Harris Park Station Upgrade
Transport for New South Wales
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Harris Park Station Easy Access Upgrade

Noise and Vibration Impact Assessment

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Client: Transport for New South Wales

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Quality Information

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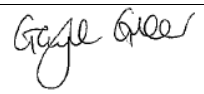
E	19-Jan-2016	Final	Gayle Greer Technical Director - Acoustics	

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1.0 Introduction

1.1 Background information

AECOM Australia Pty Ltd (AECOM) has been commissioned by Transport for New South Wales (TfNSW) to undertake a Noise and Vibration Impact Assessment of the construction and operation of the proposed upgrade to Harris Park Station.

The Harris Park Station Easy Upgrade would include the following key elements:

- retention and refresh of the existing station concourse including a new family accessible toilet
- installation of two new platform lifts
- demolition of existing stairs at the western entrance and replacement with new ramp and stairs with canopies
- demolition of existing non-compliant ramp at the eastern entrance and replacement with a new lift and stairs with canopies
- upgraded footpath along Station Street East
- installation of new canopies on stairs and station entrances for weather protection
- provision of interchange facilities including kiss and ride zones and taxi waiting facilities
- installation of bicycle racks at both station entrances
- ancillary works including minor drainage works, adjustments to lighting and ticketing machines, improvements to station communication systems with new infrastructure (including additional CCTV cameras) and way finding signage.

The footbridge and concourse works are expected to commence in early 2017, take up to 18 months to complete and would be undertaken during both standard construction hours and out-of-hours.

The following policies and guidelines are relevant for this assessment:

- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change (DECC), 2009
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC), 2006
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011
- *NSW Industrial Noise Policy* (INP), Environment Protection Authority (EPA), 2000
- *Construction Noise Strategy* (CNS) Transport Construction Authority (TCA), 2011
- *DIN Standard 4150: Part 3 1999 Structural Vibration in Buildings - Effects on Structures*, 1999
- *British Standard 7385: Part 2 1993 Evaluation and Measurement of Vibration in Buildings*, 1993
- *British Standard 6472: Part 1 2008 Evaluation of Human Exposure to Vibration in Buildings*, 2008.

Definitions for acoustic terminology used within this report can be found within Appendix A.

1.2 Scope

The scope of this construction noise and vibration impact assessment is to:

- establish the existing background noise levels in the vicinity of Harris Park Station
- establish the construction noise management levels and vibration limits that would apply to the Harris Park Station upgrade works
- establish the operational noise criteria that would apply to the operation of Harris Park Station
- predict environmental noise and vibration levels at nearby residential and other sensitive receivers due to the upgrade works

- predict noise levels from additional off-site construction traffic generated by the Harris Park Station works
- provide mitigation measures where necessary to reduce and manage noise and vibration impacts from the workstation upgrade works to comply with established construction noise management levels and vibration limits
- consider operational noise from the operation of the upgraded Harris Park Station.

1.3 Site description

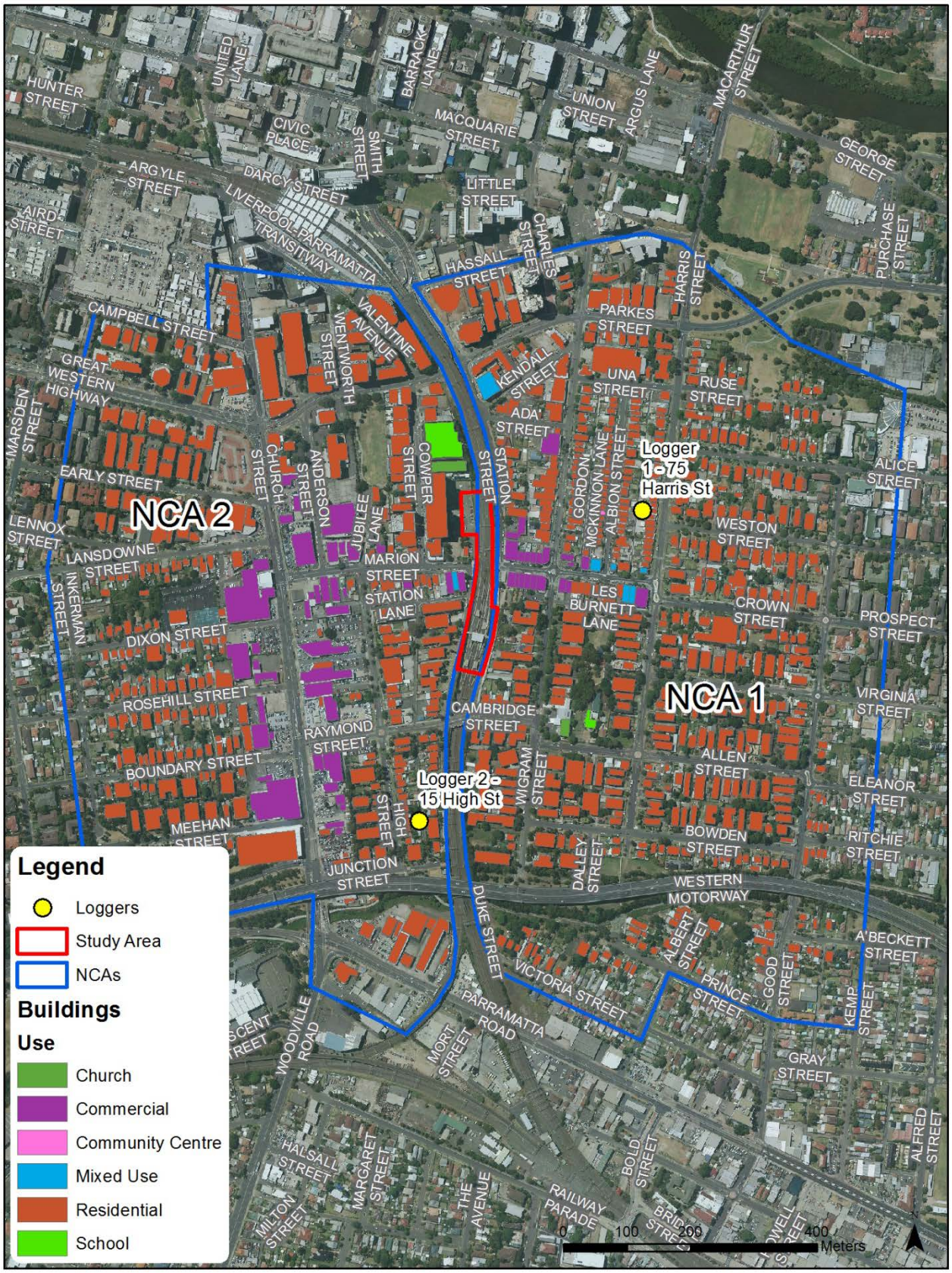
Figure 1 shows the location of Harris Park Station and its surrounding environment. The station is located within a mixed use environment which comprises primarily residential dwellings with some commercial and retail uses. In addition, two schools and a place of worship are located within the area.

The potentially worst affected residential receiver to the study area is located at 27 Station Street, West Parramatta located immediately west of the study area approximately 15 metres from the study area. It should be noted a sixteen storey residential apartment block is located at 8 Cowper Street, Parramatta overlooking the northern section of the study area. The nearest commercial premise to the study area is located at 43-45 Marion Street, Parramatta located approximately 20m west of the study area.

The nearest school, Alphacrucis College at 30 Cowper Street, Parramatta is located approximately 50 m north, north-west of the study area.

Station Street West to the west and Wigram Street to the east are considered to be sub-arterial roads as per categories within the *NSW Road Noise Policy*.

Figure 1 Receivers and logger locations



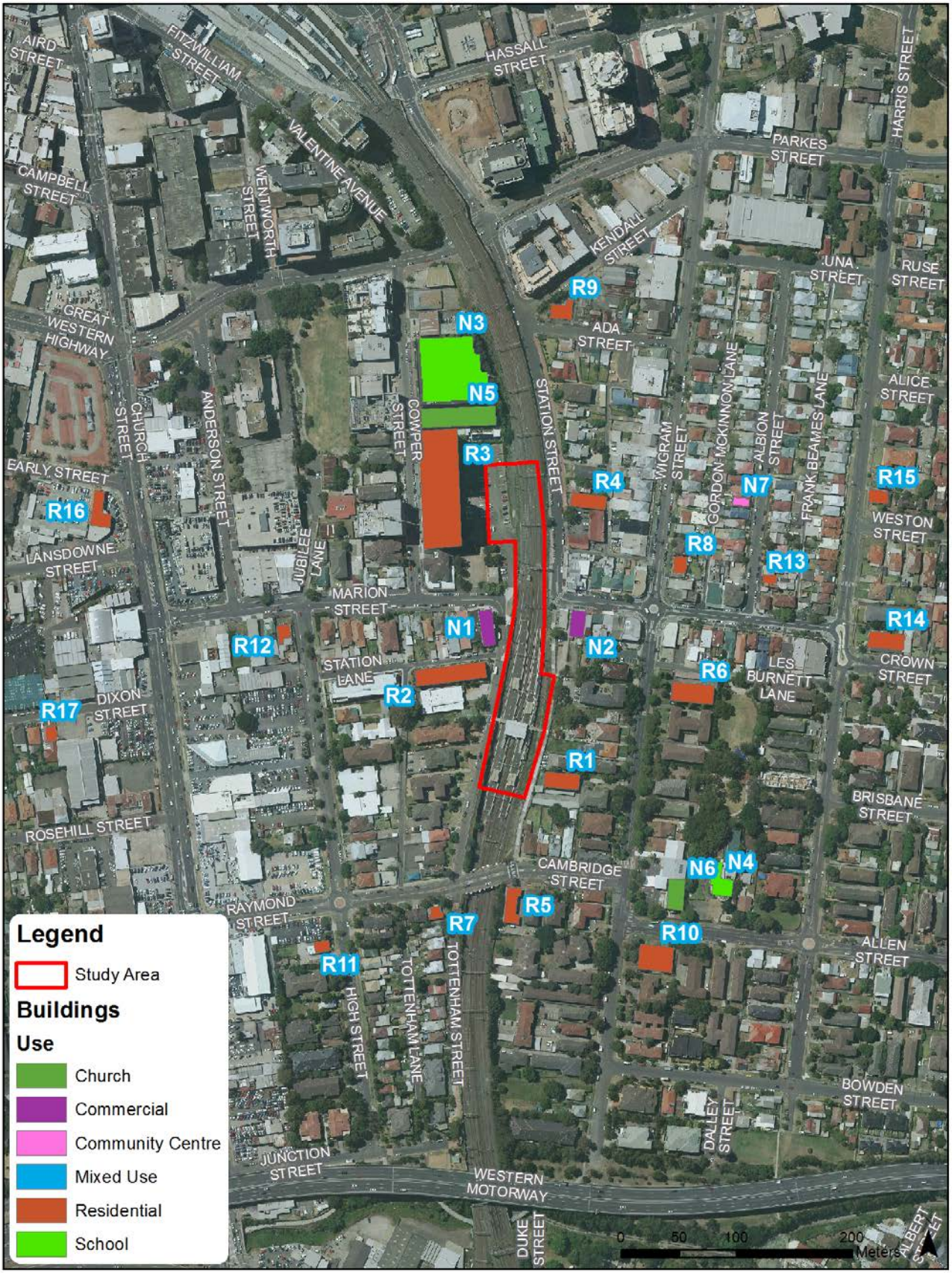
In order to simplify the assessment methodology, 17 representative residential receivers have been selected to represent receivers on their block with likely similar background noise levels. Representative non-residential have also been selected, including all schools, places of worship and community centres, plus two nearest commercial premises to the study area. Residences located at the nearest location to the worksite on their block were selected as the potentially worst affected receivers and are listed in Table 1.

Table 1 Representative receiver addresses

Receiver ID	Receiver address	Approx. distance to study area, m
	Residential	
R1	27 Station Street West, Harris Park	10
R2	8 Cowper Street, Parramatta	20
R3	22 Station Street East, Harris Park	30
R4	40 Wigram Street, Harris Park	50
R5	8 Cambridge Street, Granville	80
R6	Les Burnett Lane, Harris Park	100
R7	20 Tottenham Street, Granville	110
R8	59 Wigram Street, Harris Park	110
R9	2 Ada Street, Harris Park	130
R10	25-27 Wigram Street, Harris Park	160
R11	11 Marion Street, Harris Park	190
R12	34 High Street, Granville	190
R13	4 Albion Street, Harris Park	190
R14	55 Harris Street, Harris Park	270
R15	65 Harris Street, Harris Park	280
R16	65 Church Street, Parramatta	330
R17	31 Dixon Street, Parramatta	370
	Non-residential	
N1	Commercial premise, 43-45 Marion Street, Harris Park	10
N2	Commercial premise, 53B Marion Street, Harris Park	20
N3	School – Alphacrucis College, 30 Cowper Street, Parramatta	60
N4	School – St Oliver's Primary School, 33 Wigram Street, Harris Park	170
N5	Place of Worship – Nan Tien Temple, 22 Cowper Street, Parramatta	30
N6	Place of Worship – St Oliver Plunkett's Catholic Church, 35 Wigram Street, Harris Park	140
N7	Community Centre – Harris Park Community Centre, 11 Albion Street,	160

Representative receiver locations are shown in Figure 2.

Figure 2 Representative receiver locations



2.0 Existing Acoustic Environment

2.1 Noise sensitive receivers

Figure 1 shows the receivers which were assessed within this report. Residential and other sensitive receivers which could potentially be affected by the works are scattered around the study area. Unattended and attended noise monitoring was completed to quantify and qualify the existing noise environment in the vicinity of the works.

Two noise catchment areas (NCA) were identified as representing the residential receivers. One logger was placed within each NCA at a representative location. A description of the receivers within each NCA is described in Table 2.

Table 2 Noise catchment area descriptions

NCA	Description
1	Residential receivers – Mixture of single storey and multi-storey residential houses Small group of commercial receivers to the east of the station around Station Street East Church and school in the south east.
2	Residential receivers – Mixture of single storey and multi-storey residential houses Large cluster of commercial receivers to the west of the station centred around Church Street School to the north, north-east of the station.

2.2 Instrumentation

The noise loggers used for long term monitoring and their locations are presented in Table 3. The noise loggers were calibrated prior to and after the monitoring session with a drift in calibration not exceeding ± 0.5 dB.

All the acoustic instrumentation employed during the noise measurements comply with the requirements of "*AS IEC 61672.1-2004 Electroacoustics – Sound level meters – Specifications*".

All instruments used were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last 2 years).

Table 3 Noise monitoring details

NCA	Location	Model	Serial number
1	75 Harris Street, Harris Park	Rion NL-21	865769
2	15 High Street, Harris Park	ARL 315	15-299-444

3.0 Unattended noise measurements

Noise monitoring was conducted to determine existing background noise levels at sensitive receivers. Noise loggers were placed at the locations indicated in Table 3. The noise loggers monitored noise levels continuously from 22 June to 3 July 2015.

The loggers measured the noise levels over the sample period and then determined L_{A10}, L_{A90}, L_{Amax}, and L_{Aeq} levels of the noise environment. The L_{A10} and L_{A90} noise levels are the levels exceeded for 10 percent and 90 percent of the measurement period respectively. The L_{A90} is taken as the background level. The L_{Amax} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the NSW EPA's *Industrial Noise Policy*, for each monitoring location. The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. Table 4 presents individual ABLs for each day's assessment periods. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring period.

Table 4 also presents the existing L_{Aeq} ambient noise level selected for each day, evening and night-time period, in accordance with the *Industrial Noise Policy*. An overall representative L_{Aeq} noise level is determined by logarithmically averaging each assessment period for the entire monitoring period.

In accordance with the *Industrial Noise Policy*, any noise monitoring conducted during periods of extraneous weather conditions was excluded from the data set. The *Industrial Noise Policy* advises that data may be affected where adverse weather, such as wind speeds higher than 5 m/s or rain, occurs. During the measurement period for this assessment, periods of adverse weather occurred during three daytime periods. Weather data was acquired from the Bureau of Meteorology's (BOM) Sydney Olympic Park weather station.

Graphical noise logging results are presented in Appendix B and periods where data has been omitted are indicated.

Table 4 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels

Measurement date	L_{Aeq} Ambient noise levels, dB(A)			L_{A90} Background noise levels, dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
75 Harris Street – NCA 1						
Monday 22 June 2015	*	52	47	*	43	39
Tuesday 23 June 2015	*	50	46	*	41	39
Wednesday 24 June 2015	53	49	46	41	41	35
Thursday 25 June 2015	*	*	*	*	*	*
Friday 26 June 2015	55	49	*	42	43	*
Saturday 27 June 2015	54	50	47	42	45	42
Sunday 28 June 2015	*	49	47	*	44	39
Monday 29 June 2015	54	56	46	40	43	39
Tuesday 30 June 2015	55	51	*	41	43	*
Wednesday 01 July 2015	*	51	*	*	43	*
Thursday 02 July 2015	*	*	*	*	*	*
Friday 03 July 2015	*	*	*	*	*	*
Rating background level	**-**	**-**	**-**	**41**	**41[2]**	**39**
Log Average L_{Aeq}	**54**	**52**	**47**	**-**	**-**	**-**
15 High Street – NCA 2						
Monday 22 June 2015	*	60	55	*	50	44
Tuesday 23 June 2015	60	*	54	48	*	45
Wednesday 24 June 2015	65	54	52	48	48	42
Thursday 25 June 2015	*	*	*	*	*	*
Friday 26 June 2015	59	*	*	49	*	*
Saturday 27 June 2015	58	59	56	47	50	47
Sunday 28 June 2015	*	54	52	*	50	42
Monday 29 June 2015	57	55	52	48	48	44
Tuesday 30 June 2015	58	54	*	49	48	*
Wednesday 01 July 2015	*	54	*	*	49	*
Thursday 02 July 2015	*	*	*	*	*	*
Friday 03 July 2015	*	*	*	*	*	*

Measurement date	L_{Aeq} Ambient noise levels, dB(A)			L_{A90} Background noise levels, dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Rating background level	-	-	-	48	48[2]	44
Log Average L_{Aeq}	61	56	54	-	-	-

Notes:

1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays.

   Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays.

   Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

2. Evening RBLs have been set to no higher than daytime RBLs in accordance with the INP Application Notes.

3.1 Existing noise environment summary

The acoustic environment for NCA 1 is characterised by road traffic on local roads and on the M4 Western Motorway, train operations on the Main Western Line and natural sounds such as birds. NCA 1 is considered to be suburban as it is characterised by local traffic flows with some commercial areas.

Similar to NCA 1, NCA 2 is characterised by road traffic on local roads, on arterial roads including Church Street/Great Western Highway and on the M4 Western Motorway, rail traffic on the Main Western Line and natural sounds such as birds. NCA 2 is considered to be urban as it is characterised by relatively high traffic flows and commercial areas.

Both NCAs exhibit slightly higher RBLs during the evening compared with the daytime, with lowest RBLs occurring at night-time. This may be due to increased activity during the evening periods due to peak traffic activity occurring after 6pm. The community generally expects greater control of noise during the more sensitive evening and night-time periods than the daytime period, and evening RBLs have been set to no higher than daytime RBLs in accordance with the *Industrial Noise Policy* Application Notes.

4.0 Construction noise and vibration criteria

4.1 Construction activity noise criteria

4.1.1 Interim Construction Noise Guideline

The NSW EPA's *Interim Construction Noise Guideline* is the principal guideline for the assessment and management of construction noise in NSW. This document replaces the previous publication the *Environmental Noise Control Manual* and is used as the basis for establishing construction noise management levels.

The *Interim Construction Noise Guideline* recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the Environmental Impact Assessment (EIA) process'. Noise levels due to construction activities are predicted at nearby receivers using environmental noise modelling software and compared to the levels provided in Section 4 of the *Interim Construction Noise Guideline*.

Where an exceedance of the management levels is predicted the *Interim Construction Noise Guideline* advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practises to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as contact details.

Where construction noise levels reach 75 dB(A) residential receivers can be considered as 'highly noise affected' and the proponent should, in consultation with the community, consider restricting hours to provide respite periods.

The *Interim Construction Noise Guideline* defines what is considered to be feasible and reasonable as follows:

- *Feasible*

  A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

- *Reasonable*

  Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."

The construction noise management levels for the residential and other sensitive land uses are detailed in Table 5 and Table 7.

Table 5 ***Interim Construction Noise Guideline*** **Residential Noise Management Levels**

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. - Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Notes:

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

Table 6 presents the NMLs applicable to residential receivers nearby to this development.

Table 6 Construction noise management levels – Residential receivers

Noise catchment area	Period	RBL, L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out of hours noise management levels, $L_{Aeq,15min}$, dB(A)
1	Day	41	51	46
	Evening	41[1]	N/A	46
	Night	39	N/A	44
2	Day	48	58	53
	Evening	48[1]	N/A	53
	Night	44	N/A	49

Notes:

1. Evening RBLs have been set to no higher than daytime RBLs in accordance with the INP Application Notes.

Table 7 presents the NMLs applicable to noise sensitive receivers other than residential.

Table 7 Construction noise management levels – Other receivers

Land use	Noise management levels, $L_{Aeq,15min}$ (applies when properties are in use)
Classrooms at schools and other educational institutions	55 dB(A)[1]
Places of worship	55 dB(A)[1]
Commercial premises (including offices, retail outlets)	70 dB(A)
Community centres	55 dB(A)[1]

Notes:

1. These management levels are based upon a 45 dB(A) internal noise management level and a 10 dB reduction through an open window.

4.1.2 Sleep disturbance criteria

The *Interim Construction Noise Guideline* requires a sleep disturbance analysis where construction works are planned to extend over more than two consecutive nights. On the basis of the ambient noise environment during the night-time period, the predicted L_{A1} noise levels and number of expected L_{A1} noise events should be predicted in order to determine the likelihood of potential sleep disturbance.

The *Interim Construction Noise Guideline* makes reference to the NSW *Environmental Criteria for Road Traffic Noise* now superseded by the *Road Noise Policy*, for guidance in assessing the potential for sleep disturbance.

The guidance provided in the *Road Noise Policy* for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the $L_{A1(1\ min)}$ noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB. The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

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

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 8.

Table 8 Sleep disturbance criteria

Noise catchment area	Background noise level (L_{A90}), dB(A)	Sleep disturbance criteria,	$L_{A1(1\ minute)}$, dB(A)
		Screening level	Awakening reaction
1	39	54	60 – 65
2	44	59	60 – 65

4.2 Construction traffic noise criteria

The *Interim Construction Noise Guideline* does not provide direct reference to an appropriate criterion to assess the noise arising from construction traffic on public roads. However the *Road Noise Policy* provides the following guidance for assessing relative increases in criteria:

> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*

Thus, the criterion applied to traffic movements on public roads generated during the construction phase of the project is an increase in existing road traffic noise of no more than 2 dB(A).

The *Road Noise Policy* does not require assessment of noise impact to commercial or industrial receivers. The external noise criteria are applied 1 metre from the external facade of the affected building.

4.3 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in Table 9.

Table 9 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration) [1]	*Assessing Vibration: A Technical Guideline* (AVATG)

Notes

1. This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- Continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities for example, a tunnel boring machine.
- Impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities.
- Intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

4.3.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 10. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

Table 10 DIN 4150: Structural damage safe limits for building vibration

Group	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Vibration at the horizontal plane of the highest floor
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order, i.e. heritage buildings)	3	3 to 8	8 to 10	8

4.3.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline *Assessing Vibration: A Technical Guideline* is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 11. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 11 Preferred and maximum vibration dose values for intermittent vibration (m/s$^{1.75}$)

Location	Daytime (7 am – 10 pm)		Night-time (10 pm – 7 am)	
	Preferred	Max	Preferred	Max
Critical areas	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

5.0 Operational Noise Criteria

5.1.1 Industrial Noise Policy

The NSW *Industrial Noise Policy* provides guidance in relation to acceptable noise limits for industrial noise emissions, which includes, but is not limited to, noise emissions from mechanical plant.

The assessment procedure in the *Industrial Noise Policy* has two components:

- controlling **intrusive** noise impacts in the short term for residences
- maintaining noise level **amenity** for residences and other land uses

Both components are assessed at the boundary of the noise sensitive receiver site, or if the site boundary is more than 30 metres from the noise sensitive building, a distance of 30 metres from the noise sensitive building.

Adjustments to the level of noise predicted (or measured) at the assessment location may be applied in accordance with Section 4 of the *Industrial Noise Policy* to account for the subjective effects of specific noise characteristics including tonality, low frequency content, intermittency, impulsiveness and duration.

5.1.1.1 Intrusive noise impacts

The *Industrial Noise Policy* states that the noise from any single noise source should not be greatly above the prevailing background noise level. Industrial noise sources are generally considered acceptable if the A-weighted equivalent continuous sound pressure level of noise from the source, measured over a 15 minute period ($L_{Aeq,15\ min}$) does not exceed the Rating Background Level (RBL) by more than 5 dB(A) for the period under consideration. This is termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the *Industrial Noise Policy*.

The RBLs and the respective intrusive criteria for the day, evening and night periods are provided in Table 12.

Table 12 Intrusive criteria

Location	Period	RBL (L_{A90}), dB(A)	Intrusive Criteria (RBL+5), dB(A)
Residential receivers – NCA 1	Day	41	46
	Evening	41	46
	Night	39	44
Residential receivers – NCA 2	Day	48	53
	Evening	48	53
	Night	44	49

5.1.1.2 Protecting amenity

To limit continuing increase in noise levels, the maximum ambient noise level within an area from all industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the *Industrial Noise Policy*. That is the noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the "background creep" or "amenity criterion".

The amenity criteria applicable to this development are provided in Table 13.

Table 13 Amenity criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)		Ambient Noise Level, dB(A)	Amenity Criteria
			Acceptable	Maximum		
Residential receivers – NCA 1	Suburban	Day	55	60	54	55

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)		Ambient Noise Level, dB(A)	Amenity Criteria
			Acceptable	Maximum		
		Evening	45	50	52	45
		Night	40	45	47	40
Residential receivers – NCA 2	Urban	Day	60	65	61	60
		Evening	50	55	56	50
		Night	45	50	54	45
School classroom - internal	All	Noisiest 1-hour period when in use	35	40	-	35
Place of Worship - internal	All	When in use	40	45	-	40
Commercial premises	All	When in use	65	70	-	65

5.1.1.3 Summary

A summary of the environmental noise criteria is presented in Table 14 below.

Table 14 Summary of environmental noise emission criteria

Location	Time of Day	Criteria L_{Aeq}, dB(A)		
		Intrusive	Amenity	Project Specific Noise Levels[1]
NCA 1	Day	46	55	46
	Evening	46	45	45
	Night	44	40	40
NCA 2	Day	53	60	53
	Evening	53	50	50
	Night	49	45	45
School classroom	Noisiest 1-hour period when in use	-	45[2]	45
Place of Worship	When in use	-	50[2]	50
Commercial premises	When in use	-	65	65

Notes:

1. Project Specific Noise Levels represent the lower of the intrusive and amenity criteria.
2. External noise level assuming windows remain closed

The above criteria apply to environmental noise emission from plant installed as part of the upgrade.

6.0 Construction Noise Assessment

6.1 Construction stages and scheduling

In consultation with TfNSW, six stages of construction have been assumed to occur for the upgrade works. These would be confirmed by TfNSW and the construction contractor, prior to construction commencing and further assessment would be undertaken if required. Proposed construction stages for the Harris Park Easy Access Upgrade are described in Table 15.

Table 15 Construction stages and scheduling

Activity	Hours	Approx. duration of works
Site establishment and enabling works		
- Establishment of site compound (erect fencing, tree protection zones, site offices, amenities and plant/material storage areas etc) - Establishment of temporary facilities as required (e.g. temporary pedestrian access to station, temporary bathroom)	Standard or day time possession	5 days
- Removal of vegetation to allow for new lifts/stairs	Standard	3 days
- Services relocation	Mostly in standard, with cutover works (not noisy) during possessions	56 days – NB: includes a minimum 2 day weekend possession
Lift, footbridge and platform upgrades		
Similar tasks modelled as one: - Demolition of existing structures as required - Platform modifications including foundations for columns, footings and lift shafts - Construction of columns, stairs, canopies and anti-throw screens - Replacement of non-compliant stairs - Construction of lift shafts	Standard or 48 hr possession	15 days – NB: includes 2 day weekend possessions
	Standard or 48 hr possession	75 days
	Standard or 48 hr possession	90 days – NB: includes weekend possessions
- Stormwater works and installation of new gabion wall on eastern side	Standard or 48 hr possession	145 days
- Installation of lifts - Installation of fixtures, lighting and CCTV cameras for affected areas	Standard or day time possession	70 days
- Platform resurfacing	48 hr possession	4 days – NB: Assume resurfacing can be done in 2 x 2 weekend daytime possessions
Station building works		
- Reconfiguration of internal station buildings to allow for a new communications/equipment room and new family access toilet and conversion of ticket window	Standard	60 days
- Refresh of station building (existing glazing to be replaced, and existing façade to be overclad)	Standard or 48 hr possession	75 days
- Installation of solar panels (if viable)	Standard	Unknown

Activity	Hours	Approx. duration of works
Interchange works		
- Construction of accessible ramps on both sides of the station	Standard	60 days
- Conversion of 'no parking' zone on Station Street to kiss and ride - Conversion of two hour restricted parking spaces on Station Street West and Cambridge Street to kiss and ride - Creation of taxi zone on Station Street East and Station Street West with shelters (shared with kiss and ride)	Standard	20 days
Finalisation		
- Installation of new bicycle racks on both sides of the station - Installation of wayfinding signage - Electrical and power supply upgrade works - Replanting/landscaping and fencing adjustments and bollards	Standard	100 days
Testing and commissioning		

Notes:

1. Works with potentially high impacts in terms of noise levels and timing are highlighted in blue

Potentially high noise impact works, highlighted in blue in Table 15, have been assessed below.

Other lift, footbridge and platform upgrade works (with the exception of lift, fixtures, lighting and CCTV installation) have similar noise levels and the same hours as the stair and lift shaft construction. This work activity has therefore been selected as representative of all lift, footbridge and platform upgrade works.

Testing and commissioning is not considered to be significantly noise intensive and as such has not been considered further in this assessment.

The works would be undertaken during standard hours and track possessions.

6.2 Construction sources

Noise sources and their respective sound power levels (SWLs) for each work package of works are shown in Table 16. These SWLs are presented as equivalent continuous levels, described by the L_{Aeq} parameter, and have been taken from data provided in Australian Standard AS2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites* and the UK Department for Environment, Food and Rural Affairs (DEFRA) "*Update of noise database for prediction of noise on construction and open sites*" noise database and assume equipment is modern and in good working order.

Construction equipment L_{Amax} levels are generally considered to be 8 dB higher than L_{Aeq} levels as a rule of thumb, and differences between TfNSW's *Construction Noise Strategy* L_{Amax} levels and the L_{Aeq} levels presented in Table 16 vary from 5 to 10 dB. Therefore the L_{Aeq} levels generally correlate with the levels presented in the TfNSW's *Construction Noise Strategy.*

Table 16 Indicative construction activities, noise sources and levels

Stage	Sub-stage	Description of noise intrusive works in sub-stage	Equipment	SWL, L_{Aeq} dB(A)	Hours	Approx. duration of works
1. Site establishment and enabling works	1A	Establishment of site compound (erect fencing, tree protection zones, site offices, amenities and plant/material storage areas etc)	Trucks	98	Standard or day time possession	5 days
			Generator	93		
			Bobcat	104		
			Hand tools	94		
	1B	Removal of vegetation on western and eastern sides to allow for new lift and entry plaza	Mulcher	113	Standard	3 days
			Chainsaw	110		
			Bobcat	104		
			Trucks	98		
			Hand tools	94		
2. Lift, footbridge and platform upgrades	2A	Construction of columns, stairs, canopies and anti-throw screens Replacement of non-compliant stairs Construction of lift shafts	Trucks	98	Standard or 48hr possession	90 days, loudest demolition works 15 days
			300 tonne crane	106		
			Demolition saw	110		
			Generator	93		
			Jackhammer	108		
			Excavator	98		
			Grinder	108		
			Bobcat	104		
			Scissor lift	100		
			Franna crane	93		
			Hand tools	98		
			Hydreama / Hirail	98		
			Manitou	92		

Stage	Sub-stage	Description of noise intrusive works in sub-stage	Equipment	SWL, L_{Aeq} dB(A)	Hours	Approx. duration of works
3. Station building works	3A	Reconfiguration of internal station buildings to allow for a new communications/ equipment room and new family accessible toilet and conversion of ticket window	Trucks	98	Standard	60 days
			Demolition saw	110		
			Jackhammer	108		
			Excavator	98		
			Grinder	108		
			Nail gun	94		
			Hand tools	94		
			Lighting tower	95		
	3B	Refresh of station building (existing glazing to be replaced, and existing façade to be overclad)	200 tonne crane	106	Standard or 48 hour	75 days
			Trucks	98		
			Scissor lift	100		
			Hand tools	94		
			Lighting tower	95		
4. Interchange works	4A	Construction of accessible ramps on both sides of the station	Trucks	98	Standard	60 days
			Demolition saw	110		
			Jackhammer	108		
			Excavator	98		
			Concrete pump	106		
			Concrete truck	106		
			Hand tools	94		
5. Finalisation	5A	Installation of new bicycle racks on both sides of the station.	Trucks	98	Standard	100 days
		Installation of wayfinding signage Electrical and power supply upgrade works	Coring machine	108		
		Replanting/landscaping and fencing adjustments and bollards	Hand tools	94		

6.3 Modelling and conditions

In order to assess the noise impact from the site during construction, a noise model was created to represent 'reasonable' worst periods of upgrade works.

The upgrade works have been modelled in SoundPLAN Version 7.3. The following features were included in the noise model:

- ground topography
- ground absorption and reflection
- buildings (residential and non-residential)
- receivers (shown in Figure 1)
- construction noise sources (listed in Table 16)

Noise emissions from the construction sites have been modelled using an implementation of the International Organisation for Standardization (ISO) 9613 propagation algorithm with neutral metrological conditions.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures would also vary as the construction equipment moves around the site.

6.4 Construction noise assessment

A summary of the construction noise results is shown in Table 17, Table 18 and Table 19 for the standard hours, day and evening out of hours, and night-time out of hours respectively. Predicted impacts which exceed NMLs are shown in bold black, with 'highly affected' residential receivers shown in bold red. Results are presented graphically in Appendix C.

The results below represent worst case construction scenarios as the location of noise sources representing construction equipment have been conservatively modelled at the nearest location within the study area to each receiver. This represents a conservative assessment with measured noise levels likely to be lower than those predicted below.

The highly affected noise level only applies to residential receivers. Residential receivers have been assessed against the standard hours, out of hours daytime and evening and out of hours night-time criteria. The level of impact may change depending on the final construction methodology and further assessment would be undertaken if required.

Table 17 shows predicted noise impacts at selected representative receivers during standard hours.

Table 17 Predicted noise impacts at representative receivers – Standard hours

	Representative receiver address	Approx. dist. to worksite, m	NML, dB(A)	Predicted noise impact during sub-stage[1], dB(A)						
				1A –Site compound establishment	1B – Vegetation removal	2A – Lift, footbridge and platform upgrade	3A – Reconfig. of station building	3B – Refresh station building	4A – Interchange works	5A - Finalisation
	Residential									
R1	27 Station Street West, Harris Park	10	58	**74**	**75**	**72**	**72**	**68**	**72**	**78**
R2	8 Cowper Street, Parramatta	20	58	**70**	**59**	56	56	52	56	**74**
R3	22 Station Street East, Harris Park	30	51	**69**	**58**	**55**	**55**	51	**55**	**73**
R4	40 Wigram Street, Harris Park	50	51	**62**	**56**	**53**	**53**	50	**53**	**66**
R5	8 Cambridge Street, Granville	80	51	**57**	**62**	**59**	**59**	**55**	**59**	**61**
R6	Les Burnett Lane, Harris Park	100	51	**52**	**61**	**58**	**58**	**55**	**58**	**56**
R7	20 Tottenham Street, Granville	110	58	52	**60**	57	57	53	57	56
R8	59 Wigram Street, Harris Park	110	51	**53**	**53**	50	50	46	50	**57**
R9	2 Ada Street, Harris Park	130	51	51	51	48	48	44	48	**55**
R10	25-27 Wigram Street, Harris Park	160	51	42	45	42	42	39	42	46
R11	11 Marion Street, Harris Park	190	58	47	45	42	42	39	42	51
R12	34 High Street, Granville	190	58	45	54	51	51	47	51	49
R13	4 Albion Street, Harris Park	190	51	45	50	47	47	44	47	49
R14	55 Harris Street, Harris Park	270	51	44	51	48	48	44	48	48
R15	65 Harris Street, Harris Park	280	51	42	49	46	46	43	46	46
R16	65 Church Street, Parramatta	330	58	39	43	40	40	37	40	43
R17	31 Dixon Street, Parramatta	370	58	40	43	40	40	37	40	43

	Representative receiver address	Approx. dist. to worksite, m	NML, dB(A)	Predicted noise impact during sub-stage[1], dB(A)						
				1A –Site compound establishment	1B – Vegetation removal	2A – Lift, footbridge and platform upgrade	3A – Reconfig. of station building	3B – Refresh station building	4A – Interchange works	5A - Finalisation
	Non-residential receivers									
N1	Commercial premise, 43-45 Marion Street, Harris Park	10	70	**76**	70	67	67	63	67	**80**
N2	Commercial premise, 53B Marion Street, Harris Park	20	70	69	66	63	63	59	63	**73**
N3	Alphacrucis College, 30 Cowper Street, Parramatta	60	55	**56**	49	46	46	43	46	**60**
N4	St Oliver's Primary School, 33 Wigram Street, Harris Park	170	55	40	45	42	42	39	42	44
N5	Nan Tien Temple, 22 Cowper Street, Parramatta	30	55	**65**	**56**	53	53	49	53	**69**
N6	St Oliver Plunkett's Catholic Church, 35 Wigram Street, Harris Park	140	55	42	44	41	41	38	41	46
N7	Harris Park Community Centre, 11 Albion Street, Harris Park	160	55	49	54	51	51	48	51	53

Notes:

1. Items in **BOLD BLACK** indicate predicted noise impact at this receiver during this work stage is above NML. Items in **BOLD RED** indicate a 'highly affected' residential receiver with level of 75 dB(A) or greater

Results show the largest number of residential exceedances during standard hours occur during Stage 1B – Vegetation removal and Stage 5A – Finalisation. The largest impacts will be experienced by residences along Station Street and west of Wigram Street facing the study area, with several residences predicted to be 'highly affected'. One multi-storey apartment block is included in these premises, located at 8 Cowper Street, Parramatta.

Residences exceeding NMLs are located generally up to two streets west from the study area, and several streets east of the study area, extending to Good Street. NML exceedances extend north to Hassall Street and south to Bowden Street.

Some non-residential receivers are predicted to exceed NMLs. Of these receivers, one is a school located at 30 Cowper Street, Parramatta.

Table 18 shows predicted noise impacts at selected representative receivers during daytime and evening out of hours.

Table 18 Predicted noise impacts at representative receivers – Daytime and evening out of hours

Representative receiver address		Approx. dist. to worksite, m	NML, dB(A)	Predicted noise impact during sub-stage[1], dB(A)		
				1A –Site comp. estab.	2A – Lift, foot-bridge and platform upgrade	3B – Refresh station building
	Residential					
R1	27 Station Street West, Harris Park	10	53	**74**	**72**	**68**
R2	8 Cowper Street, Parramatta	20	53	**70**	**56**	52
R3	22 Station Street East, Harris Park	30	46	**69**	**55**	**51**
R4	40 Wigram Street, Harris Park	50	46	**62**	**53**	**50**
R5	8 Cambridge Street, Granville	80	46	**57**	**59**	**55**
R6	Les Burnett Lane, Harris Park	100	46	**52**	**58**	**55**
R7	20 Tottenham Street, Granville	110	53	52	**57**	53
R8	59 Wigram Street, Harris Park	110	46	**53**	**50**	46
R9	2 Ada Street, Harris Park	130	46	**51**	**48**	44
R10	25-27 Wigram Street, Harris Park	160	46	42	42	39
R11	11 Marion Street, Harris Park	190	53	47	42	39
R12	34 High Street, Granville	190	53	45	51	47
R13	4 Albion Street, Harris Park	190	46	45	**47**	44
R14	55 Harris Street, Harris Park	270	46	44	**48**	44
R15	65 Harris Street, Harris Park	280	46	42	46	43
R16	65 Church Street, Parramatta	330	53	39	40	37
R17	31 Dixon Street, Parramatta	370	53	40	40	37

Representative receiver address		Approx. dist. to worksite, m	NML, dB(A)	Predicted noise impact during sub-stage[1], dB(A)		
				1A –Site comp. estab.	2A – Lift, foot-bridge and platform upgrade	3B – Refresh station building
	Non-residential receivers					
N1	Commercial premise, 43-45 Marion Street, Harris Park	10	70	**76**	67	63
N2	Commercial premise, 53B Marion Street, Harris Park	20	70	69	63	59
N3	Alphacrucis College, 30 Cowper Street, Parramatta	60	55	**56**	46	43
N4	St Oliver's Primary School, 33 Wigram Street, Harris Park	170	55	40	42	39
N5	Nan Tien Temple, 22 Cowper Street, Parramatta	30	55	**65**	53	49
N6	St Oliver Plunkett's Catholic Church, 35 Wigram Street, Harris Park	140	55	42	41	38
N7	Harris Park Community Centre, 11 Albion Street, Harris Park	160	55	49	51	48

Notes:

1. Items in **BOLD BLACK** indicate predicted noise impact at this receiver during this work stage is above NML.

As daytime and evening NMLs are equivalent, assessments for both periods are identical. Several receivers are predicted to exceed daytime and evening out of hours NMLs, with the largest number of exceedances predicted during Stage 1A – Site compound establishment. Highly affected receivers are located directly facing the study area along Station Street and Wigram Street, including the apartment block at 8 Cowper Street, Parramatta.

Residences exceeding NMLs are located generally up to two streets west from the study area, and several streets east of the study area, extending to Good Street. NML exceedances extend north to Hassall Street and south to Bowden Street.

Some non-residential receivers are predicted to exceed daytime and evening out of hours NMLs, however it should be noted NMLs apply only when premises are in use.

Table 19 shows predicted noise impacts at selected representative receivers during night-time out of hours.

Table 19 Predicted noise impacts at representative receivers – Night-time out of hours

	Representative receiver address	Approx. dist. to worksite, m	NML, dB(A)	Predicted noise impact during sub-stage[1], dB(A)	
				2A – Lift, footbridge and platform upgrade	3B – Refresh station building
	Residential				
R1	27 Station Street West, Harris Park	10	49	**72**	**68**
R2	8 Cowper Street, Parramatta	20	49	**56**	**52**
R3	22 Station Street East, Harris Park	30	44	**55**	**51**
R4	40 Wigram Street, Harris Park	50	44	**53**	**50**
R5	8 Cambridge Street, Granville	80	44	**59**	**55**
R6	Les Burnett Lane, Harris Park	100	44	**58**	**55**
R7	20 Tottenham Street, Granville	110	49	**57**	**53**
R8	59 Wigram Street, Harris Park	110	44	**50**	**46**
R9	2 Ada Street, Harris Park	130	44	**48**	44
R10	25-27 Wigram Street, Harris Park	160	44	42	39
R11	11 Marion Street, Harris Park	190	49	42	39
R12	34 High Street, Granville	190	49	**51**	47
R13	4 Albion Street, Harris Park	190	44	**47**	44
R14	55 Harris Street, Harris Park	270	44	**48**	44
R15	65 Harris Street, Harris Park	280	44	**46**	43
R16	65 Church Street, Parramatta	330	49	40	37
R17	31 Dixon Street, Parramatta	370	49	40	37
	Non-residential receivers				
N1	Commercial premise, 43-45 Marion Street, Harris Park	10	-	67	63
N2	Commercial premise, 53B Marion Street, Harris Park	20	-	63	59
N3	Alphacrucis College, 30 Cowper Street, Parramatta	60	-	46	43
N4	St Oliver's Primary School, 33 Wigram Street, Harris Park	170	-	42	39
N5	Nan Tien Temple, 22 Cowper Street, Parramatta	30	-	53	49
N6	St Oliver Plunkett's Catholic Church, 35 Wigram Street, Harris Park	140	-	41	38
N7	Harris Park Community Centre, 11 Albion Street, Harris Park	160	-	51	48

Notes:

1. Items in **BOLD BLACK** indicate predicted noise impact at this receiver during this work stage is above NML.

Several receivers are predicted to exceed night-time out of hours NMLs. Similarly to daytime and evening out of hours periods, some receivers are predicted to be 'highly affected', with the largest number of exceedances predicted during Stage 2A – Lift, footbridge and platform upgrades.

Residences exceeding NMLs are located generally up to two streets west from the study area, and several streets east of the study area, extending to Good Street. NML exceedances extend north to Hassall Street and south slightly short of the Western Motorway.

Non-residential receivers are not expected to be operating during night-time hours, therefore NMLs do not apply, and hence no exceedances of NMLs are anticipated.

Mitigation measures which are considered feasible and reasonable have been specified in Section 6.7.

6.5 Sleep disturbance assessment

As works would be undertaken during the night-time period, sleep disturbance is required to be assessed.

Appendix D presents the predicted maximum $L_{A1(1min)}$ noise level contours. The awakening reaction criterion is predicted to be exceeded at some residences in NCA 1 and NCA 2 for the lift, platform and footbridge upgrades and station building works.

As noted above the predicted $L_{A1(1min)}$ noise level contours indicate that in some instances the awakening reaction criterion may be exceeded at some locations during the construction, demolition and services relocation stages. The predicted construction noise levels presented in Appendix D are external noise levels. The typical outdoor to indoor noise reductions provided by most standard dwellings (i.e. without acoustical treatment) is generally accepted as being 10 dB with windows open and a minimum of 20 dB with windows closed. Therefore, by closing their windows during noisy activities residents can potentially attenuate external noise levels by 20 dB.

In addition, the predicted construction noise levels are typically the worst case noise levels, therefore for the majority of time the actual L_{A1} noise levels are likely to be less than those predicted. Mitigation measures presented in Section 6.7 are designed to minimise overall impacts from construction noise, and in turn would reduce sleep disturbance impacts. Night time works noise mitigation shall be addressed in the construction noise and vibration management plan with a focus on work scheduling and community notification.

6.6 Construction traffic assessment

No traffic counts have been conducted for this project; however the proposed construction vehicles have been estimated by TfNSW as approximately 1-3 vehicles per day Monday to Friday. For weekend possession works there would be approximately 8-16 vehicles per day. From on-site observations during the deployment of unattended noise measurement equipment, the existing traffic flow is substantially greater than the proposed construction traffic numbers. Therefore, the construction vehicles would have an insignificant impact on existing road traffic noise in the area. The traffic generated by these works is therefore deemed to comply with the *Road Noise Policy* criteria.

6.7 Construction noise mitigation measures

6.7.1 Construction Noise and Vibration Management Plan

Due to the exceedances presented in Table 17, Table 18 and Table 19, AECOM recommends that a Construction Noise and Vibration Management Plan (CNVMP) is devised and implemented prior to commencement of construction activities.

The CNVMP should include all feasible and reasonable mitigation options to manage the noise emissions from the site and also any complaints which may occur due to the construction activity noise. The CNVMP should include, but not limited, the following:

- identification of nearby residences and other sensitive land uses
- description of approved hours of work
- description and identification of all construction activities, including work areas, equipment and duration
- description of what work practices (generic and specific) would be applied to minimise noise and vibration
- a complaints handling process
- noise and vibration monitoring procedures
- overview of community consultation required for identified high impact works

6.7.2 Community consultation and complaints handling

All residents and sensitive receivers impacted by noise from the proposed works which are expected to exceed the NML should be consulted about the project prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works.

The information provided to the residents should include:

- programmed times and locations of construction work

- the hours of proposed works
- construction noise and vibration impact predictions
- construction noise and vibration mitigation measures being implemented on site

Community consultation regarding construction noise and vibration should be detailed in the Community Involvement Plan for the construction of the project and should include a 24 hour hotline and complaints management process.

6.7.3 Work practices

Induction and training should be provided to relevant staff and sub-contractors outlining their responsibilities with regard to noise.

6.7.4 Construction hours and work scheduling

Details of any necessary out-of-hours work required should form part of the CNVMP.

Noisy work should be scheduled to be undertaken during the standard hours as far as possible. Noisy activities that cannot be undertaken during standard construction hours should to be scheduled as early as possible during the evening and / or night-time periods. Should out-of-hours works be required, an out-of-hours works application form should be submitted to TfNSW for approval on a case-by-case basis.

Particularly noisy activities such as the use of concrete saws and excavators with hammers should be scheduled where feasible and reasonable around times of high background noise to provide masking. High noise impact works shall be conducted during the mid-morning or mid-afternoon when ambient noise is at its loudest, as far as possible.

Respite periods would be provided for these high noise impact activities. A one hour respite period for every three hours of work causing acute impacts is recommended;

6.7.5 Plant and equipment selection and location

The selection of plant and equipment can have a significant impact on construction noise levels. Appropriate plant should be selected for each task to minimise the noise contributions.

Alternative works methods such as use of hydraulic or electric-controlled units in place of diesel units should be considered and implemented where feasible and reasonable. The use of alternative machines that perform the same function (such as rubber wheeler plant) should be considered in place of steel tracked plant.

Equipment should be regularly inspected and maintained to ensure it is in good working order.

Plant should be located on site with as much distance as possible between the plant and noise sensitive receivers. Noisy equipment should be orientated away from residential receivers where feasible and reasonable.

6.7.6 Construction traffic

Truck drivers should be advised of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (i.e. minimising the use of engine brakes, and no extended periods of engine idling). Site access and egress points should be located away from residences and other sensitive land uses, where feasible and reasonable. Construction sites should be arranged to limit the need for reversing associated with regular / repeatable movements (e.g. trucks transporting spoil) to minimise the use of reversing alarms. Where feasible and reasonable, non-tonal reversing alarms should be used, taking into account the requirements of the Workplace Health and Safety legislation.

6.7.7 Noise monitoring

A noise monitoring program should be presented in the CNVMP.

The noise monitoring program should be implemented to assist in confirming and controlling the site specific potential for disturbance at particularly sensitive localities at the commencement of activities and periodically during the construction program as the works progress as well as for any out of hours works. The results should be reviewed to determine if additional mitigation measures are required. All measurements should be undertaken in accordance with Australian Standard 1055.1-1997 – Acoustics – Description and measurement of environmental noise, Part 1: General procedures.

6.7.8 TfNSW Construction Noise Strategy - Additional noise mitigation measures

TfNSW's *Construction Noise Strategy* provides practical guidance on how to minimise, to the fullest extent practicable, the impacts on the community from airborne noise, ground-borne noise and vibration generated during the construction of TfNSW projects. This is done through the application of all feasible and reasonable mitigation measures. Where exceedances are still expected to occur after standard mitigation measures have been applied, the *Construction Noise Strategy* recommends the implementation of additional mitigation measures. These mitigation measures are specified within TfNSW's *Construction Noise Strategy* and presented in Table 20 below.

The provision of additional mitigation is based on the predicted exceedances above RBLs and when the exceedances occur. The RBLs can be found in Table 6.

Table 20 Additional mitigation measures matrix

Time period		**Mitigation measures**	**$L_{Aeq,15min}$ noise level above background noise level (RBL)**	**Quantitative assessment of noise levels**	
		0 – 10 dB(A) Noticeable	**10 – 20 dB(A) Clearly audible**	**20 – 30 dB(A) Moderately intrusive**	**>30 dB(A) Highly intrusive**
Standard	Weekday (7am-6pm) Saturday (8am-1pm) Sun/Pub Hol (Nil)	-	-	LB, M	LB, M
OOHW Period 1	Weekday (6pm-10pm) Saturday (7-8am) & (1-10pm) Sun/Pub Hol (8am-6pm)	-	LB	LB, M	LB, M, IB, RO, PC, SN
OOHW Period 2	Weekday (10pm-7am) Saturday (10pm-8am) Sun/Pub Hol (6pm-7am)	LB	LB, M	LB, M, IB, PC, SN	LB, M, IB, PC, SN, AA

Table 21 outlines the additional mitigation measures.

Table 21 Description of additional mitigation measures

Abbreviation	Mitigation measure	Explanation
LB	Letter box drops	All residences should be notified as a minimum by letterbox drop 7 days ahead of construction activities.
M	Monitoring	Attended noise monitoring is to be undertaken as follows: At the commencement of out of hours works (within the first two nights), where out of hours works activities change; and Noise measurements shall be undertaken in accordance with the procedure documented in AS1055.1-1997 Acoustics - Description and Measurement of Environmental Noise - General Procedures.
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
RO	Project specific respite offer	Residents subjected to lengthy periods of noise or vibration may be eligible for a project specific respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. The offer could comprise pre-purchased movie tickets or similar offer. This measure is determined on a project-by-project basis.
PC	Phone calls	Phone calls detailing relevant information would be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific notifications	Specific notifications are letterbox dropped or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise management levels. This form of communication is used to support periodic notifications, or to advertise unscheduled works.
AA	Alternative accommodation	Alternative accommodation options should be provided for residents living in close proximity to construction works that are likely to incur noise levels significantly above the applicable level.

6.8 Construction vibration assessment

Vibration intensive works are proposed to occur as part of the Harris Park Station upgrade works.

The works may include the use vibration generating equipment including:

- jackhammer
- vibratory rollers
- plate compactors.

The safe working distances of these items of equipment from residential buildings are shown in Table 22.

If the safe working distances are complied with no adverse impact from the vibration intensive works are likely in terms of human response or cosmetic damage.

Mitigation measures to control excessive vibration are discussed within section 6.9. A number of heritage listed premises lie within close proximity of the study area, presented in Appendix E. The closest heritage listed buildings to the proposed vibration intensive works would be located at:

- 48 Wigram Street
- 1, 3 and 5 Cambridge Street.

Table 22 Safe working distances of vibration intensive equipment to be used during the footbridge and concourse upgrade works

Plant	Rating/Description	Safe working distance		
		Human response	Cosmetic building damage	
			Residential	Heritage building
Jackhammer	Handheld	Avoid contact with structure	1 m nominal	10 m
Vibratory roller	<50 kN (Typically 1-2 tonnes)	15 – 20 m	5 m	60 m
	<100 kN (Typically 2-4 tonnes)	20 m	6 m	80 m
	<200 kN (Typically 4-6 tonnes)	40 m	12 m	High risk of impact to heritage listed buildings within an approximate 100 m radius
	<300 kN (Typically 7-13 tonnes)	100 m	15 m	
	>300 kN (Typically 13-18 tonnes)	100 m	20 m	
	>300 kN (>18 tonnes)	100 m	25 m	
Plate compactors	5 horsepower	Avoid contact with structure	1 m nominal	10 m

6.9 Construction vibration mitigation measures

For vibration intensive activities that occur within the safe working distances, as presented in Table 22, management methods to mitigate should include, but not be limited, to the following:

6.9.1 Equipment selection and maintenance

The use of less vibration intensive methods of construction or equipment should be considered where possible to reduce the potential for cosmetic damage. All equipment should be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts.

6.9.2 Works scheduling and respite periods

Works scheduling can often be adopted to effectively manage construction vibration impacts and in particular to limit potential impacts. Wherever possible, vibration intensive works should be limited to the least sensitive times of the day.

Respite periods should be negotiated with the community for construction activities expected to generate high levels of vibration.

6.9.3 Supplementary vibration monitoring

If vibration intensive equipment is to be used within the safe working distances for cosmetic damage, as presented in Table 22, then it is recommended that attended vibration measurements are undertaken when work commences (or a vibration intensive activity commences), to determine site specific safe working distances. Vibration intensive work should not proceed within the safe working distances unless a permanent vibration monitoring system is installed approximately a metre from the building footprint, to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the peak particle velocity objective. It is also advisable to carry out dilapidation surveys of sensitive historical structures before construction works begins.

For work scheduled to occur near a building, within the safe working distance for human response but outside the safe working distance for cosmetic damage, it is considered that the additional measures highlighted in Section 6.7 would be sufficient to mitigate the vibration impact at nearby residential receivers. Therefore vibration monitoring would not be required at these properties.

7.0 Operational Noise

New plant associated with the upgraded Harris Park Station will include two lifts, lighting and electrical equipment including security cameras.

Mechanical plant details are yet to be finalised and will be determined during the detailed design phase. Mechanical plant noise emissions are not expected to significantly impact surrounding receivers and the use of standard noise controls such as quiet plant selection, duct lining and enclosures etc, is expected to reduce noise emissions to acceptable levels.

Operational noise associated with mechanical plant shall be assessed during the detailed design phase and plant shall be selected and treated with the view to achieve noise goals presented in the *NSW Industrial Noise Policy*. Operational noise criteria are presented in Section 5.0.

No changes are planned for bus stops, kiss and ride areas and road layouts which would significantly affect operational noise emissions.

8.0 Conclusions

A noise and vibration impact assessment has been completed for the proposed upgrade works at Harris Park Station. Nearby noise and vibration sensitive receivers were identified and attended and unattended noise measurements were completed to characterise the existing noise environment. The measured noise levels were used to establish construction noise management levels.

8.1 Construction activity noise

Construction scenarios have been developed in in consultation with TfNSW and the proposed equipment has been detailed within this assessment. Six construction stages have been proposed, with seven sub-stages being identified as potentially noisy. Noise impacts for these sub-stages were assessed.

The predicted construction noise levels exceed the construction noise management levels for some scenarios at residential and non-residential receivers. Noise exceedances are as expected for such works and are generally unavoidable with all feasible and reasonable controls being implemented. However, implementation of additional mitigation measures should aim to minimise and manage noise impacts where possible.

Mitigation measures have been recommended in line with TfNSW's *Construction Noise Strategy* in order to minimise and manage the impact of construction noise on nearby noise sensitive receivers.

8.2 Construction traffic

The road traffic noise associated with construction activities was assessed in accordance with EPA's *Road Noise Policy* guidelines. The qualitative road traffic noise assessment associated with construction indicates compliance with the *Road Noise Policy* acoustic criteria as the noise increase on construction routes is predicted to be negligible.

8.3 Construction vibration

Safe working distances to nearby structures have been recommended. If the safe working distances are maintained then no adverse impact from the vibration intensive works is likely in terms of human response or cosmetic damage. Additional measures would be required if working within the safe working distances.

8.4 Operational noise

Operational noise criteria have been provided, however mechanical plant details shall be finalised during the detailed design stage.

New plant associated with the upgraded Harris Park Station will include two lifts, lighting and electrical equipment including security cameras.

Mechanical plant noise emissions are not expected to significantly impact surrounding receivers and the use of standard noise controls such as quiet plant selection, duct lining and enclosures etc, is expected to reduce noise emissions to acceptable levels.

Operational noise associated with mechanical plant shall be assessed during the detailed design phase and plant shall be selected and treated with the view to achieve noise goals presented in the *NSW Industrial Noise Policy*. Operational noise criteria are presented in Section 5.0.

No changes are planned for bus stops, kiss and ride areas and road layouts which would significantly affect operational noise emissions.

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

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

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:

0dB(A)	Threshold of human hearing
30dB(A)	A quiet country park
40dB(A)	Whisper in a library
50dB(A)	Open office space
70dB(A)	Inside a car on a freeway
80dB(A)	Outboard motor
90dB(A)	Heavy truck pass-by
100dB(A)	Jackhammer/Subway train
110 dB(A)	Rock Concert
115dB(A)	Limit of sound permitted in industry
120dB(A)	747 take off at 250 metres

Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.

Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW *Industrial Noise Policy* and the EPA's *Road Noise Policy*.

Appendix B

Noise Logging

Appendix B Noise Logging

NL1 - 75 Harris Street Harris Park - 22/06/15 - 03/07/15

Logger Type: Rion NL21

Serial No : 00865769

Address: 75 Harris Street, Harris Park

Location: Back Garden

Facade / Free Field: Free Field

Environment: Noise from local roads and the M4. Also trains passing on the Main Western Line and natural sounds such as birds.

Table 23 Measured noise levels - 75 Harris Street

INP Noise Level, dB(A)		
Period	**Log Average**	
Day	54	42
Evening	53	43
Night	47	39

Figure 3 Logger location map - 75 Harris Street

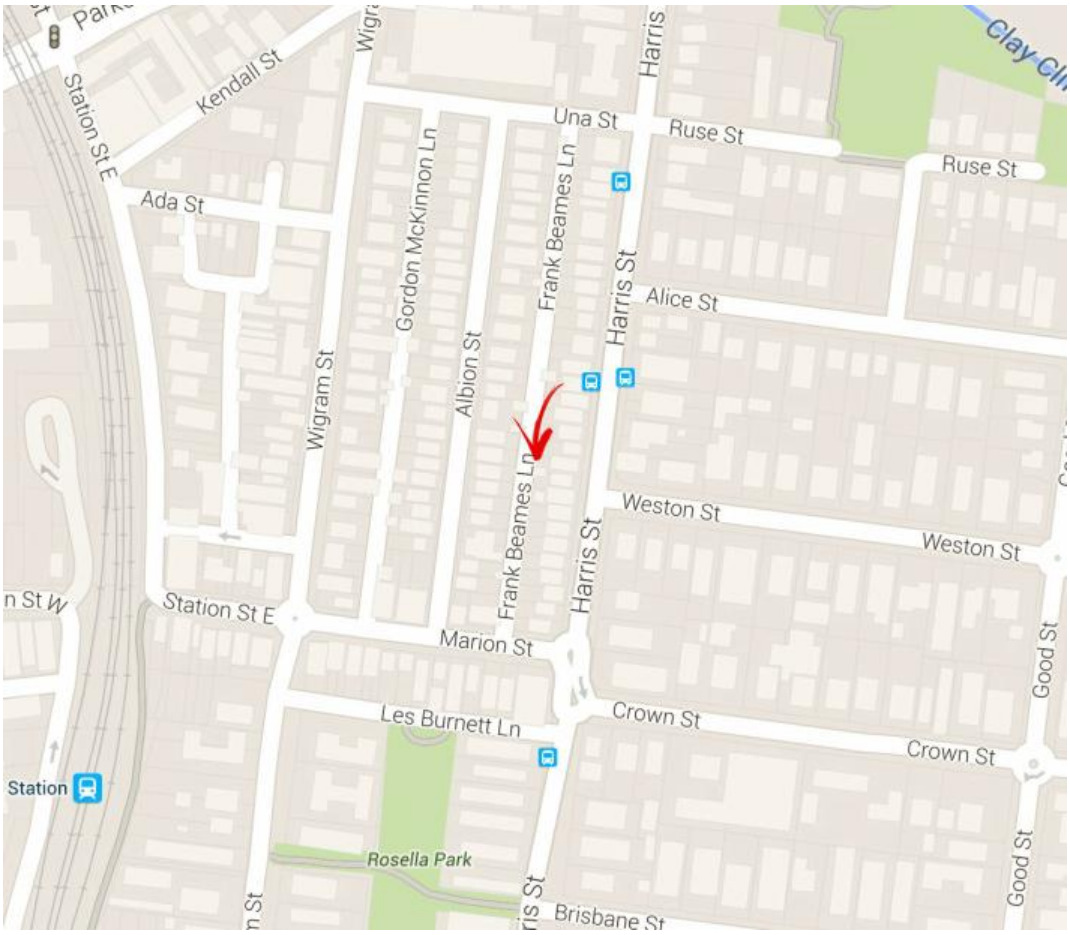
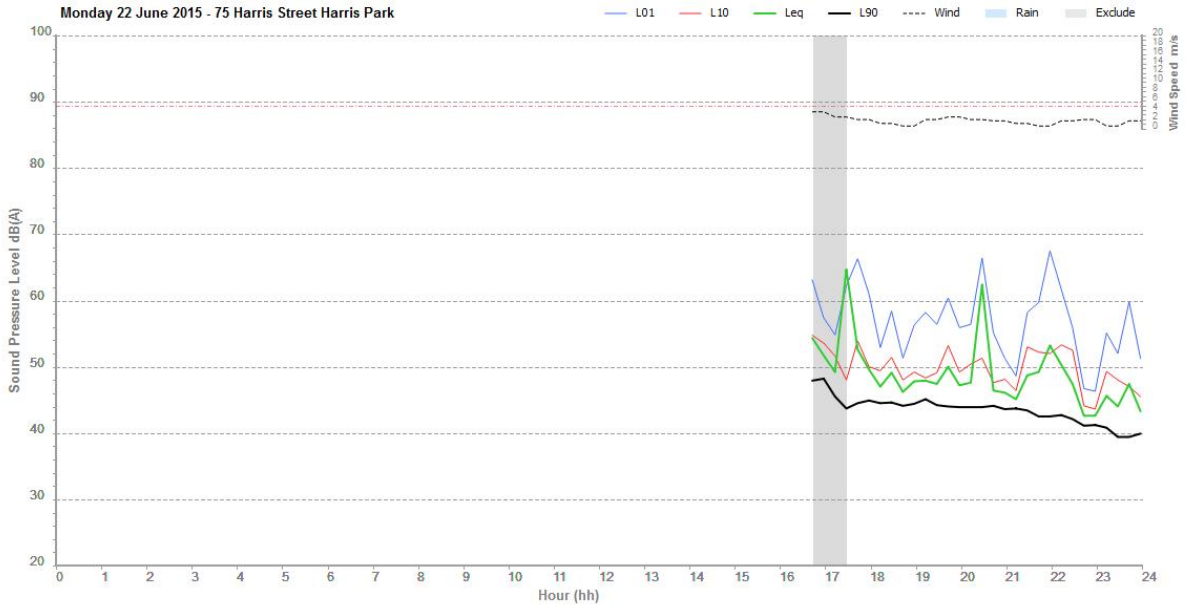
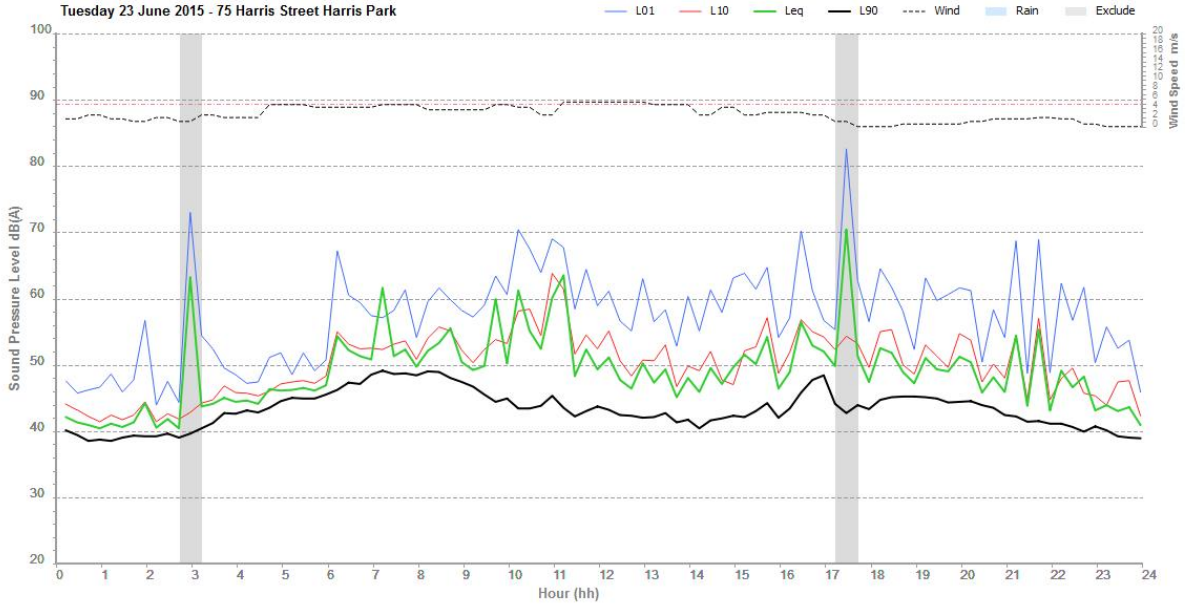


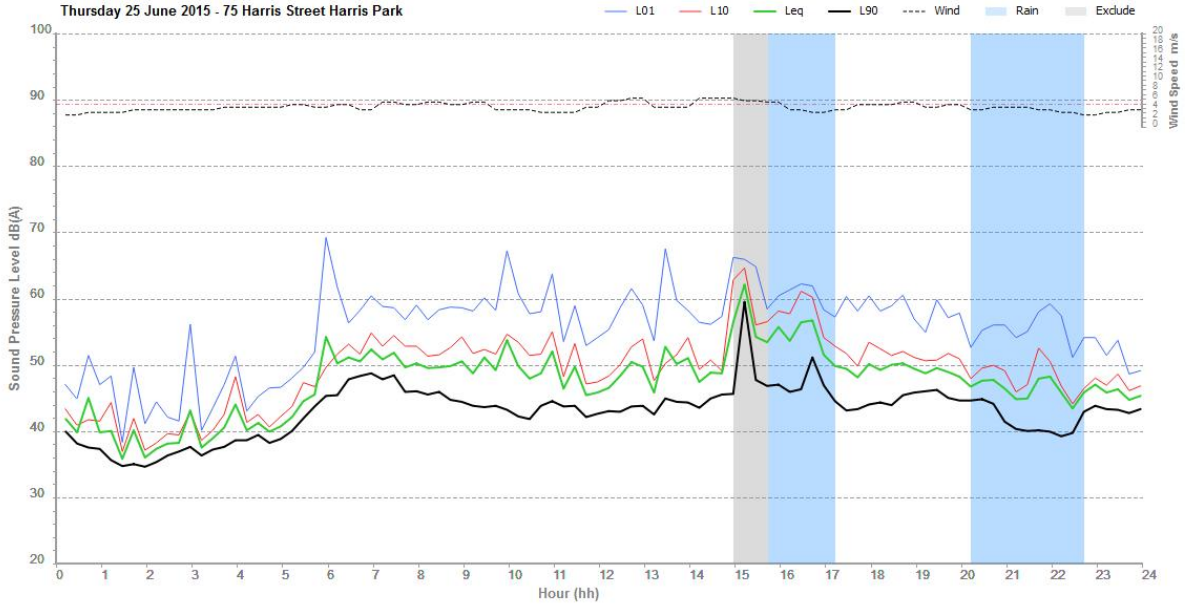
Figure 4 Logger setup photo - 75 Harris Street

Logger graphs - 75 Harris Street






Wednesday 24 June 2015 - 75 Harris Street Harris Park
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)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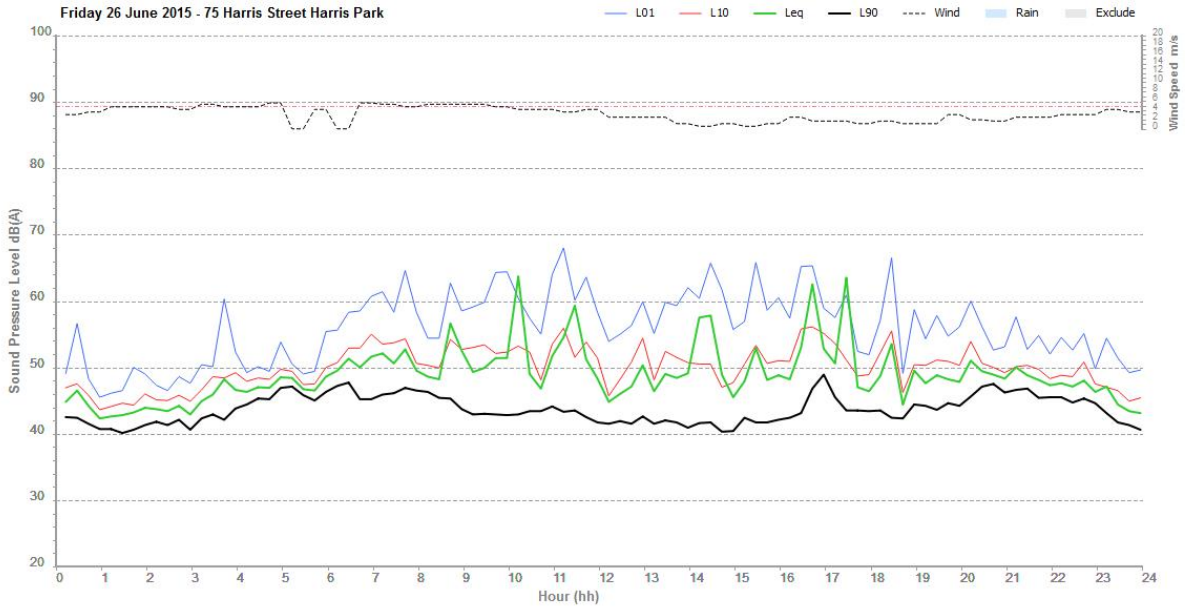
Wind Speed m/s
Hour (hh)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Rain
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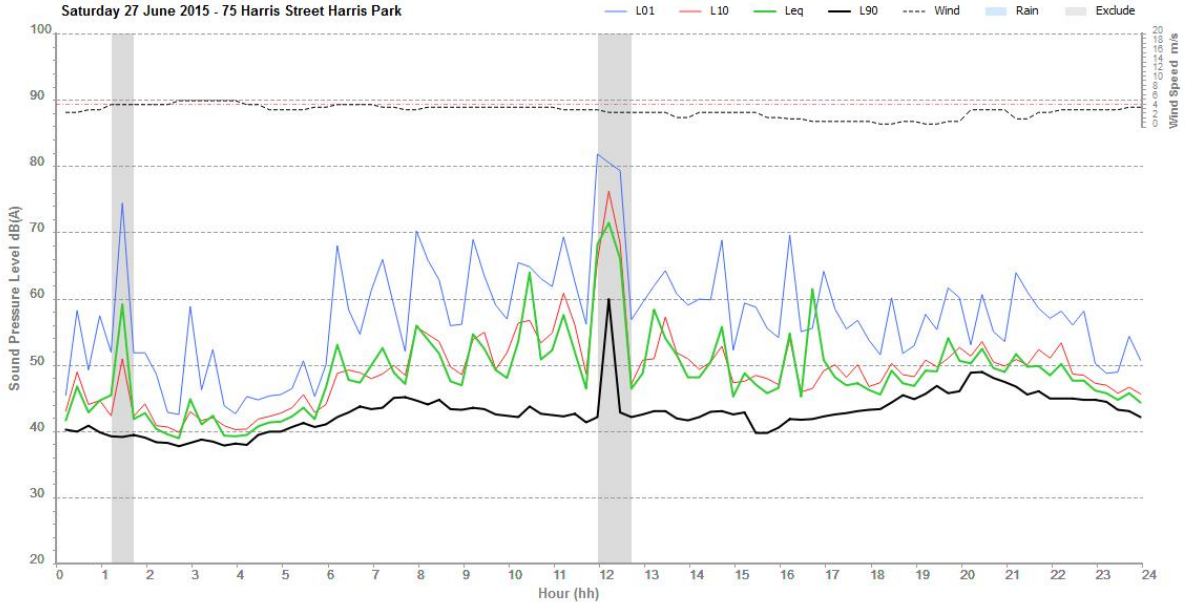
Wind Speed m/s
Hour (hh)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L01
L10
Leq
L90
Wind
Rain
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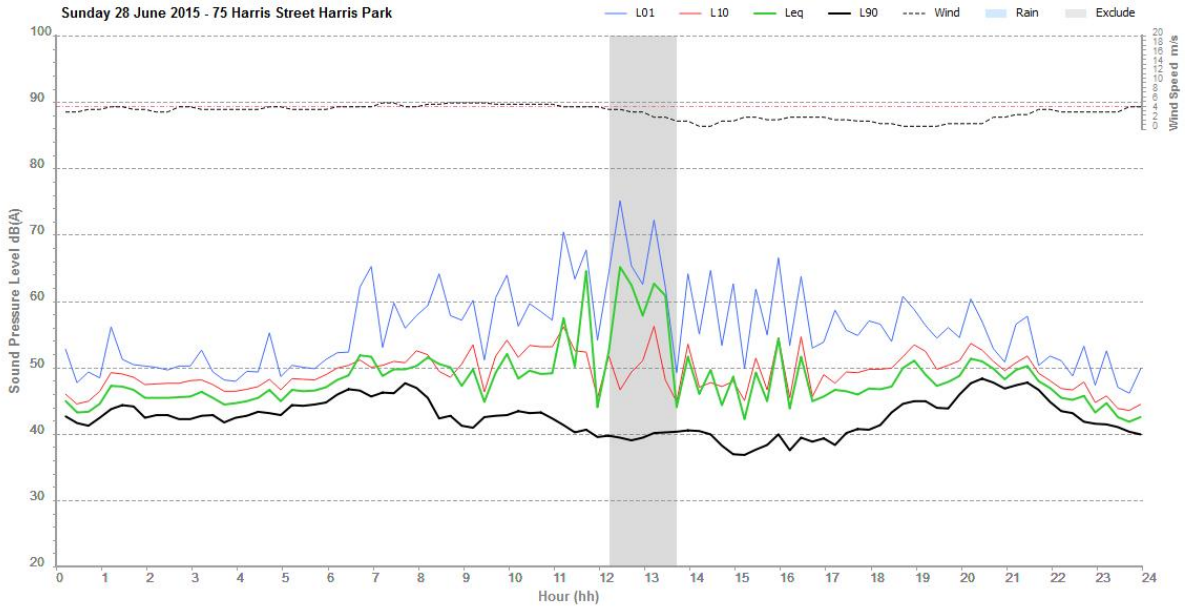
Wind Speed m/s
Hour (hh)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Leq
L90
Wind
Rain
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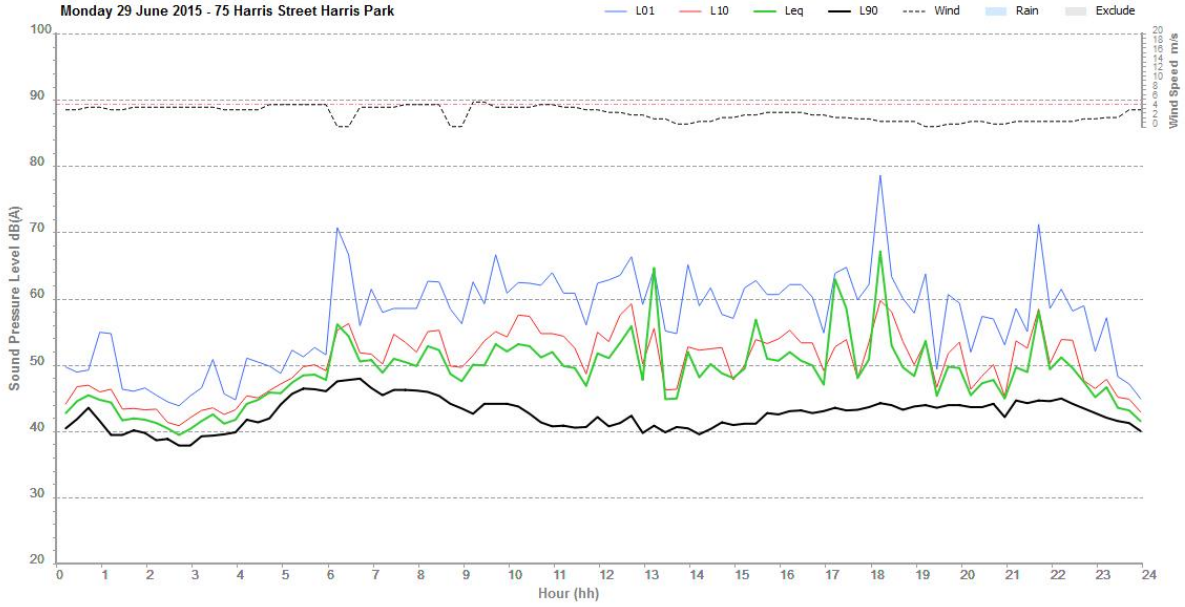
Wind Speed m/s
Hour (hh)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Leq
L90
Wind
Rain
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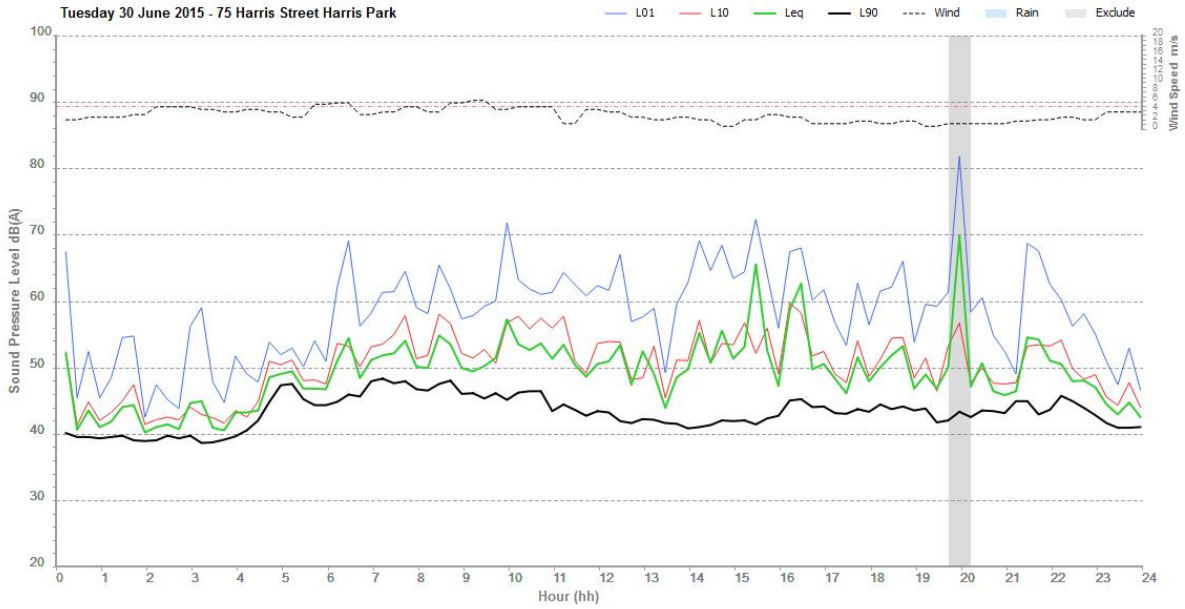
Wind Speed m/s
Hour (hh)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L90
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Rain
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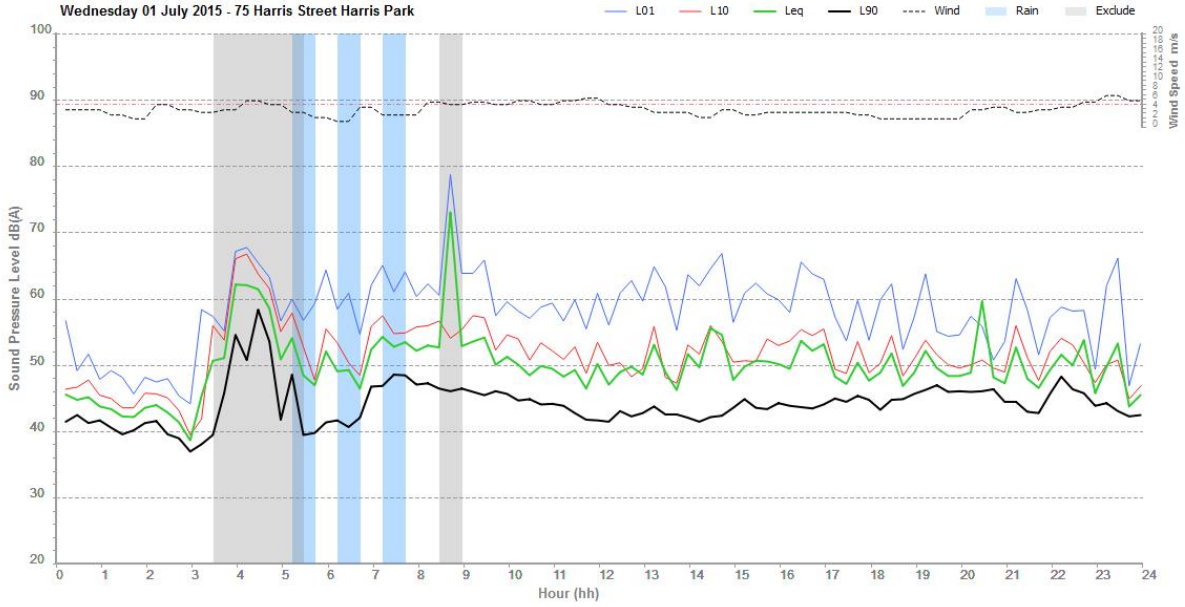
Wind Speed m/s
Hour (hh)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Leq
L90
Wind
Rain
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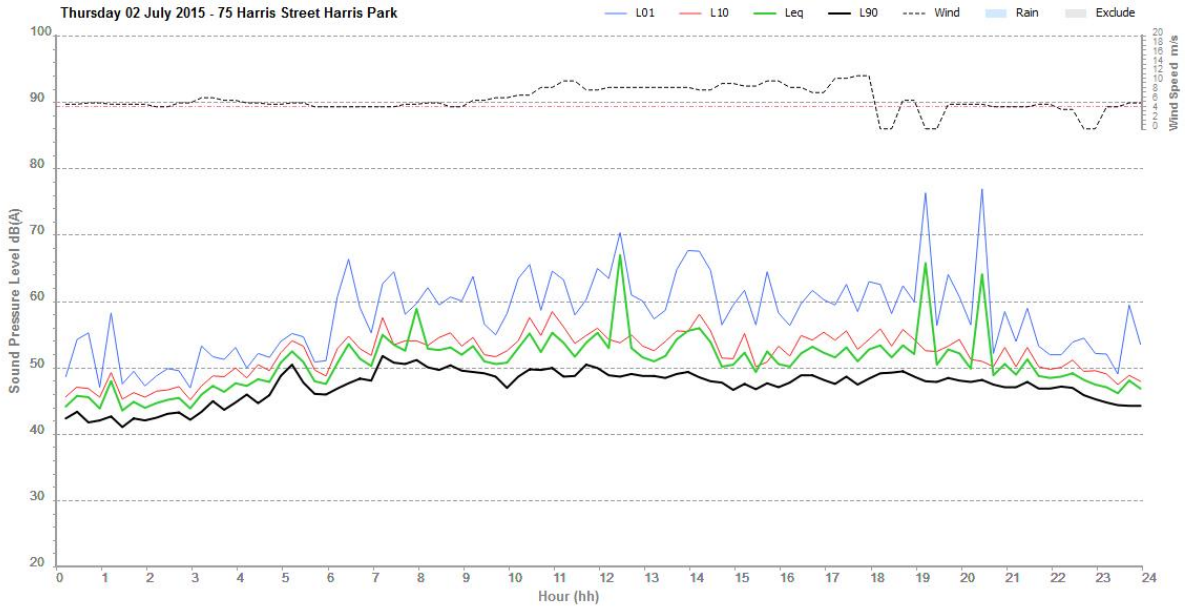
Wind Speed m/s
Hour (hh)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Rain
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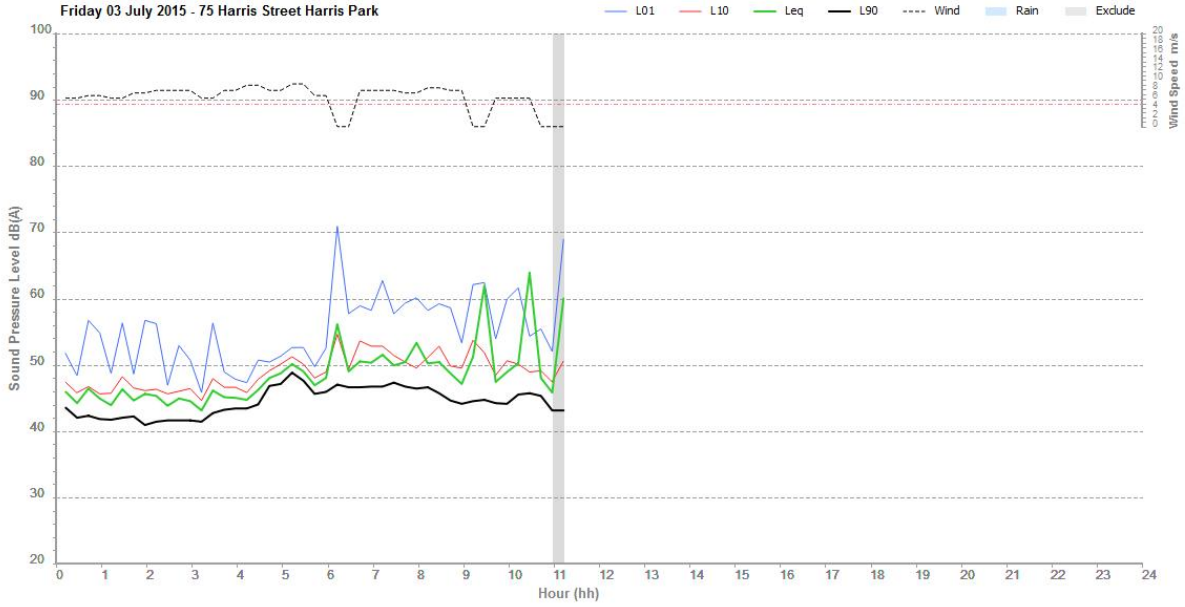
Wind Speed m/s
Hour (hh)


Friday 03 July 2015 - 75 Harris Street Harris Park
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)

NL2 - 15 High Street Granville - 22/06/15 - 03/07/15

Logger Type: ARL 215

Serial No : 15-299-444

Address: 15 High Street Granville

Location: Back Garden

Facade / Free Field: Free Field

Environment: Noise from road traffic on local and arterial roads including Church Street, Great Western Highway, M4. Also trains passing on the Main Western Line and natural sounds such as birds.

Table 24 Measured noise levels - 15 High Street

INP Noise Level, dB(A)		
Period	**Log Average**	**RBL**
Day	58	48
Evening	56	49
56	56	45

Figure 5 Logger location map - 15 High Street

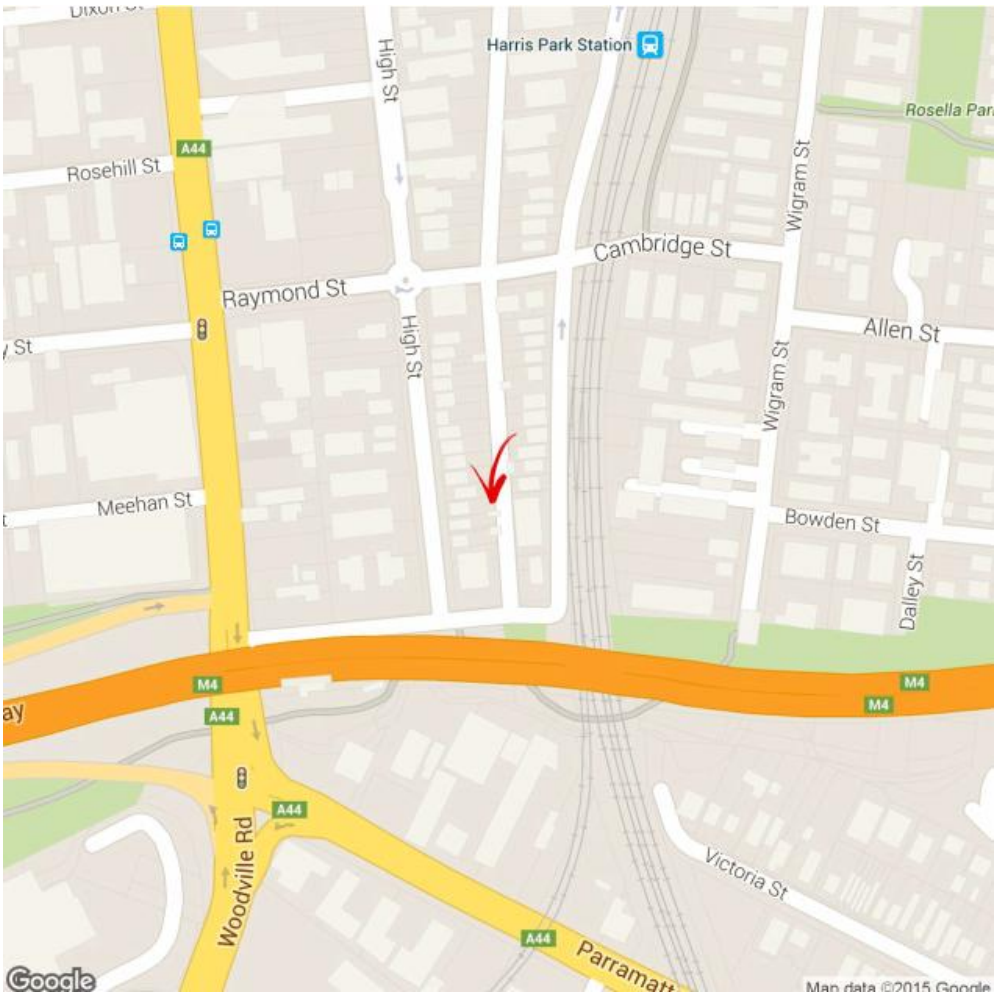
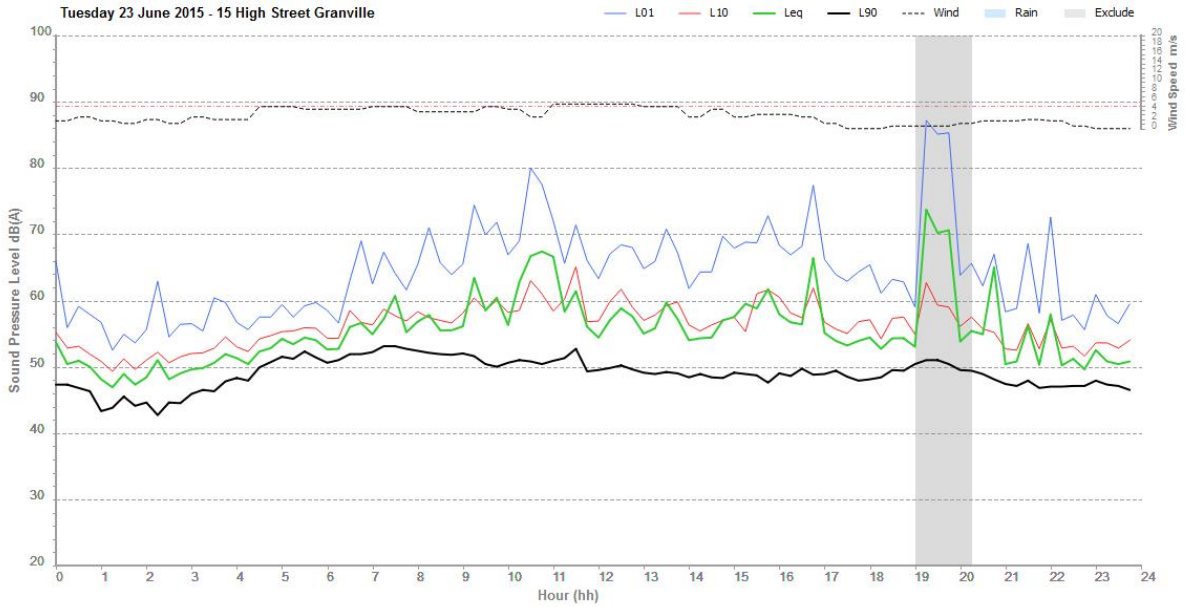
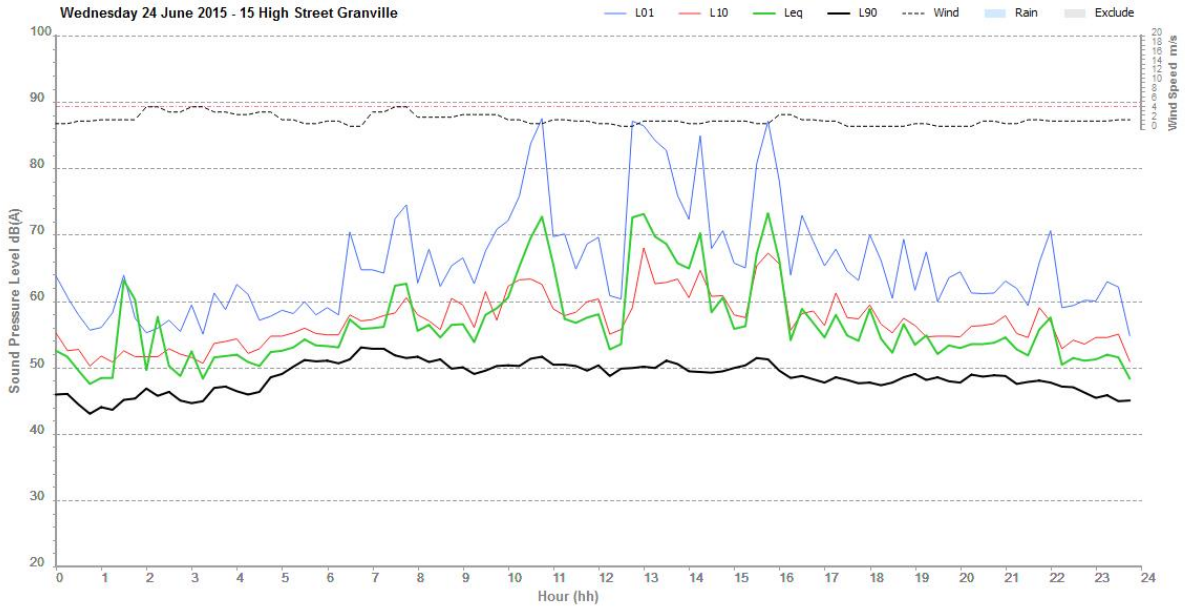


Figure 6 Logger setup photo - 15 High Street

Logger graphs - 15 High Street

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Wind
Rain
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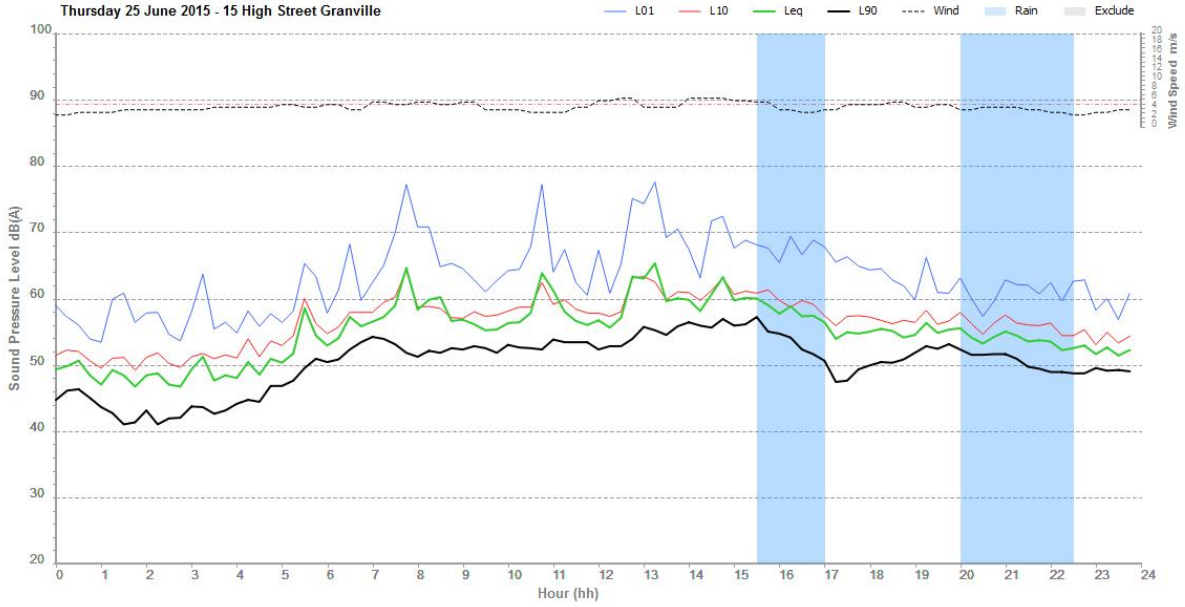
Wind Speed m/s
Hour (hh)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Rain
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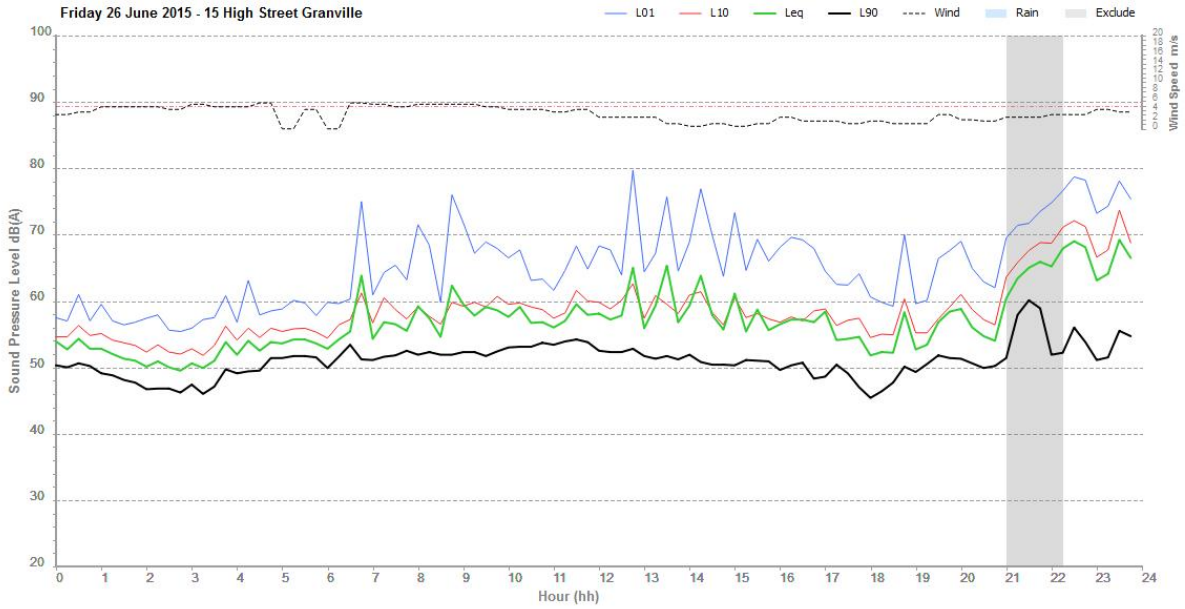
Wind Speed m/s
Hour (hh)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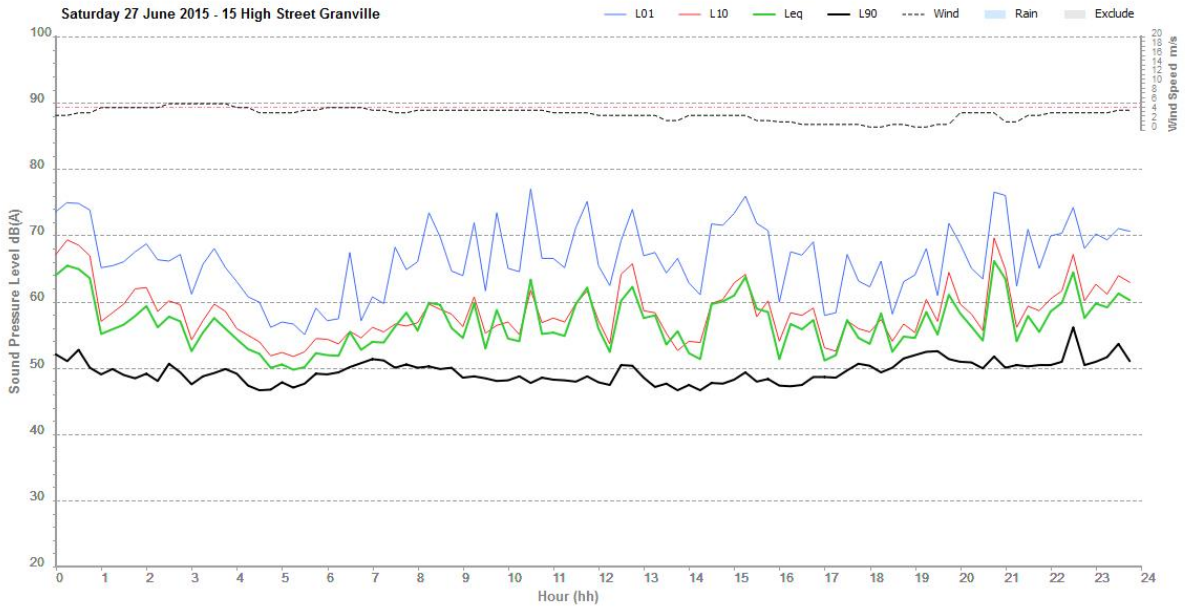
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)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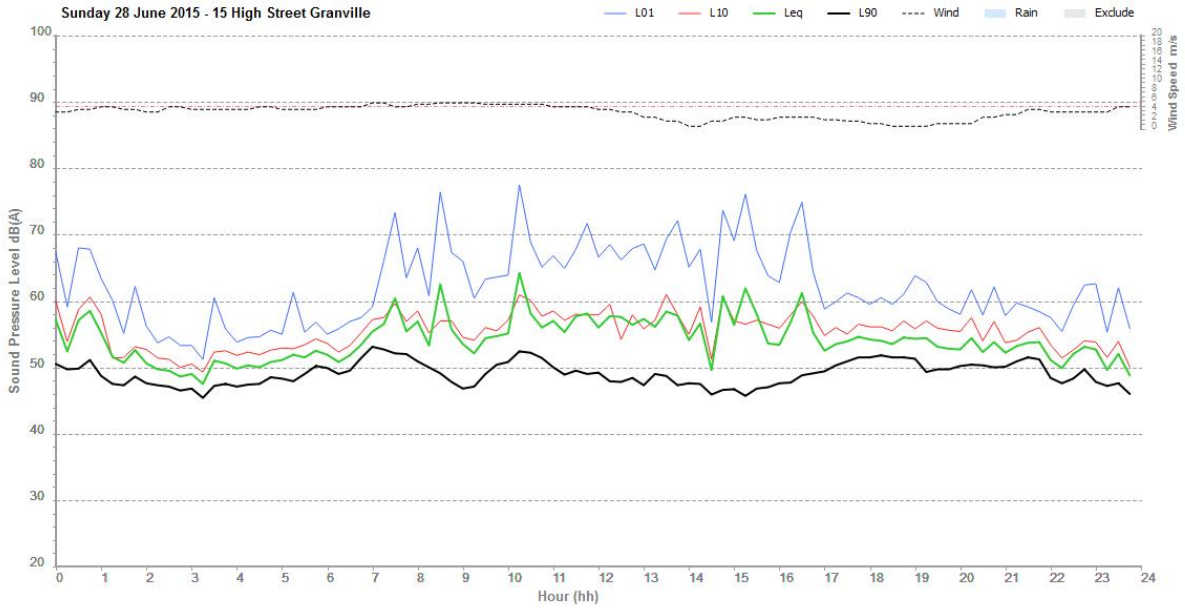
Wind Speed m/s
Hour (hh)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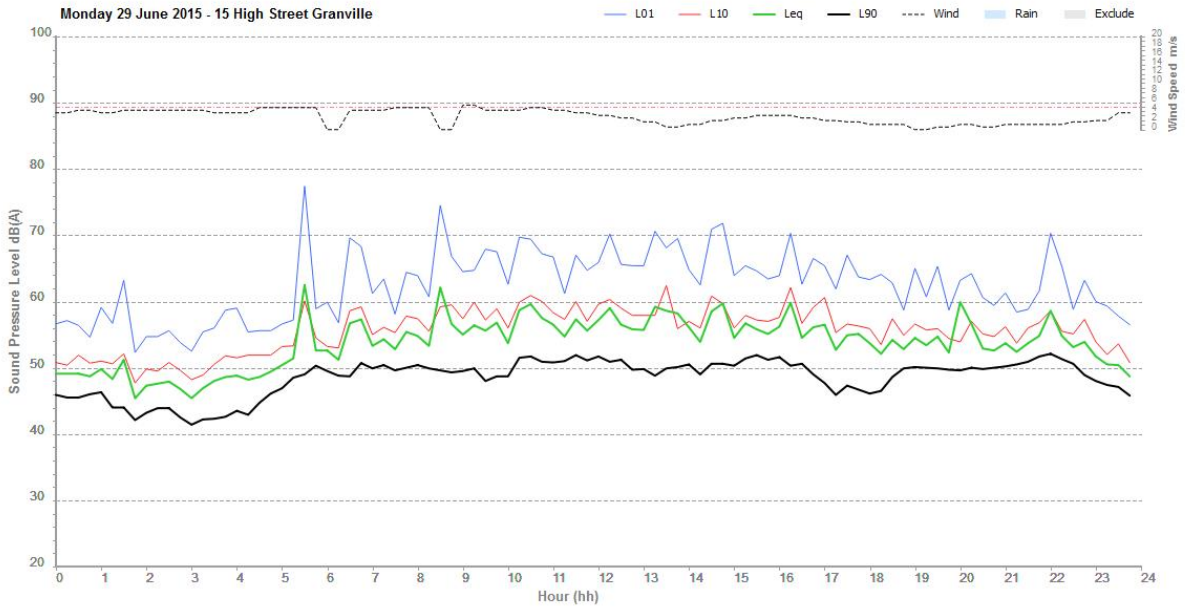
Hour (hh)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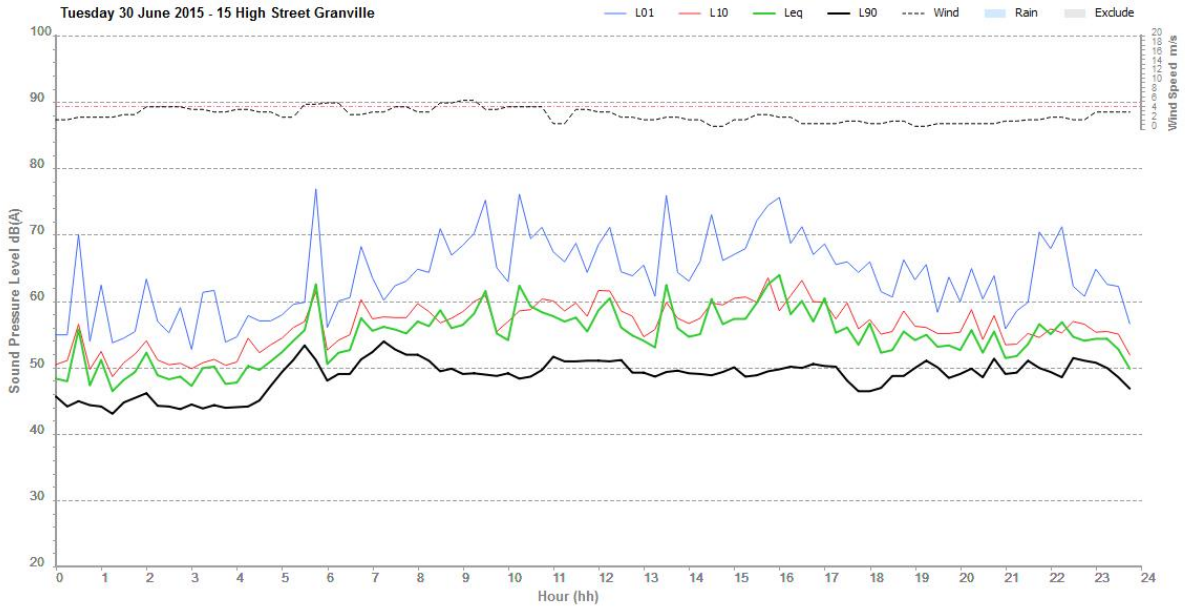
Wind Speed m/s
Hour (hh)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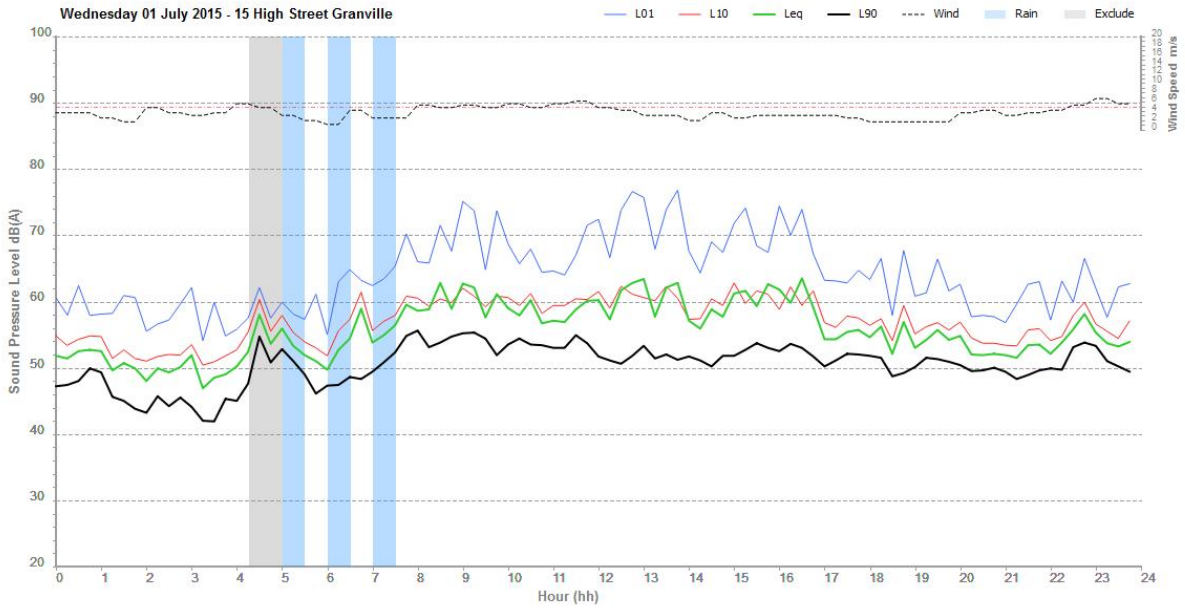
Wind Speed m/s
Hour (hh)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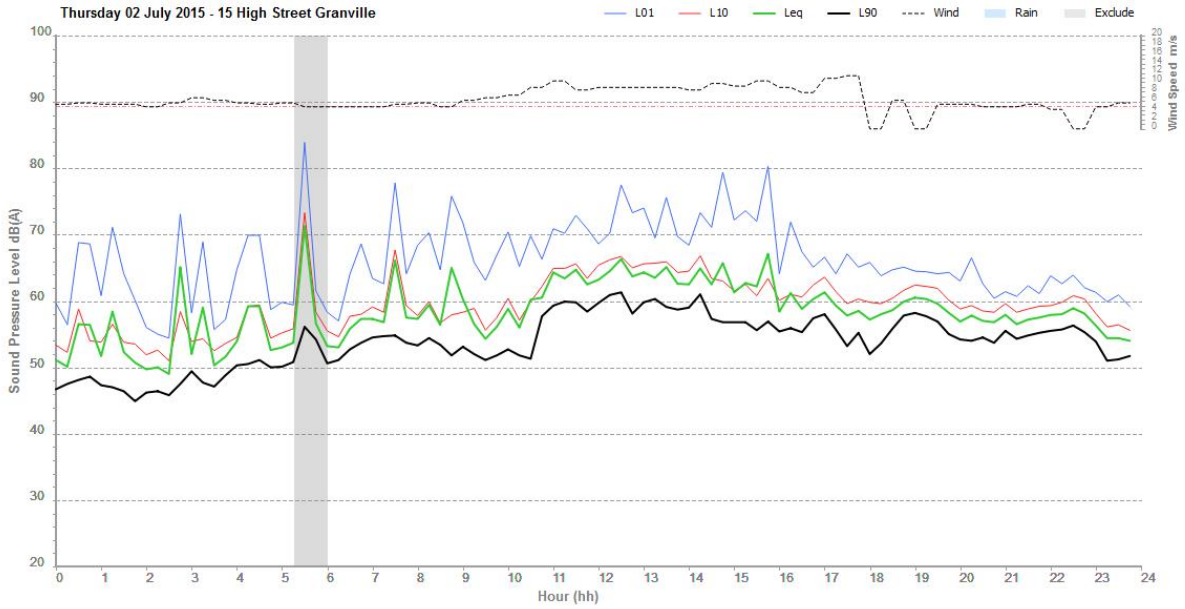
Hour (hh)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Wind
Rain
Exclude
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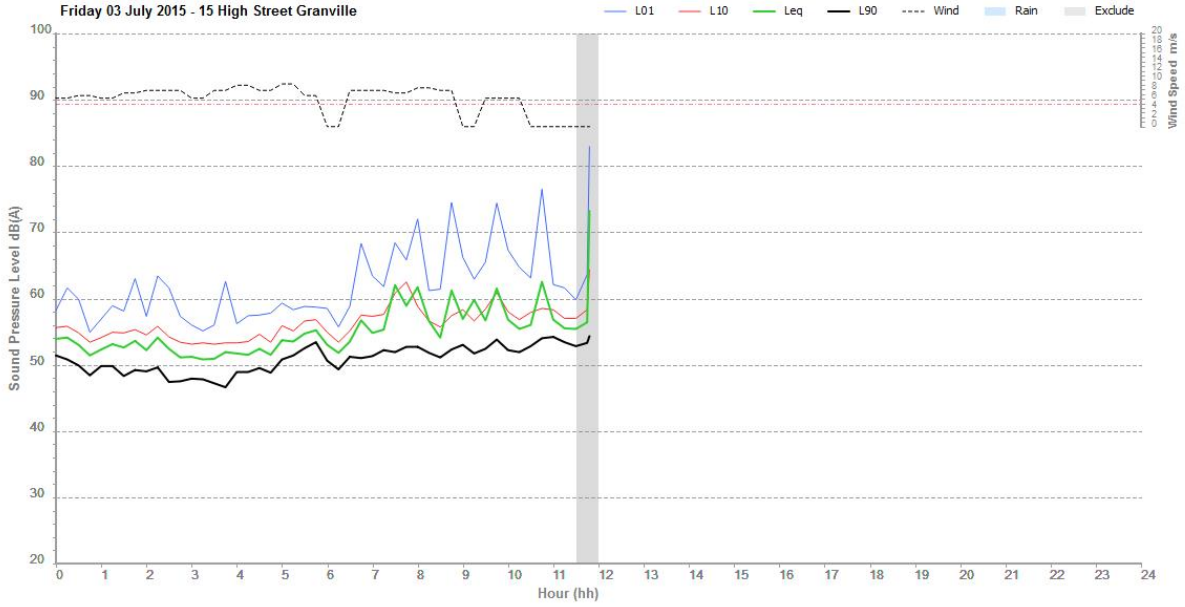
Hour (hh)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L01
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L90
Wind
Rain
Exclude
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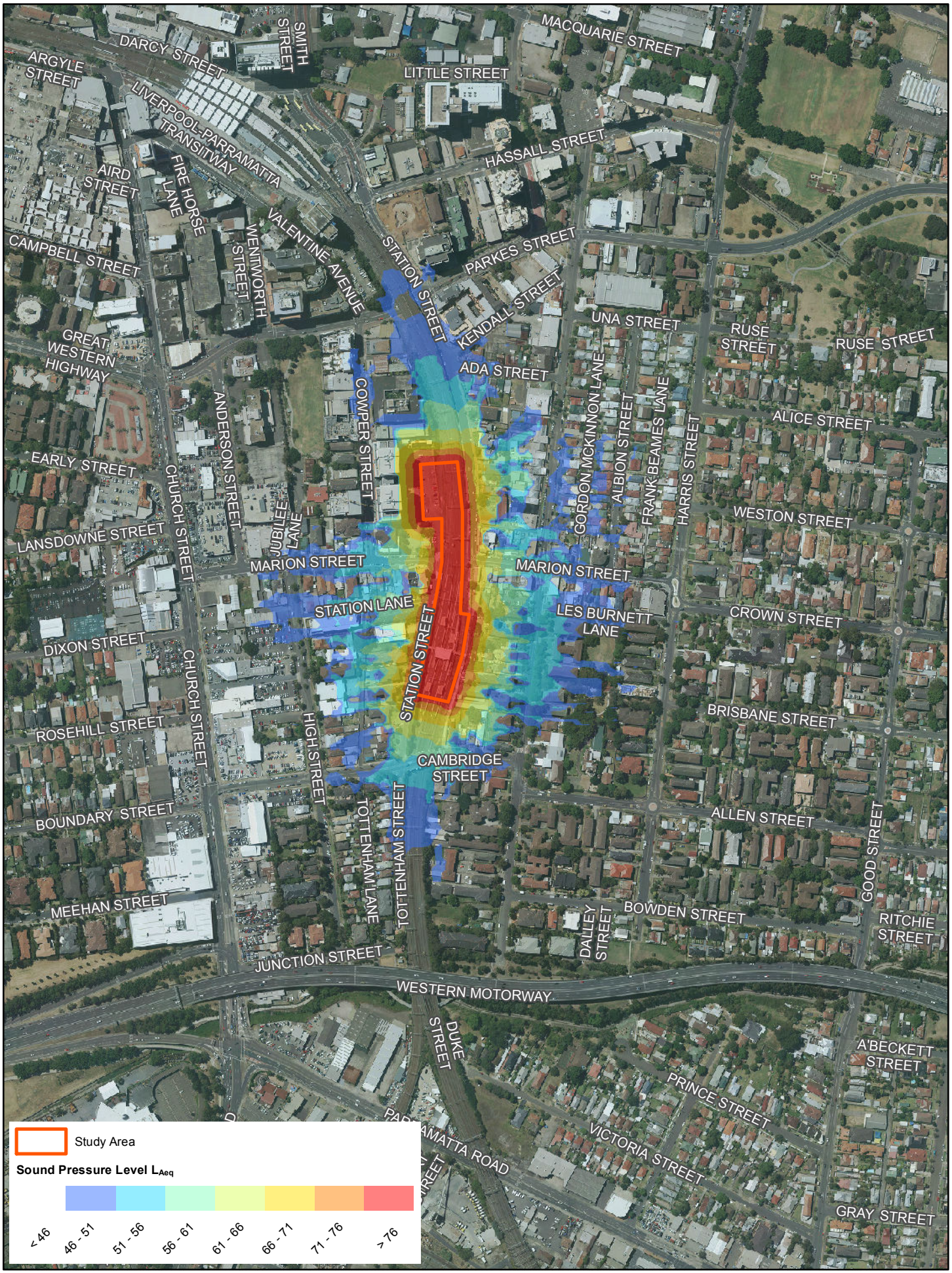
Wind Speed m/s
Hour (hh)

Appendix C

Construction Noise Assessment Maps

Appendix C Construction Noise Assessment Maps



Harris Park Station Upgrade Works

1A - Site establishment and enabling works - Daytime Possession

Dec 2015

60327214

0 100 200 400 Meters

N

Fig. 1

Harris Park Station Upgrade Works

1B - Removal of vegetation - Standard Hours

Dec 2015

60327214

0 100 200 400 Meters

N

Fig. **2**

Harris Park Station Upgrade Works

2A - Lift, footbridge and platform upgrades - 48hr Possession

Dec 2015

60327214

0 100 200 400 Meters

N

Fig. **3**

Harris Park Station Upgrade Works

3A - Station building works - Standard Hours

Dec 2015

60327214

Fig. 4

Harris Park Station Upgrade Works

3B - Station refresh works - 48hr Possession

Dec 2015

60327214

0 100 200 400 Meters

N

Fig. **5**

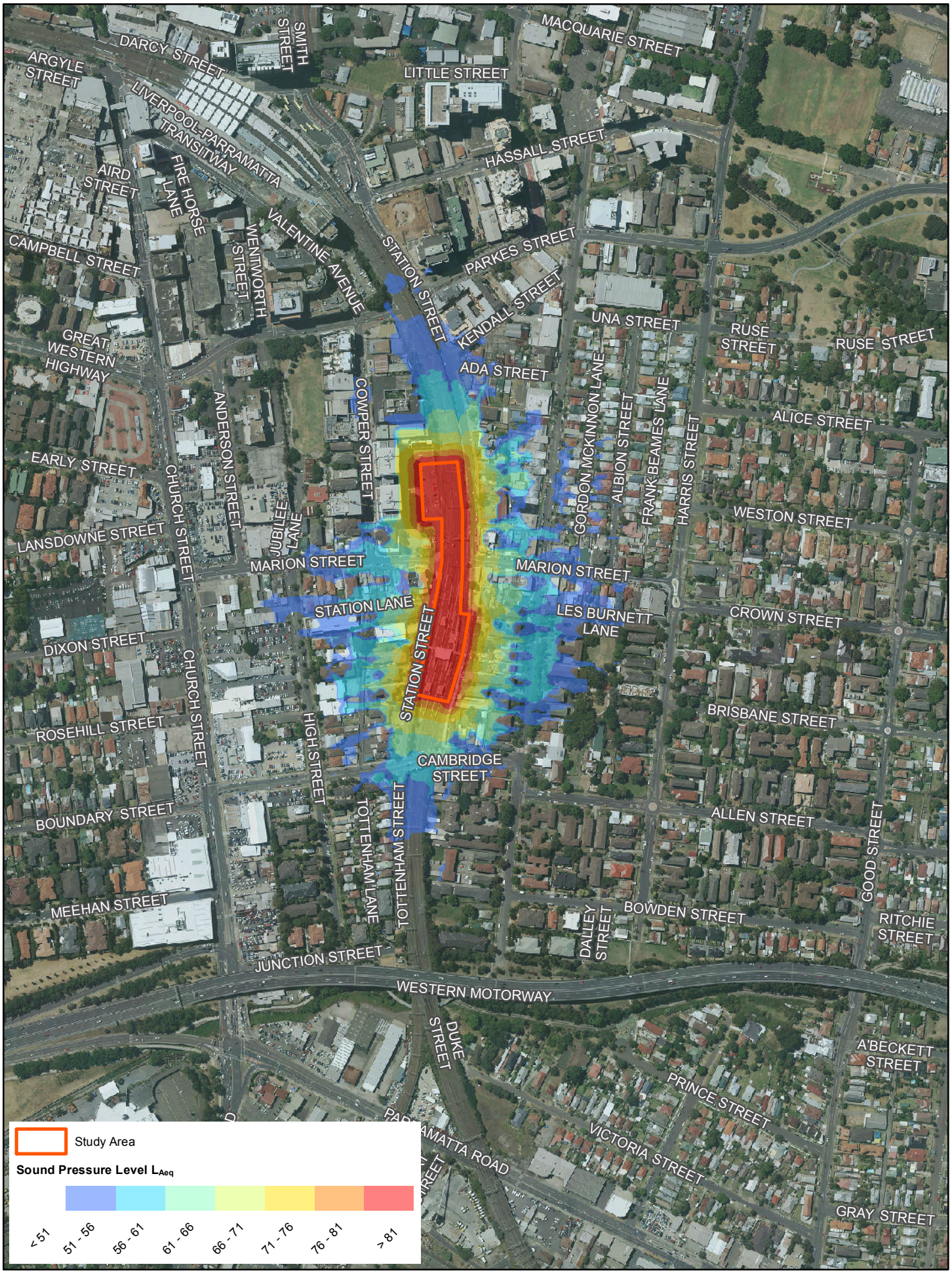
Harris Park Station Upgrade Works

4A - Interchange works - Standard Hours

Dec 2015

60327214

Fig. 6



Harris Park Station Upgrade Works
5A - Finalisation - Standard Hours

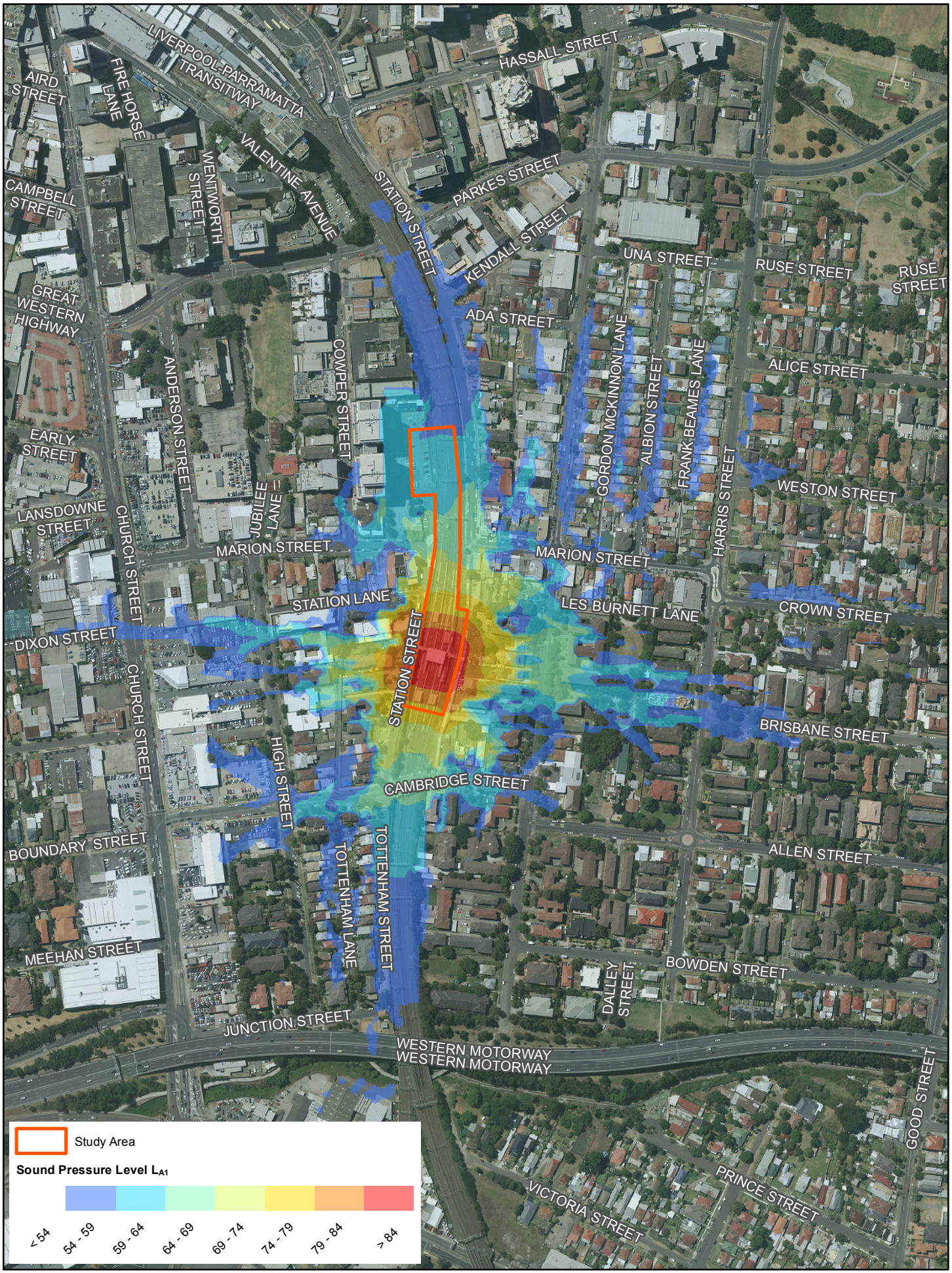
Dec 2015
60327214

Fig. **7**

Appendix D

Sleep Disturbance Noise Assessment Maps

Appendix D Sleep Disturbance Noise Assessment Maps



Harris Park Station Upgrade Works

2A - Lift, footbridge and platform upgrades - 48hr Possession

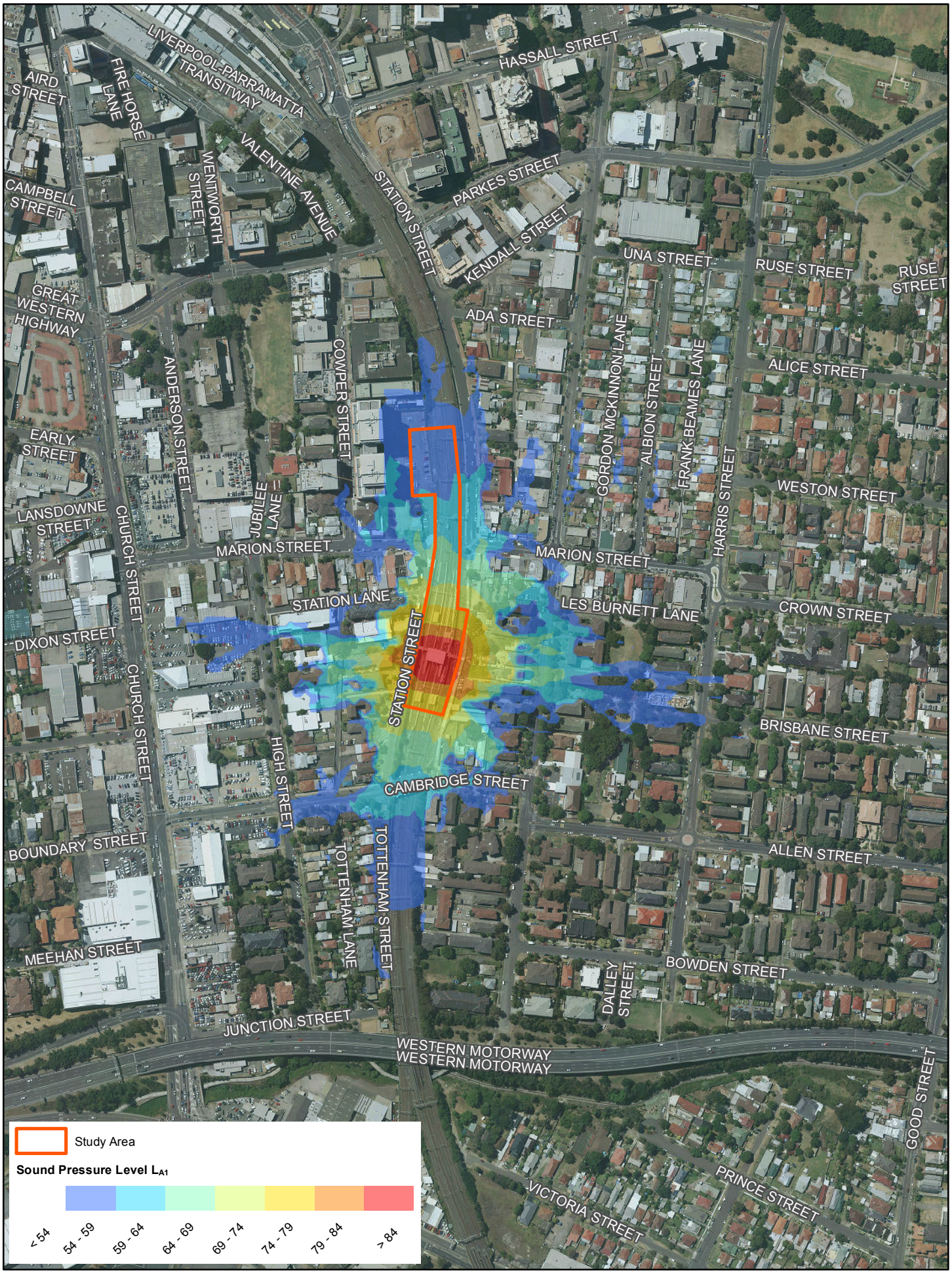
Dec 2015

60327214

0 100 200 400 Meters

N

Fig. 1



Harris Park Station Upgrade Works

3B - Station refresh works - 48hr Possession

Dec 2015

60327214

0 100 200 400 Meters

N

Fig. **2**

Appendix E

Heritage Listed Buildings Map

Appendix E Heritage Listed Buildings Map