

TFNSW

TAP3 NORTH STRATHFIELD STATION NOISE AND VIBRATION IMPACT ASSESSMENT

NORTH STRATHFIELD STATION -
TRANSPORT ACCESS PROGRAM

SEPTEMBER 2018



Question today *Imagine tomorrow* Create for the future




TAP3 North Strathfield Station Noise and Vibration Impact Assessment North Strathfield Station - Transport Access Program

TfNSW

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

REV	DATE	DETAILS
0	04/09/2018	Draft issue
1	26/09/2018	Issue

	NAME	DATE	SIGNATURE
Prepared by:	Tom Gouvernet	26/09/2018	
Reviewed by:	Chris Marsh	26/09/2018	
Approved by:	Chris Marsh	26/09/2018	

This document may contain confidential and legally privileged information, neither of which are intended to be waived, and must be used only for its intended purpose. Any unauthorised copying, dissemination or use in any form or by any means other than by the addressee, is strictly prohibited. If you have received this document in error or by any means other than as authorised addressee, please notify us immediately and we will arrange for its return to us.



TABLE OF CONTENTS

EXECUTIVE SUMMARY	III
1 INTRODUCTION	1
1.1 PROJECT DESCRIPTION	1
1.2 SENSITIVE RECEIVERS	3
2 EXISTING ENVIRONMENT	5
2.1 NOISE MONITORING LOCATIONS	5
2.2 INSTRUMENTATION AND QUALITY CONTROL	5
2.3 UNATTENDED NOISE SURVEY	5
2.4 OPERATOR ATTENDED NOISE SURVEY	6
3 ASSESSMENT CRITERIA	7
3.1 OPERATIONAL NOISE	7
3.1.1 PROJECT INTRUSIVENESS NOISE LEVEL	7
3.1.2 PROJECT AMENITY NOISE LEVELS	7
3.1.3 PROJECT NOISE TRIGGER LEVELS	8
3.1.4 MAXIMUM NOISE LEVEL EVENT	9
3.2 CONSTRUCTION NOISE	10
3.2.1 CONSTRUCTION NOISE ASSESSMENT PERIODS	10
3.2.2 CONSTRUCTION NOISE MANAGEMENT LEVELS	10
3.3 MAXIMUM NOISE LEVELS	12
3.4 CONSTRUCTION TRAFFIC NOISE	13
3.5 VIBRATION	13
3.5.1 COSMETIC BUILDING DAMAGE	13
3.5.2 HUMAN COMFORT	14
4 CONSTRUCTION NOISE ASSESSMENT	15
4.1 NOISE MODELLING METHODOLOGY	15
4.2 ASSESSMENT SCENARIOS	15
4.3 NOISE SOURCE LEVELS	17
4.4 PREDICTED NOISE LEVELS	17
4.5 ASSESSMENT OF PREDICTED NOISE LEVELS	21
4.6 CONSTRUCTION TRAFFIC NOISE	21



5	CONSTRUCTION VIBRATION ASSESSMENT	22
6	CONSTRUCTION NOISE AND VIBRATION MITIGATION AND MANAGEMENT	23
6.1	STANDARD CONSTRUCTION NOISE AND VIBRATION MITIGATION.....	23
6.2	ADDITIONAL CONSTRUCTION NOISE MITIGATION.....	25
6.3	SITE SPECIFIC CONSTRUCTION NOISE MITIGATION	26
6.3.1	CONSTRUCTION NOISE.....	26
6.3.2	CONSTRUCTION TRAFFIC NOISE.....	27
6.4	ADDITIONAL CONSTRUCTION VIBRATION MITIGATION	27
7	OPERATIONAL NOISE ASSESSMENT	28
8	CONCLUSION.....	29

EXECUTIVE SUMMARY

WSP Australia Pty Ltd (WSP) has been engaged to undertake a noise and vibration impact assessment for the proposed North Strathfield Station Upgrade (the proposal).

The proposal is intended to improve accessibility and amenities for customers and include new lifts, walkways and upgrades to parking and vehicle access at North Strathfield Station. The potential for construction noise and vibration impacts to occur was assessed in line with TfNSW's *Construction Noise and Vibration Strategy* (CNVS) (TfNSW, 2018) and the *Noise Policy for Industry* (NPfI) (EPA, 2017) was used to assess operational noise.

Sensitive receivers for both noise and vibration were identified in the area surrounding the proposal and were organised into Noise Catchment Areas (NCAs) based on a similar noise environments within these areas.

A site survey was carried out on 1st August 2018 to establish the existing background noise levels in the areas surrounding North Strathfield station using two unattended noise monitors. The results of the survey were used to set Noise Management Levels (NML) in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECCW, 2009) and noise triggers for operational noise in accordance with the NPfI.

A total of six construction activities were assessed, with all works to be undertaken during standard construction working hours and three also requiring works to be undertaken during four 48-hour rail possessions. The total duration of work is expected to be up to 12 months.

Three dimensional computer noise modelling predicted that the NMLs are likely to be exceeded during construction activities for:

- Activities 2, 3 and 4 in all NCAs
- Activity 4 is predicted to have highly noise affected exceedances in all NCAs except 4 and 5
- Activities 1, 5, and 6 in all NCAs except NCA 4
- Representative residential receivers in NCAs 8 and 6 are predicted to be highly noise affected during most activities
- Non-residential receivers are predicted to be noise affected during most activities.

Construction traffic noise has been assessed in accordance with the *Road Noise Policy* (RNP) (EPA, 2011). Due to the small amount of construction traffic predicted, the noise increase is expected to be negligible along Concord Road. Construction traffic has the potential to exceed the night time RNP noise criteria in the event that the total forecasted daily construction traffic use this road in a one hour period.

Minimum working distances for vibration intensive plant have been outlined to comply with human comfort and cosmetic damage vibration limits.

Site specific noise mitigation measures have been recommended including:

- Limiting traffic movements along Wellbank Street during the night period
- Providing temporary barriers
- Using temporary screening or enclosures around works involving a concrete saw when used near the educational receiver to the west of the site
- Further consultation with the identified educational receiver (The McDonald College & Our Lady of the Assumption Catholic Primary School) to minimise impacts during sensitive periods and on sensitive facilities within the college.

Standard and additional noise and vibration mitigation measures have also been provided to reduce impacts on nearby sensitive receivers with reference to the CNVS.

For operational noise, the mechanical plant selections have not yet been finalised. However, it is not expected that the mechanical plant would have a significant noise impact. Any mechanical plant, equipment or other operational noise source proposed is to be designed to meet the NPfI noise triggers identified in this report.

ABBREVIATIONS

CNVS	TfNSW <i>Construction Noise and Vibration Strategy</i> 2018
dB	Decibel
dBA	A-Weighted Decibel
DEC	(NSW) Department of Environment Conservation
DECCW	(NSW) Department Of Environment, Climate Change And Water
DEFRA	UK Department For Environment, Food And Rural Affairs
EPA	(NSW) Environment Protection Authority
ICNG	<i>Interim Construction Noise Guideline</i> 2009
NPfI	<i>Noise Policy for Industry</i> 2017
NATA	National Association Of Testing Authorities
NML	Noise Management Level
PPV	Peak Particle Velocity
RBL	Rating Background Level as defined in the NPfI
RNP	<i>Road Noise Policy</i> 2011
SWL	Sound power level
TAP3	Transport Access Program Stage 3
TfNSW	Transport for NSW
VDV	Vibration Dose Value

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

Transport for New South Wales (TfNSW) proposes to provide accessibility upgrades at the North Strathfield Station (the proposal). WSP has been engaged to undertake a noise and vibration assessment for the proposal.

The proposal involves an upgrade of North Strathfield Station as part of the Transport Access Program 3 (TAP 3) which would improve accessibility and amenities for customers. Works are expected to take place over a 12-month period. Each construction activity is expected to occur within standard hours or during rail possessions, which will occur over a 48 hour period during a weekend. Around four rail possessions are expected to occur.

The proposal would include the following key elements:

The Proposal would include the following key elements:

- provision of three new lifts and associated weather canopies to allow for access to each of the station platforms and Queen Street from the existing footbridge
- footbridge connection from lift 1 from Queen Street to existing pedestrian footbridge
- upgrade of existing platform surfaces (re-grading/re-asphalting) at locations across platforms to provide compliant accessible paths and ramps to station amenities
- modifications to existing canopies to accommodate new lift on Platform 3
- installation of solar panels on existing and/or upgraded canopies Hamilton Street entrance to Platform 3
- modifications to the existing station building including:
 - upgrade of the existing unisex (ambulant) toilet
 - upgrade of the existing family accessible toilet
 - new Station Services Equipment Room
 - new staff ambulant toilet
- installation of new combined services route from Queen Street to new Station Services Equipment Room the within platform building
- upgrade to stormwater drainage connection from new lifts and associated canopies to existing stormwater system
- upgrade of the existing footpaths including widening of footpaths at the Queen Street entrance, re-grading and widening of footpaths from the Hamilton Street entrance to Platform 3
- provision of one new DDA-compliant on-street parking space and one DDA-compliant kiss-and-ride space along Queen Street to the south of the station entrance, including new kerb and ramps
- landscaping and planting works within the station precinct
- ancillary works including adjustments to lighting, electrical upgrades, electronic ticketing, new seating, improvement to station communications systems (including CCTV cameras), public address, hearing loops, wayfinding signage and installation of tactile ground surface indicators (TGSIs).

Figure 1.1 outlines the location of the proposal.



1.2 SENSITIVE RECEIVERS

The proposal has the potential to impact nearby properties that are considered sensitive to noise and vibration.

Receivers potentially sensitive to both noise and vibration in the following categories as defined in the NPfI and the ICNG have been identified in the surrounding area:

- Residential
- Commercial
- Educational institutions
- Active recreation areas.

The receivers surrounding the proposal have been categorised into NCAs based on a similar noise environments within these areas. Construction noise and vibration impacts have been assessed at representative receiver locations within each NCA. Table 1.1 presents the representative receivers for each NCA.

The Macdonald College has residential facilities for boarders, however the location of these facilities was not able to be determined through desktop review. As a result, the school has only been assessed to the educational noise management levels.

Table 1.1 NCA and classification of representative receivers

NCA	RECEIVER TYPE	ADDRESS	RECEIVER ID
1	Residential	2A Hamilton Street, North Strathfield	R1
	Commercial	13 George Street, North Strathfield	C1
	Educational	1A Hamilton Street, North Strathfield (The McDonald College & Our Lady of the Assumption Catholic Primary School)	E1
	Active recreation	17 George Street, North Strathfield	AR1
2	Residential	19-21 George Street, North Strathfield	R2
3	Residential	58 George Street, North Strathfield	R3A
	Residential	72 George Street, North Strathfield	R3B
	Residential	88 George Street, North Strathfield	R3C
4	Residential	48 George Street, North Strathfield	R4
5	Residential	53 Queen Street, North Strathfield	R5
6	Residential	73 Queen Street, North Strathfield	R6
	Commercial	81-83 Queen Street, North Strathfield	C2
7	Residential	121 Queen Street, North Strathfield	R7
8	Residential	27 Beronga Street, North Strathfield	R8

1.3 LIST OF REFERENCED DOCUMENTS

This report has been written with reference to the following documents:

- TfNSW Construction Noise and Vibration Strategy 2018 (CNVS)
- NSW EPA Noise Policy for Industry 2017 (NPfI)
- NSW DECC Interim Construction Noise Guideline 2009 (ICNG)
- NSW EPA Road Noise Policy 2011 (RNP)
- NSW EPA Assessing Vibration: a technical guideline 2005 (AVTG)

Furthermore, the following Standards are referenced in this report:

- Australian Standard AS 1055-1997- *Acoustics-Description and Measurement of Environmental Noise*
- British Standard BS 7385-2: *Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration*
- Australian Standard AS 2436:2010 - *Guide to noise and vibration control on construction, demolition and maintenance sites*
- Department for Environment Food and Rural Affairs (United Kingdom), *Update of noise database for prediction of noise on construction and open sites – Phase 3: Noise measurement data for construction plant used on quarries*
- British Standard BS 7385 *Part 2-1993 Evaluation and measurement for vibration in buildings*
- German Standard DIN 4150: *Part 3 – 1999 Structural Vibration in Buildings: Effects on Structures.*

2 EXISTING ENVIRONMENT

The prevailing background and ambient noise levels surrounding the site were determined through a combination of unattended and operator attended noise surveys in general accordance with the Australian Standard 1055-1997-*Acoustics-Description and Measurement of Environmental Noise* (AS 1055) and the NPfL.

2.1 NOISE MONITORING LOCATIONS

Two noise monitoring locations were used to characterise the existing noise environment at representative residential receivers on either side of the station, presented in Table 2.1 and shown in Figure 1.1.

Table 2.1 Noise monitoring locations

NOISE MONITORING LOCATION	SURVEY METHOD	ADDRESS
NM01	Unattended measurement and Attended measurement	50 George Street, North Strathfield
NM02	Unattended measurement and Attended measurement	145 Wellbank Street, North Strathfield

2.2 INSTRUMENTATION AND QUALITY CONTROL

The monitoring equipment was fitted with windshields and were field calibrated before and after monitoring. No significant drifts in calibration (± 0.5 dB) were noted. The weather conditions at the time of monitoring were recorded at Sydney Olympic Park (Bureau of Meteorology station number 066212), which is located approximately two kilometres east of the proposal site.

Monitoring data were excluded during periods of weather where wind speeds were greater than five metres per second or during significant rainfall that may have adversely affected the collected data.

All the monitoring equipment has a current certified calibration certificate (National Association of Testing Authorities, NATA) at the time of use. Details of all equipment used to conduct the noise survey are presented in Table 2.2. Copies of the calibration certificates can be provided upon request.

Table 2.2 Noise monitoring equipment

LOCATION	SURVEY METHOD	MANUFACTURER AND MODEL NO.	SERIAL NO.
NM01	Unattended measurement	ARL EL 316	16-207-023
NM02	Unattended measurement	Svan 958	36659
NM01and NM02	Attended measurement	Norsonic 140	1404791

2.3 UNATTENDED NOISE SURVEY

Unattended noise monitoring for background noise levels in the vicinity of North Strathfield Station were carried out by WSP between 23rd July and 1st August 2018 at NM01 and NM02.

The results are summarised in Table 2.3 and detailed daily plot of data are presented for NM01 and NM02 in Appendix A.

Table 2.3 Summary of unattended noise monitoring results

LOCATION	RATING BACKGROUND LEVEL (RBL) dBA ^{1,2}			AMBIENT NOISE LEVEL dBA $L_{eq, 15 \text{ minute}}$		
	DAY	EVENING	NIGHT	DAY	EVENING	NIGHT
NM01	48	46	41	61	60	55
NM02	44	45	41	62	61	57

- (1) Rating Background Level (RBL) The overall single-figure background level representing each assessment period (daytime/evening/night-time) as defined in the NPfI.
- (2) Time periods defined as – Day: 7am to 6pm Monday to Saturday, 8am to 6pm Sunday; Evening: 6pm to 10pm; Night: 10pm to 7am Monday to Saturday, 10pm to 8am Sunday.

2.4 OPERATOR ATTENDED NOISE SURVEY

WSP carried out operator attended measurements to characterise the noise environment and identify the contributors to the acoustic environment. Attended measurements were carried out at NM01 and NM02 Wednesday, 1st August 2018.

At NM01, the background levels were characterised by general urban hum. Ambient noise levels were influenced by traffic along George Street, bird noise, train pass-bys, and aircraft fly-overs.

At NM02, the background levels were characterised by general urban hum from distant traffic. Ambient noise levels were controlled by light traffic along Wellbank Street, with train pass-bys and aircraft fly-overs contributing.

During the surveys, the weather was noted as being dry with light wind and suitable for noise monitoring.

The results of the attended noise surveys and observations are detailed in Table 2.4.

Table 2.4 Summary of attended noise measurement results

LOCATION	TIME	dBA $L_{eq}(15min)$	dBA $L_{90}(15min)$	OBSERVATIONS
NM01	11:40am – 11:55am	60	47	Aircraft: up to 65 dBA Car pass-bys: up to 63 dBA Birds: around 50-54 dBA
NM02	12:40pm – 12:55pm	60	50	Aircraft: up to 65 dBA Car pass-bys: up to 63 dBA Distant traffic: around 47 dBA

3 ASSESSMENT CRITERIA

3.1 OPERATIONAL NOISE

Operational noise emissions from the proposal to surrounding noise sensitive areas are assessed according to the NPfI.

In assessing the impact of industrial noise sources, the NPfI requires consideration of intrusive, amenity and sleep disturbance noise impacts.

3.1.1 PROJECT INTRUSIVENESS NOISE LEVEL

Table 3.1 presents the project intrusiveness level based on the measured RBL.

Table 3.1 Established Project Intrusiveness Noise Level, residential receivers only

MONITORING LOCATION	NCA	TIME PERIOD	RBL dBA	PROJECT INTRUSIVENESS NOISE LEVEL (RBL + 5dB) dBA L _{eq} , 15 minute
NM01	1-4	Day	48	53
		Evening	46	51
		Night	41	46
NM02	5-8	Day	44	49
		Evening	44 ¹	49
		Night	41	46

(1) When evening RBL exceeds day RBL, evening RBLs are set at day RBL levels as per the NPfI

3.1.2 PROJECT AMENITY NOISE LEVELS

To limit continuing increases in noise levels, the maximum amenity noise level within an area from industrial noise sources should not normally exceed the amenity noise levels prescribed in the NPfI.

The recommended amenity noise levels 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 as follows:

Project amenity noise level = recommended amenity noise level (Table 2.2 of NPfI) minus 5 dB(A)

The amenity criteria has been established at the identified receivers based on the results of the attended and unattended noise survey. The established amenity criteria applicable to the proposal are presented in Table 3.2.

Residential receivers represented by NM01 and NM02 are classified as an urban noise environment in accordance with the NPfI as the area is generally dominated by urban hum and noise levels do not significantly reduce during the evening and night.

Table 3.2 Established Project Amenity Noise Level

TYPE OF RECEIVER ¹	RECOMMENDED AMENITY NOISE LEVEL (ANL) dBA L _{eq, period}	PROJECT AMENITY NOISE LEVEL (ANL - 5dB) dBA L _{eq, period}	PROJECT ADJUSTED ANL ² dBA L _{eq period}		
			DAY	EVENING	NIGHT
Educational	45 ³	40	40	40	40
Active recreation	55	50	50	50	50
Commercial	65	60	60	60	60
Suburban Residential (NM01&02)	Day: 60 Evening: 50 Night: 45	Day: 55 Evening: 44 Night: 40	55	45	40

- (1) Amenity levels only apply during times of use for all receivers except residential.
- (2) day: the period from 7:00 am to 6:00 pm Monday to Saturday; or 8:00 am to 6:00 pm on Sundays and public holidays; evening: the period from 6:00 pm to 10:00pm; night: the remaining periods.
- (3) A 10dB internal to external correction has been applied, in accordance with Section 2.6 of the NPfI.

3.1.3 PROJECT NOISE TRIGGER LEVELS

In assessing the noise impact of the proposal on surrounding residential receivers, both the intrusiveness and amenity criterion must be considered. The most stringent trigger level forms the project noise trigger levels (PNTL) for the development under assessment.

In order to standardise the time periods for the intrusiveness and amenity noise levels, the following conversion between L_{eq, period} and L_{eq, 15 minute} has been applied (as per Section 2.2 of the NPfI):

$$\text{dBA } L_{\text{eq, 15 minute}} = \text{dBA } L_{\text{eq, period}} + 3 \text{ dB}$$

As required in Section 2.2 of the NPfI, all project noise trigger levels and limits are expressed as L_{eq, 15 minute}, unless otherwise expressed. A summary of the PTNL applicable to this project is presented in Table 3.3.

Table 3.3 Summary of NSW Noise Policy for Industry Project Noise Trigger Levels (PNTL)

RECEIVER TYPE	TIME PERIOD ¹	NOISE LEVEL dBA L_{eq} , 15 minute		
		INTRUSIVENESS	AMENITY	PTNL
Education	When in use	-	43	43
Active recreation	When in use	-	53	53
Commercial	When in use	-	63	63
Suburban residential (NM01&02)	Day	49	58	49
	Evening	49	48	48
	Night	46	43	43

(1) Non-residential receivers trigger levels apply when the premises are in use. Day: the period from 7:00 am to 6:00 pm Monday to Saturday; or 8:00 am to 6:00 pm on Sundays and public holidays; evening: the period from 6:00 pm to 10:00pm; night: the remaining periods.

3.1.4 MAXIMUM NOISE LEVEL EVENT

The potential for sleep disturbance from maximum noise level events from the premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

As outlined in the NPfI, where the development night time noise levels at a residential location exceed the following, a detailed maximum noise level event assessment should be undertaken:

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

Table 3.4 summarises the maximum noise level event screening criteria for this project.

Table 3.4 Maximum noise level event – project screening criteria

NCA	PROVIDED SCREENING CRITERIA	ADJUSTED RBL dBA $L_{eq, 15 \text{ minute}}$	PROJECT SCREENING CRITERIA
1-4	40 $L_{Aeq, 15 \text{ minute}}$ dBA	$(41 + 5)^1$ 46	46 $L_{eq, 15 \text{ minute}}$ dBA
	52 L_{AFmax} dBA	$(41 + 15)^2$ 56	56 L_{Fmax} dBA
5-8	40 $L_{Aeq, 15 \text{ minute}}$ dBA	$(41 + 5)^1$ 46	46 $L_{eq, 15 \text{ minute}}$ dBA
	52 L_{AFmax} dBA	$(41 + 15)^2$ 56	56 L_{Fmax} dBA

- (1) RBL + 5 as outlined in the NPfI
(2) RBL + 15 as outlined in the NPfI

3.2 CONSTRUCTION NOISE

The CNVS establishes assessment methods for construction noise impacts at sensitive receivers from Transport for NSW Infrastructure and Services (TfNSW I&S) Division projects. The strategy includes reference to objectives in the ICNG.

3.2.1 CONSTRUCTION NOISE ASSESSMENT PERIODS

The CNVS assessment time periods applicable to the proposal are presented in Table 3.5.

Table 3.5 CNVG assessment periods

NAME	RBL PERIOD	TIME PERIODS
Standard Hours (SH)	Day	Monday to Friday – 7am to 6pm Saturday – 8am to 1pm Sunday/Public Holiday – Nil
OOHW Period 1	Day	Saturday - 7:00am to 8:00am and 1:00pm to 6:00pm Sunday and public holidays - 8:00am to 6:00pm
	Evening	Monday to Saturday - 6:00pm to 10:00pm
OOHW Period 2	Day	Sunday and public holidays - 7:00am to 8:00am
	Evening	Sunday and public holidays - 6:00pm to 10:00pm
	Night	All days 10:00pm to 7:00am

3.2.2 CONSTRUCTION NOISE MANAGEMENT LEVELS

A quantitative assessment requires the development of NML based on existing RBLs and a comparison of predicted construction noise levels with the NML.

Recommended standard hours represent the times of the day when receivers are likely to be less sensitive to noise impacts. Where work is proposed outside of standard hours, justification is required and more stringent NMLs apply. For all other receiver types, the NMLs only apply when the receiver is being used.

Table 3. sets out the application of the management levels for noise at residences.

Table 3.6 Application of the ICNG noise management levels for residential receivers

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

Representative RBLs for the area have been derived from noise monitoring described in Section 2. Table 3. presents the NMLs for residential receivers and Table 3. for the nearest non-residential sensitive receivers.

Table 3.7 Noise management levels at residential receivers

NCA	TIME	RBL dBA	NOISE MANAGEMENT LEVEL dBA L_{eq}, 15 minute	HIGHLY NOISE AFFECTED LEVEL dBA L_{eq}, 15 minute
NCA 1 to 4	Standard hours	48	58	75
	Out-of-hours – Day	48	53	
	Out-of-hours – Evening	46	51	
	Out-of-hours – Night	41	46	
NCA 5 to 8	Standard hours	44	54	
	Out-of-hours – Day	44	49	
	Out-of-hours – Evening	44	49	
	Out-of-hours – Night	41	46	

Table 3.8 Noise management levels for non-residential sensitive receivers

LAND USE	NOISE MANAGEMENT LEVEL (EXTERNAL) dBA L_{eq}, 15 minute
Educational	55 ¹
Active Recreation	65
Commercial (offices)	70

Note 1: An internal to external correction of 10 dB has been applied as per the ICNG

Feasible and reasonable mitigation and management measures should be implemented where NMLs are exceeded either during or outside of recommended standard hours for construction work.

3.3 MAXIMUM NOISE LEVELS

Construction noise during the night has the potential to disturb people's sleep patterns. Guidance in the ICNG and NPfI references further information in the RNP that discusses criteria for the assessment of sleep disturbance.

The RNP and the NPfI suggest a screening level of $L_{1,1min}$ dBA, equivalent to the RBL + 15 dB. Where this level is exceeded, further analysis should be carried out. Section 5.4 of the RNP then goes on to state that:

- Maximum internal noise levels below 50 to 55 dBA would be unlikely to result in people's sleep being disturbed
- If the noise exceeds 65 to 70 dBA once or twice each night the disturbance would be unlikely to have any notable health or wellbeing effects.

The guidance within the RNP indicates that internal noise levels of 50 to 55 dBA are unlikely to cause sleep awakenings. Therefore, at levels above 55 dBA, sleep disturbance would be considered likely. Assuming that receivers may have windows partially open for ventilation, a 10 dB outside to inside correction has been adopted as indicated in the NPfI. Therefore, sleep disturbance screening criteria of RBL+15 dB and L_{max} 65 dBA have been adopted in this report.

3.4 CONSTRUCTION TRAFFIC NOISE

The RNP provides guidance on the assessment of noise impacts from road traffic noise on sensitive receivers.

The RNP criteria apply to traffic generated by construction activities. The existing roads immediately surrounding the project site are a mix of sub-arterial and local roads. Arterial, sub-arterial and collector roads are assessed over day (7am-10pm) and night (10pm-7am) periods and local roads are assessed over a one hour period (typically the peak hour) within the respective day and night periods. Table 3.9 presents a summary of the applicable criteria for residences.

Table 3.9 Road traffic noise criteria for residential receivers on existing roads affected by additional traffic from land use developments

ROAD TYPE	ROAD TRAFFIC NOISE CRITERIA	
	DAY	NIGHT
Arterial/Sub-arterial/Collector	60 L _{eq} 15hr dBA	55 L _{eq} 9hr dBA
Local Road	55 L _{eq} 1hr dBA	50 L _{eq} 1hr dBA

The RNP application notes state that ‘for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dBA above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dBA of, or exceeds, the relevant day or night noise assessment criterion.’

Therefore, if the road traffic noise levels increase by more than 2 dBA as a result of the proposed construction traffic and the criteria in Table 3.9 are exceeded, investigation of mitigation options would be required.

3.5 VIBRATION

Construction vibration can lead to:

- Cosmetic and structural building damage.
- Loss of amenity due to perceptible vibration, termed human comfort.

Importantly, cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building’s structural integrity. Damage of this nature is typically described as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks, and separation of partitions or intermediate walls from load bearing walls. If there is no significant risk of cosmetic damage, then structural damage is not considered a significant risk and is not further assessed.

3.5.1 COSMETIC BUILDING DAMAGE

The CNVS presents minimum working distances based on the British Standard BS 7385-2: *Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration*. The CNVS details a general vibration screening criteria for intermittent vibration sources in Appendix A.3.4 based on BS 7385-2 as follows:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

Heritage buildings and structures would be assessed as per the screening criteria in Section A.3.4 of the CNVS as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound.

3.5.2 HUMAN COMFORT

The CNVS requires the assessment of vibration on human comfort in accordance with *Assessing Vibration – A technical guideline*.

The proposal may generate intermittent vibration during construction. The applicable criteria are shown in Table 3.10 as vibration dose value ($\text{m/s}^{1.75}$), with the proposed construction vibration limits highlighted.

Table 3.10 Vibration limits for human exposure from intermittent vibration

LOCATION	ASSESSMENT PERIOD	Vibration Dose Value ($\text{m/s}^{1.75}$)	
		PREFERRED VALUES	MAXIMUM VALUES
Residences	Daytime	0.2	0.4
	Night	0.13	0.26
Offices, schools, educational institutions, and places of worship	Anytime	0.4	0.8
Workshops	Anytime	0.8	1.6

4 CONSTRUCTION NOISE ASSESSMENT

4.1 NOISE MODELLING METHODOLOGY

A noise model was prepared using the SoundPLAN 8 Industrial Module implementing the ISO9613-2 algorithm.

A three dimensional representation of the physical environment within the project area was simulated. Modelling inputs for each scenario included ground contours, locations of sensitive receivers, noise-generating equipment as well as any other inputs which have an effect on the noise environment, such as the buildings surrounding the proposal. The model considered noise sources, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings.

The following assumptions were used in the modelling:

- All noise sources in each scenario operating simultaneously.
- All noise sources modelled at two metres from ground level.
- Topography for the area provided by SIX Maps NSW.
- NCA noise impacts assessed at the most affected receiver
- Receiver heights 1.5 metres above ground level, or at the most affected facade.

The noise modelling is considered to be conservative (worst-case as it assumes all equipment operating simultaneously at their closest point within the work area to the receivers.

4.2 ASSESSMENT SCENARIOS

The following scenarios outlined in Table 4.1 have been modelled as part of the quantitative assessment. Out-of-hours work is only expected to take place during the identified four 48-hour rail possessions.

Table 4.1 Modelling scenarios

ACTIVITY ID	STAGE	ACTIVITIES	TIMING	DURATION
1	Site establishment and enabling works	<ul style="list-style-type: none">— establishment of site compounds (i.e. erect fencing, tree protection zones, site offices, amenities and plant/material storage areas)— establishment of temporary facilities as required (e.g. temporary access stairs, temporary toilets, temporary construction lights etc.)— erect site boarding around the different work fronts at station— installation of power where required.	Standard hours or 48-hour rail shutdown	5 days

ACTIVITY ID	STAGE	ACTIVITIES	TIMING	DURATION
2	Lift works (Platforms 1, 2 and 3)	<ul style="list-style-type: none"> — removal and relocation of existing communications equipment within platform (where required) — removal of existing railings and other existing footbridge components (as required) — demolition of required areas of existing brick wall associated with platform-facing section of pavilion building to make space for the new lift shaft/entry — waterproofing (as required), installation of reinforcement, formwork and concrete to form the lift pit — erection of lift shaft structure — lift installation and commissioning — architectural fit-out around lift shaft including new weather canopies and brick façade. 	Standard hours, out-of-hour period 1 day and evening, out-of-hour period 2 day, evening, and night	45 days
3	Lift works (eastern entrance)	<ul style="list-style-type: none"> — excavation of existing garden bed to accommodate area for new lift shaft — waterproofing (as required), installation of reinforcement, formwork and concrete to form the lift pit — removal of existing railings and other existing footbridge components (as required) — erection of lift shaft structure — lift installation and commissioning — architectural fit-out around lift shaft including new weather canopies and brick façade. 	Standard hours, out-of-hour period 1 day and evening, out-of-hour period 2 day, evening, and night	45 days
4	New walkway construction	<ul style="list-style-type: none"> — demolition of existing non-compliant ramp (where required) — excavation and regrading of existing walkway areas. 	Standard hours, out-of-hour period 1 day and evening, out-of-hour period 2 day, evening, and night	45 days
5	Station building works	<ul style="list-style-type: none"> — reconfiguration of internal station building areas to allow for upgrades to existing unisex and Family Accessible Toilets 	Standard hours	60 days

ACTIVITY ID	STAGE	ACTIVITIES	TIMING	DURATION
6	Upgrades to accessible parking and kiss-and-ride	<ul style="list-style-type: none"> — regrading of existing pedestrian paths to interchange locations — installation of new kerb and ramps at the proposed kiss-and-ride and DDA-compliant car park locations — installation of relocated bike racks. 	Standard hours	60 days

4.3 NOISE SOURCE LEVELS

The nominated equipment for the construction work scenarios and the sound power level (SWL) of each item are detailed in Table 4.2. SWLs have been sourced from *AS 2436:2010 - Guide to noise and vibration control on construction, demolition and maintenance sites*, the *Department for Environment Food and Rural Affairs (United Kingdom), Update of noise database for prediction of noise on construction and open sites – Phase 3: Noise measurement data for construction plant used on quarries* (DEFRA noise database), and the CNVS.

Table 4.2 Sound power levels

ITEM	SWL dBA	ACTIVITY ID
Asphalt paving machine	106	6
Bobcat	107	1
Concrete boom/line pump	109	6
Concrete (demolition/road) saws ¹	118	2, 4, 5, 6
Concrete truck	109	6
Excavator (10 tonne)	100	2, 3, 5, 6
Generator	103	1
Grinders	105	5
Hand tools	102	1, 2, 3, 4, 5, 6
Hi-rail truck	103	2, 3, 4
Impact wrenches	111	2, 3
Jack hammers	113	2, 4, 5, 6
Lighting tower	80	5
Trucks (medium rigid), including high rail dump trucks (rubber tyre)	103	1, 5, 6

(1) A +5 penalty has been applied for special audible characteristics as per the CNVS

4.4 PREDICTED NOISE LEVELS

The predicted noise levels for each scenario are presented in Table 4.3 outlining the noise level within each NCA for each representative receiver type. Predicted noise levels at buildings within each NCA is presented in Appendix B.

The maximum noise level assessment for sleep disturbance is presented in Table 4.4. The predicted noise levels have been assessed at the closest affected representative receiver within each NCA.

The calculations are conservative as they include all equipment operating simultaneously at their closest point to the receiver in a worst case 15-minute period. Actual noise levels from the construction site would be expected to be lower. Where a predicted noise level exceeds a less stringent management level, it follows that the more stringent management levels are also exceeded.

The formatting within the construction noise assessment tables indicates the following:

- The **orange shaded cells** show exceedances of the standard hours day period.
- The **yellow shaded cells** show exceedances of the out-of-hours day period.
- The **green shaded cells** show exceedances of the out-of-hours evening period.
- The **blue shaded cells** show exceedances of the out-of-hours night period.
- The **cells with red text** show exceedances of highly noise affected noise management levels.

Where a predicted noise level exceeds a less stringent management level, it follows that the more stringent management levels are also exceeded.

The formatting within the sleep disturbance maximum noise level table indicates the following:

- The **grey shaded cells** show exceedances of the RBL + 15 screening criteria.
- The **blue shaded cells** show exceedances of the L_{max} screening criteria.

Table 4.3 Predicted construction noise levels

NCA	RECEIVER ID	RECEIVER TYPE	NOISE MANAGEMENT LEVEL (NML)				ACTIVITY PREDICTED NOISE LEVEL dBA L _{eq} , 15 minute					
			STANDARD HOURS	OUT-OF-HOURS DAY	OUT-OF-HOURS EVENING	OUT-OF-HOURS NIGHT	ACTIVITY 1	ACTIVITY 2	ACTIVITY 3	ACTIVITY 4	ACTIVITY 5	ACTIVITY 6
1	E1	Educational	55	55	-	-	87	> 90	68	> 90	85	75
	R1	Residential	58	53	51	46	79	77	61	> 90	74	74
	C1	Commercial	70	70	70	70	71	73	61	85	66	72
	AR1	Active Recreation	65	65	65	65	80	> 90	64	> 90	86	73
2	R2	Residential	58	53	51	46	65	65	52	79	66	62
3	R3A	Residential	58	53	51	46	61	60	43	75	68	68
	R3B	Residential	58	53	51	46	56	68	53	70	70	65
	R3C	Residential	58	53	51	46	60	50	36	74	50	47
4	R4	Residential	58	53	51	46	48	62	46	60	55	57
5	R5	Residential	54	49	49	46	59	71	57	72	70	73
6	R6	Residential	54	49	49	46	76	75	66	88	74	90
	C2	Commercial	70	70	70	70	79	76	68	> 90	75	> 90
7	R7	Residential	54	49	49	46	62	69	58	76	74	68
8	R8	Residential	54	49	49	46	61	64	52	75	67	62

Note 1: Activity descriptions are outlined in Section 4.2, and noise management level periods in Table 3.5

Note 2: Activities 1, 2, 3 and 4 occur during Standard Hours and Out-Of-Hours Works. Activities 5 and 6 only occur during Standard Hours.

Table 4.4 Predicted sleep disturbance assessment

NCA	RECEIVER ID	NOISE MANAGEMENT LEVEL (NML)		ACTIVITY PREDICTED MAXIMUM NOISE LEVEL L _{max} dBA			
		RBL +15 SCREENING CRITERIA	MAXIMUM NOISE LEVEL EVENT	ACTIVITY 1	ACTIVITY 2	ACTIVITY 3	ACTIVITY 4
1	R1	56	65	87	85	69	> 90
2	R2	56	65	73	73	60	87
3	R3A	56	65	69	68	51	83
	R3B	56	65	64	76	61	78
	R3C	56	65	68	58	44	82
4	R4	56	65	56	70	54	68
5	R5	56	65	67	79	65	80
6	R6	56	65	84	83	74	> 90
7	R7	56	65	70	77	66	84
8	R8	56	65	69	72	60	83
9	R9	56	65	87	85	69	> 90

Note 1: Activity descriptions are outlined in Section 4.2, and noise management level periods in Table 3.5

4.5 ASSESSMENT OF PREDICTED NOISE LEVELS

During the majority of the construction activities, the predictions indicate that construction noise levels could significantly impact the closest receivers. This is expected to occur during the worst case 15 minutes when works are carried out during standard hours or rail possessions. These impacts include exceedance of noise management levels, highly noise affected properties, and in some cases sleep disturbance. However, works are expected to take place intermittently over a 12-month period, so these exceedances will not occur continuously over the duration of the proposal. Out of hours works generally should only take place during rail possessions (occurring over a 48 hour period on a weekend) with only four rail possessions expected to occur over the duration of the proposal.

The predictions are based on a worst case 15-minute period. As these predictions are highly conservative and it is understood that the proposed works are short term in nature, actual noise levels from the construction site are expected to be lower.

During standard hours work activities 5 and 6 (Station building works and parking upgrades respectively), exceedances are predicted to occur at representative residential receivers in all NCA, except NCA 4, by greater than 30 dB. The residential representative receiver at NCA 6 is predicted to be highly noise affected during activities 1 (site establishment) and 6 (parking upgrades), and NCA 1 is predicted to be highly noise affected during activity 1.

Predicted noise levels indicate exceedances of standard hours and out-of-hours NMLs at all NCA residential representative receivers during activities 1, 2, and 4 (Site establishment, lift works within at platforms and new walkway construction).

Activity 3 (Lift works adjacent to Queen Street) is predicted to cause exceedances at all NCAs during out-of-hours works, with the exception of NCA 3.

Activity 4 (new walkway construction) is predicted to cause the greatest exceedances of night time NMLs, with exceedances of greater than 30 dB at NCA 1. All other NCAs, except NCA 4 and 5, are predicted to be highly noise affected during activity 4.

Maximum noise level exceedances are predicted to occur during all out-of-hours work activities at all NCAs, with the exception of R3A, R3C, and R4 during activity 3.

All non-residential representative receivers assessed are predicted to exceed NMLs during all activities. NMLs only apply when the premises are in use and therefore the premises would only be impacted when it is occupied.

4.6 CONSTRUCTION TRAFFIC NOISE

The potential for noise impacts to occur due to light and heavy vehicle movements on public roads generated by the construction work has been assessed.

A screening calculation in line with the Calculation of Road Traffic Noise (CoRTN, Welsh Office 1988) was undertaken to predict noise impacts due to vehicle movements on public roads. Construction traffic is expected to travel along Wellbank Street and Concord Road to reach the project site. A scenario of 10 heavy vehicle and 20 light vehicle movements generated by the construction work occurring within a one hour period was assessed. These vehicles were assumed to be travelling at 50 kilometres per hour. The screening calculation indicated that noise levels from the construction traffic along Concord Road would be able to meet the RNP criteria.

Along Wellbank Street, in the event that all of the vehicles travel down Wellbank Street in one hour, exceedance of the RNP night time criteria for local roads affected by traffic generating developments would likely occur. In order to not cause an increase of more than 2 dB above existing noise levels, vehicle movements from construction would need to be limited to 17 light vehicles and three heavy vehicles or a traffic flow of equivalent noise level.

5 CONSTRUCTION VIBRATION ASSESSMENT

Certain construction activities would require the use of vibration intensive equipment that may affect the nearest sensitive receivers. The vibration intensive plant nominated as part of the work is jack hammering (Activities 2, 4, 5, and 6 – lift construction, walkway construction, station building works and parking upgrades).

Table 5.1 presents the indicative minimum working distances for the nominated construction plant to minimise the risk of structural damage and human comfort for sensitive receivers, based on the data provided in the CNVS.

The minimum working distances are based on the typical distance from receivers' work permitted to be carried out to meet the limits set out in Section 3.5. The distances are indicative only and results may vary depending on the activity, equipment, local ground, and receiver conditions.

Table 5.1 Recommended minimum working distances for vibration intensive plant

PLANT ITEM	RATING/ DESCRIPTION	MINIMUM WORKING DISTANCE	
		COSMETIC DAMAGE	HUMAN RESPONSE
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

If minimum working distances are complied with, no adverse impacts are expected for cosmetic damage or human response on nearby sensitive receivers. If works occur within these minimum working distances, mitigation measures outlined in Section 6 should be considered.

6 CONSTRUCTION NOISE AND VIBRATION MITIGATION AND MANAGEMENT

6.1 STANDARD CONSTRUCTION NOISE AND VIBRATION MITIGATION

The CNVS outlines standard measures for mitigating and managing construction noise and vibration to be implemented across all TfNSW I&S construction projects where reasonable and feasible. These standard measures are outlined in Appendix C.

Prior to commencement of works, a Construction Noise and Vibration Management Plan (CNVMP) would be prepared and implemented in accordance with the requirements of the Interim Construction Noise Guideline and Construction Noise and Vibration Strategy. The CNVMP would take into consideration measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable.

The CNVMP would outline measures to reduce the noise impact from construction activities. Reasonable and feasible noise mitigation measures which would be considered, include:

- avoiding any unnecessary noise when carrying out manual operations and when operating plant
- ensuring spoil is placed and not dropped into awaiting trucks
- avoiding/limiting simultaneous operation of noisy plant and equipment within discernible range of a sensitive receiver where practicable
- switching off any equipment not in use for extended periods e.g. heavy vehicles engines would be switched off whilst being unloaded
- avoiding deliveries at night/evenings wherever practicable
- no idling of delivery trucks
- keeping truck drivers informed of designated vehicle routes, parking locations and acceptable delivery hours for the site
- minimising talking loudly; no swearing or unnecessary shouting, or loud stereos/radios onsite; no dropping of materials from height where practicable, no throwing of metal items and slamming of doors.
- maximising the offset distance between noisy plant and adjacent sensitive receivers and determining safe working distances
- using the most suitable equipment necessary for the construction works at any one time
- directing noise-emitting plant away from sensitive receivers
- regularly inspecting and maintaining plant to avoid increased noise levels from rattling hatches, loose fittings etc
- using non-tonal reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms for all plant used regularly onsite (greater than one day), and for any out of hours works
- use of quieter and less vibration emitting construction methods where feasible and reasonable.

The most applicable management measures are outlined as follows:

- Construction hours and scheduling
 - Works would generally be carried out during standard construction hours (i.e. 7.00 am to 6.00 pm Monday to Friday; 8.00 am to 1.00 pm Saturdays). Any works outside these hours may be undertaken if approved by TfNSW and the community is notified prior to these works commencing. An Out of Hours Work application form would need to be prepared by the Contractor and submitted to the TfNSW Environment and Planning Manager for any works outside normal hours.
- Respite periods
 - Where the $L_{Aeq} (15\text{minute})$ construction noise levels are predicted to exceed 30 dB above the Rating Background Level and/or 75 dBA at nearby affected sensitive receivers, respite periods would be observed, where practicable, and in accordance with the CNVS. This would include restricting the hours that very noisy activities can occur.
- Vibration monitoring
 - To avoid structural impacts as a result of vibration or direct contact with structures, the proposed works would be undertaken in accordance with the safe work distances and attended vibration monitoring or vibration trials would be undertaken where these distances are required to be challenged
 - Vibration resulting from construction and received at any structure outside of the project would be managed in accordance with:
 - for structural damage vibration - British Standard *BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings* and for structurally unsound heritage items German Standard *DIN 4150: Part 3 – 1999 Structural Vibration in Buildings: Effects on Structures*.
 - for human exposure to vibration the acceptable vibration - values set out in the *Environmental Noise Management Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006) which includes British Standard *BS 6472:1992 Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*.
 - Property conditions surveys would be completed prior to any vibration intensive work being carried out at or within the minimum distances set out in the CNVS. Where a heritage item is determined to be structurally unsound and a reassessment of the minimum working distances would be required. Minimum working distances should be confirmed prior to carrying out any vibration intensive work on site.

Table 6.1 provides indicative benefits of typical engineering control mitigation measures for construction activities, based on guidance in AS 2436 and experience on similar construction projects.

Table 6.1 - Indicative noise reduction from construction controls

ENGINEERING CONTROLS	POSSIBLE NOISE BENEFIT, dBA
Portable temporary screens	5-10
Screen or enclosure for stationary equipment	10-15
Maximising the offset distance between noisy plant items and sensitive receivers.	3-6
Avoiding using noisy plant simultaneously and/or close together, adjacent to sensitive receivers.	2-5
Orienting equipment away from sensitive receivers.	3-5
Carrying out loading and unloading away from sensitive receivers.	3-5
Using noise source controls, such as the use of residential class mufflers, to reduce noise from all plant and equipment including bulldozers, cranes, graders, excavators and trucks	5-10
Selecting site access points and roads as far as possible away from sensitive receivers	3-6

6.2 ADDITIONAL CONSTRUCTION NOISE MITIGATION

Where all reasonable and feasible standard mitigation measures have been applied and exceedances are still predicted to occur, the CNVS provides guidance on additional mitigation measures to be implemented for each receiver depending on how far the predicted noise level is above the RBL and NML. Additional mitigation measures and their associated acronyms are outlined in Appendix C. Table 6.2 outlines when to implement the additional noise management measures.

Table 6.2 Implementation of additional mitigation measures

CONSTRUCTION HOURS	RECEIVER PERCEPTION	dBA ABOVE RBL	dBA ABOVE NML	ADDITIONAL MITIGATION MEASURES ¹
Standard Hours	Noticeable	5 to 10	0	-
Monday-Friday (7am-6pm)	Clearly audible	> 10 to 20	< 10	-
Saturday (8am-1pm)	Moderately intrusive	> 20 to 30	> 10 to 20	PN, V
	Highly intrusive	> 30	> 30	PN, V
	75dBA or greater	N/A	N/A	PN, V, SN
OOHW Period 1	Noticeable	5 to 10	< 5	-
Monday-Friday (6pm-10pm)	Clearly audible	> 10 to 20	5 to 15	PN
Saturday (7am-8am, 1pm-10pm)	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO
Sunday/PH (8am-6pm)	Highly intrusive	> 30	> 25	PN, V, SN, RP ² , DR ²
OOHW Period 2	Noticeable	0 to 10	< 5	PN
Monday-Saturday (12am-7am, 10pm-12am)	Clearly audible	> 10 to 20	5 to 15	PN, V
Sunday/PH (12am-8am, 6pm-12am)	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RP, DR
	Highly intrusive	> 30	> 25	PN, V, SN, AA, RP, DR

(1) Acronyms are defined in Appendix C, Additional Mitigation Measures

(2) Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only

6.3 SITE SPECIFIC CONSTRUCTION NOISE MITIGATION

6.3.1 CONSTRUCTION NOISE

Due to the large number of highly noise affected NCAs, the following site specific construction noise mitigation measures should be considered:

- During site establishment (activity 1), temporary barriers should be erected to ensure that work would be conducted behind temporary hoardings/screens wherever practicable. The installation of construction hoarding would take into consideration the location of sensitive receivers to ensure that 'line of sight' is broken, where feasible. This has the potential to reduce noise levels between 5 and 10 dB.
- During platform lift works, new walkway construction, station building works, and upgrades to parking and kiss-and-ride (activities 2, 4, 5, and 6), use of the concrete saw is the main contributor to construction noise. The concrete saw is a particularly loud construction plant item which produces a noise the ICNG identifies as an 'annoying characteristic' and incurs a +5 dB penalty. Without the concrete saw, the total activity noise level is reduced by 8-10

dB. It is recommended that the use of the concrete saw is limited where possible, and works are undertaken during standard hours and avoid sensitive time periods.

- When a concrete saw is to be used near the educational receiver E1, it is recommended that a temporary screen or enclosure (10-15 dB reduction) is placed around the works in conjunction with temporary barriers. The educational receiver E1 may have particularly noise sensitive facilities, such as recording studios and performance theatres. It would also likely be more sensitive during certain times of the day such as during lessons or when these facilities are in use. Therefore, further consultation should be undertaken to determine feasible construction periods and inform construction staging with respect to minimising impacts on the education facility. As much as reasonably possible noise intensive construction works in the vicinity of affected educational buildings are to be minimised.
- Application of the above mitigation measures has the potential to reduce the magnitude of exceedances during the activity with the greatest noise impact (activity 4) by up to 14 dB during standard hours and up to 26 dB during out-of-hours works at the most affected receiver, with no highly noise affected receivers predicted.

6.3.2 CONSTRUCTION TRAFFIC NOISE

Construction traffic along Wellbank Street has the potential to exceed night time RNP criteria. Therefore, it is recommended that traffic along Wellbank street during the night is controlled in the Construction Noise and Vibration Management Plan.

6.4 ADDITIONAL CONSTRUCTION VIBRATION MITIGATION

Where vibration intensive activities occur within the minimum working distances, all reasonable and feasible standard mitigation measures have been applied, and exceedances of vibration management levels are expected, the CNVS provides guidance on additional mitigation measures to be implemented for each receiver. Additional mitigation measures and the associated acronyms are outlined in Appendix C. Table 6.3 outlines how to implement the additional noise management measures.

Table 6.3 Implementation of additional vibration mitigation measures

CONSTRUCTION HOURS	RECEIVER PERCEPTION	ABOVE VIBRATION LIMIT	ADDITIONAL MITIGATION MEASURES ³
Standard hours	Human disturbance	> HVML ¹	PN, V, RO
	Building damage	> DVML ²	V, AC
OOHW Period 1	Human disturbance	> HVML ¹	PN, V, SN, RO, RP, DR
	Building damage	> DVML ²	V, AC
OOHW Period 2	Human disturbance	> HVML ¹	PN, V, SN, RO, AA, RP, DR
	Building damage	> DVML ²	V, AC

- (1) Human vibration management level – see maximum vibration dose values for human comfort outlined in Section 3.5
- (2) Damage vibration management level – see screening criteria for cosmetic damage outlined in Section 3.5
- (3) Acronyms are outlined in Appendix C

7 OPERATIONAL NOISE ASSESSMENT

With the exception of the proposed reconfiguration, the operation of North Strathfield Station would remain unchanged as a result of the proposal. There would be no expected changes to operational rail and hence, this has not been assessed.

During the operation of the proposal, there may be minor changes to the provision of a new kiss-and-ride area on Queen Street, however this is not expected to significantly change noise emissions.

New plant and equipment associated with the upgrade to North Strathfield Station would include three new lifts, and equipment for the Family Accessible Toilet.

Operational noise from the proposal would need to be designed to meet the NPfI noise goals presented in Section 3.1. Mechanical plant details are yet to be finalised. It is expected however that mechanical noise emissions would not have a significant impact on the surrounding environment, and that the use of standard controls such as quiet plant selection, and duct lining and/or attenuators, will allow mechanical plant noise to be reduced to acceptable levels.

If required, operational noise emissions shall be addressed during the detailed design phase in order to comply with operational noise criteria as per the NPfI.

8 CONCLUSION

WSP has undertaken a noise and vibration assessment for the proposed North Strathfield Station upgrade. Six construction scenarios have been assessed for eight noise catchment areas surrounding the proposal site. The key findings of this assessment include:

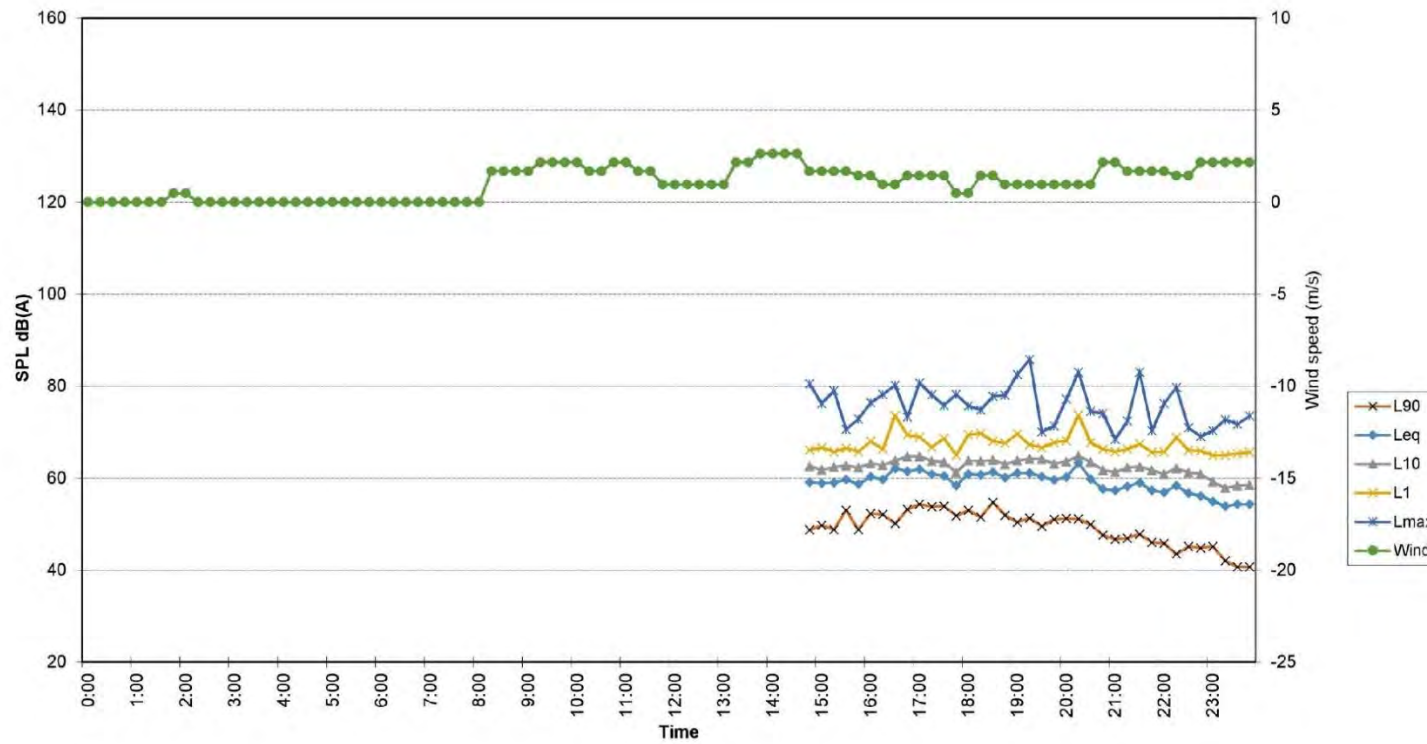
- NMLs were derived for residential and non-residential sensitive land uses using the ICNG in accordance with the CNVS based on background noise monitoring.
- NML exceedances were predicted at residential receivers for:
 - Activities 2, 3 and 4 in all NCAs
 - Activity 4 is predicted to have highly noise affected exceedances in all NCAs except NCA 4 and 5
 - Activities 1, 5, and 6 in NCAs except NCA 4
 - Residential receivers in NCAs 8 and 6 are predicted to be highly noise affected during most activities
 - Non residential receivers are predicted to be noise affected during most activities
- Construction traffic noise has been assessed in accordance with the RNP, and the noise increase due to increased traffic is expected to be negligible along Concord Road. Construction traffic noise has the potential to exceed the night criteria along Wellbank Street.
- Safe working distances to nearby receivers have been recommended. If safe working distances are maintained, then no adverse impacts in terms of human comfort or cosmetic damage are expected.
- Site specific noise mitigation measures have been recommended including:
 - Limiting traffic movements along Wellbank Street during the night period.
 - Providing temporary barriers
 - Using temporary screening or enclosures around works involving a concrete saw when used near the educational receiver to the west of the site
 - Consultation with MacDonald College with regard to use of high noise generating equipment with the potential to impact the use of the educational facility.
- The standard CNVS construction noise and vibration management measures and additional mitigation measures are recommended for the receivers within NCAs with predicted exceedances or within safe working distances.
- Mechanical plant has not yet been finalised. Mechanical plant is not expected to significantly impact the existing environment, and standard noise controls are expected to reduce noise emissions to acceptable levels as outlined in the NPfI. Operational noise emissions should be designed to meet the NPfI noise triggers derived in this report.

APPENDIX A

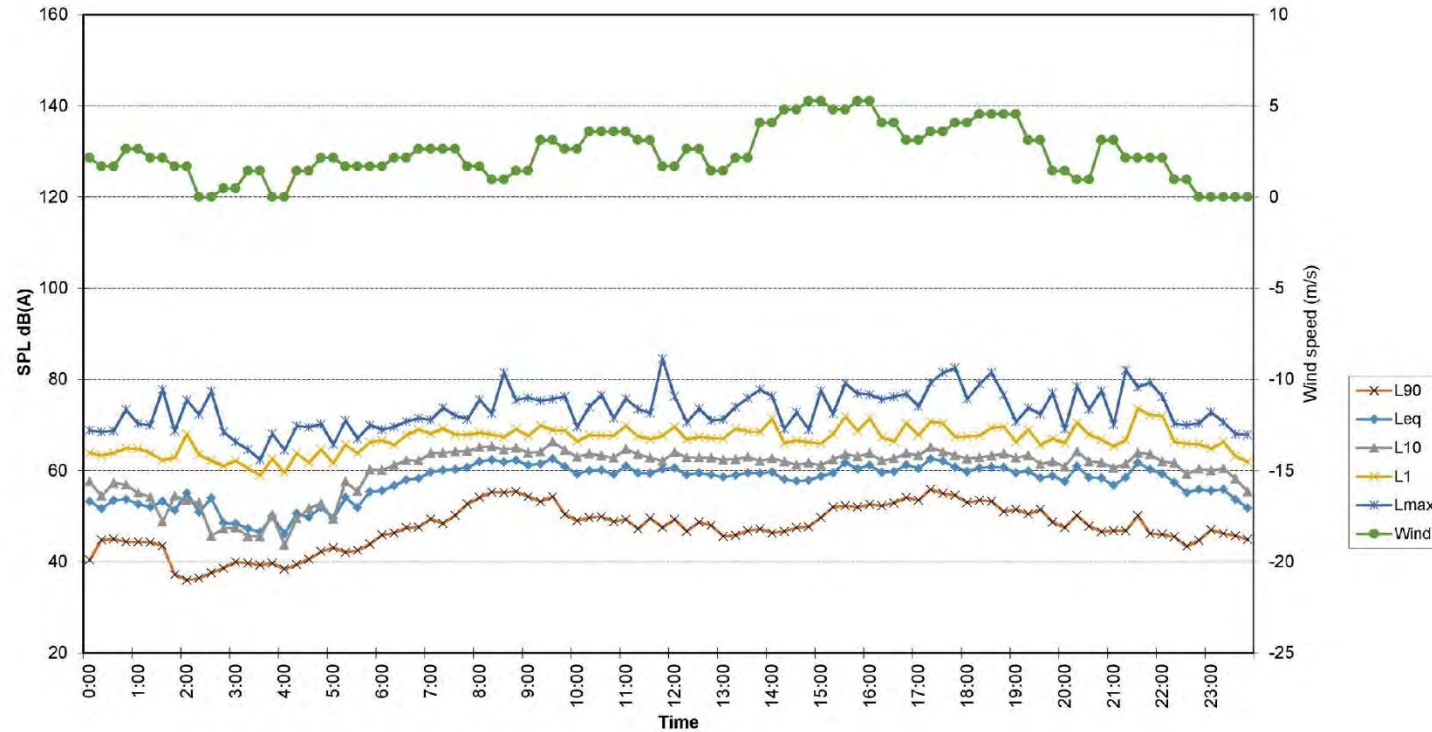
NOISE MONITORING GRAPHS



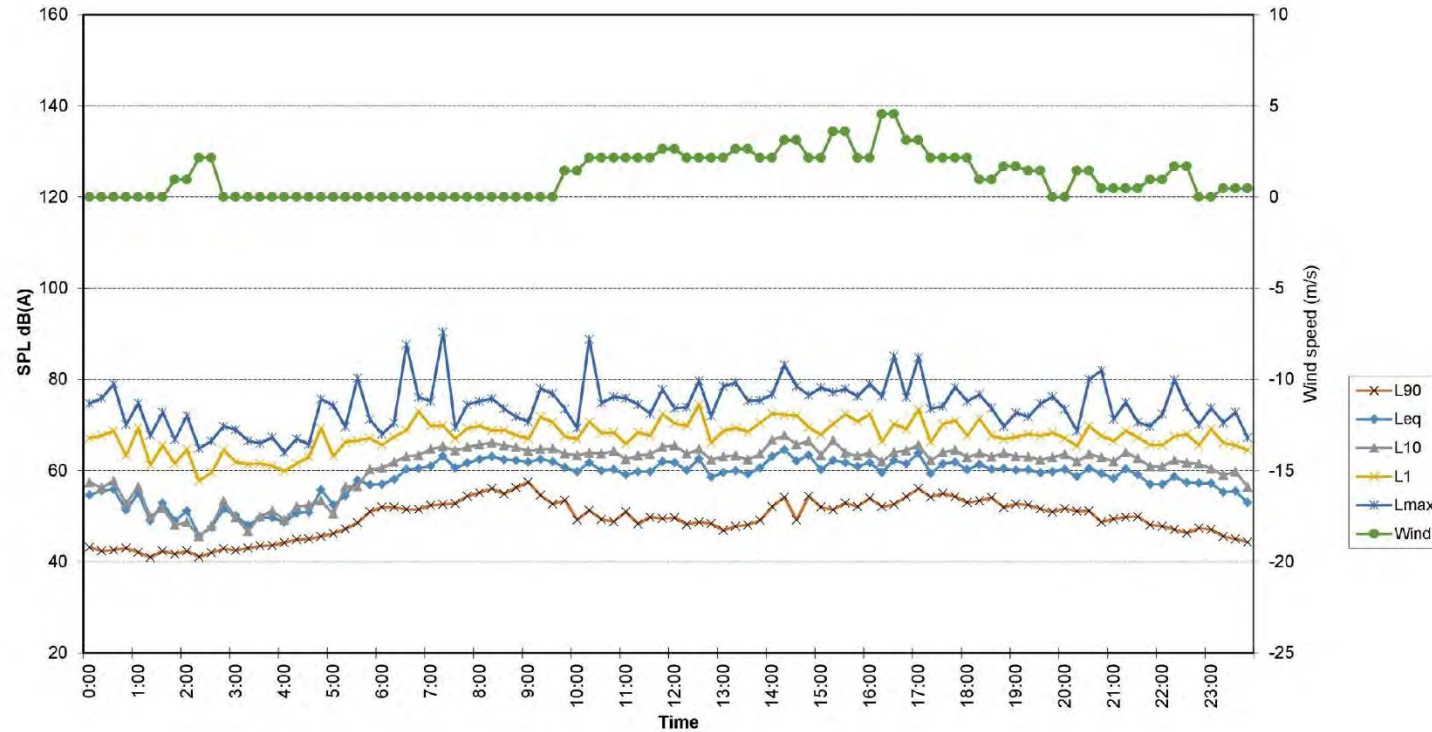
Location - 50 George Street
Measured Noise Levels - Monday 23-07-2018



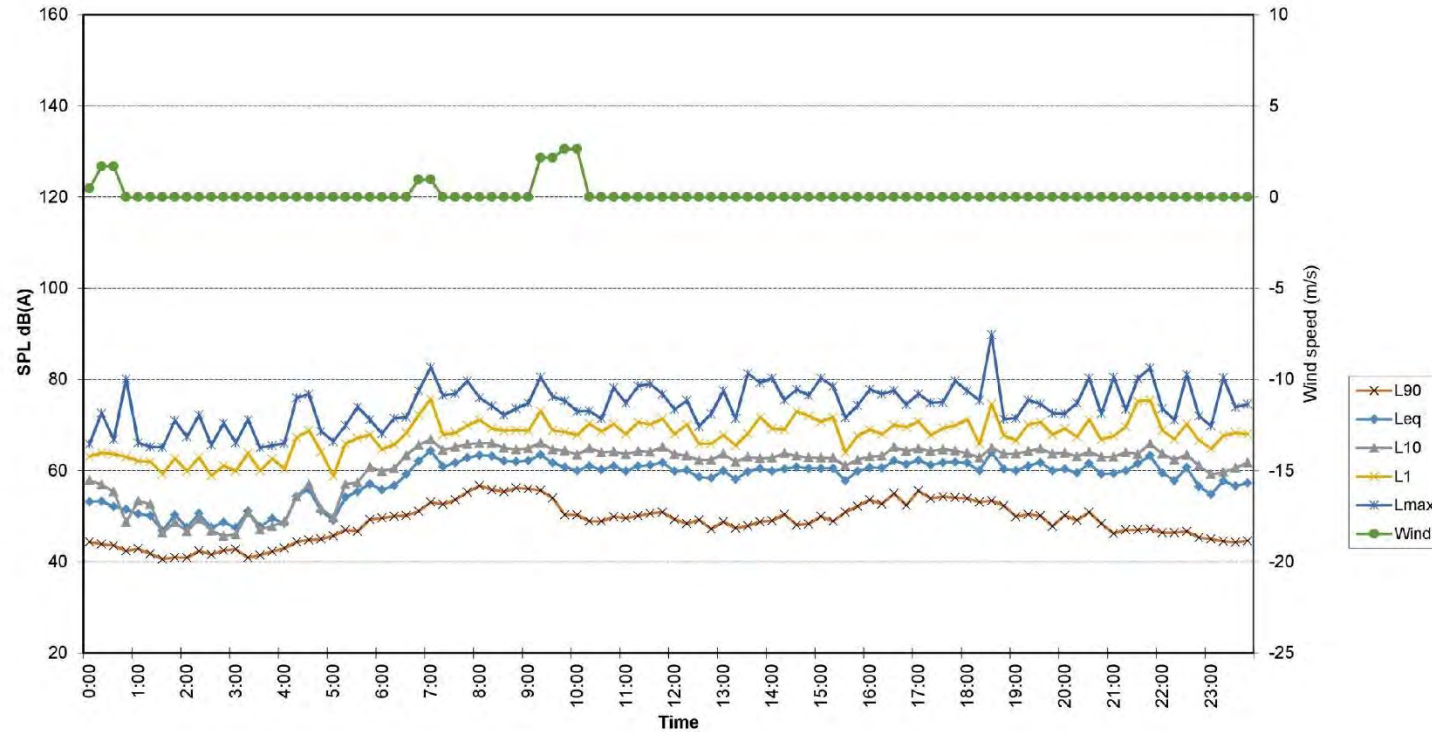
Location - 50 George Street
Measured Noise Levels - Tuesday 24-07-2018



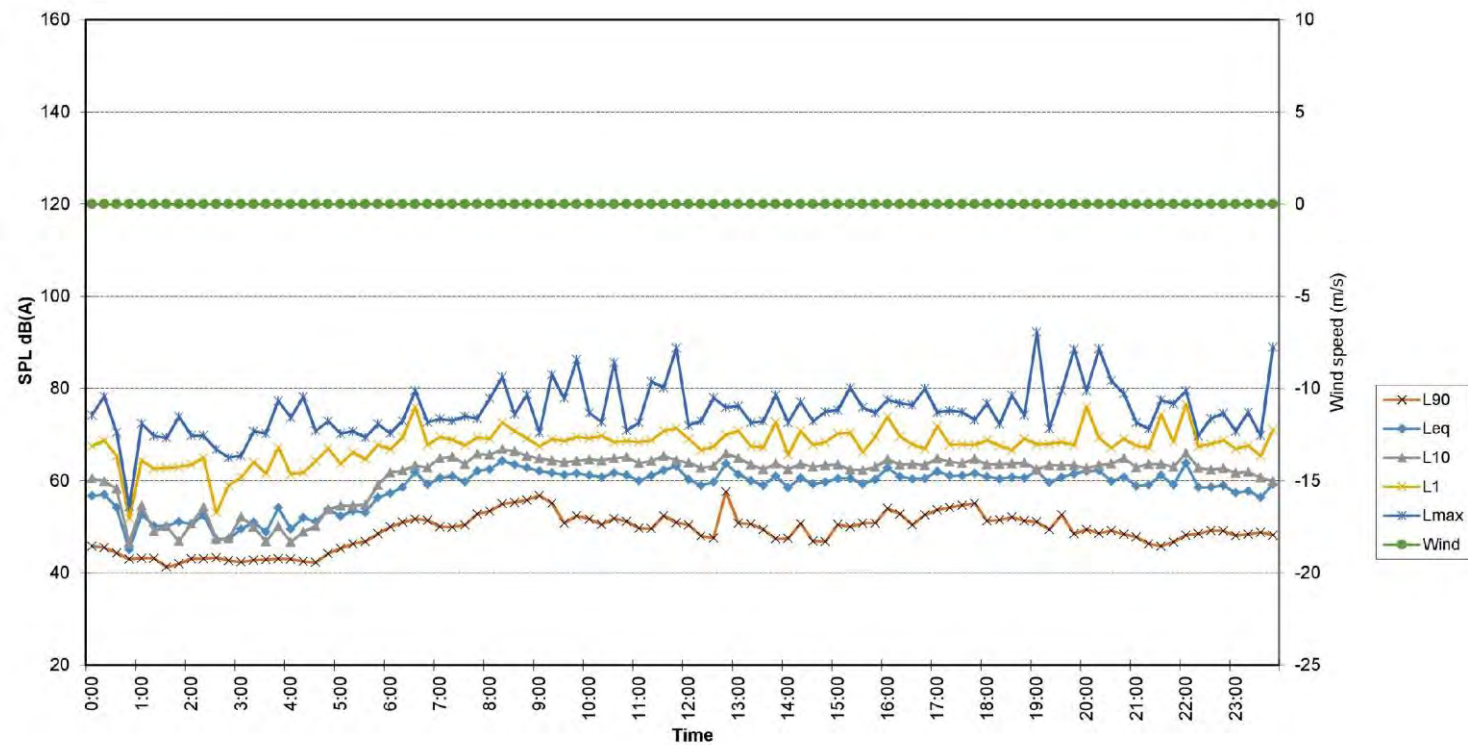
Location - 50 George Street
 Measured Noise Levels - Wednesday 25-07-2018



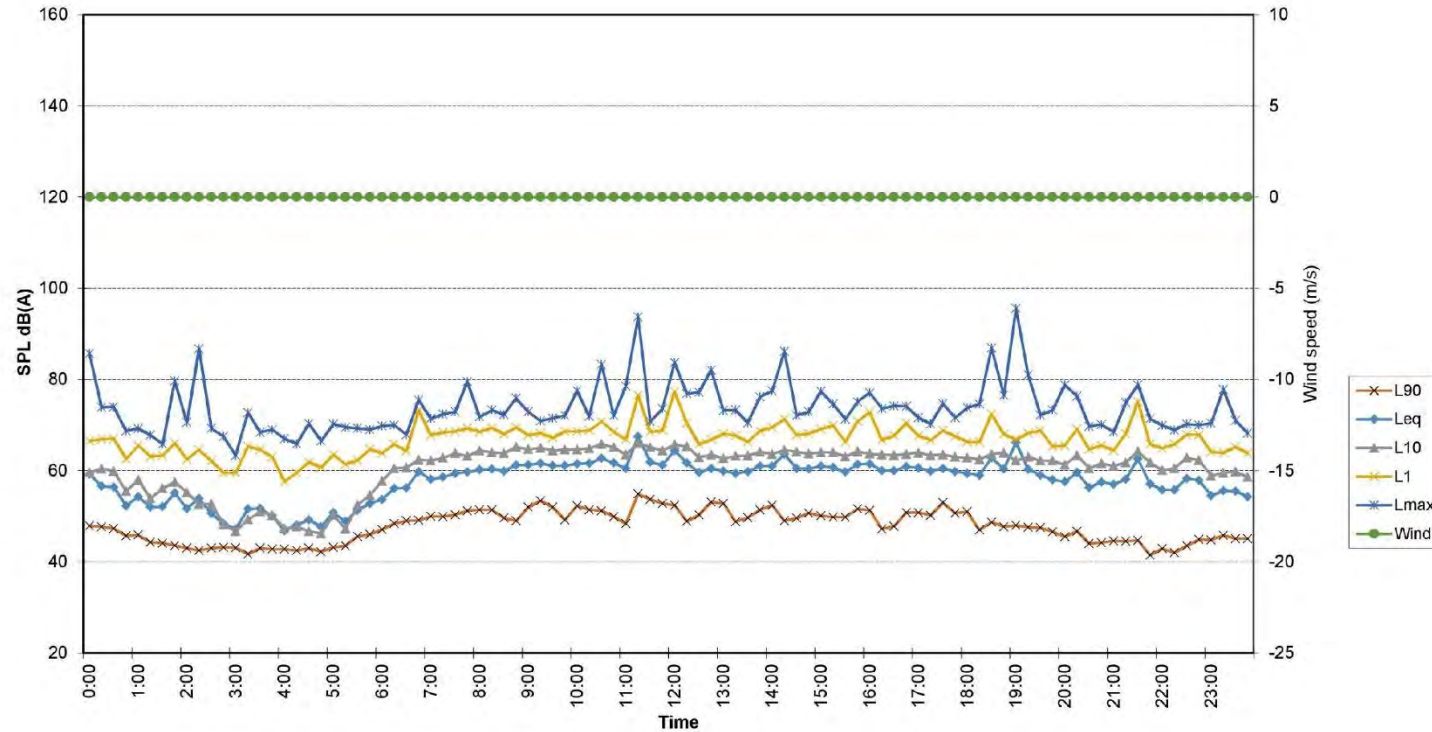
Location - 50 George Street
 Measured Noise Levels - Thursday 26-07-2018



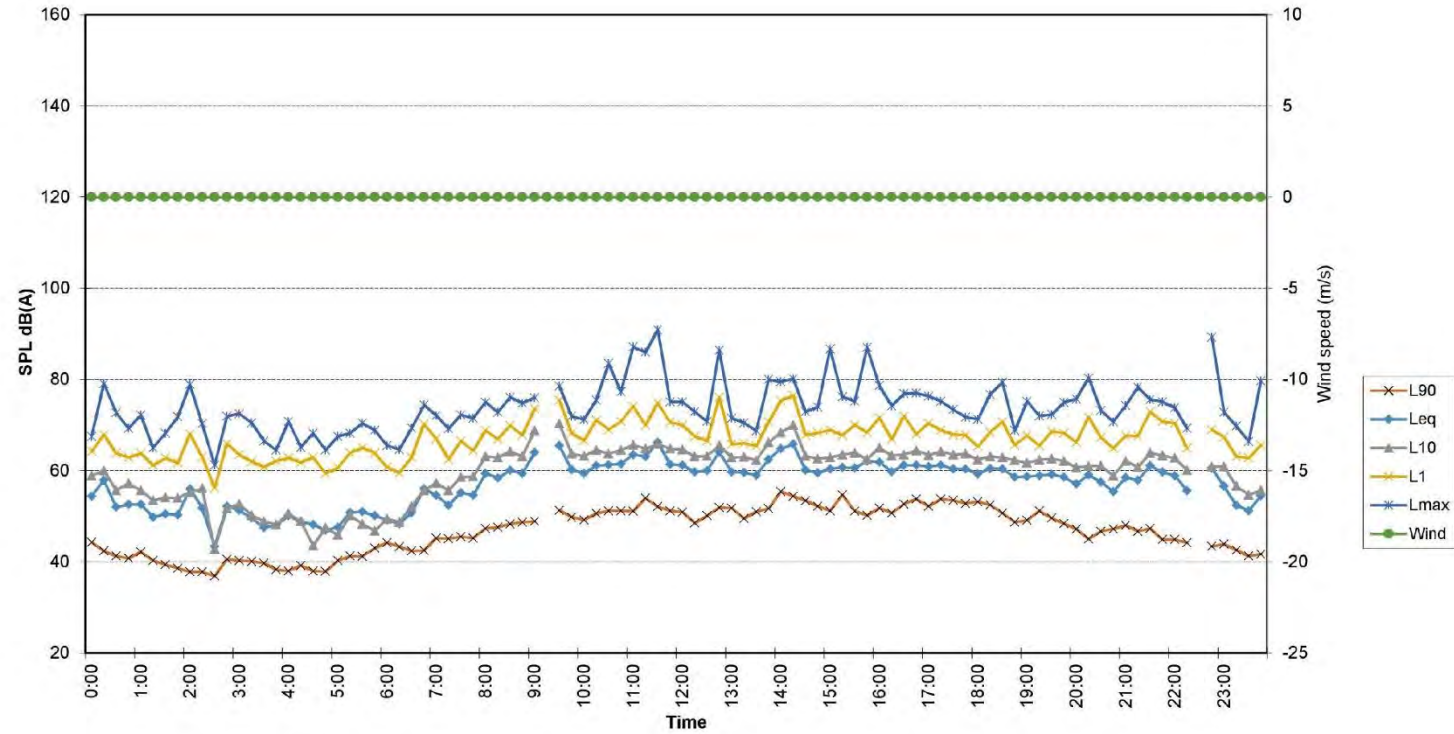
Location - 50 George Street
Measured Noise Levels - Friday 27-07-2018



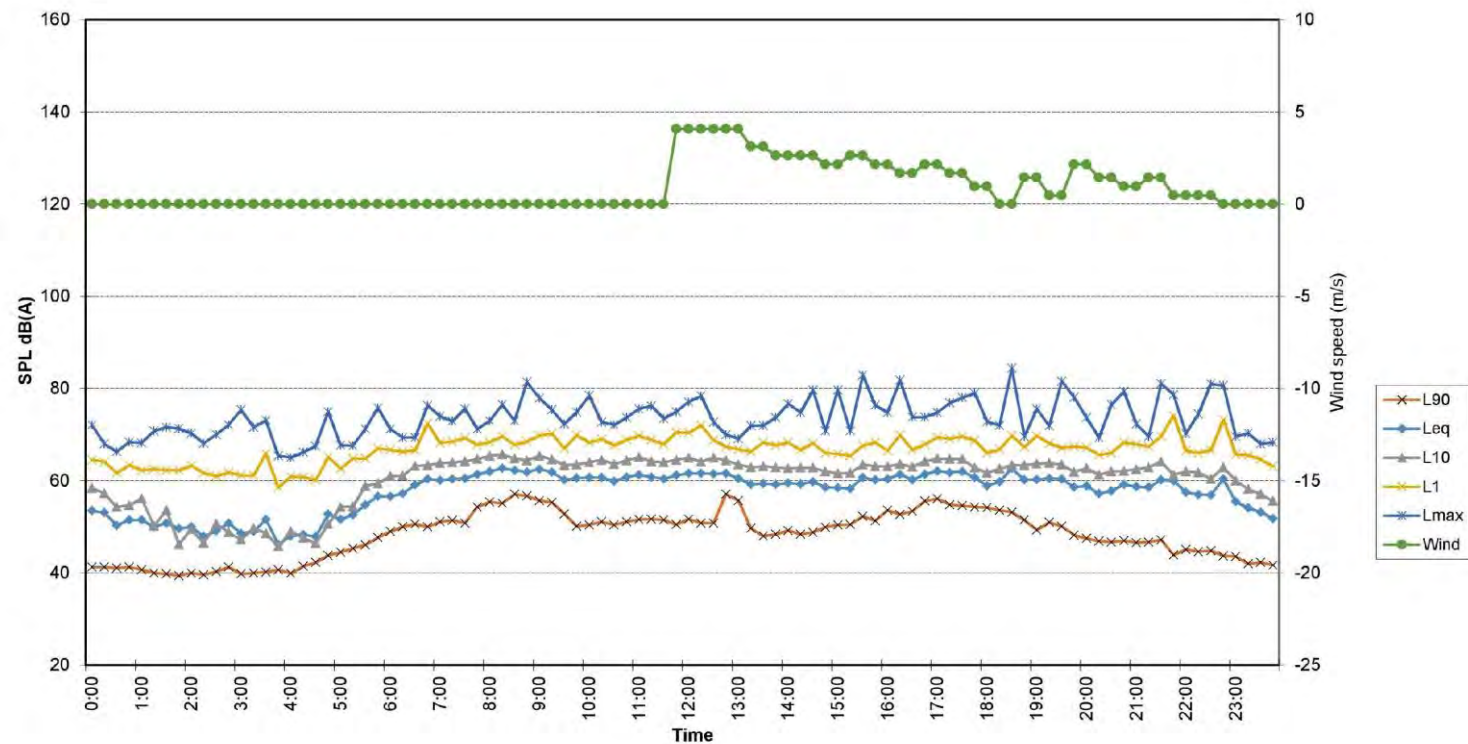
Location - 50 George Street
 Measured Noise Levels - Saturday 28-07-2018



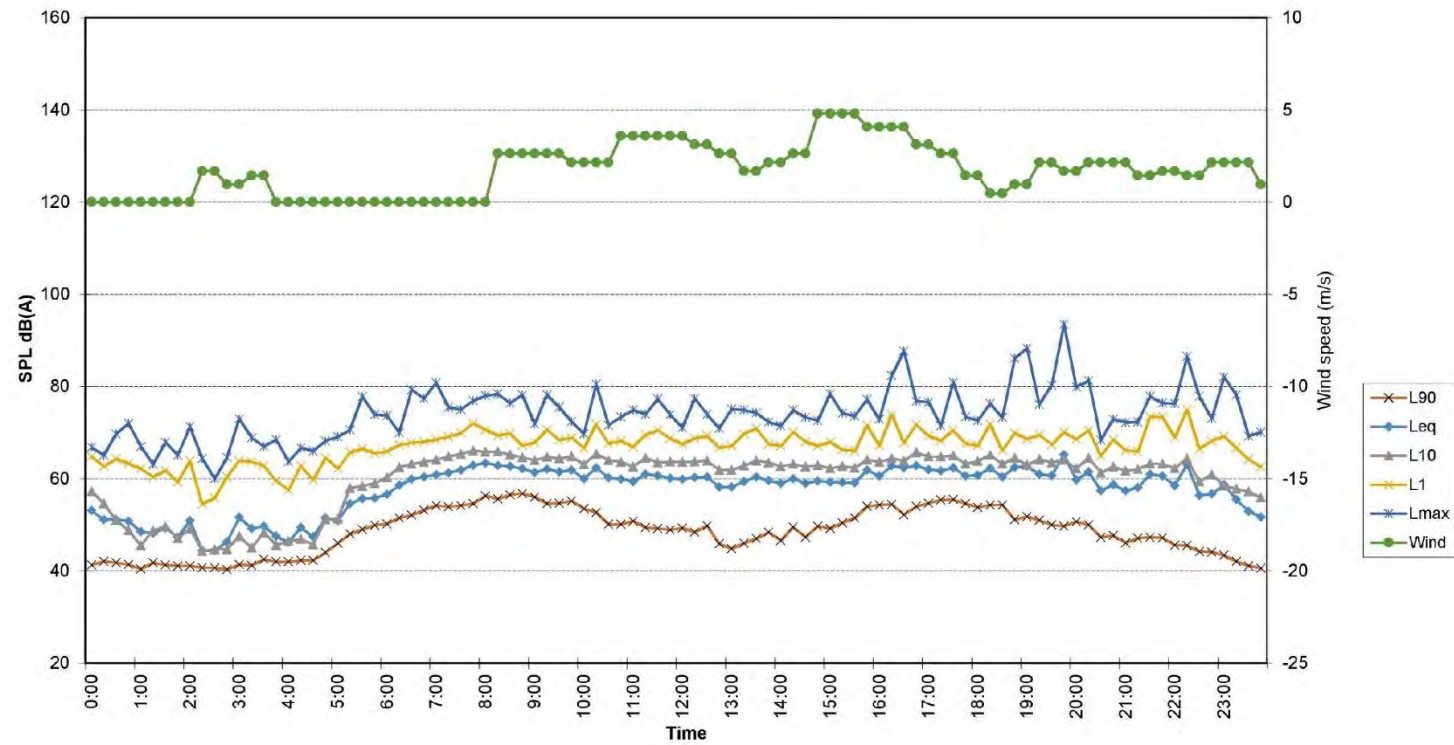
Location - 50 George Street
Measured Noise Levels - Sunday 29-07-2018



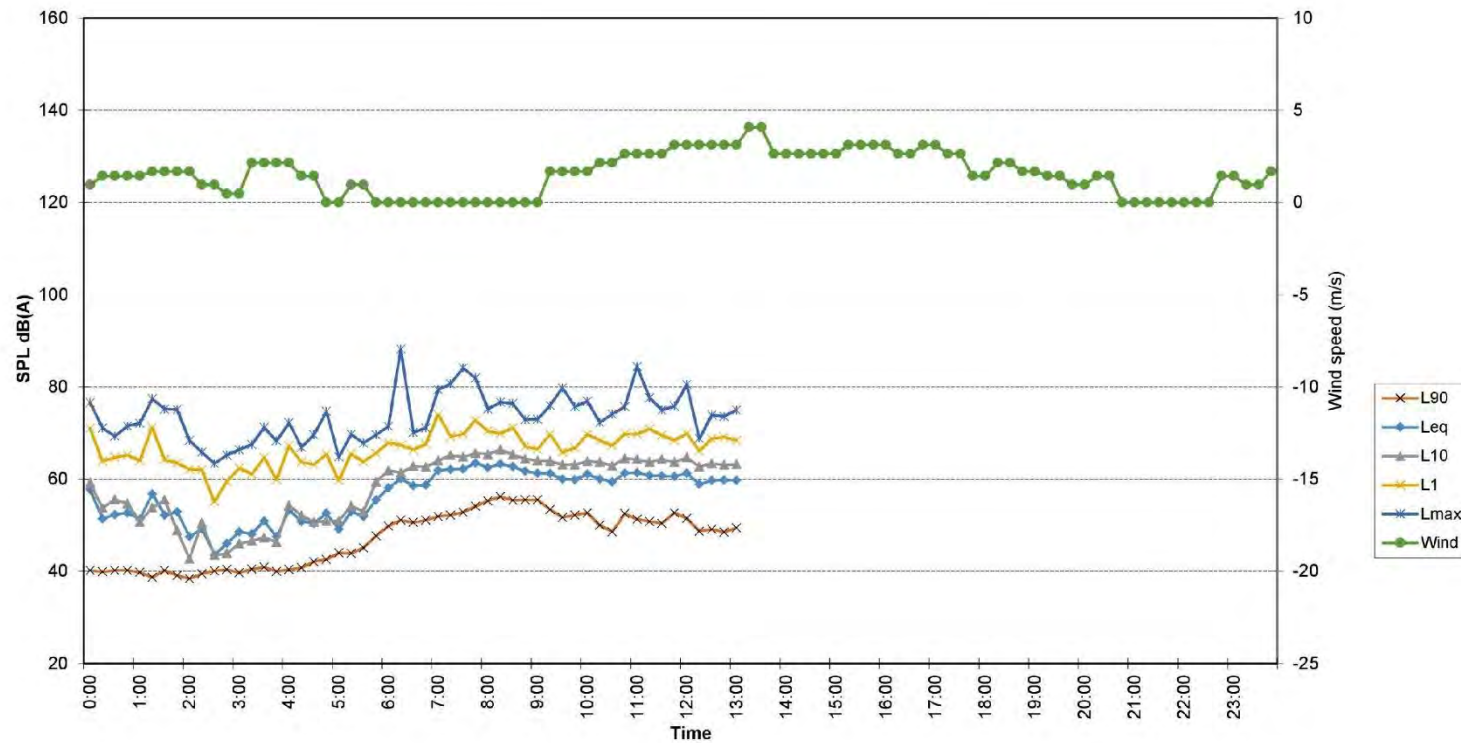
Location - 50 George Street
Measured Noise Levels - Monday 30-07-2018



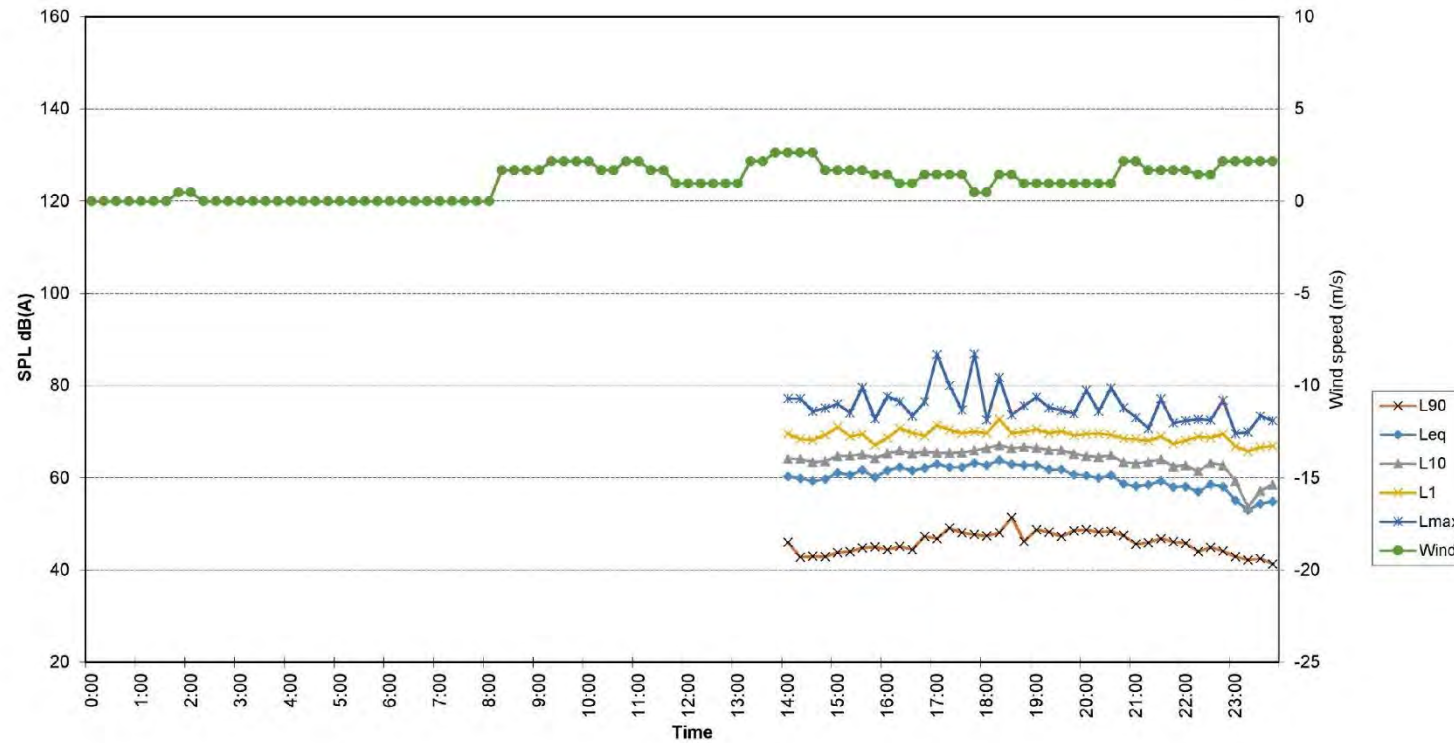
Location - 50 George Street
Measured Noise Levels - Tuesday 31-07-2018



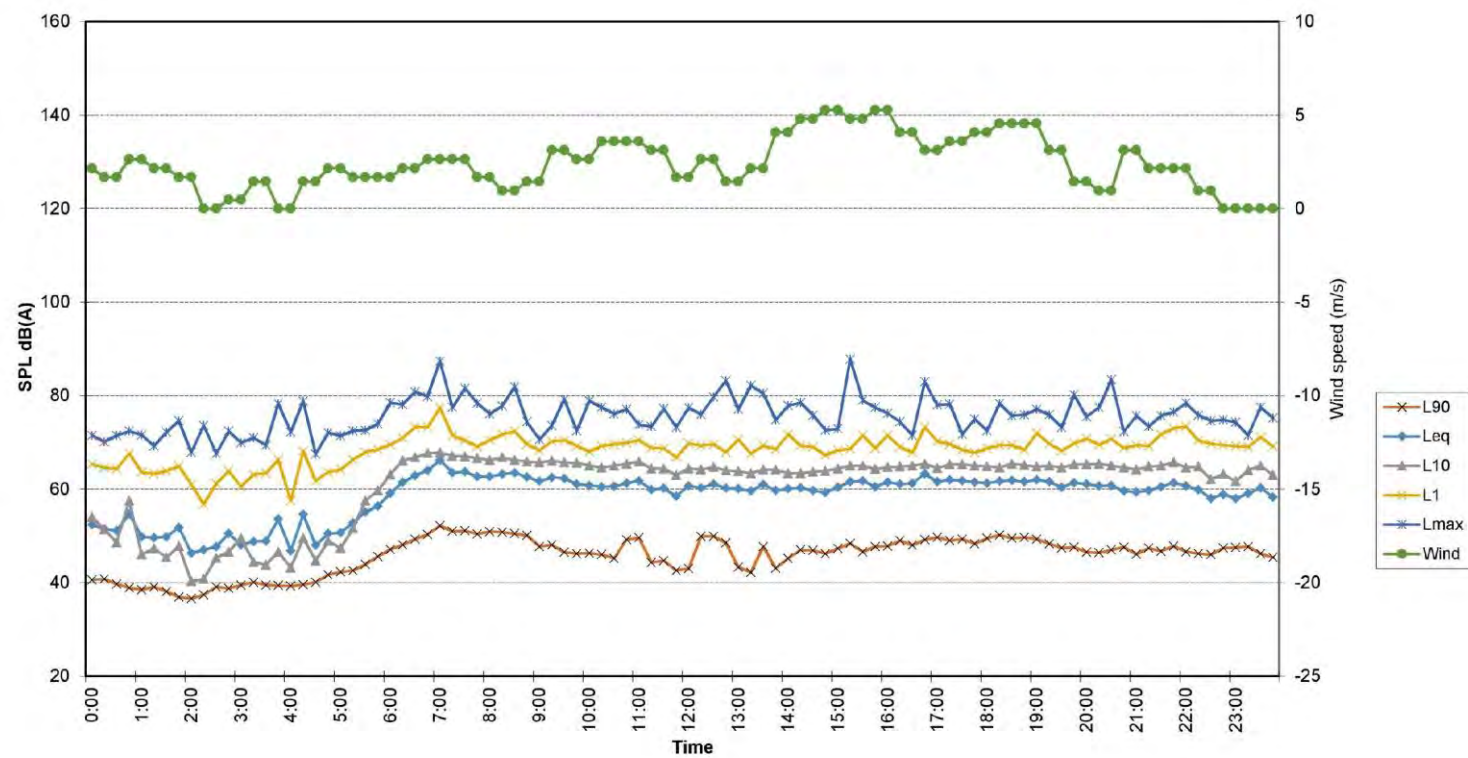
Location - 50 George Street
Measured Noise Levels - Wednesday 01-08-2018



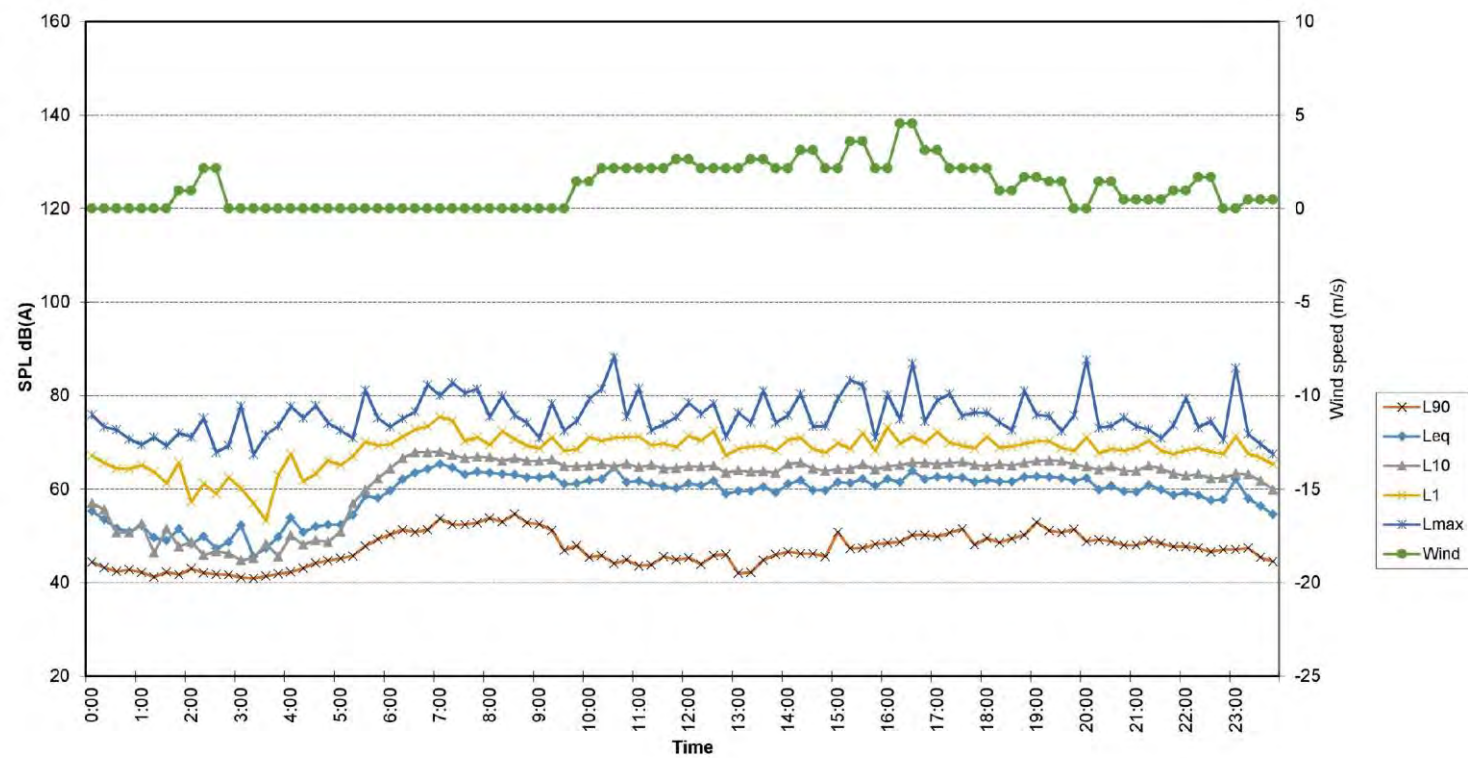
Location - 145 Wellbank St
Measured Noise Levels - Monday 23-07-2018



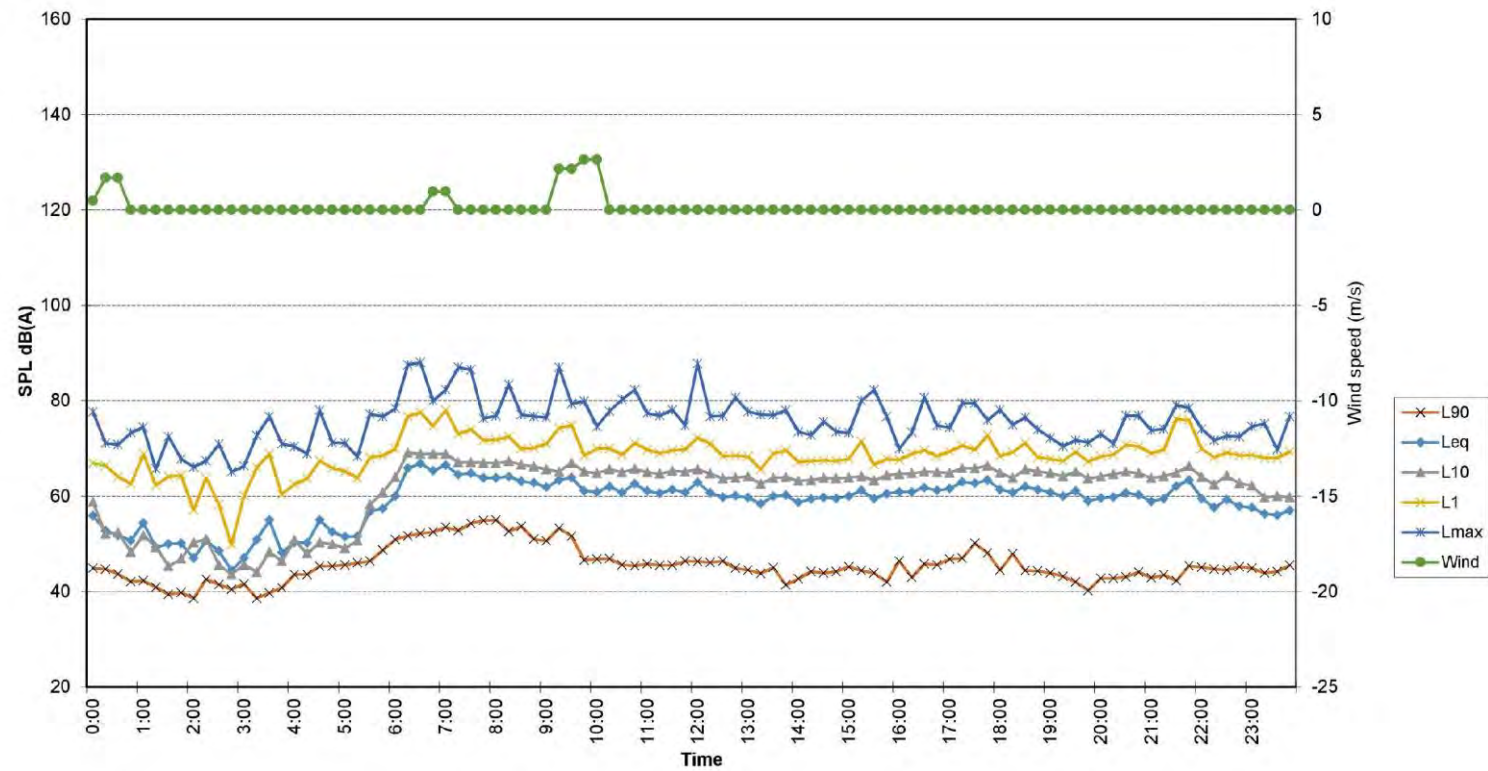
Location - 145 Wellbank St
Measured Noise Levels - Tuesday 24-07-2018



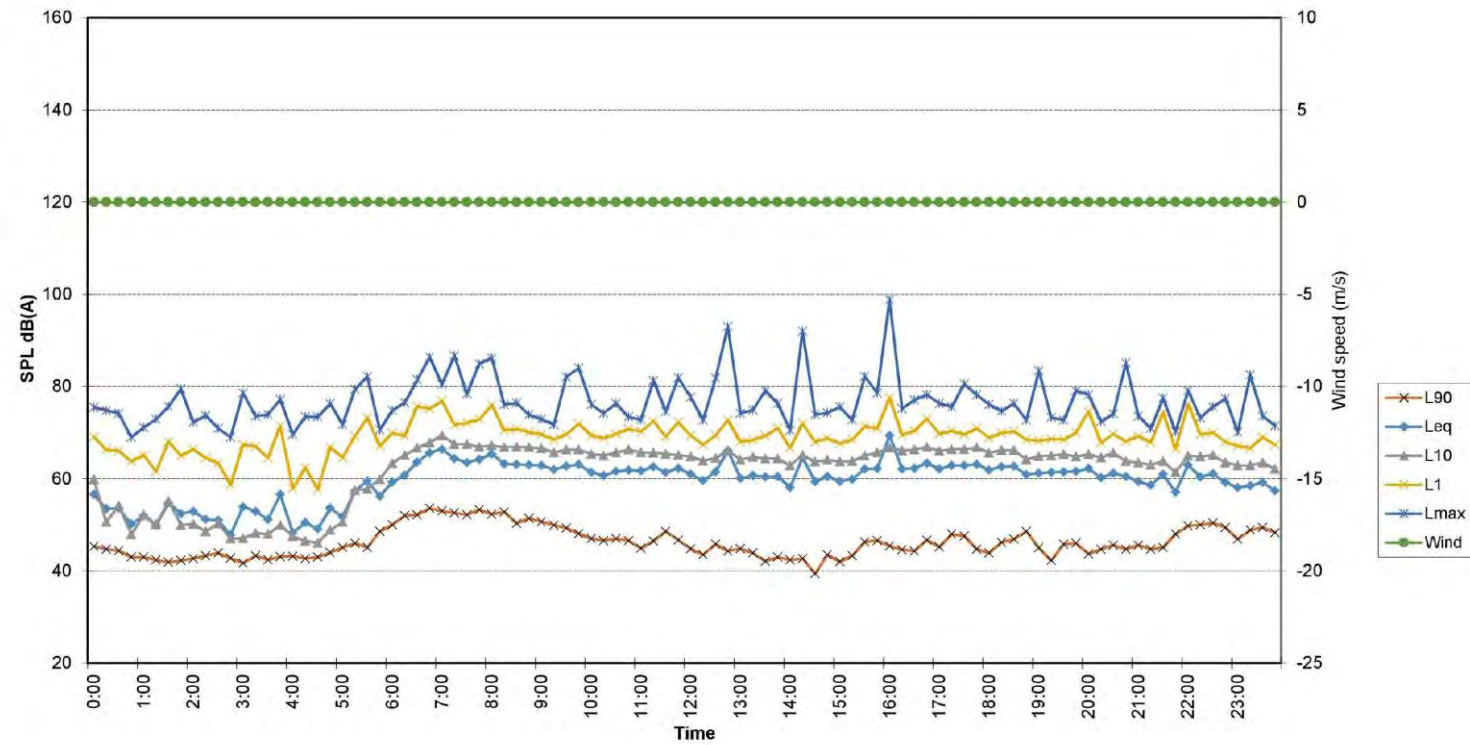
Location - 145 Wellbank St
Measured Noise Levels - Wednesday 25-07-2018



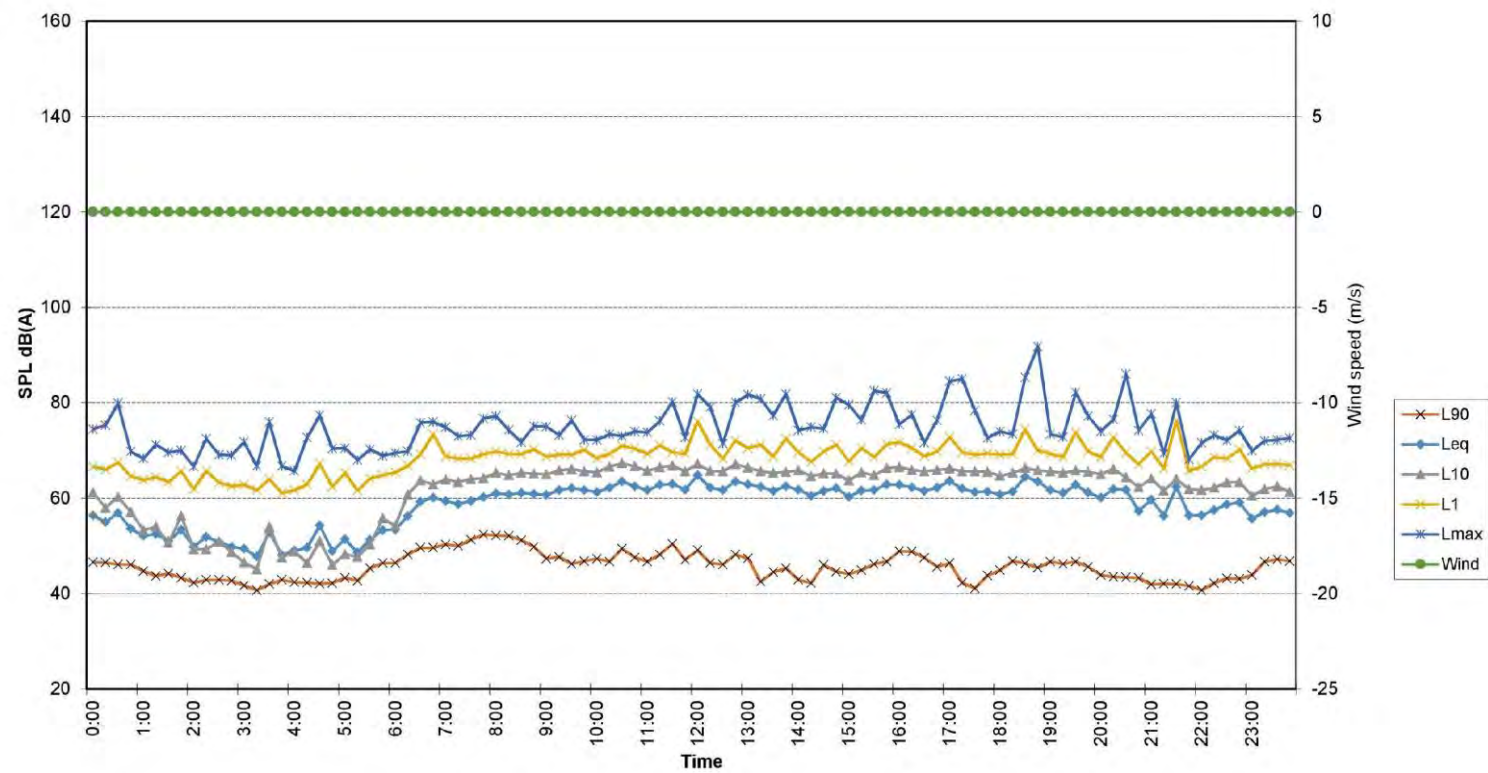
Location - 145 Wellbank St
Measured Noise Levels - Thursday 26-07-2018



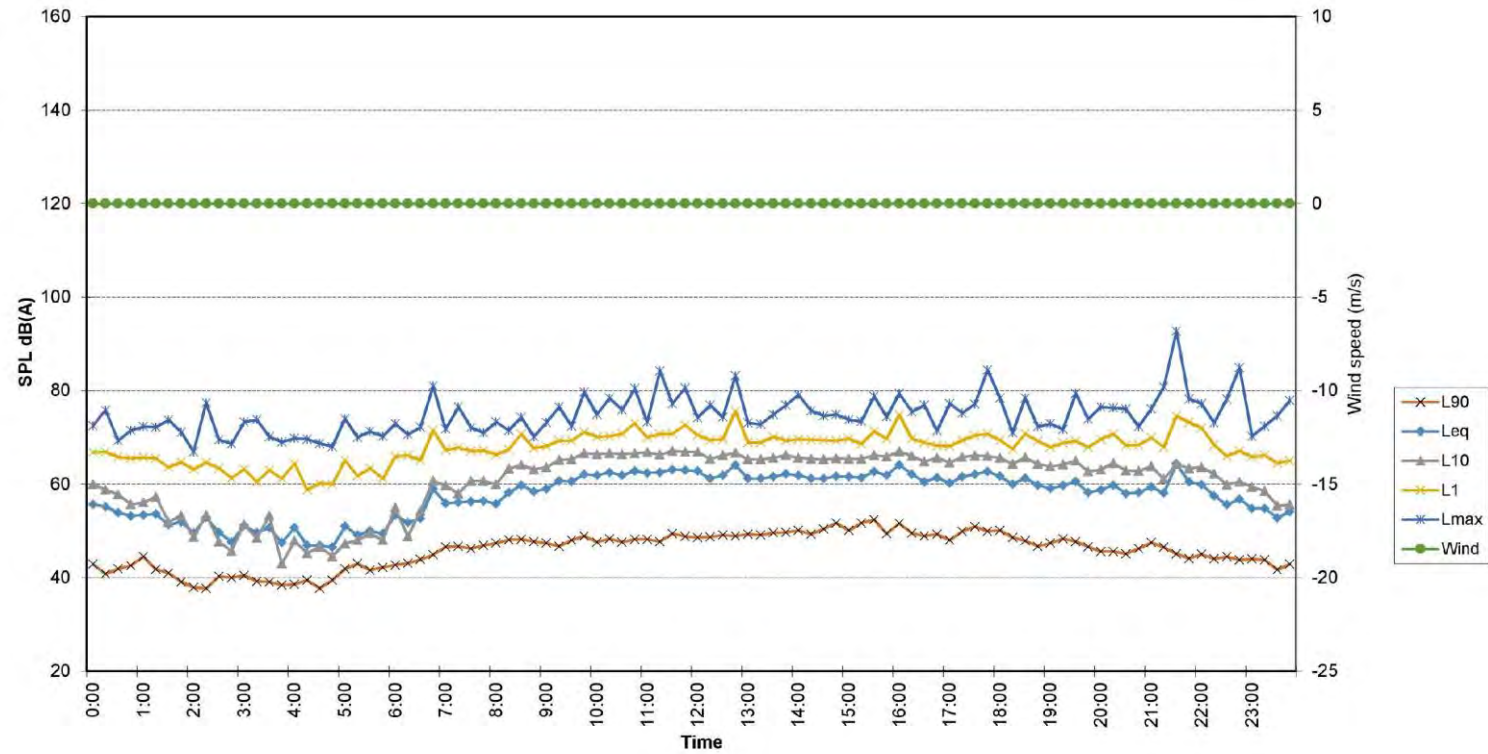
Location - 145 Wellbank St
Measured Noise Levels - Friday 27-07-2018



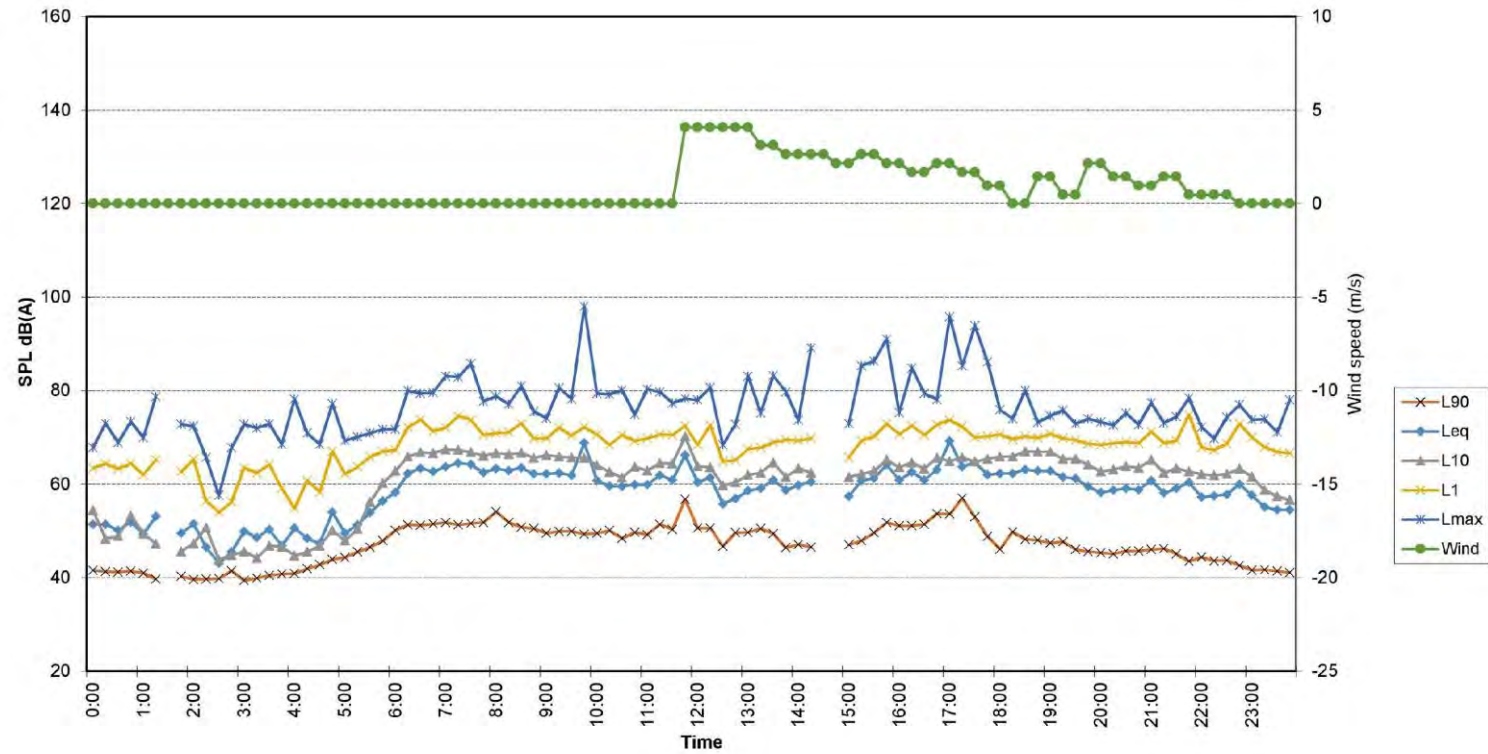
Location - 145 Wellbank St
Measured Noise Levels - Saturday 28-07-2018



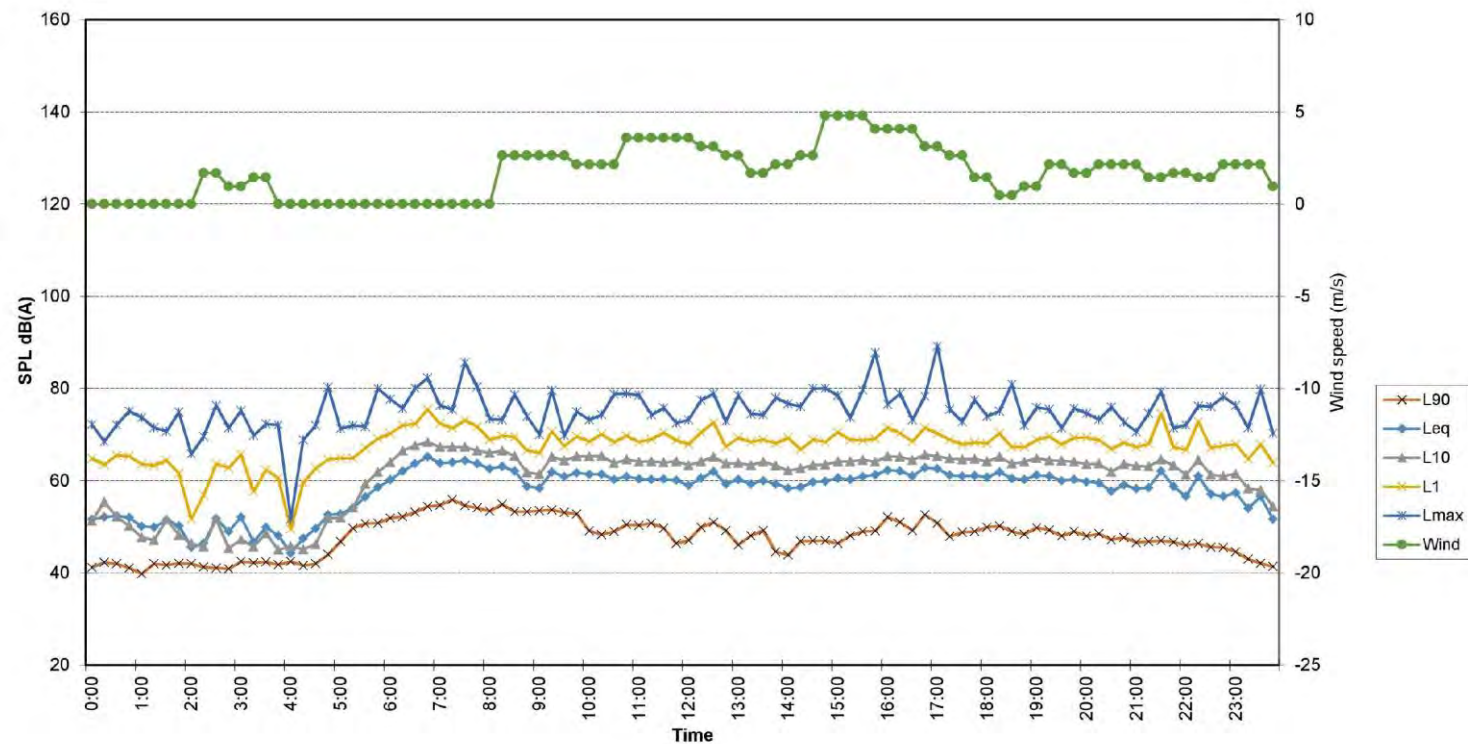
Location - 145 Wellbank St
Measured Noise Levels - Sunday 29-07-2018



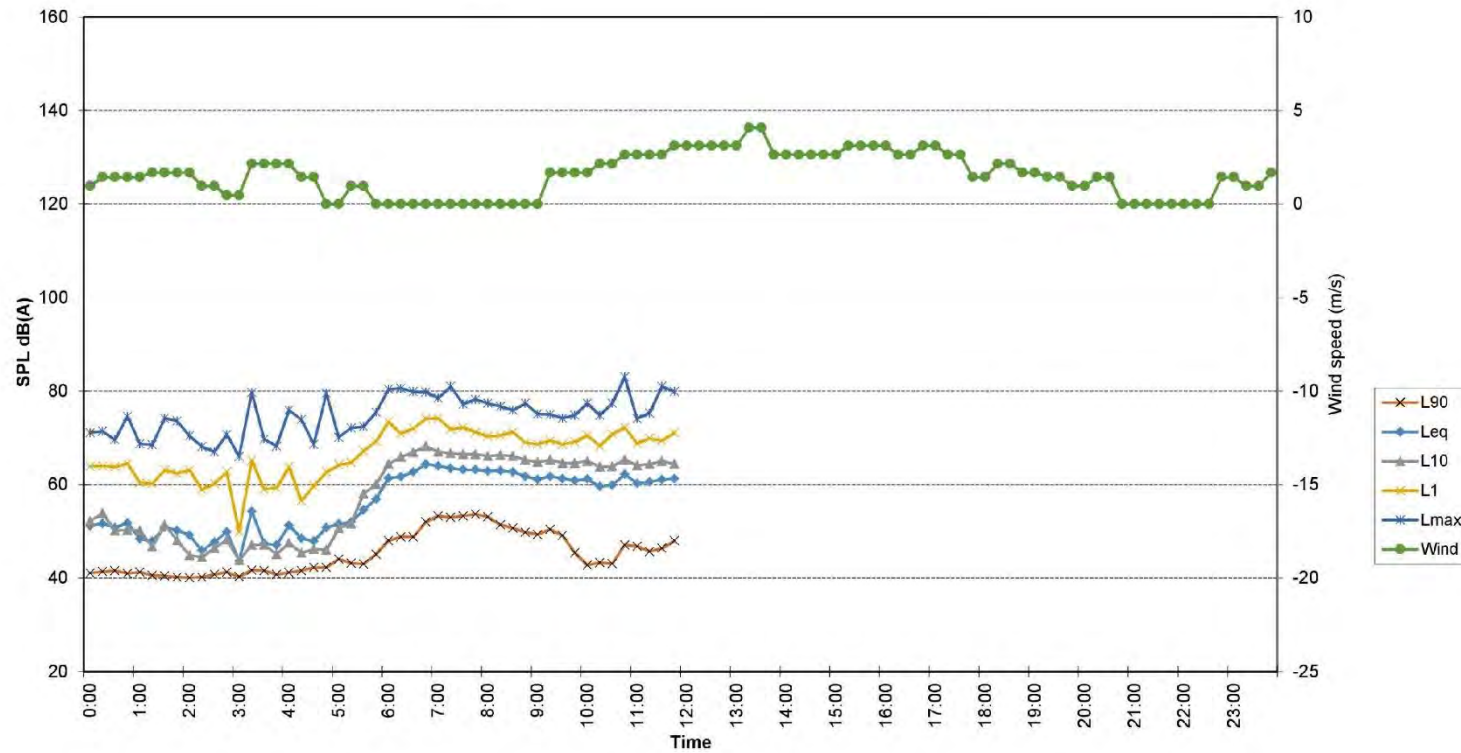
Location - 145 Wellbank St
Measured Noise Levels - Monday 30-07-2018



Location - 145 Wellbank St
Measured Noise Levels - Tuesday 31-07-2018



Location - 145 Wellbank St
Measured Noise Levels - Wednesday 01-08-2018







































APPENDIX B

PREDICTED NOISE MAPS





Map: NS_Act1	Author: TJG			Legend  Site Location	Noise level, dBA Leq period <table border="0"><tr><td> < 35</td><td> 40 - 45</td><td> 50 - 55</td><td> 60 - 65</td><td> 70 - 75</td><td> > 80</td></tr><tr><td> 35 - 40</td><td> 45 - 50</td><td> 55 - 60</td><td> 65 - 70</td><td> 75 - 80</td><td></td></tr></table>	 < 35	 40 - 45	 50 - 55	 60 - 65	 70 - 75	 > 80	 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80	
 < 35	 40 - 45					 50 - 55	 60 - 65	 70 - 75	 > 80								
 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80													
Date: 2018-08-31	Approved by: CXM																


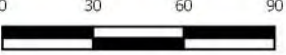































To be read in conjunction with WSP document: PS110578-180831-TJG-TAP3NorthStrathfieldNVIA
Map Source: NSW SDA Maps

1:2,500 at A3

TAP 3: North Strathfield Upgrade
Activity 1 - Site establishment and enabling works



www.wsp.com




































Map: NS_Act2	Author: TJG			Legend  Site Location	Noise level, dBA Leq period <table border="0"><tr><td> < 35</td><td> 40 - 45</td><td> 50 - 55</td><td> 60 - 65</td><td> 70 - 75</td><td> > 80</td></tr><tr><td> 35 - 40</td><td> 45 - 50</td><td> 55 - 60</td><td> 65 - 70</td><td> 75 - 80</td><td></td></tr></table>	 < 35	 40 - 45	 50 - 55	 60 - 65	 70 - 75	 > 80	 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80		TAP 3: North Strathfield Upgrade Activity 2 - Lift works (Platforms 1, 2 and 3)
 < 35	 40 - 45					 50 - 55	 60 - 65	 70 - 75	 > 80									
 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80														
Date: 2018-08-31	Approved by: CXM																	

To be read in conjunction with WSP document: PS110578-180831-TJG-TAP3NorthStrathfieldNVIA
Map Source: NSW SDA Maps

1:2,500 at A3



www.wsp.com




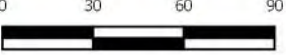


































Map: NS_Act3	Author: TJG			Legend  Site Location	Noise level, dBA Leq period <table border="0"><tr><td> < 35</td><td> 40 - 45</td><td> 50 - 55</td><td> 60 - 65</td><td> 70 - 75</td><td> > 80</td></tr><tr><td> 35 - 40</td><td> 45 - 50</td><td> 55 - 60</td><td> 65 - 70</td><td> 75 - 80</td><td></td></tr></table>	 < 35	 40 - 45	 50 - 55	 60 - 65	 70 - 75	 > 80	 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80		TAP 3: North Strathfield Upgrade Activity 3 - Lift works (eastern entrance)
 < 35	 40 - 45					 50 - 55	 60 - 65	 70 - 75	 > 80									
 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80														
Date: 2018-08-31	Approved by: CXM																	

To be read in conjunction with WSP document: PS110578-180831-TJG-TAP3NorthStrathfieldNVIA
Map Source: NSW SDA Maps

1:2,500 at A3



www.wsp.com



Map: NS_Act4	Author: TJG			Legend  Site Location	Noise level, dBA Leq period <table border="1"><tr><td> < 35</td><td> 40 - 45</td><td> 50 - 55</td><td> 60 - 65</td><td> 70 - 75</td><td> > 80</td></tr><tr><td> 35 - 40</td><td> 45 - 50</td><td> 55 - 60</td><td> 65 - 70</td><td> 75 - 80</td><td></td></tr></table>	 < 35	 40 - 45	 50 - 55	 60 - 65	 70 - 75	 > 80	 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80		TAP 3: North Strathfield Upgrade Activity 4 - New walkway construction
 < 35	 40 - 45					 50 - 55	 60 - 65	 70 - 75	 > 80									
 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80														
Date: 2018-08-31	Approved by: CXM																	

To be read in conjunction with WSP document: PS110578-180831-TJG-TAP3NorthStrathfieldNVIA
Map Source: NSW SDA Maps

1:2,500 at A3


www.wsp.com









Map: NS_Act5		Author: TJG				Legend Site Location	Noise level, dBA Leq period <table border="1"><tr><td> < 35</td><td> 40 - 45</td><td> 50 - 55</td><td> 60 - 65</td><td> 70 - 75</td><td> > 80</td></tr><tr><td> 35 - 40</td><td> 45 - 50</td><td> 55 - 60</td><td> 65 - 70</td><td> 75 - 80</td><td></td></tr></table>	< 35	40 - 45	50 - 55	60 - 65	70 - 75	> 80	35 - 40	45 - 50	55 - 60	65 - 70	75 - 80		TAP 3: North Strathfield Upgrade Activity 5 - Station building works
< 35	40 - 45	50 - 55	60 - 65					70 - 75	> 80											
35 - 40	45 - 50	55 - 60	65 - 70	75 - 80																
Date: 2018-08-31		Approved by: CXM																		

To be read in conjunction with WSP document: PS110578-180831-TJG-TAP3NorthStrathfieldNVIA
Map Source: NSW SDA Maps

1:2,500 at A3

www.wsp.com



Map: NS_Act6	Author: TJG			Legend  Site Location	Noise level, dBA Leq period <table border="1"><tr><td> < 35</td><td> 40 - 45</td><td> 50 - 55</td><td> 60 - 65</td><td> 70 - 75</td><td> > 80</td></tr><tr><td> 35 - 40</td><td> 45 - 50</td><td> 55 - 60</td><td> 65 - 70</td><td> 75 - 80</td><td></td></tr></table>	 < 35	 40 - 45	 50 - 55	 60 - 65	 70 - 75	 > 80	 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80		TAP 3: North Strathfield Upgrade Activity 6 - Upgrades to accessible parking and kiss-and-ride 
 < 35	 40 - 45					 50 - 55	 60 - 65	 70 - 75	 > 80									
 35 - 40	 45 - 50	 55 - 60	 65 - 70	 75 - 80														
Date: 2018-08-31	Approved by: CXM	To be read in conjunction with WSP document: PS110578-180831-TJG-TAP3NorthStrathfieldNVIA Map Source: NSW SDA Maps	1:2,500 at A3															

© WSP Australia Pty Ltd (WSP) Copyright in the design, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorized recipient and the document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCS Certified Quality System to ISO 9001. © A/NZ/ISO 9001 FOR A/NZ/ISO 9001 OF WSP Australia Pty Ltd.

APPENDIX C

STANDARD AND ADDITIONAL NOISE AND VIBRATION MITIGATION MEASURES



C1 STANDARD MITIGATION MEASURES

Table C.1 Standard management measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Implementation of any project specific mitigation measures required	Airborne noise Ground-borne noise & vibration	In addition to the measures set out in this table, any project specific mitigation measures identified in the EIA documentation (e.g. REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement stakeholder consultation measures (refer to Sections 8.2.1 and 8.3 for further details of community consultation measures)	Airborne noise Ground-borne noise & vibration	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities delivered to sensitive receivers at least 7 days prior to commencement of relevant works. In addition to Periodic Notification, the following strategies may be adopted on a case-by-case basis: <ul style="list-style-type: none"> • Project Specific Website • Project Infoline • Construction Response Line • Email Distribution List • Web-based Surveys • Social Media • Community and Stakeholder Meetings and • Community Based Forums (if required by approval conditions).
Register of noise and vibration sensitive receivers	Airborne noise Ground-borne noise & vibration	A register of most affected noise and vibration sensitive receivers (NVSRs) would be kept on site. The register would include the following details for each NVSR: <ul style="list-style-type: none"> • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number. The register may be included as part of the Project's Community Liaison Plan or similar document and maintained in accordance with the requirements of this plan.
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating noise with special audible characteristics and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period	Ground-borne noise & vibration Airborne noise	Noise with special audible characteristics and vibration generating activities (including jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling) may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block. 'Continuous' includes any period during which there is less than a 1 hour respite between ceasing and recommencing any of the work. No more than two consecutive nights of noise with special audible characteristics and/or vibration generating work may be undertaken in the same NCA over any 7-day period, unless otherwise approved by the relevant authority.
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: <ul style="list-style-type: none"> • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on noise generating activities with special audible characteristics

ACTION REQUIRED	APPLIES TO	DETAILS
Site inductions <i>continued</i>		<ul style="list-style-type: none"> Location of nearest sensitive receivers Construction employee parking areas Designated loading/unloading areas and procedures Site opening/closing times (including deliveries) Environmental incident procedures.
Behavioural practices	Airborne noise	<p>No swearing or unnecessary shouting or loud stereos/radios on site.</p> <p>No dropping of materials from height, throwing of metal items and slamming of doors.</p> <p>No excessive revving of plant and vehicle engines.</p> <p>Controlled release of compressed air.</p>
Monitoring	Airborne noise Ground-borne noise & vibration	A noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements shall be undertaken at all buildings within 25 m of vibration generating activities when these activities commence to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to major project construction activities with the potential to cause property damage.

Table C.2 Standard source measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Equipment selection	Airborne noise Ground-borne noise & vibration	<p>Use quieter and less vibration emitting construction methods where feasible and reasonable, see APPENDIX C.</p> <p>For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.</p>
Maximum noise levels	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the allowable noise levels in APPENDIX C.
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the allowable noise levels in APPENDIX C.
Use and siting of plant	Airborne-noise	<p>Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided.</p> <p>The offset distance between noisy plant and adjacent sensitive receivers is to be maximised.</p> <p>Plant used intermittently to be throttled down or shut down.</p> <p>Noise-emitting plant to be directed away from sensitive receivers.</p>
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out-of-hours work, including delivery vehicles.

ACTION REQUIRED	APPLIES TO	DETAILS
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur <i>as far as possible</i> from sensitive receivers.
Minimise disturbance arising from delivery of goods to construction sites <i>continued</i>		Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction Related Traffic	Airborne noise	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.
Silencers on Mobile Plant	Airborne noise	Where possible reduce noise from mobile plant through additional fittings including: Residential grade mufflers Damped hammers such as “City” Model Rammer Hammers Air Parking brake engagement is silenced.
Prefabrication of materials off-site	Airborne noise	Where practicable, pre-fabricate and/or prepare materials off-site to reduce noise with special audible characteristics occurring on site. Materials can then be delivered to site for installation.
Engine compression brakes	Airborne noise	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission’s ‘In-service test procedure’ and standard.

Table C.3 Standard path measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

C2 ADDITIONAL MITIGATION MEASURES

Table C.4 Additional mitigation measures

MEASURE	DESCRIPTION	ABBREVIATION
Periodic Notification	<p>For each I&S project, a notification entitled 'Project Update' or 'Construction Update' is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information will be published on the TfNSW website (www.transport.nsw.gov.au).</p> <p>Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them.</p> <p>Content and length is determined on a project-by-project basis and must be approved by TfNSW prior to distribution.</p> <p>Most projects distribute notifications on a monthly basis. Each notification is graphically designed within a branded template.</p> <p>In certain circumstances media advertising may also be used to supplement Periodic Notifications, where considered effective.</p> <p>Periodic Notification may be advised by the I&S Community Engagement Team in cases where AMMM are not triggered as shown in Tables 9 to 11, for example where community impacts extend beyond noise and vibration (traffic, light spill, parking etc). In these circumstances the I&S Community Engagement Team will determine the community engagement strategy on a case-by-case basis.</p>	PN
Verification Monitoring	<p>Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e. for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e. for specific periods of construction noise).</p> <p>The purpose of monitoring is to confirm that:</p> <ul style="list-style-type: none"> • construction noise and vibration from the project are consistent with the predictions in the noise assessment • mitigation and management of construction noise and vibration is appropriate for receivers affected by the works <p>Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the CNVIS amended. Refer to Section 8.4 for more details.</p>	V
Specific Notification	<p>Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing.</p> <ul style="list-style-type: none"> • Letters may be letterbox dropped or hand distributed • Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs • Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that will be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project <p>Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.</p>	SN
Respite Offer	<p>The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise pre-purchased movie tickets, bowling activities, meal vouchers or similar offer. This measure is determined on a case-by-case basis, and may not be applicable to all I&S projects.</p>	RO

MEASURE	DESCRIPTION	ABBREVIATION
Alternative Accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts. Alternative accommodation will be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.	AA
Alternative construction methodology	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent will need to consider alternative construction options that achieve compliance with the VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.	AC
Respite Period	OOHW during evening and night periods will be restricted so that receivers are impacted for no more than 3 consecutive evenings and no more than 2 consecutive nights in the same NCA in any one week. A minimum respite period of 4 evenings/5 nights shall be implemented between periods of consecutive evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHWS Approval Protocol (Section 6). Note; this management measure does not apply to OOHWS Period 1 – Days (See Table 1).	RP
Duration Reduction	Where Respite Periods (see management measure above) are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by-project basis, and may not be applicable to all I&S projects. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with I&S Community Engagement Representatives.	DR

APPENDIX D

GLOSSARY



'A' FREQUENCY WEIGHTING

The 'A' frequency weighting roughly approximates to the Fletcher-Munson 40 phon equal loudness contour. The human loudness perception at various frequencies and sound pressure levels is equated to the level of 40 dB at 1 kHz. The human ear is less sensitive to low frequency sound and very high frequency sound than midrange frequency sound (i.e. 500 Hz–6 kHz). Humans are most sensitive to midrange frequency sounds, such as a child's scream. Sound level meters have inbuilt frequency weighting networks that very roughly approximates the human loudness response at low sound levels. It should be noted that the human loudness response is not the same as the human annoyance response to sound. Here low frequency sounds can be more annoying than midrange frequency sounds even at very low loudness levels. The 'A' weighting is the most commonly used frequency weighting for occupational and environmental noise assessments.

AMBIENT NOISE

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. Ambient noise is usually assessed as an energy average over a set time period 'T' (Leq, T).

AUDIBLE

Audible refers to a sound that can be heard. There are a range of audibility grades, varying from 'barely audible', 'just audible' to 'clearly audible' and 'prominent'.

BACKGROUND NOISE

Total silence does not exist in the natural or built-environments, only varying degrees of noise. The background noise level is the minimum repeatable level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. It is typically quantified by the noise level that is exceeded for 90 per cent of the measurement period 'T' (LA90, T). Also see Rating Background Level.

'COSMETIC' DAMAGE

'Cosmetic' damage is described as minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks, and separation of partitions or intermediate walls from load bearing walls.

DECIBEL

The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0–120 dB. The decibel is 10 times the logarithm of the ratio of any two quantities that relate to the flow of energy (i.e. power). When used in acoustics it is the ratio of square of the sound pressure level to a reference sound pressure level, the ratio of the sound power level to a reference sound power level, or the ratio of the sound intensity level to a reference sound intensity level. *See also Sound Pressure Level and Sound Power Level.* Noise levels in decibels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dB, and another similar machine is placed beside it, the level will increase to 53 dB (from $10 \log_{10} (10(50/10) + 10(50/10))$) and not 100 dB. In theory, 10 similar machines placed side by side will increase the sound level by 10 dB, and one hundred machines increase the sound level by 20 dB. The human ear has a vast sound-sensitivity range of over a thousand billion to one so the logarithmic decibel scale is useful for acoustical assessments.

dBA See 'A' frequency weighting

EQUIVALENT CONTINUOUS SOUND LEVEL, L_{EQ}

Many sounds, such as road traffic noise or construction noise, vary repeatedly in level over a period of time. More sophisticated sound level meters have an integrating/averaging electronic device inbuilt, which will display the energy time-average (equivalent continuous sound level - L_{Aeq}) of the 'A' frequency weighted sound pressure level. Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends

to indicate an average which is strongly influenced by short-term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.

FREE FIELD

In acoustics a free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall or inside an anechoic chamber.

FREQUENCY

The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.

HERTZ (HZ)

The unit used to measure frequency of sound expressed by cycles per second.

HUMAN RESPONSE TO NOISE LEVEL CHANGES

- Less than 3 dBA = no perceivable difference
- 3 dBA = barely perceptible difference
- 5 dBA = readily perceptible difference
- 10 dBA = ‘doubling’ (or ‘halving’) of performance

[Reference; Cowan, J.P., 1994 *Handbook of Environmental Acoustics* & Bell, L.H. and D.H. Bell. 1994. *Industrial Noise Control Fundamentals and Applications*]

NOISE

Noise is unwanted, harmful or inharmonious (discordant) sound. Sound is wave motion within matter, be it gaseous, liquid or solid. Noise usually includes vibration as well as sound.

NOISE AVERAGING PERIODS

Noise can be measured over various periods of time. The five ‘averaging periods’ used in this report are described below:

- $L_{Aeq(15\text{ min})}$ describes an average noise level across a period of time (either day, evening, night, or over a 15-minute period). It accounts for the full range of noise levels encountered in a given area over a given period.
- L_{A90} describes the noise level that occurs for 90 per cent of the time and therefore describes the background noise level.
- L_{A10} describes the noise level that occurs for 10 per cent of the time and therefore describes what the environment is like during the noisiest periods.
- L_{Amax} describes the average maximum noise level recorded at any point in time.
- Rating background (noise) levels (RBLs) describe the ambient noise levels during the day, evening and at night. It represents the overall single-figure background noise level determined based on measured L_{A90} in each relevant assessment period as described in detail in the NPfI (EPA 2017).

RATING BACKGROUND LEVEL

As defined in the NPfI, it is the single figure level that represents the background noise level for each day, evening or night period. It is median of the assessment background levels. The assessment background level is the lowest 10th percentile of each $L_{90(15\text{min})}$ measurement in each period per day.

SOUND ATTENUATION

A reduction of sound due to distance, enclosure or some other device. If an enclosure is placed around a machine, or an attenuator (muffler or silencer) is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 20 dB reduces the sound energy by one hundred times.

SOUND PRESSURE

The rms sound pressure measured in pascals (Pa). A pascal is a unit equivalent to a newton per square metre (N/m²).

SOUND PRESSURE LEVEL (LP)

The level of sound measured on a sound level meter and expressed in decibels (dB). It is the logarithmic ratio of the square of sound pressure received to the reference pressure. L_p varies with distance from a noise source.

SOUND POWER LEVEL, (SPL) L_w

The sound power level of a noise source is the inherent noise of the device. Therefore sound power level does not vary with distance from the noise source or with a different acoustic environment.