adopted as the maximum limit where feasible. Where this level cannot be achieved hearing protection will be required for people to access the spaces. 9) Criteria does not include noise emissions from the pool.			

7.5 Vibration Criteria

The effects of vibration upon buildings can be separated into three main categories:

- Perceptibility of the occupants to the vibration and the possibility of them being disturbed or annoyed;
- Vulnerability of the building structures to vibration induced damaged;
- Vulnerability of the contents of the building that includes types of equipment, activities and processes.

7.5.1 Human Response to Vibration

7.5.1.1 Human Comfort - Vibration Monitoring (as per AVaTG)

Human are very sensitive to vibration, and they can be disturbed, annoyed and have their work activities interfered with if the levels are too high. The ICNG references AVaTG issued by the Department of Environment and Conservation NSW for measurement and assessment of vibration. The AVaTG provides vibration criteria for continuous, impulsive and intermittent vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

The criteria are discussed in more detail in the following sections.

7.5.1.1.1 Continuous and impulsive vibration (1-80 Hz)

According to the AVaTG for continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted root-mean-square acceleration values and results are to be

compared against the following preferred and maximum values given for each orthogonal axis. The frequency weightings as per BS6841:1987 (reproduced in Appendix B3 of the guideline) are to be applied to the RMS measurement values (1-80Hz). The criteria in the AVaTG are derived from the limiting values of the assessment curves and multiplying factors from BS 6472:1992 (the curves are no longer referenced in the superseded version of the standard BS 6472:2008). We have assumed hotels will be assessed as per the criteria for residences.

Table 2.2 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1–80 Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992

The AVaTG notes *"Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. An example is a construction or excavation project."*

7.5.1.1.2 Intermittent vibration (1-80 Hz)

According to the AVaTG for intermittent vibration, assessment of impact should be considered on the basis of vibration dose values (VDV). Acceptable values of vibration dose are given as follows. We have assumed hotels will be assessed as per the criteria for residences.

Table 2.4 Acceptable vibration dose values for intermittent vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
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

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.
Source: BS 6472–1992

7.5.2 Design and Monitoring of Structural Response to Vibration (as per BS7385)

The Standards used for the construction vibration limits are intended to protect against damage to buildings, and not necessarily to prevent human annoyance. The prescribed limits are substantially above human perceptibility levels.

Building integrity rather than human comfort is generally considered when the building is unoccupied which however is not expected here.

BS7385 provides vibration criteria to prevent structural damage as per Table 14. The peak particle velocity limit (PPV) of 50mm/s at 4Hz and above applies for reinforced or framed structures, industrial and heavy commercial buildings. The vibration levels refer to measurements at the base of the building facing the source of vibration.

Table 14: Recommended Structural Damage Criteria PPV (mm/s).

Line	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50mm/s at 4Hz and above	
2	Unreinforced or light framed	15mm/s at 4Hz increasing to 20mm/s at 15 Hz	20 mm/s at 15Hz and increasing to 50mm at 40Hz and above.
Note 1: Values referred to are at the base of the building. Note 2: For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6mm (zero to peak should noise be exceeded).			

It should however be noted that compliance with the vibration limits to avoid structural damage of buildings, cannot provide certainty. If damage occurs despite compliance with the standard, it is to be assumed that other causes are responsible, however, further investigations are necessary. And on the other hand, exceeding the limits does not necessarily lead to damage.

7.5.3 Operational Vibration Criteria for Simulators

In regards to vibration limits for the simulators, Qantas note the following:

*"*Any 'external' or 'non-simulated' vibration evident through the sim platform and/or flight controls, will have a negative impact on training and the simulator fidelity. A possible consequence is that the simulator would be rendered 'unsuitable for training'".

7.5.4 Equipment Damage Criteria

Information about vibration limits to avoid damage to the simulators, equipment in the simulators and in the monitoring rooms has currently not been provided by Qantas.

In absence of vibration criteria for the equipment in the monitoring and simulator rooms NDY recommends assessments in line with requirements that have previously been nominated for data centres next to a construction site. A PPV criteria of 3mm/s has been used on these projects in the past.

7.5.5 Summary of Project Vibration Criteria

Internal design vibration criteria have been based on the AS2670-2:1990, British Standard 7385-2 1993 and NDY previous project experience. The human comfort criteria apply to both construction and traffic (road and rail) induced vibration.

The internal design noise levels for the development are summarized in Table 15.

Table 15: Summary of Vibration Criteria

Location	Vibration Criterion[1)]
Training Rooms (including IPT, CBT, classrooms); Office/Admin area	▪ **Human Comfort:** Design review based on AS2670 Base Curve with office multiplier for rail and road operational vibration impact. Construction vibration impacts to be assessed on a PPV basis. Monitoring/compliance testing to be carried out against NSW AVaTG criteria for offices and educational institutions. ▪ **Structural Integrity:** 50mm/s PPV at 4Hz and above.
Simulator/Monitor Rooms	▪ **Human Comfort:** Design review based on AS2670 Base Curve with workshop multiplier for rail and road vibration impact. Construction vibration impacts to be assessed on a PPV basis. Monitoring/compliance testing to be carried out against NSW AVaTG criteria for workshops. ▪ **Equipment Integrity:** Currently assumed to be 3mm/s PPV. ▪ **Structural Integrity:** 50mm/s PPV at 4Hz and above.
Simulator Cabin	▪ **Operational Considerations:** No additional vibration to interfere with simulator induced vibration.
EP Area	▪ **Human Comfort:** Design review based on AS2670 Base Curve with workshop multiplier for rail and road operational vibration impact. Construction vibration impacts to be assessed on a PPV basis. Monitoring/compliance testing to be carried out against NSW AVaTG criteria for workshops. ▪ **Structural Integrity:** 50mm/s PPV at 4Hz and above.
1) Criteria apply to all day and night time periods.	

8 OPERATIONAL NOISE IMPACT ASSESSMENT

8.1 Traffic Routes

Access routes and site traffic routes are shown in Figure 3.

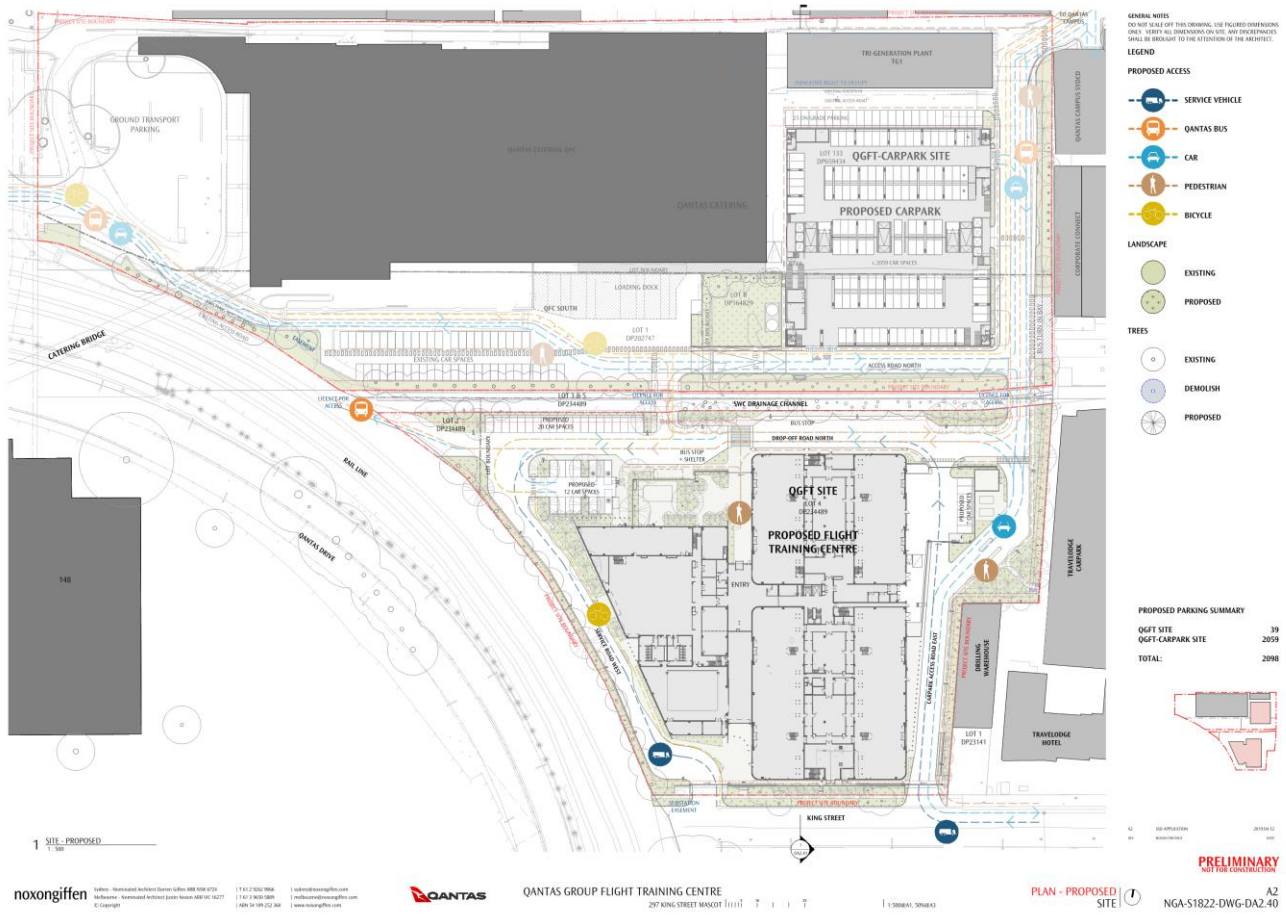

Figure 3: Access Routes and Site Traffic

8.2 Changes to Traffic on surrounding Public Roads

The most common method of prediction road traffic noise is the CoRTN (Calculation of Road Traffic Noise). Using the CORTN algorithms for freely flowing road traffic, the L_{eq} noise level generated by traffic movement may be calculated from the following general relationship:

- L_{eq} = 10 Log (N) + K where N is the traffic flow volume and K is a Site Constant

The site constant (K) is calculated from the actual site conditions, including distance from the road edge, the speed of traffic flow, and any site-specific factors such as shielding by fences etc. Providing the site factors remain constant, as is the case with changes that do not alter the roadway itself, it is possible to calculate the change to road traffic noise levels as:

- L_{eq} change = 10 log (N2/N1) where N1 is the initial traffic flow and
  N2 is the future traffic flow

For a land use development that has the potential to create additional traffic on existing road networks, the noise criteria at the facade of a building should comply with the noise criteria depending on the road category, as detailed in Section 7.2.

More relevantly, the additional traffic generated by the proposed development should be limited to 2dBA so traffic impacts to the nearest affected noise receivers are minimal (see Section 3.4).

In accordance with RNP, the functional role of a road defines the road category and based on the functional role descriptions, there are a number of sub-arterial and local roads categories surrounding the proposed development. Table 16 details the road category for each relevant road.

Table 16: Road Categories

Road	Road Category	Assessment Period
Qantas Drive	Sub-arterial Road	$L_{Aeq,15\ hour\text{-}Day}$ and $L_{Aeq,9\ hour\text{-}night}$
Seventh Street	Local Road	$L_{Aeq,1hour}$
Joyce Drive	Sub-arterial Road	$L_{Aeq,15\ hour\text{-}Day}$ and $L_{Aeq,9\ hour\text{-}night}$
Robey Street	Local Road	$L_{Aeq,1hour}$
O'Riordan Street	Sub-arterial Road	$L_{Aeq,15\ hour\text{-}Day}$ and $L_{Aeq,9\ hour\text{-}night}$
King Street	Local Road	$L_{Aeq,1hour}$
Bourke Street	Local Road	$L_{Aeq,1hour}$
Kent Road	Local Road	$L_{Aeq,1hour}$
Coward Street	Local Road	$L_{Aeq,1hour}$

The traffic noise impact associated with the additional traffic generated by the proposed development on the public road networks surrounding has been carried out based on the peak hour traffic information such as existing traffic volumes, additional traffic volumes and traffic distribution outlined in the Traffic Report.

Existing and future traffic volumes on the local roads and sub-arterial roads are outlined in Table 17.

Table 17: Existing and Predicted Traffic Volumes

Roads	Peak Hour Traffic Volumes, vph					
	Existing		Development		Additional generated by Development	
	am	pm	am	pm	am	pm
Qantas Drive						
– west of O'Riordan Street	4,375	3,435	4,471	3,469	96	34
– east of Robey Street	4,375	3,545	4,471	3,579	96	34
– east of Lancastrian Drive	3,665	3,415	3,733	3,436	68	21
– west of Lancastrian Drive	3,790	3,615	3,914	3,700	124	85
Joyce Drive						
– east of O'Riordan Street	3,350	2,870	3,463	2,927	113	57
Seventh Street						
– south of Qantas Drive	1,930	2,230	1,930	2,230	0	0
Robey Street						
– east of Qantas Drive	2,190	1,965	2,218	1,978	28	13
– west of O'Riordan Street	2,170	1,945	2,198	1,958	28	13
– east of O'Riordan Street	690	630	690	630	0	0
O'Riordan Street						
– north of Qantas Drive	1,520	2,100	1,558	2,123	38	23
– north of Robey Street	3,190	3,385	3,217	3,421	27	36
– north of King Street	3,195	3,560	3,252	3,605	57	45
– north of Bourke Street	2,435	2,795	2,484	2,831	49	36
– north of Coward Street	2,260	2,385	2,287	2,413	27	28
King Street						
– east of O'Riordan Street	510	580	554	602	44	22
– west of O'Riordan Street	280	325	437	427	157	102
Bourke Street						
– north of O'Riordan Street	1,255	1,405	1,263	1,414	8	9
– north of Qantas Access	1,190	1,170	1,198	1,179	8	9
– north of Coward Street	660	975	670	985	10	10

Roads	Peak Hour Traffic Volumes, vph					
	Existing		Development		Additional generated by Development	
	am	pm	am	pm	am	pm
Kent Road						
– north of Coward Street	1,045	1,010	1,079	1,038	34	28
– south of Coward Street	330	230	394	286	64	56
Coward Street						
– east of O'Riordan Street	960	1,205	1,003	1,233	43	28
– east of Bourke Street	535	620	558	640	23	20
– east of Qantas Access	1,155	1,040	1,185	1,064	30	24
– east of Kent Road	1,165	1,090	1,195	1,114	30	24
– west of Kent Road	460	310	460	310	0	0

The traffic noise impacts associated with the additional traffic generated by the proposed development on the nearest affected receivers for are shown in Table 18.

Table 18: Noise Levels Change – Roads

Roads	Predicted Change in Noise Levels, dBA			
	am	pm	Max. allowable for minimal impact	Compliance
Qantas Drive				
– west of O'Riordan Street	0.1	0	2	Y
– east of Robey Street	0.1	0	2	Y
– east of Lancastrian Drive	0.1	0	2	Y
– west of Lancastrian Drive	0.1	0.1	2	Y
Joyce Drive				
– east of O'Riordan Street	0.1	0.1	2	Y
Seventh Street				
– south of Qantas Drive	0	0	2	Y

Roads	Predicted Change in Noise Levels, dBA			
	am	pm	Max. allowable for minimal impact	Compliance
Robey Street				
– east of Qantas Drive	0.1	0	2	Y
– west of O'Riordan Street	0.1	0	2	Y
– east of O'Riordan Street	0	0	2	Y
O'Riordan Street				
– north of Qantas Drive	0.1	0	2	Y
– north of Robey Street	0	0	2	Y
– north of King Street	0.1	0.1	2	Y
– north of Bourke Street	0.1	0.1	2	Y
– north of Coward Street	0.1	0.1	2	Y
King Street				
– east of O'Riordan Street	0.4	0.2	2	Y
– west of O'Riordan Street	1.9	1.2	2	Y
Bourke Street				
– north of O'Riordan Street	0	0	2	Y
– north of Qantas Access	0	0	2	Y
– north of Coward Street	0.1	0	2	Y
Kent Road				
– north of Coward Street	0.1	0.1	2	Y
– south of Coward Street	0.8	0.9	2	Y
Coward Street				
– east of O'Riordan Street	0.2	0.1	2	Y
– east of Bourke Street	0.2	0.1	2	Y
– east of Qantas Access	0.1	0.1	2	Y
– east of Kent Road	0.1	0.1	2	Y
– west of Kent Road	0	0	2	Y

As shown in Table 18 the expected changes in noise levels between the existing and future traffic during the morning and afternoon peak traffic hour are less than 0.5 dBA with the exception of receivers along King Street and Kent Street. The increase on King Street (west of O'Riordan Street) which is expected to increase by 1.9dBA

(am) and 1.2dBA (pm) and is located adjacent Qantas Drive as well as the increase on Kent Road (south of Coward Street) which is expected to increase by 0.8dBA (am) and 0.9dBA (pm).

All of the predicted results are compliant with the maximum allowable increase as per the NSW RNP which is considered barely perceptible to the average person.

8.3 Service Vehicle & Car Movements on Site

8.3.1 Service Vehicles

8.3.2 Service Vehicle Noise Data and Design Assumptions

The typical noise sources for service vehicle activities are the vehicle movements, loading/unloading activities and voices.

The assumed sound power levels for service vehicle activities and movements are summarised below in Table 19.

Table 19: Sound Power Levels for Service Vehicle Activities and Movements

Activities	Sound Power Levels [dBA]	
	L_{Aeq}	L_{Amax}
Truck reversing into or departing from loading bay	101	105
Truck idling and unloading activities	93	106
Truck acceleration passby	99	104

The following assumptions associated with loading/unloading activities have been made in predicting the noise impact on the receivers:

- Service vehicles loading/unloading operations on the Eastern building site: only 1 truck per 15 minute period during all hours of the day.
- Trucks are moving at max 20km/h on site.
- Max 1 truck movements on Carpark Access Road East (driving in or out of site) per 15 minute period during all hours of the day.
- Truck movements on the Carpark Access Road East and Service Road West for service and maintenance to occur outside of peak hour traffic.
- Routes as per Figure 3.
- 2m high Barrier along South Eastern Site Boundary as indicated in Figure 4. Barrier to be continuous, solid with no gaps or breaks and have a minimum surface density of 10kg/m. Suitable materials would be 18mm plywood or 9mm cement sheet. Barrier not required where building on neighbouring site exceeds 2m height.

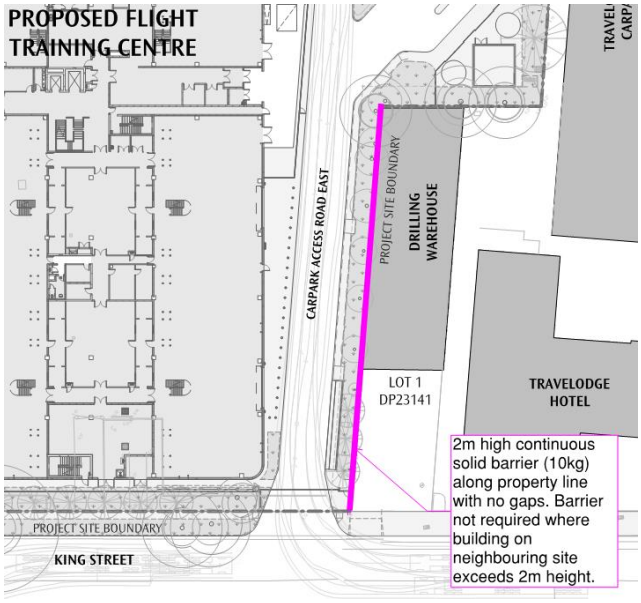

Figure 4: Barrier – South Eastern Site Boundary

8.3.3 Noise Impact from Service Vehicles

The predicted noise Leq levels associated with the service vehicle movements at the nearest affected noise receivers are presented in Table 20.

According to the NPfI the potential for sleep disturbance from maximum noise level events needs to be considered in residential areas during the night-time period. A sleep disturbance assessment has been carried based on expected Lmax values.

Table 20: Predicted Boundary Noise Levels associated with services vehicle movements on site

Receivers	Noise Level	External Noise Levels [dBA]					
		Day Period (07:00 – 18:00)		Evening Period (18:00 – 22:00)		Night Period (22:00 -07:00)	
		Predicted	PTNL Criteria	Predicted	PTNL Criteria	Predicted	PTNL Criteria
Industrial (West)	$L_{eq,15min}$	<48	68	<48	68	<48	68
Commercial (North/East/South)	$L_{eq,15min}$	<62	63	<62	63	<62	63
Urban Residential (316 King Street)	$L_{eq,15min}$	<29	55	<29	50	<29	45
	Sleep Disturbance L_{max}	n/a	n/a	n/a	n/a	<35	55

As shown in Table 20, the predicted noise level associated with the service vehicle movements on site are expected to comply with the L_{Aeq} noise criteria at the nearest affected commercial and industrial receivers in all cases.

Predicted Lmax noise levels comply with the conservative sleep disturbance criteria at the nearest residential receiver during the night time. The predicted Leq levels during the day and evening time are also well below

the sleep disturbance criteria for the night time period and at this stage we expect noise emissions will not affect the residential area.

8.3.4 Car Noise Data and Design Assumptions

The noise assessment for car movements on site has been based on the assumed hourly contribution of 1 vehicle to the Leq and Lmax shown in Table 21. The values are based on the data provided by TUV Nord.

Table 21: Cars Noise Data: Hourly Contribution of 1 vehicle to the Leq and Lmax

Activities	Sound Pressure Levels[dBA]		SWL [dBA]
	hourly contribution of 1 vehicle to L_{eq} @ 25m	L_{max} @ 7.5m	L_{max}
Car 20km/h free flowing traffic	24	60	-
Car 20km/h accelerating	27	63	-
Car door slam	-	-	103

The following information and assumptions associated in regards to car movements have been made in predicting the noise impact on the receivers:

- Cars are moving at max. 20km/h on site.
- Assessment based on the higher of the morning and afternoon peak vehicle counts. The assessment is based on the vehicle movement for the total number of Stage 2 carparking spaces to cover the worst case scenario. The Traffic report notes an existing peak hour count of 450 vehicles and additional generated vehicle count for King Street, Qantas Drive and Kent Street servicing the site as shown in Table 22. For a 15 minute period we have assumed a total of 113 vehicle movement through the King Street, 99 vehicles through the Qantas Drive entrance and 73 vehicles through the Kent Street entrance during all hours of the day which is assumed to be a very conservative approach.
- The vehicle distribution over the three access routes has been based on the percentage rates of the existing arrivals and departures as per the Traffic Report. The peak hour car movements used for the assessment are shown in Table 22.

Table 22: Vehicle Movement on the site associated with the carpark

Access	Additional peak hour Vehicles (Table 17)		Summary of Existing Arrival/Departure Routes						NEW Peak Hour Vehicles (vehicles per 15min)	
			Current Peak Hour Count		Arrival Distribution		Departures			
	am	pm	am	pm	am	pm	am	pm	am	pm
King Street	384	174	450	300	25%	25%	55%	35%	453 (113)	250 (62)
Qantas Drive	201	124			50%[1)]	25%	20%	45%	397 (99)	291 (73)
Kent Street	98	84			25%	50%	25%	20%	283 (71)	291 (73)
Total	**683**	**382**	**450**	**300**	**100%**	**100%**	**100%**	**100%**	**1133 (283)**	**832 (208)**
1) The percentage value has been changed from the 55% noted in the Traffic Report to maintain a total of 100%.										

- We have assumed noise levels of free flowing traffic and of accelerating vehicles each for 50% of the cars.
- Routes as per Figure 3.
- 2m high Barrier along South Eastern Site Boundary as indicated in Figure 4. Barrier to be continuous, solid with no gaps or breaks and have a minimum surface density of 10kg/m. Suitable materials would be 18mm plywood or 9mm cement sheet. Barrier not required where building on neighbouring site exceeds 2m height.

8.3.5 Noise Impact from Cars

The predicted noise Leq levels associated with the car movements at the nearest affected noise receivers are presented in Table 23.

According to the NPfI the potential for sleep disturbance from maximum noise level events needs to be considered in residential areas during the night-time period. A sleep disturbance assessment has been carried based on expected Lmax values.

Table 23: Predicted Boundary Noise Levels associated with car movements on site

Receivers	Noise Level	External Noise Levels [dBA]					
		Day Period (07:00 – 18:00)		Evening Period (18:00 – 22:00)		Night Period (22:00 -07:00)	
		Predicted	PTNL Criteria	Predicted	PTNL Criteria	Predicted	PTNL Criteria
Industrial (West)	$L_{eq,15min}$	<36	68	<36	68	<36	68
Commercial (North/East/South)	$L_{eq,15min}$	<61	63	<61	63	<61	63
Urban Residential (316 King Street)	$L_{eq,15min}$	<11	55	<11	50	<11	45
	Sleep Disturbance L_{max}	n/a	n/a	n/a	n/a	<32	55

As shown in Table 23, the predicted noise level associated with the car movements on site are expected to comply with the L_{Aeq} noise criteria at the nearest affected commercial and industrial receivers in all cases.

Predicted Lmax noise levels comply with the conservative sleep disturbance criteria at the nearest residential receiver during the night time. The predicted Leq levels during the day and evening time are also well below the sleep disturbance criteria for the night time period and at this stage we expect noise emissions will not affect the residential area.

8.4 Car Park Noise Emissions

8.4.1 Car Park Noise Data and Design Assumptions

The assessment of the noise predictions to the sensitive receivers has been based on the following parameters:

- The car parking levels are to be connected via an internal ramps.
- The carparking levels have an open façade design.
- Peak hour movement of a total of 283 vehicles associated with the carpark for a 15 minute period during all hours of the day which equals 1133 per hour as shown in Table 22.
- Cars are evenly distributed across the levels.
- Road surface of the car park area is concrete.

8.4.2 Noise Impact from Car Park

The noise associated with multistorey carpark on the nearest affected receivers is shown in Table 24.

Table 24: Predicted Boundary Noise Levels associated with Car Park Activities

Receivers	Noise Level	External Noise Levels [dBA]					
		Day Period (07:00 – 18:00)		Evening Period (18:00 – 22:00)		Night Period (22:00 -07:00)	
		Predicted	PTNL Criteria	Predicted	PTNL Criteria	Predicted	PTNL Criteria
Industrial (West)	$L_{eq,15min}$	<47	68	<47	68	<47	68
Commercial (North/East/South)	$L_{eq,15min}$	<58	63	<58	63	<58	63
Urban Residential (316 King Street)	$L_{eq,15min}$	<38	55	<38	50	<38	45
	Sleep Disturbance L_{max}	n/a	n/a	n/a	n/a	<32	55

As shown in Table 24, the predicted noise level associated with the multi-storey carpark are expected to comply with the L_{eq} noise criteria at the nearest affected commercial and industrial receivers in all cases.

Predicted L_{max} noise levels comply with the conservative sleep disturbance criteria at the nearest residential receiver during the night time. The predicted L_{eq} levels during the day and evening time are also well below the sleep disturbance criteria for the night time period and at this stage we expect noise emissions will not affect the residential area.

8.5 Bus Movements on Site

The Traffic Report notes that "*Qantas also operates its own internal bus service, connecting the various parts of the corporate campus with jet base and international and domestic terminals. It operates a fleet of buses (mainly small buses) that circulate about every half hour. In peak periods (weekday morning and afternoon) larger buses operate. The main stops are the jet base, corporate building (on Bourke Street) and the domestic/international terminals. Intermediate stops are located at major car parks, such as King Street North and catering.* […] *Within the site, the existing bus network will [be] maintained with some minor changes to accommodate the new development. As part of the new flight training centre, new bus stops will be provided on the access road between the canal and flight training centre building.*"

Only minor changes are to be expected to the route and stops but not the number of bus movements on site. As such, this is not expected to result in any change to the currently existing noise levels.

8.6 Building Services Plant Noise

Mechanical service equipment is proposed to comprise of AHUs, CRAC units, hydraulic pumps, FCUs and fans. AHUs and fans will be located in the L02 North and L03 East plant rooms. The equipment will be treated with internally lined ductwork and/or attenuators where required to ensure boundary noise compliance is achieved.

Noise emissions from hydraulic pumps, CRAC units, FCUs and fans located in the building will sufficiently be shielded by the building envelope design for boundary noise compliance.

It should be noted that new generators are not proposed on site, electrical services will be connected to the existing Tri-gen located North of the carpark.

8.7 Other Operational Noise Activities

We understand simulator maintenance work will be carried out in the simulator bays and the building façade is expected to shield the noise emissions. As such noise emissions due to maintenance work have been assumed to not contribute to the boundary noise emissions.

Fire training sessions will be conducted in a container which will shield the noise emissions to the boundary. Noise emissions due to fire training activities have been assumed to not contribute to the boundary noise emissions.

8.8 Operational Noise Summary

The assessment throughout this section has found that all operational noise activities (including traffic on the site and on surrounding streets, service vehicles, building services, operational activities) are predicted to comply with regulated noise limits at all surrounding receivers.

The existing environment is relatively loud due to the proximity to aircraft movements, rail, and major roads. In general, the L_{eq} operating noise from this project is predicted to be within benchmark L_{eq} measurements of the existing environment. This will minimise the impact to surrounding existing buildings.

8.9 Operational Vibration Impact

All operational activities expected to occur on this site are likely to have very little impact on the surrounding buildings on a vibration basis and will readily comply with the vibration limits.

9 CONSTRUCTION NOISE ASSESSMENT

General recommendations to manage construction noise and vibration are provided in the section below based on typical worst case demolition and construction activities. A detailed construction noise and vibration management plan and a quantitative construction noise assessment will need to be developed in the later stages of the project with the consultant team and contractor when construction equipment and methodologies are confirmed prior to issuing a construction certificate.

9.1 Hours of Work

Qantas proposed construction hours:

- Works are proposed to be conducted between the hours of 6am to 8pm Monday to Sunday due to the critical nature of the project.
- 24 hour construction works are being proposed once the building is enclosed.

9.2 Information provided in The Geotech Report

The Geotech Report notes the following:

- *Bore piles*
- Use of an *appropriately sized smooth drum roller (say 15 tonne static weight)*
- Ground conditions of sand/clay layers for 20-25m
- *Excavations on the site are expected to be minimal, any excavation is expected to be within filling and sandy soils and should be readily achievable using conventional earthmoving equipment such as a hydraulic excavator with bucket attachment.*

9.3 Initial Construction Noise and Vibration Review

9.3.1 Noise Level Data

The following has been assumed in regards to noise intensive equipment/activities:

- Piles to be bored.
- Ground rock breaking activities are not expected to be required due to ground conditions of sand and clay.
- Excavations expected to be minimal.

For the assessment reference sound levels for representative equipment have been taken from the DEFRA, BS5228 and AS2436 databases. The documents include extensive databases of sound data covering trucks, excavators, hand tools and all manner of other construction equipment and activities. The ratings listed are for individual pieces of equipment at constant operation.

Table 25: Typical External Noise Levels of Demolition and Construction Machinery/Activity taken from DEFRA, BS5228 and AS2436 databases.

Item #	Activity /Machinery	Source	Leq Sound Pressure Level at 10m (dBA)
Demolition Activities			
1	Tracked excavator, breaking up brick foundation (121kW, 15t)	DEFRA	90

2	Jack hammers	AS2436	93
3	Hand-held hydraulic breaker 20kg / 69bar	DEFRA	93
4	Backhoe mounted hydraulic breaker, breaking road surface (67kW)	DEFRA	88
5	Tracked excavator, loading dump truck	DEFRA	85
Earthworks			
6	Tracked Excavator, Ground Excavation Works (25t, 125kW)	DEFRA	77
Piling (bored piling)			
7	Crane mounted Auger	DEFRA	79
General Construction			
8	Electric tower crane, lifting	DEFRA	77
9	Hand-held Circular Saw (Petrol - Cutting Concrete Blocks), 3kW, 9kg	DEFRA	79
10	Generator, Power for Site Cabins (3kW)	DEFRA	65
11	Truck (>20 tonne)	AS2436	79
Noisy Activities when Building is Enclosed			
12	screw guns	BS5228	73
13	tile cutting	BS5228	81

9.3.2 Construction Activities and Mitigation

The following has been assumed in regards to vibration intensive equipment/activities:

- Piles to be bored.
- Ground rock breaking activities are not expected to be required due to ground conditions of sand and clay.
- Drum roller are expected to be non-vibratory.
- Excavations on the site are expected to be minimal, any excavation is expected to be within filling and sandy soils and should be readily achievable using conventional earthmoving equipment such as a hydraulic excavator with bucket attachment.

Based on the information provided in the Geotech Report Due to the ground conditions we expect vibration intensive activities/equipment to be limited. Piles are being bored, ground rock breaking activities not expected to be required due to ground conditions of sand and clay, drum roller will be non-vibratory.

The following general noise source control measured should be reviewed and implemented where required:

- Site access for construction vehicles to be set up away from the Eastern boundary line.
- During extended construction hours less intrusive works will be scheduled to be carried out and/or works will be carried out away from sensitive receivers.
- Activities that approach the highly noise affected criteria for the residential receivers to be carried out during times where receivers are less sensitive to noise. The receivers will be consulted.
- Avoid unnecessary revving of engines and turn off plant that is not being used/required;
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms;
- Where possible, avoid using tonal reverse alarm outside standard construction hours;
- Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously;

- Site set up/ movement of plant / delivery of material/ waste removal to site should generally be restricted to day time period;
- Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling;
- Ensure there is no unnecessary shouting or loud stereo/radios on site. There must be no dropping of metal from heights, throwing of metal items or slamming of doors;
- Use less noise intensive equipment where reasonable and feasible.
- Where practical fixed plant should be positioned as far as possible from the sensitive receivers;
- Use temporary site buildings and material stockpile as noise barrier;
- Employ the use of solid barrier plywood hoardings if required;
- Where practical, a partial enclosure shall be used to minimise noise levels.

Management measures for the typical demolition and construction activities selected for the initial assessment to meet the highly affected noise limits (as per Section 7.3) when carried out in close proximity to the Travelodge boundary during standard construction hours are listed in Table 26.

During extended construction hours (outside of standard construction hours) it is recommended that noisy activities are carried out away from sensitive receivers and/or less intrusive activities are scheduled during these times to meet the management levels outside of standard construction hours outlined in Section 7.3. An extension of construction hours as requested will minimize the overall exposure period.

Noise emissions to the Residential Boundary on 316 King Street are expected to readily comply with the management levels if compliance at the Travelodge receiver can be achieved.

Management measures for noisy activities carried out in close proximity to the other site boundaries will be less stringent due to sensitive receivers being located further from the site.

Once the building is enclosed large attenuation will be provided by the building façade as result of the noise sources being located within an enclosed room and compliance during standard hours and outside of standard hours is expected based on typical fitout activities.

Table 26: Initial Construction Noise Impact Assessment for Activities carried out in close Proximity to the Noise Sensitive Travelodge Boundary.

Item #	Activity /Machinery	Management Measures for Activities carried out adjacent the sensitive Travelodge receiver
Demolition Activities		
1	Tracked excavator, breaking up brick foundation (121kW, 15t)	Localized barriers with acoustic absorption and overhang to be setup as close to the breaking source the breaking source, time management, activities to be carried out during less sensitive time during the day, to be carried out during standard hours (Monday to Sunday 07:00-20:00) if criteria for extended hours cannot be met (Section 7.3)
2	Jack hammers	
3	Hand-held hydraulic breaker 20kg / 69bar	
4	Backhoe mounted hydraulic breaker, breaking road surface (67kW)	
5	Tracked excavator, loading dump truck	Site access for trucks to be away from sensitive receiver, location of truck loading to be as far away from sensitive receiver as practical, time management, noisy loading activities to be carried out during standard hours (Monday to Sunday 07:00-20:00) if criteria for extended hours cannot be met (Section 7.3)

Earthworks		
6	Tracked Excavator, Ground Excavation Works (25t, 125kW)	Minimal excavation expected to be required. Time management, to be carried out during standard hours (Monday to Sunday 07:00-20:00) if criteria for extended hours cannot be met (Section 7.3)
Piling (bored piling)		
7	Crane mounted Auger	time management, to be carried out during standard hours (Monday to Sunday 07:00-20:00) if criteria for extended hours cannot be met (Section 7.3)
Construction		
8	Electric tower crane, lifting	location of crane to be as far away from sensitive receiver as practical, if crane needs to be set-up in close proximity to the receiver noisy activities will need to be time managed, to be carried out during standard hours (Monday to Sunday 07:00-20:00) if criteria for extended hours cannot be met (Section 7.3)
9	Hand-held Circular Saw (Petrol - Cutting Concrete Blocks), 3kW, 9kg	To be set up away from the sensitive receiver, if required adjacent the boundary time management or a barrier to shield the noise emissions may be required (building façade may be used as a barrier during later stages of the construction)
10	Generator, Power for Site Cabins (3kW)	To be set up away from the sensitive receiver, if required adjacent the boundary a barrier to shield the noise emissions may be required outside standard construction hours
11	Truck (>20 tonne)	Site access for trucks to be away from sensitive receiver, time management, truck movements adjacent Travelodge during standard hours (Monday to Sunday 07:00-20:00) if criteria for extended hours cannot be met (Section 7.3)
12	screw guns	Compliance expected if carried out within enclosed building
13	tile cutting	Compliance expected if carried out within enclosed building

9.3.3 Construction Noise Assessment

NDY have calculated the expected noise levels at each boundary for each phase of construction, based on assumed construction equipment and activities per phase, and permissible running times.

The calculations assume that all activities listed as operating for a particular construction phase are operating simultaneously.

The following four tables how the construction noise is proposed to comply at each of the nearby receivers, with the table showing noise control through each phase.

The tables incorporates specific noise mitigation measures to be implemented for various activities, including:

- Installation of general or localised barriers to screen construction activities from the receiver (noted with the word Screen)
- Time management of activities to reduce the noise impact.

We have also included for reference:

- The construction noise limits applicable to each receiver
- The benchmark noise levels applicable to each receiver (to allow comparison of construction noise impacts compared to the existing noise environment.

Table 27 Construction noise per phase at Commercial Receiver / South

Expected equipment list per phase	Demolition Running Time (%)	Earthworks Running Time (%)	Piling Running Time (%)	Construction Running Time (%)
Backhoe Mounted Hydraulic Breaker, breaking road surface (67kW)	17% / Screen			
Wheeled Excavator, removing broken road surface (112kW, 17t)	67% / Screen	58%		
Tracked Excavator (Loading Dump Truck	67% / Screen	17%	8%	
Tracked loader, clearing site, idling	67% / Screen			
Bored Piling, clay, 100% on-time			25%	
Electric tower crane, lifting (88kW, 22t)				33%
Electric Circular Saw, 225mm blade				33%
Generator, Power for Site Cabins (3kW)				33%
Vibratory Roller, rolling and compacting (29kW, 4t)				33%
Existing Ambient Noise levels Leq	**L2 closest commercial receiver 295 King street (South and East Boundaries) 63 – 65 dBA Daytime and evening time, 57 dBA night time**			
Boundary Noise Limits	**70 dBA**			
Expected Noise at Boundary	**69 dBA**	**70 dBA**	**70 dBA**	**70 dBA**

Table 28 Construction noise per phase at Commercial Receiver / North

Expected equipment list per phase	Demolition Running Time (%)	Earthworks Running Time (%)	Piling Running Time (%)	Construction Running Time (%)
Backhoe Mounted Hydraulic Breaker, breaking road surface (67kW)	17% / Screen			
Wheeled Excavator, removing broken road surface (112kW, 17t)	67% / Screen	100%		
Tracked Excavator (Loading Dump Truck	67% / Screen	17%	17%	
Tracked loader, clearing site, idling	67% / Screen			
Bored Piling, clay, 100% on-time			33%	
Electric tower crane, lifting (88kW, 22t)				42%
Electric Circular Saw, 225mm blade				42%
Generator, Power for Site Cabins (3kW)				42%
Vibratory Roller, rolling and compacting (29kW, 4t)				42%
Existing Ambient Noise levels Leq	**L2 closest commercial receiver 295 King street (South and East Boundaries) 63 – 65 dBA daytime and evening time, 57 dBA night time**			
Boundary Noise Limits	**70 dBA**			
Expected Noise at Boundary	**68 dBA**	**69 dBA**	**70 dBA**	**69 dBA**

Table 29 Construction noise per phase at Hotel Receiver / East (Travelodge)

Expected equipment list per phase	Demolition Running Time (%)	Earthworks Running Time (%)	Piling Running Time (%)	Construction Running Time (%)
Backhoe Mounted Hydraulic Breaker, breaking road surface (67kW)	17% / Screen			
Wheeled Excavator, removing broken road surface (112kW, 17t)	67% / Screen	67% / Screen		
Tracked Excavator (Loading Dump Truck	42%/ Screen	42% / Screen	17%	
Tracked loader, clearing site, idling	67%/ Screen			
Bored Piling, clay, 100% on-time			17% / Screen	
Electric tower crane, lifting (88kW, 22t)				25%
Electric Circular Saw, 225mm blade				25% / Screen
Generator, Power for Site Cabins (3kW)				25%
Vibratory Roller, rolling and compacting (29kW, 4t)				25%
Existing Ambient Noise levels Leq	**L2 closest commercial receiver 295 King street (South and East Boundaries) 63 – 65 dBA daytime and evening time, 57 dBA night time**			
Boundary Noise Limits	**63 dBA**			
Expected Noise at Boundary	**63 dBA**	**60 dBA**	**63 dBA**	**63 dBA**

Table 30 Construction noise per phase at Industrial Receiver / West

Expected equipment list per phase	Demolition Running Time (%)	Earthworks Running Time (%)	Piling Running Time (%)	Construction Running Time (%)
Backhoe Mounted Hydraulic Breaker, breaking road surface (67kW)	17% / Screen			
Wheeled Excavator, removing broken road surface (112kW, 17t)	67%	75%		
Tracked Excavator (Loading Dump Truck	42%	42%	42%	
Tracked loader, clearing site, idling	67%			
Bored Piling, clay, 100% on-time			42%	
Electric tower crane, lifting (88kW, 22t)				42%
Electric Circular Saw, 225mm blade				42%
Generator, Power for Site Cabins (3kW)				42%
Vibratory Roller, rolling and compacting (29kW, 4t)				42%
Existing Ambient Noise levels Leq	**L1 closest commercial receiver (West Boundary) 71 dBA daytime and evening time, 50 dBA night time**			
Boundary Noise Limits	**75 dBA**			
Expected Noise at Boundary	**75 dBA**	**75 dBA**	**75 dBA**	**75 dBA**

9.3.4 Discussion—Construction Noise Assessment

The tables above demonstrate that the most likely construction activities during each phase will be compliant with the relevant noise limits at each receiver, with basic mitigation techniques such as screening and time management. We note that many construction activities are naturally stop-start in nature, so a degree of time management is automatically achieved.

The assessment will be updated when the contractor is engaged to ensure that final construction equipment and methodologies are still compliant with the noise limits.

9.3.4.1 Construction Noise Impacts

In addition to strict compliance with construction noise limits, we note that the existing noise environment is relatively noisy compared to the construction noise, and there is therefore limited additional noise predicted from construction compared to the benchmark levels. Noise sensitive receivers in the area are already exposed to a combination of aircraft, traffic, rail, and commercial noise.

Taking the most noise sensitive receiver of the Travelodge Hotel, the construction noise is predicted to be no higher than 63 dBA (the limit for a noise sensitive receiver).

The existing background noise levels near this location have been benchmarked (discussed elsewhere in this report) at 63-65dBA during the daytime and evening hours. This shows that the existing environment is louder already than the predicted construction noise.

The area is also within the 25-30 ANEF contour due to its exposure to aircraft noise. Australian Standards and planning regulations recommend that noise sensitive buildings within this contour are designed with appropriately upgraded facades so as to protect building occupants from the loud environmental conditions.

The same building construction measures implemented due to the ANEF contours will reduce the sensitivity of the buildings to construction noise, when compared to buildings in quieter areas with low-performance facades.

For these reasons, we believe the construction noise impacts from this project will be relatively low, both because of the compliance with relevant noise limits, and the loud existing environment which in many cases is as louder or louder than the proposed construction activities.

Refer also to the following sections of this report discussing general site management, and specific complaints management procedures, to ensure that any residual impacts are tracked and managed.

9.3.4.2 Extended Hours

Extended hours of 6am to 8pm Mon-Sun are proposed for outdoor construction works. The acoustic implications of this include:

- Extended construction hours can be preferred by commercial receivers, as the extended hours ensure that more of the work is undertaken outside of commercial operating hours
- Extended construction hours also minimise the total duration of construction noise impacts, as construction can be completed quicker
- The proposed extended hours do not include outdoor construction work during critical sleeping hours of 10pm to 6am.
- Construction activities between 6am and 7am should be limited to setting-up or quieter activities, or locations distant from the Travelodge to minimise any construction noise impact before 7am.

9.3.5 Operational Vibration Impact

The following has been assumed in regards to vibration intensive equipment/activities:

- Piles to be bored.
- Ground rock breaking activities are not expected to be required due to ground conditions of sand and clay.
- Drum roller are expected to be non-vibratory.

Based on the information available at this stage, the construction activities expected to occur on the site are likely to have little to no impact on the surrounding buildings on a vibration basis. Compliance with vibration limits is expected based on ensuring ground compacting equipment is selected to adherer to minimum safe working distances.

9.3.6 General Site Management Considerations

- All employees, contractors and subcontractors are to receive an environmental induction and should instruct all persons at the site with regard to all relevant project specific and standard noise mitigation measures, including but not limited to permissible hours or work, limitation of high noise generating activities, location of nearest affected noise receivers, construction employee parking areas, designated loading/unloading areas and procedures, site opening/closing times (including deliveries) and environmental incident procedures;
- A dedicated person will form a point of contact for dissemination of general information regarding site operations. Contact persons will also be defined to receive comment or complaints from the community.

9.3.7 Consultation

- Notification: A letter to be distributed to neighbouring sites/residents in advance of the works to notify them of the nature and estimated timescales for completion of the proposed works.
- Project info-line and construction response line: A 24-hour contact point shall be provided for any complaints regarding the construction works and a project representative shall respond to all compliant as soon as possible.

9.3.8 Complaints Management

To facilitate in managing noise and vibration complaints, clearly visible signage specifying any security measures and key contact details will be erected on the perimeter of the building site.

A 24 hour contact name, phone number and email address will be provided for the resident to contact.

In addition a log sheet will be kept by the contractor to record information about each complaint associated with the works.

The contents of the log sheet will include:

- The Name Address of the Complainant.
- Time and Date of the Complaint.
- The Nature of the Complaint.
- Subsequent Details.
- Remedial Action Undertaken.

The contents of the log sheet will be regularly maintained and updated, as soon as a complaint is made.

9.4 Noise and Vibration Monitoring

Where required, the developer will engage a qualified Acoustical Consultant to assess noise and ground borne vibration levels at agreed sensitive locations at agreed intervals. It is proposed that the results of the monitoring program are prepared by the Acoustical Consultant and contractor into monitoring reports, summarising construction noise and vibration results over the subject period. These reports will be made available to the Assessing Authority as required.

Monitoring Reports should:

- Include a representative sample of typical site activities likely to occur on a day to day basis, activities causing complaints and/or any activity nominated in writing by the Assessing Authority.
- outline activities, noise levels and remedial measures undertaken.
- make recommendations on control measures available where noise or vibration levels are found to exceed the guideline prescribed limits and describe the methods to be employed to ensure ongoing compliance, such as:
  - restricted times of operation of certain noisy activities (such as pile driving) including scheduling of noisy activities to less sensitive times.
  - the use of low noise techniques, such as Pressure or Bored Piling instead of the impact driven pre-cast pile techniques.
  - provision of sound attenuating barriers, fences or acoustic enclosures.
- Define the permissible noise levels at all relevant sensitive zones.

10 ASSESSMENT OF IMPACT FROM EXTERNAL SOURCES ON THE DEVELOPMENT

10.1 Assumptions about External Construction Works and Future Increase in Traffic Volume

10.1.1 Rail

10.1.1.1 Rail Traffic Volume

ARTC have provided information about train movements and according to their records *there were 357 trains arriving/departing Botany in Nov 2018 which averages at nearly 12 freight trains per day*.

We understand *ARTC is forecasting significant growth in trains numbers once Botany line duplication is completed in early 2020s including 32 trains by 2022, 42 (2025) and 55 (2030)*. We have interpreted these numbers as trains per day. ARTC also note that *trains will also be able to pass the subject site simultaneously following completion of duplication*.

The expected growth projections will be considered in the building envelope design.

10.1.1.2 Assumptions about Rail Construction Works

We note the following information was provided by ARTC during the meeting held on 29.01.2019 at Qantas Campus:

- Rail construction currently planned December 2020 – December 2023.
- For the duplication shoring (moving) of the tracks will be carried out where there are currently two existing rail tracks (i.e. adjacent the proposed new Training Facilities). Procedures and equipment used for shoring are the same as for rail maintenance works. Ground compacting works are expected to form part of construction and maintenance. Information about equipment can currently not be provided by ARTC, however they have offered to comment if a list of equipment was sent through. Preliminary equipment will be selected mid 2019.
- Rail maintenance works have been carried out on the track across from B148 during 2018.
- Construction works will be taking place within the existing rail corridor. Centre of track to be min 3.5m from fence line.
- Referenced documents: *ARTC 2015-2024 Sydney Metropolitan Freight Strategy* (October 2015), *Port Botany - Sydney Airport Precinct Scoping Study Prepared for Infrastructure NSW* (December 2011).
- King Street to provide access to rail construction site.

We understand there is currently no information about the proposed rail construction works available. Our assessment of the impact on the adjacent proposed Qantas training facilities is based on the following assumptions unless confirmed otherwise.

- Rail construction works to only include surface works such as laying of ballast, laying and fixing of sleeper and steel rail.
- Works with high ground vibration impacts such as rock breaking, jackhammering, ground compacting with a vibratory roller may be required. A size estimate will need to be provided if vibratory rollers or similar are expected to be used.
- Pile driving or pile boring is not expected to be required.
- Road and rail construction works will be carried out at the same time.
- The following minimum distances:

Location	Approx. dist. from Rail Line/ proposed Rail Construction works*			Approx. dist. from proposed Road Construction Works*		
	EP Area / L01 Classrooms	Simulators / L03 Admin	L02 Training	EP Area / L01 Classrooms	Simulators / L03 Admin	L02 Training
Current B148	40m	36m	40m	2-5m	20m	2-5m
New	12m	32m	45m	32m	52m	65m
* We understand detailed information about the location of rail and road construction works is currently not available, our assessment will need to be reviewed when further information becomes available.						

10.1.2 Road

10.1.2.1 Road Traffic Volume

Future increase in road traffic volume is also expected when the road widening works are completed. There is currently no information available about predicted number. We recommend these are requested from RMS to be included in our design.

10.1.2.2 Assumptions about Road Construction Works

At present the construction techniques are not known in detail, we however have based our assessment on the draft construction plant and methods for *Sydney Gateway Stage 3 – Qantas Drive* (Rev 2, dated 26-6-18) provided by RMS. RMS have forwarded the following methodology description.

"*The processes to be undertaken from immediately east of building 217 are demolition, trench excavation for drainage and utilities construction, excavation for boxing out kerbs, laying of pavement layers and construction of medians, barriers and signs.*

- *Demolition of buildings and infrastructure identified as Nos 167, 171, 221, 151/203, 133 and 166 will be undertaken using traditional demolition techniques involving hydraulic hammers and rock breakers. Dust mitigation measures will be implemented and noise/vibration monitoring will be deployed to comply with planning approval requirements. If demolition of building 217 occurs when building 151/203 is still operating, methodologies will be adopted to limit the use of equipment that emits high noise and vibration levels. This will include the use of equipment with concrete shear/pulveriser attachments.*
- *Demolition is also required of existing new jersey barriers. It is envisaged that these would be saw cut and then broken out in sections by rock hammer. Alternatively a 'nibbler' may be used which generates less noise and vibration but is slower.*
- *Trench excavation is assumed in Other Than Rock (OTR) as the general geology is alluvial materials with high water table. While there are likely man made material from fill and existing redundant service pit the excavation would produce little vibration with the exception for having to break out old road pavements and stormwater pits. Backfilling of service trenches will require compaction of clean sands and fill. Where overlaid with pavement or kerb cement stabilised sands would likely be used. Compactor will likely be small man held or excavator boom mounted.*
- *Boxing out and laying kerbs and forming barriers is passive. Laying of pavements of any form will have sub grade – sub base vibrating flat drum roller compaction. Where pavements are deep lift asphalt there is comparatively more compaction effort.*

The key sources of vibration will be the rock hammer breaking concrete and the vibrating flat drum roller. These energy sources will require investigation by an experienced acoustician to estimate at what

distance from a sensitive receiver they can operate such that acceleration to an adjacent building is not detected by the occupants."

10.1.3 Travelodge Hotel

We understand Travelodge are planning construction works on their carpark in the future. Typical noise levels from construction works (similar to 10.1.4) have been considered in the assessment.

10.1.4 Typical Noise Levels of Demolition and Construction Activities (Rail and Road)

Our preliminary assessment is based on typical best practice plant noise and activity from published sources. For the assessment reference sound levels for representative equipment have been taken from the DEFRA, AS2436:2010 and NZS 6803:1999 databases. The documents include extensive databases of sound data covering trucks, excavators, hand tools and all manner of other construction equipment and activities. The ratings listed are for individual pieces of equipment at constant operation.

Generally only typical worst case plant items that are likely to result in excessive noise levels have been included for the assessment as shown in Table 31.

Table 31: Typical external noise levels of demolition and construction machinery/activity taken from DEFRA, AS2436:2010 and NZS 6803:1999 databases.

Item #	Activity /Machinery	Source	Leq Sound Pressure Level at 10m (dBA)	*RMS Reference*	*Comment*
1	Hydraulic hammer rig, pre-cast concrete piling (145kW, 5t hammer)	DEFRA, Table 3 #1	89	*hydraulic hammer*	*not expected to be required for rail works*
2a	Breaker mounted on wheeled backhoe, breaking up concrete (59kW, 7.4t)	DEFRA, Table 1 # 1	92	*rock breaker*	*not expected to be required for rail works*
2b	Tracked excavator, breaking up brick foundation (121kW, 15t)	DEFRA, Table 1 # 9	90	*rock breaker*	*not expected to be required for rail works*
3	Pulverizer Mounted on Excavator, 147kW, 30t	DEFRA, Table 1 #4	76	*equipment with concrete shear/pulveriser attachments*	*not expected to be required for rail works*
4	Hand-held Circular Saw (Petrol - Cutting Concrete Blocks), 3kW, 9kg	DEFRA, Table 4 #72	79	*Saw cut barriers*	*not expected to be required for rail works*
5a	Jack hammers	AS2436-2010, Table 1	93	*rock hammer*	*not expected to be required for rail works*
5b	Hand-held hydraulic breaker 20kg / 69bar	DEFRA, Table 1 #7	93	*rock hammer*	*not expected to be required for rail works*

6	Nibbler	No data for Nibbler available in the above referenced data bases	Online reference literature notes 76dBA at 7m	*Nibbler*	*not expected to be required for rail works*
7	Tracked excavator, trenching, 107kW, 22t	DEFRA, Table 4 # 64	75	*trench excavation*	-
8a	Tracked excavator, loading dump truck	DEFRA, Table 1 #10	85	*trench excavation, general site activity*	-
8b	Tracked loader, clearing site, idling	NZS 6803:1999, Table 2 #6	73	*trench excavation, general site activity*	-
8c	Truck (>20 tonne)	AS2436-2010, Table 1	79	*trench excavation, general site activity*	-
9	Hydraulic Vibratory Compactor (Tracked Excavator) rolling and compacting, 225kg, 193 bar, 17500N	DEFRA, Table 2 #42	78	*Man held or excavator boom mounted compactor*	-
10	Vibratory roller, rolling and compacting (29kW, 4t)	DEFRA, Table 2 #39	74	*vibrating flat drum roller*	-
12	Backhoe mounted hydraulic breaker, breaking road surface (67kW)	DEFRA, Table 5 # 1	88	*n/a*	*not expected to be required for rail works*
13	Grader, 150kW	NZS 6803:1999, Table C.9 #45	83	*n/a*	-
14	Scraper, 475kW, laden	NZS 6803:1999, Table C.9 #14	95	*n/a*	-

Please note that the documents generally only provide average Leq noise levels and do not provide much information in terms of maximum and/or peak noise levels which would give an indication of the upper limit of noise intruding on the facilities. Results of previous construction noise measurements conducted by NDY indicate that maximum levels Lmax are approx. 3dB higher than average noise levels Leq when the noisy activity is carried out non-stop during the measurement period. When there are short breaks in the noisy activity during the measurement period Lmax levels are between 5-10dB higher than average levels Leq. The difference between Lmax and Leq levels was reviewed for excavator mounted breaker breaking rock and concrete, hammer drill drilling into concrete column and concrete slab as well as grinding of speed panel.

10.2 Acoustic Survey of Noise Impact on Training Facilities

Measurements have been carried out to assess the noise environment at the proposed site which will be impacting the facilities.

10.2.1 Noise Impact from Rail and Road

The road and rail traffic noise spectrum data is based on the highest 10% percentile of the assessed 15 minute periods which have been assessed on the site over the course of the logging period. 3dB have then been added to the results to allow for an increase in road and rail traffic predicted for the future (doubling of traffic). Maximum noise levels are not expected to be affected by an increase in road and rail noise traffic, only the frequency of maximum noise level events is expected to increase.

10.2.2 Noise Impact from Aeroplanes

The data for noise from aeroplanes is based on the highest Ls,max measured out of 17 recorded plane flyovers. The measured results ranged between 75 and 83 dBA Ls,max and 2dB have been added to for tolerance.

10.2.3 Noise Impact from Construction

For the assessment of the construction noise impact (from rail, road and Travelodge carpark) the maximum values in each frequency band for the activities listed in Section 10.1.1.2 have been used. The worst case frequency spectrum was then adjusted to 5dBF above the external construction noise level criteria from the *NSW ICNG* to allow for short exceedances of the management levels as the criteria are non-mandatory. However it is expected RMS and ARTC comply with their obligation to meet the external noise management levels as per *NSW ICNG*.

10.2.4 Noise Data used for Building Envelope Assessment

Our assessment of the building envelope design has been based on the noise data information listed in Table 32.

Table 32: External Noise Spectrum for Building Envelope Design

Location	External Noise Design Spectrum [dB] over Octave Frequency Bands [Hz]								Overall Level
	63	125	250	500	1k	2k	4k	8k	
Rail and Road Traffic Noise Impact (includes occupational noise emissions from adjacent sites)									
EP Area	80	74	71	68	68	68	65	57	74 dBA Leq
Training & Admin Block Western Facade	79	73	70	67	67	67	64	56	73 dBA Leq
Training & Admin Block Eastern Facade	74	68	65	62	62	62	59	51	68 dBA Leq
Plane Noise Impact									
All Areas	87	85	85	82	80	77	73	65	85 dBA $L_{max,slow}$

10.3 Building Envelope

The layout of the facilities has been designed so spaces that are more sensitive to noise and vibration such as simulators, training rooms and admin areas are located away from the rail and road side and are shielded by

the EP block. Based on the noise impact data as per Table 32 we recommend the following provisions are made for the façade and roof design.

10.3.1 Façade

10.3.1.1 Non-glazed Façade Constructions

Non-glazed facade system should be as listed in Table 33 below.

Table 33: Non-glazed Facade Constructions

Non-glazed Façade System	Description
Facade	Solid Façade construction (Rw 48 & Rw+Ctr 45): ▪ 175mm precast panel Lightweight façade construction to Classrooms (Rw 64 & Rw+Ctr 55): ▪ 12mm cement sheet (min 17kg/m2) ▪ 90mm double studs with 90mm thermal insulation in 200mm cavity ▪ 2x13mm impact plasterboard (min 2x13kg/m2)
External Doors	▪ **Hinged Doors**: min Rw35 rating (where indicated on Façade Mark-up). ▪ **EP Door Trainer Bifold Access Doors:** min Rw35 rating. ▪ **EP Hall South Access Roller Door**: The Braselmann acoustic roller door with an Rw35* rating (*for profiles only) is acceptable for small door opening in the Southern façade of the EP Hall. ▪ **EP Hall West/EP Raft Access Roller Doors**: minimum overall noise reduction rating of Rw 31 **and** minimum 11dB reduction @ 63Hz – If selected doors do not meet acoustic requirements an allowance should be made to back the roller door with well-sealed light weight wall such as 1x13mm standard PB either side of 90mm timber studs with 50mm thermal insulation in cavity (PB lining can be replaced with an alternative lining with the same density/surface weight). – Where no acoustic data information for the roller door is available, the requirements for a backing wall can be established subject to client satisfaction and/or compliance testing during construction. ▪ **Sim Bay Access Roller Doors**: minimum overall noise reduction rating of Rw 31 **and** minimum 18dB reduction @ 63Hz – If selected doors do not meet acoustic requirements an allowance should be made to back the roller door with well-sealed light weight wall such as 1x13mm standard PB either side of 90mm timber studs with 50mm thermal insulation in cavity (PB lining can be replaced with an alternative lining with the same density/surface weight).

10.3.1.2 Glazing Requirements

We recommend installing the glazing types listed in Table 34 in order to meet the internal noise requirements outlined above. Other glazing options with similar laboratory rated transmission loss values may be suitable as well but need to be reviewed by NDY.

Table 34: Glazing Requirements

Glazing Location	Required Minimum Field Transmission Loss (dB) over Octave Band Centre Frequency (Hz)							Suggested Glazing Constructions[1)]
	63	125	250	500	1k	2k	4k	
Simulators, Entrance Areas	22	25	30	34	34	35	46	Single Glazing (Rw35): 10.38mm laminate
								(G1 and G2 also suitable)
Admin areas	28	23	29	37	41	40	47	Double glazing (Rw36): 10.38mm laminate/12 airgap/6mm float
								Double glazing with split frame (Rw 43): 10mm float/50 airgap/6mm float
								(G2 also suitable)
Classrooms	24	30	35	43	46	50	50	Double glazing with split frame (Rw 46): 13.67mm laminate/50 airgap/5mm float
1) Where skylights are proposed an allowance for a double glazed skylight system is required as per above glazing types recommended for the space.								

10.3.2 Roof

Table 35 below lists suitable roof options to mitigate the noise impact onto the facility for compliance with the internal noise criteria.

Table 35: Roof Construction Options

Room Type	Roof Construction[1)]
EP Area, Admin Area, Simulator Bays	Roof with min Rw48 & Rw+Ctr 40 rating: ▪ concrete slab construction ▪ Kingspan Option A - Rw53dB: - 0.9mm thk KingZip Linea 400 PVDF 2 RAL TBC - 205mm Halter Clip + 6mm Thermal Pad - 2 x layers 75mm thk CSR Fibretek 350 - CSR Thermoseal Vapour Barrier - 2 layers of 9mm thk CFC - 1.5mm thk RD200/750 Structural Deck ▪ Kingspan Option B - Rw52dB: - 0.9mm thk KingZip Linea 400 PVDF 2 RAL TBC - 175mm Halter Clip + 6mm Thermal Pad - 2 x layers 75mm thk CSR Fibretek 350 - CSR Thermoseal Vapour Barrier - 1.5mm thk Steel Top Hat 34mm High - 2 layers of 9mm thk CFC - 0.7mm thk Steel WA200 Liner

Room Type	Roof Construction[1)]
Classrooms[2)]	Roof with min Rw58 & Rw+Ctr 50 rating: ▪ concrete slab construction ▪ Kingspan Option A or B described above with suspended MFT ceiling as follows: - MFT with min CAC39 - Min 500mm cavity behind MFT and 75mm thermal insulation in cavity (can be to underside of roof) - minimal ceiling penetrations - lights with backing cover or hanging down lights, mech systems ducted or lined grilles
1) Absorptive treatment finishes for room acoustics as per design report. 2) Roof/ceiling constructions are subject to building vibration isolation approach.	

11 VIBRATION ASSESSMENT

11.1 Vibration Measurements

The vibration logger was set up at Location A from 5.12.2018 - 10.12.2018 and then moved to Location B from 10.12.2018 - 14.12.2018 to capture the surface vibration levels in the proposed EP area closest to the rail line and in the more sensitive simulator and training block which is set further back from the rail line.

Attended vibration measurements with rms spectrum information for human perception were conducted at Locations A, A2, B, B1 and B2.

Please refer to Figure 5 for a mark-up of the logging locations.

The vibration monitor was configured to record all events exceeding a PPV of 0.2mm/s in either direction for unattended logging in Location A, all events exceeding a PPV of 0.1mm/s in either direction for attended logging in Location A as well as for attended and unattended logging in Location B. Samples were recorded at 1-second trigger intervals.

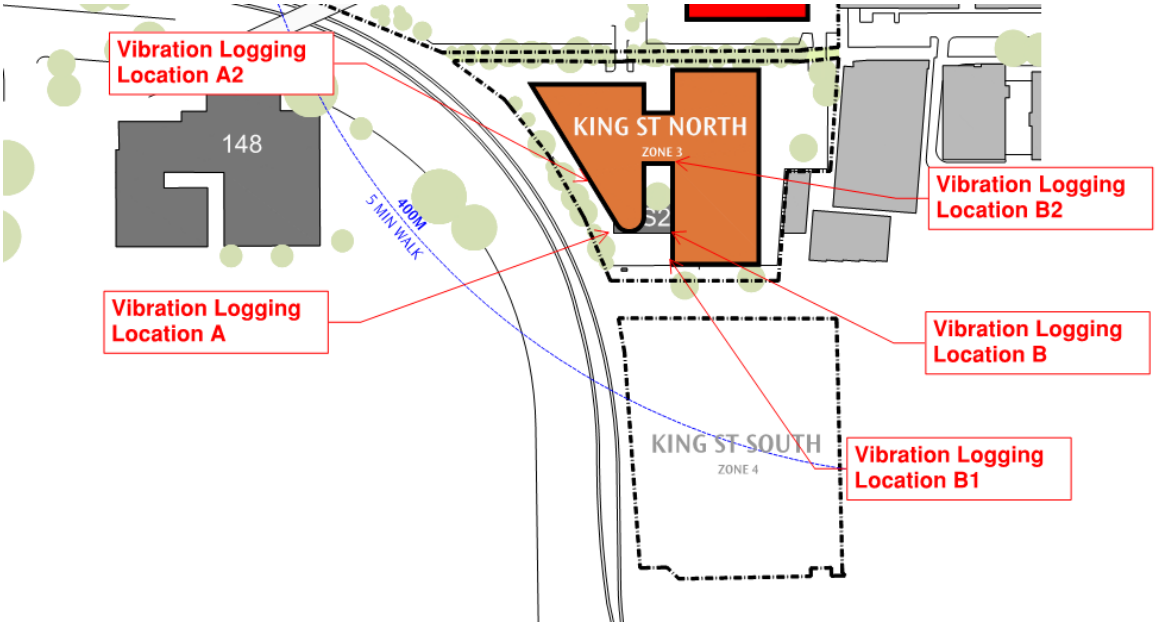

Figure 5: Vibration Measurement Locations

11.2 Structural and Equipment Integrity

The results measured in Location A are generally below 0.4mm/s PPV with a few isolated peaks up to 0.5mm/s. During attended measurements times when activities were monitored unusually high PPV values were note recorded.

The results in Location B are generally significantly below 0.3mm/s PPV with a few isolated peaks up to 0.55mm/s. During attended measurements times when activities were monitored we did not record any unusually high PPV values.

The measured results in Location A & B are generally below the criteria for the structural building integrity (50mm/s PPV) and the proposed simulator equipment integrity (3mm/s PPV).

11.3 Human Comfort

Vibration impact from the freight trains was measured on the ground at Locations A, A2, B, B1 and B2. RMS vibration measurements were conducted during the freight train passbys. A measurement at the base of Building 148 has also been added for reference.

The vibration results for the most affected vertical direction measured at the EP façade and the simulator façade are shown in the graphs below. We have plotted the rms (average) results against the rms criteria curves, for information we are also showing the maximum values in each frequency band against the curves which is looking at the highest measured levels during the assessment period.

Trucks and Trains – Location A & A2:

The measurement results for vibration from trucks and freight trains at location A and A2 are shown in Figure 6 and Figure 7 .

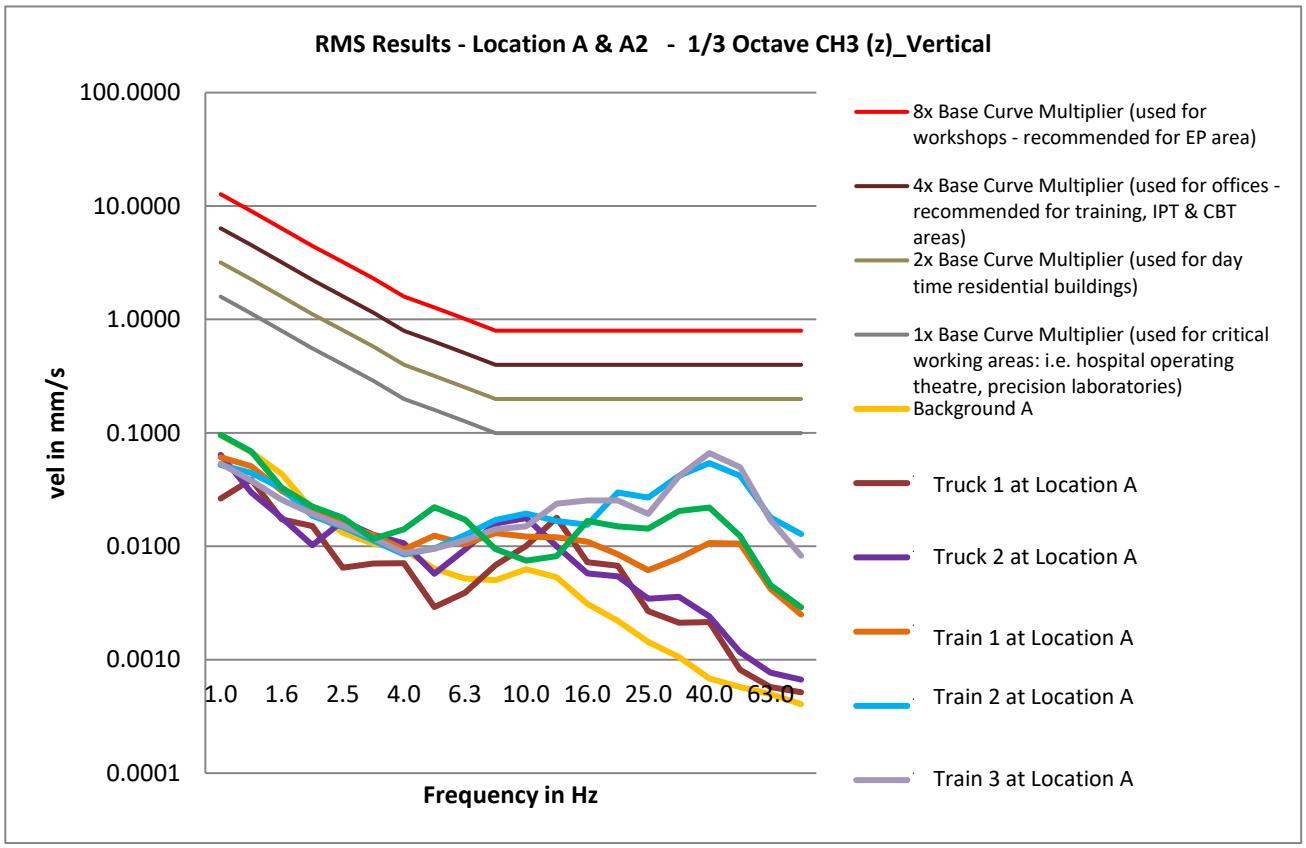

Figure 6: Vibration Measurement Results – Truck and Trains at Location A and A2 – RMS velocity

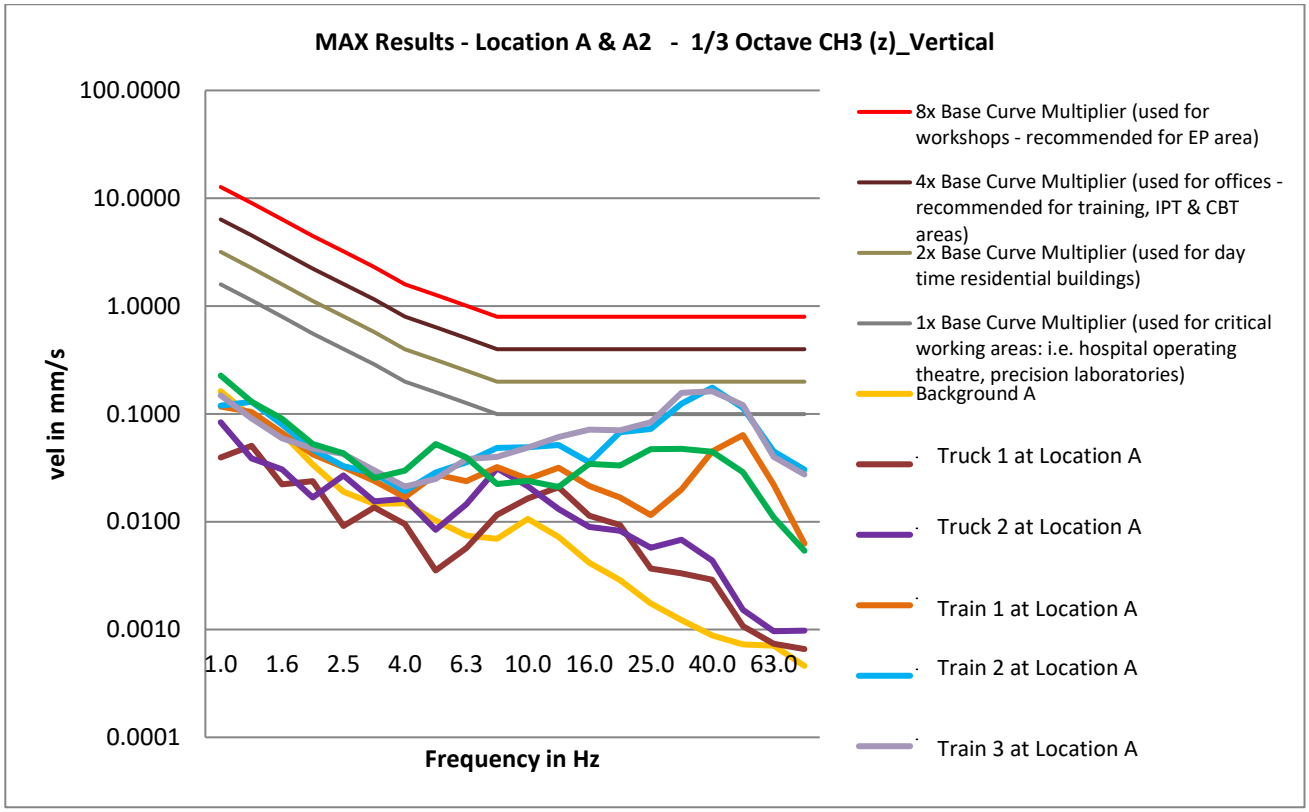

Figure 7: Vibration Measurement Results – Truck and Trains at Location A and A2 – MAX velocity (FYI)

Trucks – Location B & B1:

The measurement results for vibration from trucks at location B and B1 are shown in Figure 8 and Figure 9.

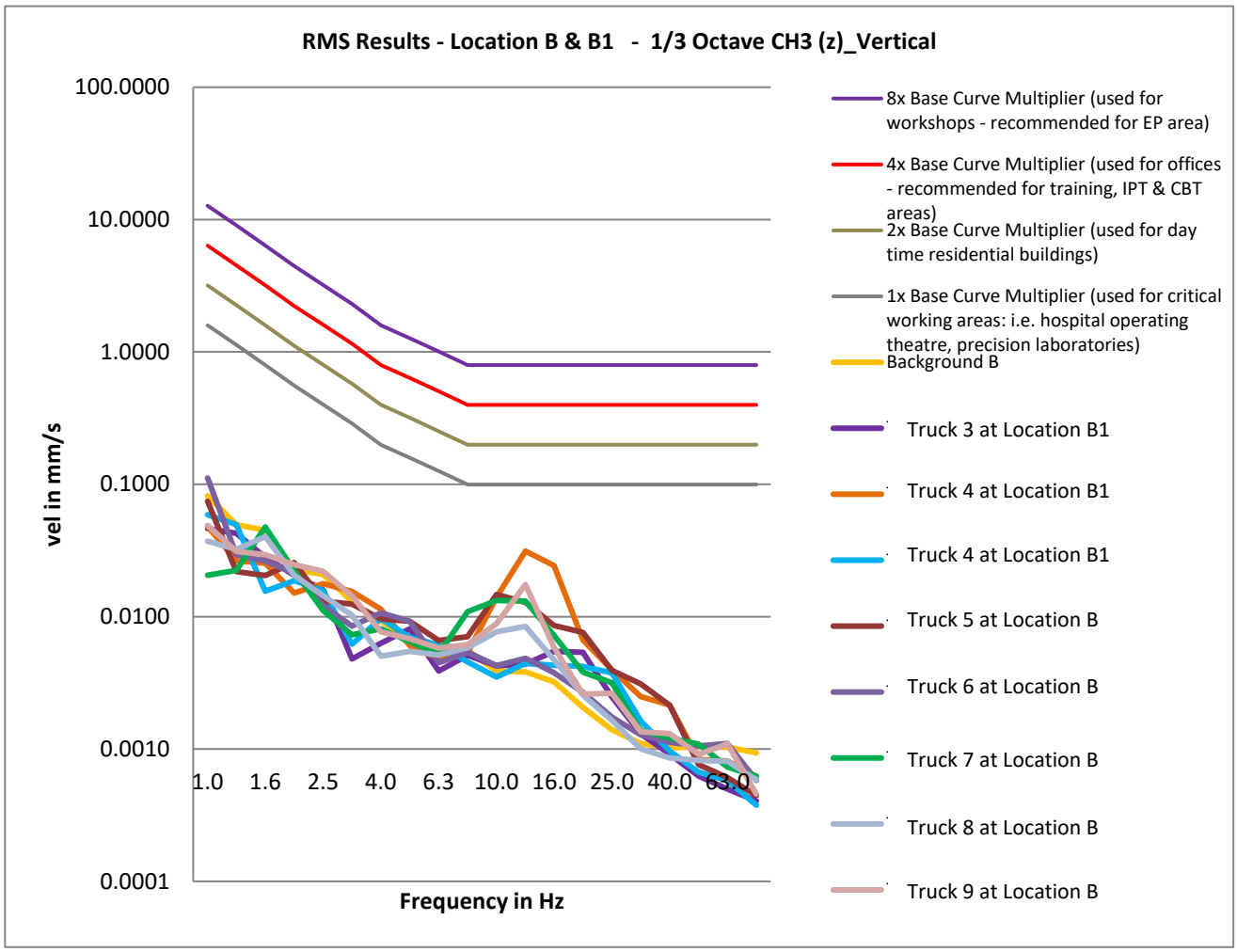

Figure 8: Vibration Measurement Results – Trucks at Location B and B1 – RMS velocity

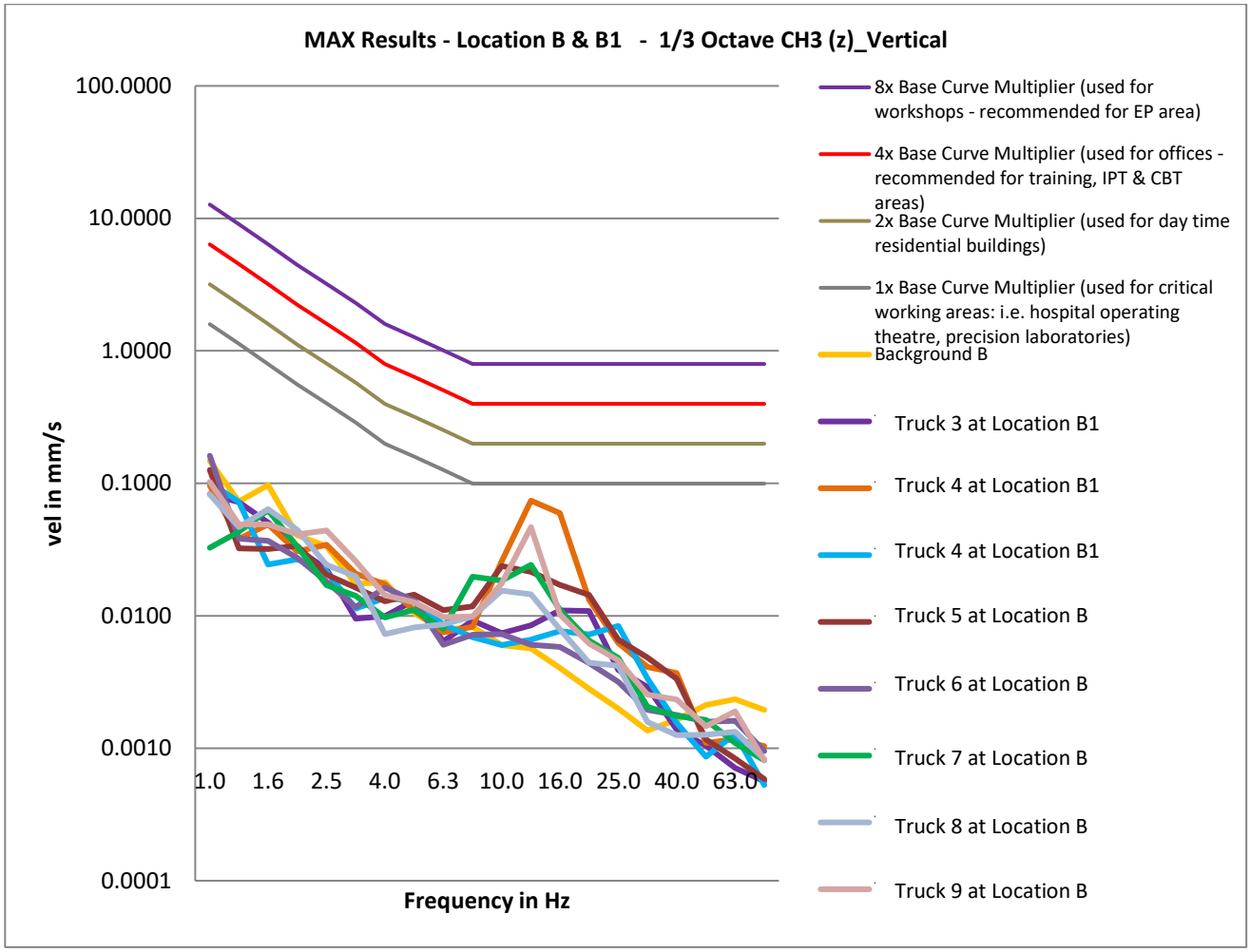

Figure 9: Vibration Measurement Results – Trucks at Location B and B1 – MAX velocity (FYI)

Train – Location B, B1 & B2:

The measurement results for vibration from trains at location B, B1 and B2 are shown in Figure 10 and Figure 11.

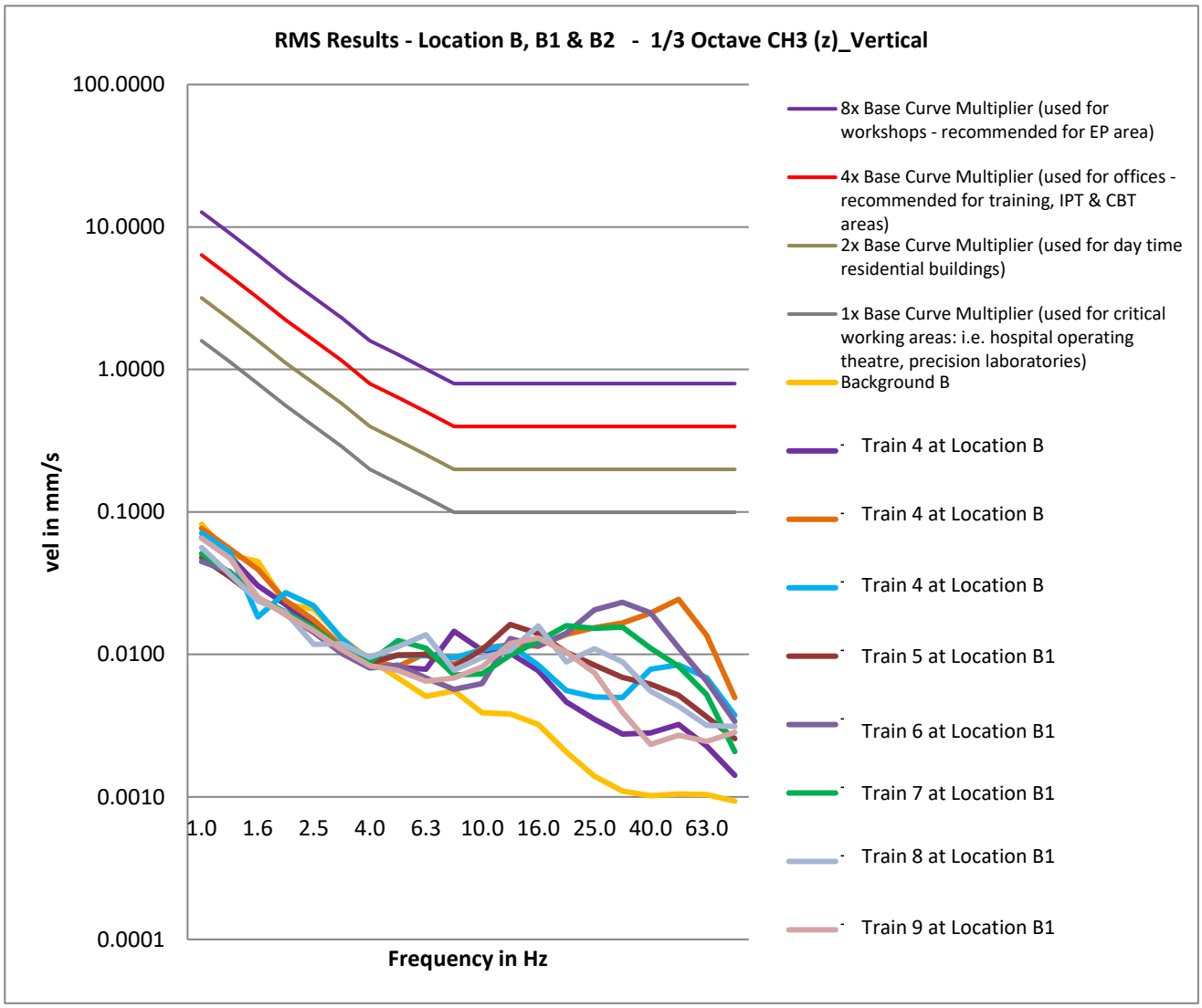

Figure 10: Vibration Measurement Results – Trains at Location B, B1 and B2 – RMS velocity

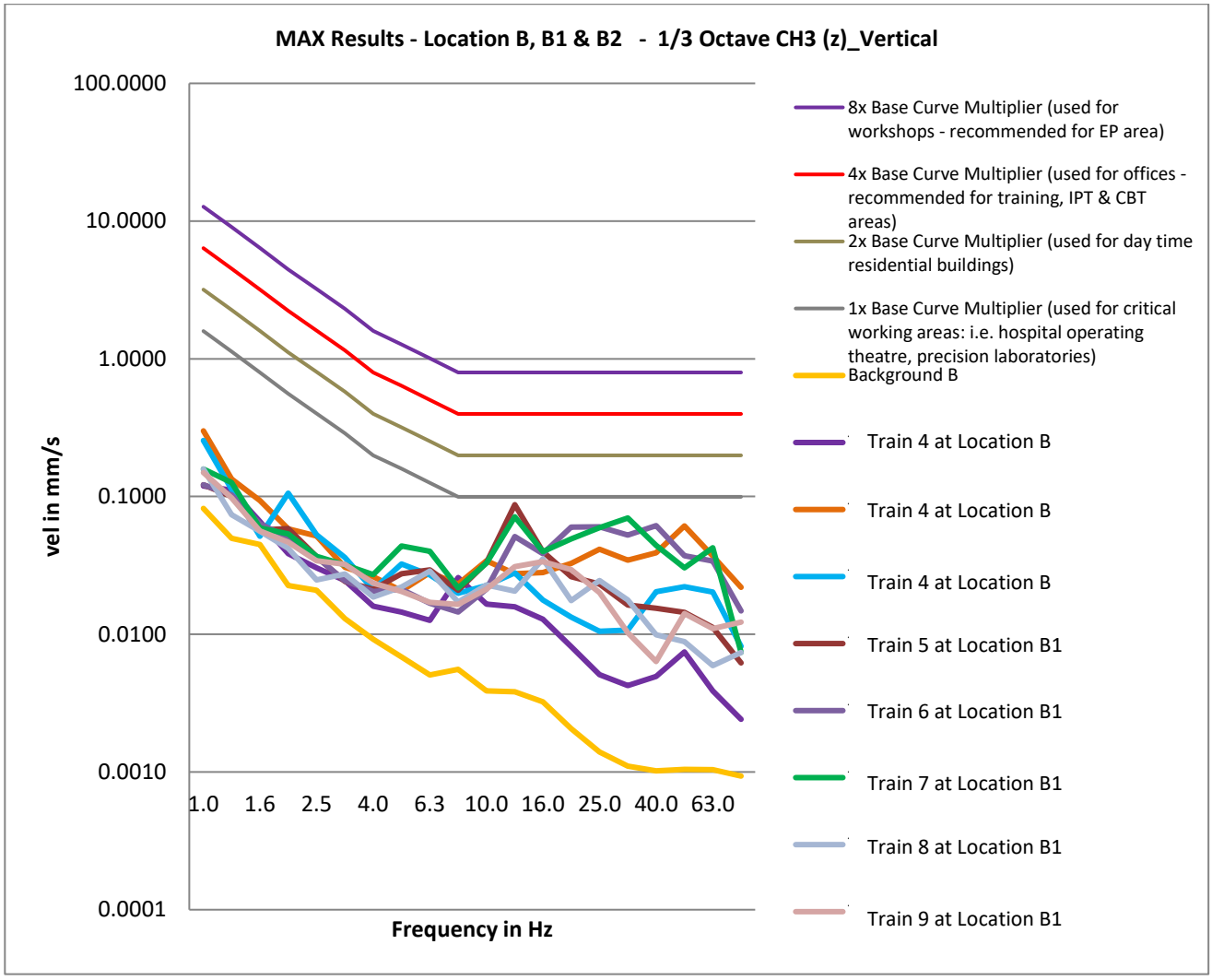

Figure 11: Vibration Measurement Results – Trains at Location B, B1 and B2 – MAX velocity (FYI)

The vibration results have been compared to the criteria curves for human perception from AS2670. Please note that the *1x Base Curve Multiplier* – Criteria is used for critical working areas such as hospital operating theatres and precision laboratories which is considered conservative. The *4x Base Curve Multiplier* – Criteria used for Offices is recommended for the training rooms, IPT & CBT areas. The 8*x Base Curve Multiplier* – Criteria used for Workshops is recommended for the EP area.

All RMS (average) results are well below the recommendation human comfort levels for the training, IPT & CBT rooms as well as the higher human comfort levels for the EP area. The conservative criteria for human comfort levels in critical working areas (i.e. hospital operating theatres, precision laboratories) is only slightly exceeded for the maximum values measured for two of the train passbys at the EP facade.

Based on the attended and unattended vibration measurement results, the train vibration is not expected to impact the human comfort of the facilities. The increase in road and rail traffic volume is only expected to increase the frequency of vibration events. Two trains passing each other may result in an increased higher vibration impact, however due to the low vibration levels currently recorded we do not expect these to exceed human comfort (Vrms) levels with increased traffic volumes in the future.

11.4 Construction Vibration

It is important to note that construction vibration levels depend on several factors. These include the activity, the machine, the geology of the ground and the distance between the building and the source. Without information on the rail construction methodology and equipment it is difficult to predict the vibration impact on the proposed Qantas Training Facilities.

Surface works are expected to have a lower vibration impact than ground compacting/breaking works.

NSW RMS give safe operating distances as per the *CNVG* for cosmetic damage to the building and for human response to vibration which has been used as a guideline at this stage. Table 36 below lists minimum safe working distances for critical equipment.

Table 36: RMS Safe Operating Distances - *Construction Noise and Vibration Guideline 2016*

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration Guideline - AVaTG)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	2 m

11.4.1 Railway Construction/Maintenance

Based on the safe working distance information provided by RMS the equipment listed in Table 37 below is expected to impact the facilities.

Table 37: Review of Vibration Impact from Rail Construction

Location (Approx. dist. from proposed Rail Construction works)	EP Area – Ground Floor & L01 Classrooms (12m)	Simulator Building - Simulators / L03 Admin (32m)	Simulator Building - L02 Training (45m)

Location	EP Area – Ground Floor & L01 Classrooms	Simulator Building - Simulators / L03 Admin	Simulator Building - L02 Training
Machinery that can cause human response	Vibratory Roller (<100kN, 2-4 tonnes) Medium Hydraulic Hammer (900kg, 12-18t excavator)	-	-
	Vibratory Roller (<200kN, 4-6 tonnes)		-
	Vibratory Roller (<300kN, 7-13 tonnes) *Vibratory Roller (>300kN, >13 tonnes)* *Large Hydraulic Hammer (1600 kg, 18-34t excavator)*		
Machinery that can cause structural damage	*Vibratory Roller (>300kN, >13 tonnes)* *Large Hydraulic Hammer (1600 kg, 18-34t excavator)*	-	-

It should be noted that the safe working distances for structural damage are between 20 and 25m for the following equipment (but not limited to) and therefore this equipment is not expected to be suitable for use in this area due to the close proximity of several existing buildings to the rail line, however confirmation from RMS and ARTC has not been provided.

- Vibratory Roller (>300kN, >13 tonnes)
- Large Hydraulic Hammer (1600 kg, 18-34t excavator)

11.4.2 Gateway Road Construction Vibration

Classrooms are proposed in the EP area on Ground Floor and L01. These classrooms are closer to the roadworks than the safe working distances for some of the equipment listed by RMS and a temporary exceedance of human comfort vibration levels may occur in these areas if the equipment as per Table 38 (or similar) are used during construction works based on the safe working distance information provided by RMS.

Table 38: Review of Vibration Impact from Road Construction

Location (Approx. dist. from proposed Road Construction works)	EP Area – Ground Floor & L01 Classrooms (32m)	Simulator Building - Simulators / L03 Admin (52m)	Simulator Building - L02 Training (65m)
Machinery that can cause human response	Vibratory Roller (<200kN, 4-6 tonnes)	-	- -
	Vibratory Roller (<300kN, 7-13 tonnes) Vibratory Roller (>300kN, >13 tonnes) *Large Hydraulic Hammer (1600 kg, 18-34t excavator)*		
Machinery that can cause structural damage	-	-	-

It should be noted that the safe working distances for structural damage are between 20 and 25m for the following equipment (but not limited to) and therefore this equipment may not be suitable to be used in this

area due to the close proximity of several existing buildings to the road construction corridor, however confirmation from RMS and ARTC has not been provided.

- Vibratory Roller (>300kN, >13 tonnes)
- Large Hydraulic Hammer (1600 kg, 18-34t excavator)

11.4.3 Assessment of Construction Vibration Impact on proposed Qantas Site

Please note that details about the rail and road construction methodologies have not been confirmed yet.

The assessments and mitigation measures to mitigate potential vibration impacts will need to be further developed and refined as the project progresses.

We have assumed that use of very heavy machinery for construction works will be restricted to all adjacent existing buildings based on the safe operating distances for building damage (see Table 36).

11.4.3.1 EP Area – Ground Floor & L01 Classrooms

The following options are available to manage a potential exceedance of human comfort levels in the Ground Floor and L1 classrooms in the EP area:

1) Temporary or one-off notified minor exceedances of human comfort vibration levels are notified and accommodated.
2) Implement vibration isolation measures in the building design (i.e. rubber bearings at the building foundations or room in room isolation).

11.4.3.2 Simulator Building - Simulators / L03 Admin

Simulators are proposed to be located at a similar distance from the rail to the existing current location. We understand rail construction activities will be similar to maintenance activities. We also understand there are currently no issues from rail maintenance on the existing facilities and have therefore assumed that there will be no issues to the new proposed facilities accordingly.

Impact from road construction vibration is expected to be low based on safe minimum working distances as per Table 36.

11.4.3.3 Simulator Building - L02 Training

Impact from rail and road construction vibration is expected to be low based on safe minimum working distances as per Table 36.

12 CONCLUSIONS

The following conclusions are based on the noise data and assumptions outlined in Section 7.4.

12.1 Operational Noise Impact

12.1.1 Changes to Traffic surrounding Public Roads

Based on the existing and development peak hour traffic flows the expected change in noise levels between the existing and future for all public road networks during day and night periods are within 2dB(A). As per the RNP an increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person.

12.1.2 Service Vehicles and Car Activities on the Site

The predicted noise level associated with the service vehicles and cars movements on site are expected to comply with boundary noise criteria at the nearest affected industrial receivers in all cases with the proposed barrier along the South-Eastern boundary line.

12.1.3 Carpark Noise

The predicted noise level associated with the multi-storey carpark are expected to comply with boundary noise criteria at the nearest affected industrial receivers in all cases.

12.1.4 Bus Movements on Site

We have assumed there are only changes to the bus routes but not the number of bus movements on site. As such, it is not expected to result in any change to the currently existing noise levels.

12.1.5 Building Services Plant Noise

Noise emissions from the equipment are expected to be treated with internally lined ductwork and/or attenuators where required.

12.1.6 Other Operational Sources

Noise emissions due to fire training activities and maintenance work have assumed to not contribute to the boundary noise emissions and have not been assessed at this stage.

12.1.7 Operational Vibration Impact

All operational activities expected to occur on this site are likely to have very little impact on the surrounding buildings on a vibration basis and will readily comply with the vibration limits.

12.2 Construction Noise and Vibration

Noise and vibration impact during the construction phase is proposed to be managed through the implementation of a detailed Construction Noise and Vibration Management plan including a quantitative assessment to be developed in the later stage of the project with the consultant team and contractor prior to the issue of a construction certificate. This will require the contractor to undertake a range of measures to ensure that noise and vibration impacts are minimised and comply with the relevant construction noise and vibration standards during the construction phase. NDY carried out an initial assessment and provided general recommendations to manage the construction noise and vibration in the Section 9 of this report.

12.3 Impact from External Sources on the Development

12.3.1 Noise Impact

The impact from current noise sources on the site has been assessed and an allowance for an increase from Gateway and Rail Duplication as well as construction noise impact from works adjacent the site has been made in the design. The building envelope has been designed to mitigate external noise levels to compliance with internal noise criteria.

12.3.2 Vibration Impact

The impact from current vibration sources on the site has been assessed and an allowance for the impact from Gateway and Rail Duplication has been considered.

Based on the attended and unattended vibration measurement results, the road and train operational vibration is not expected to impact the human comfort, equipment integrity and structural integrity of the facilities.

The potential impact from vibration due to construction adjacent the site has been assessed. Options to mitigate potential vibration impacts have been reviewed. The mitigation measures will need to be further developed and refined as the project progresses and construction methodologies for Gateway and the Rail Duplication are confirmed.

13 SEARS PROJECT RESPONSE

Table 39 summarizes the SEARs for the project:

Table 39: SEARs Project Response

Noise and Vibration SEARs	Project Response
a description of all potential noise and vibration sources during the construction and operational phases of the development, including on and off-site traffic noise	▪ Section 8 ▪ Section 10 ▪ Section 9
a noise impact assessment, including a cumulative noise impact assessment in accordance with relevant Environment Protection Authority guidelines	▪ Detailed Assessment: Section 8 – Traffic on Public Roads - Assessment Summary: Section 12.1.1, – Service Vehicles and Car Traffic on the Site - Assessment Summary: Section 12.1.2 – Bus Traffic on the Site - Assessment Summary: Section 12.1.4 – Carpark - Assessment Summary: Section 12.1.3 – Building Services Equipment - Assessment Summary: Section 12.1.5 – Other Occupational Sources - Assessment Summary: Section 12.1.6
consideration of the operational requirements of the development in relation to surrounding noise sources such as the proposed Sydney Gateway Project and the Botany Rail Duplication Project	▪ Detailed Assessment: Section 10 – Road and Rail Impact: Section 10.2.1 – Impact from Planes: Section 10.2.2 – Construction Impact from other Sites: Section 10.2.3 ▪ Assessment Summary: Section 12.3
an initial assessment of typical construction activities expected to be carried out, considering activities with justification for any requested extended construction hours *details of noise mitigation, management and monitoring measures*	▪ Initial Construction Noise and Vibration Assessment: Section 9 – Detailed assessment: Section 9.3.3

14 APPENDIX A

Graphical data for NOISE monitoring location L1:

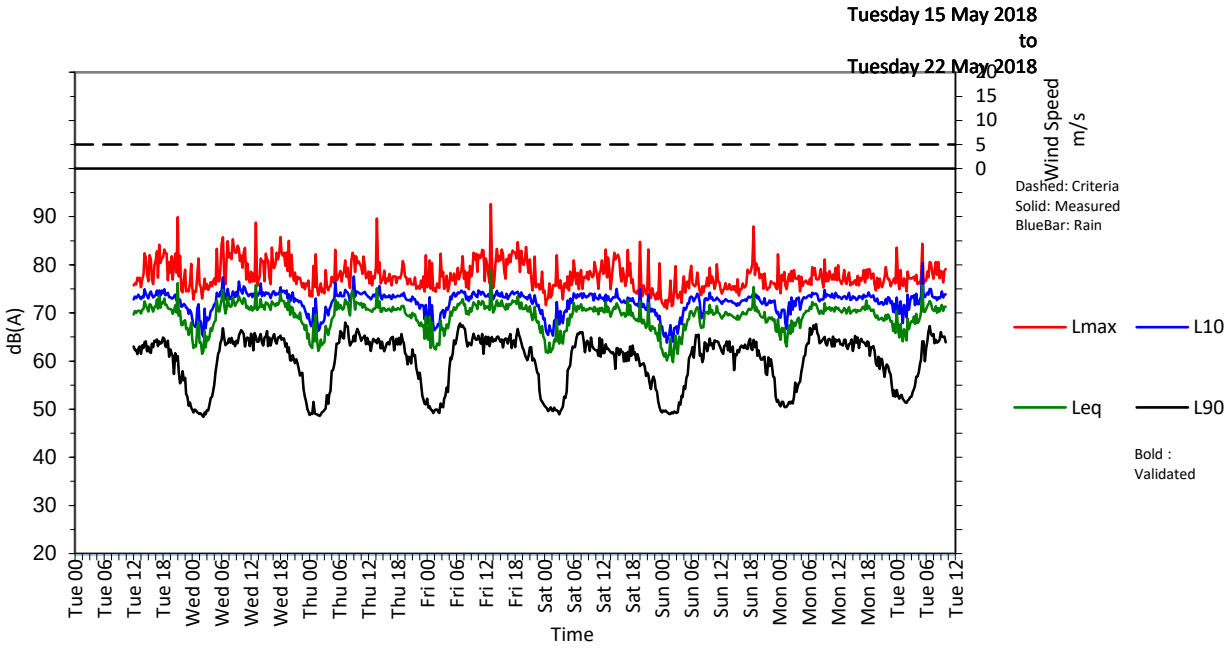

Figure 12: Qantas Jetbase B148 - unattended measured noise levels, Tuesday 15 May to Tuesday 22 May 2019

Graphical data for NOISE monitoring location L2:

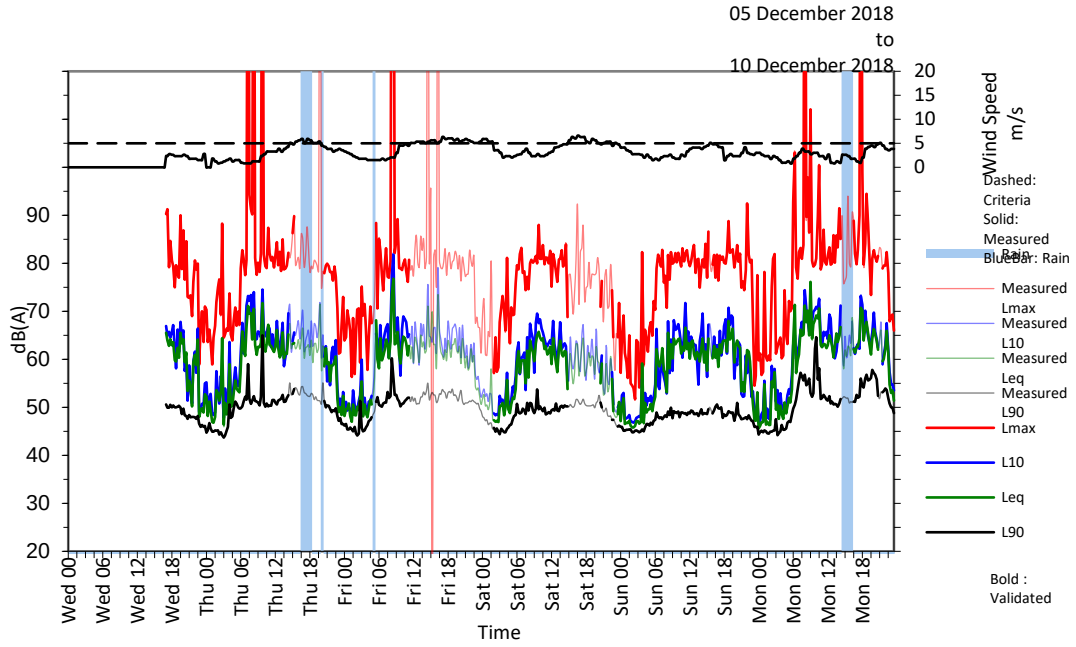

Figure 13: 295 King Street Boundary - unattended measured noise levels, Wednesday 5 to Monday 10 December 2018

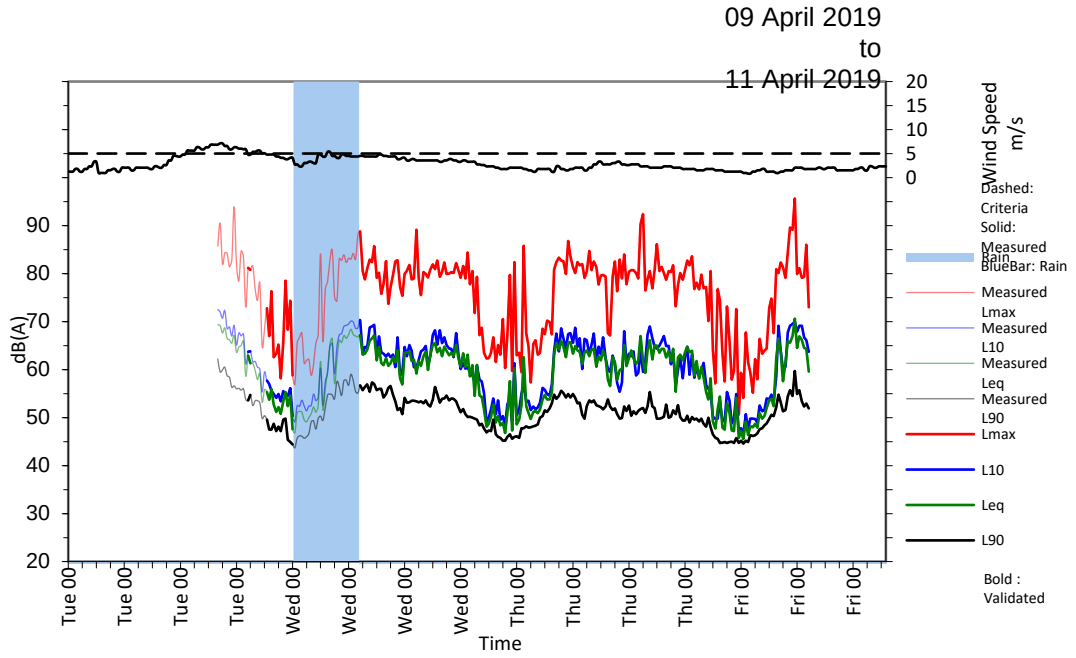

Figure 14: 295 King Street Boundary - unattended measured noise levels, Wednesday 09 April to Friday 12 April 2019

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