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TRANSPORT ACCESS PROGRAM (TAP3)

Noise and Vibration Impact Assessment
Banksia Station

10 August 2020

JACOBS

TK877-01F06 TAP Banksia NVIA (r4)

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Executive summary

This noise impact assessment was conducted on the behalf of Transport for NSW (TfNSW) in support of a proposal to upgrade Banksia Station as part of both the Transport Access Program and More Trains More Services Program.

The assessment considers the following impacts on nearby sensitive receivers:

- Construction noise and vibration impacts from the Banksia Station upgrade works in accordance with the *Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2009), *Assessing Vibration: A technical guideline* (Department of Environment and Conservation, 2009) and the *Construction Noise and Vibration Strategy* (Transport for NSW, 2018).
- Operational noise impact from reconfiguration of the public announcement (PA) system at Banksia Station in accordance with the *Noise Policy for Industry* (Environmental Protection Authority, 2017).

Construction noise and vibration

The construction noise assessment found that residential receivers that are located near to the station will be noise affected by the construction works, with some potentially highly affected receivers as a result of noisier construction activities. Receivers further away from the station may be noise affected during higher noise impact works, however construction noise levels are likely to comply with the NMLs for other activities.

As the works are to be carried out within an active rail corridor, some of the activities will need to be completed outside standard construction hours during rail possession periods or during the midnight to dawn shutdown period. Works outside standard construction hours are likely to be highly intrusive to residential receivers with direct line of sight to the works. Recommendations are provided in Section 4.4 to reduce noise levels and are to be reviewed and adopted where feasible and reasonable during detailed design, in particular where works are completed outside standard construction hours during rail possession periods. Where all reasonable and feasible mitigation measures have been applied and noise levels are still above the relevant noise objectives, additional noise management measures are provided to manage the impact on the community surrounding the station.

Potential vibration impact to residential, commercial/industrial and heritage receivers has been completed and assessed against the relevant guidelines for structural damage from vibration and for human disturbance. The risk of structural damage to property is assessed as very low to negligible for most receivers, with the exception of heritage structures on the station platforms/buildings themselves. Further assessment of vibration impact will be required at the detailed design phase to ensure vibration impact is managed and mitigated where feasible.

Industrial Noise

The Proposal forms part of two government initiatives, the TAP and the More Trains, More Service Program. The Proposal includes new canopies along much of Platforms 2 and 3 and Platform 4 and new public announcement (PA) system speakers that will be spread along these canopies as well as comparable locations on Platform 1. This will result in some PA speakers being closer to sensitive receivers, which are currently located adjacent to the existing station buildings.

The PA systems provide announcements on network status information, impending train arrivals and emergency messages. The duration and infrequency of announcements from the PA system means that they are unlikely to significantly contribute to the overall average L_{Aeq} noise levels. Noise from the PA system can be mitigated through appropriate system design to ensure sound coverage of the platform with minimal noise spill. Appropriate criteria for the PA system to achieve along the railway platform would be specified as part of detailed design to ensure compliance with the noise emission requirements at nearby noise sensitive receivers presented in this study.

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1 Introduction

1.1 Scope

Transport for NSW (TfNSW) proposes to undertake accessibility upgrades at Banksia Station (the Proposal) as part of the Transport Access Program (TAP). TAP is an initiative to provide a better experience for public transport customers by delivering accessible, modern, secure and integrated transport infrastructure where it is needed most. The TAP objective is "to contribute to Commonwealth Disability Discrimination Act (DDA) related targets through Disability Standards for Accessible Public Transport (DSAPT) compliance upgrades, including associated customer benefits derived from DSAPT compliance."

While over the next ten years the More Trains, More Services Program will simplify and modernise the rail network, creating high capacity and turn up and go services for many customers. Customers will experience more frequent train services, with less wait times, less crowding and more seats on a simpler, more reliable network. As part of the Banksia Station upgrades, the program will support the introduction of the 10 car New Intercity Fleet (NIF) trains on the South Coast line.

The Proposal forms part of the Transport Access Program and More Trains More Services Program.

Banksia Station is located on the T4 - Illawarra Line. Situated within an established suburban area, this southern city station is located just west of the Princess Highway and 12 kilometres south of the City of Sydney. With the railway line and station platforms aligned roughly north-south, entry to the station is via a passenger underpass accessed off Hattersley Street (to the east) and Railway Street (to the west).

Renzo Tonin & Associates has been engaged to undertake this noise and vibration impact assessment for the proposed upgrades to Banksia Station (the Proposal) to describe and assess the noise and vibration impacts associated with the Proposal.

1.2 Project description and aim of study

The Banksia Station Upgrade (the Proposal) forms part of the Transport Access Program and More Trains More Services Program. The key features of the Proposal are summarised as follows:

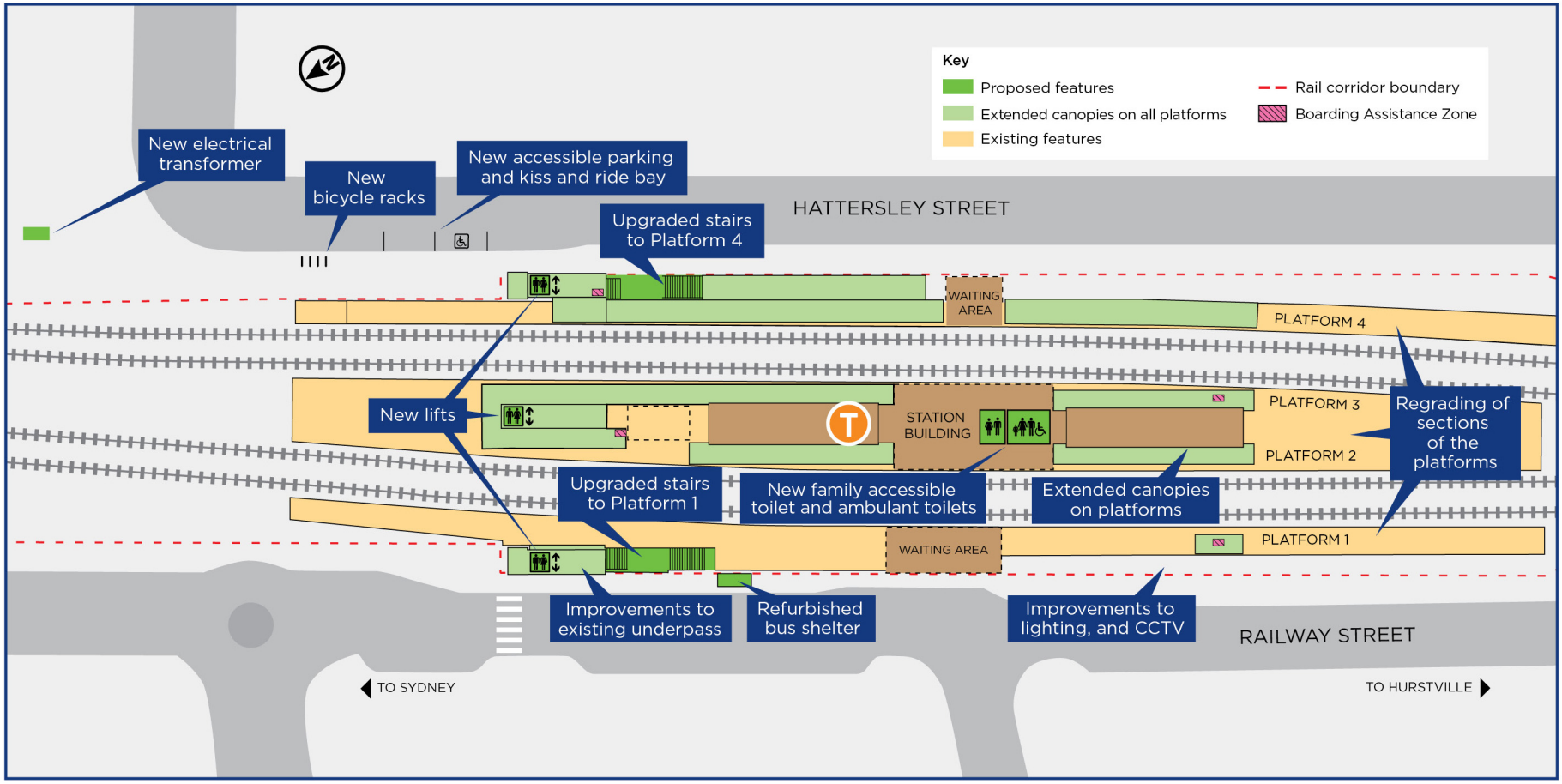
- construction of three new lifts and landings to provide access between Railway Street, Hattersley Street, the existing underpass and the platforms
- upgrade of the existing stairs between Platform 1 (Railway Street) and Platform 4 (Hattersley Street) and the underpass to include new compliant handrails, TGSIs and nosing
- construction of new platform canopies on Platform 1, Platforms 2 and 3 and Platform 4
- interior changes to the existing station building on Platforms 2 and 3
- bus stop, parking, kiss and ride and footpath upgrade work to include:

  - a new bus shelter on Railway Street alongside Platform 1 to replace the existing bus shelter in the same location
  - a new kerb ramp at the Railway Street pedestrian crossing
  - widening of the footpath between the lift and bus stop on Railway Street
  - one new accessible car parking space and one kiss and ride space along Hattersley Street
  - a new kerb ramp at the Hattersley Street entrance
- upgrade of the existing surfaces (re-grading/re-surfacing) of all four platforms to provide compliant accessible paths to station amenities and between the new lifts and boarding assistance zones
- electrical upgrades including a new transformer (to be installed on land next to Fortescue Reserve)
- drainage upgrades including the installation of new pumps in the underpass and new stormwater pipes to transfer rainfall runoff from the canopies on Platforms 2 and 3 and in the underpass to existing stormwater pipes on Hattersley Street
- ancillary works including adjustments to high voltage powerlines, lighting, electronic ticketing, relocation or replacement of existing customer facilities, improvements to station communications, hearing loops, wayfinding signage and new TGSIs.

It is noted that there are no changes to trackwork proposed as part of the Proposal.

Figure 1 shows the general layout of key elements for the Proposal.

Figure 1: Banksia Station – Key features of the Proposal



1.3 Key construction activities

Subject to planning approval, construction is expected to commence in mid-2020 and take around 12 months to complete. The scope of works for the Proposal includes the following works:

- Station upgrade
- Electrical upgrade
- Parking, kiss and ride and pedestrian works
- Drainage works
- Ancillary work

The area required to construct the project is referred to as the construction footprint and is indicated in Figure 2. The construction staging and methodology is indicative and is based on the current concept design and would be further developed during the detailed design of the Proposal by the nominated Construction Contractor in consultation with TfNSW. The key stages of the construction work for the Proposal are the following:

- Site establishment and enabling work
- Lift work
- Canopy work
- Station building work
- Platform modification work
- Installation of services and infrastructure
- Finalisation works

The proposed construction activities, methodology and staging for the Proposal are further detailed in Section 4.2.

Temporary site facilities would be required to accommodate a site office, amenities, laydown and storage areas for materials and piling rig and crane set up and material delivery areas, the locations of which are shown in Figure 2.

Figure 2: Banksia Station – site location and locations of temporary site facilities and laydown areas

1.4 Assessment objectives

This study aims to quantify the noise and vibration impact associated with the construction of the Proposal, in particular in relation to out of hours construction work during rail possessions. This assessment also aims to quantify the change in operational noise levels associated with the modifications, including the change in platforms servicing the trains from the Illawarra Local tracks to the Illawarra Main tracks; and changes to the PA systems.

The assessment objectives are to determine the levels of noise and vibration impact on sensitive receives located near to the project and determine the levels of mitigation that will be required to enable compliance with the current NSW requirements.

This assessment considers the following policies and guidelines:

- *Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013) [1]
- *Noise Policy for Industry* (Environment Protection Authority, 2016) (NPfI) [2]
- *Interim Construction Noise Guideline* ((Department of Environment and Climate Change, 2009) (ICNG) [4]
- *Construction Noise and Vibration Strategy* (Transport for NSW, 2018) (CNVS) [3]
- *Assessing Vibration: A technical guideline* (DEC, 2006) (AVTG) [5].

The proposed construction packages do not include a large number of associated heavy vehicles movements. As such, impacts from construction traffic associated with the works is considered to be minor and is not been further addressed in this assessment. Where required, construction heavy vehicles and delivery vehicles should be scheduled during standard construction hours where feasible and reasonable.

In undertaking the assessment, in order to quantify the existing acoustic environment unattended noise monitoring was conducted.

Three-dimensional noise modelling software was used to create a noise model of the proposal to predict noise levels and assess the need for noise mitigation.

The Transport for NSW *Construction Noise and Vibration Strategy* (2019) (CNVS) 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 infrastructure projects through the application of all feasible and reasonable mitigation measures.

The TfNSW CNVS will be adopted by the project to assist in managing the impacts from construction noise and vibration.

1.5 Acoustic terms & quality

APPENDIX A of this report presents a glossary and description of acoustic terms used in this report.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 Existing noise environment

Background noise varies over the course of any 24 hour period, typically from a minimum at 3:00 am in the morning, to a maximum during morning and afternoon traffic peak hours. Therefore, the *Noise Policy for Industry* (NPfI) (EPA, 2017), referenced by the ICNG for determining the Rating Background Level (RBL), requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The NPfI defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

Residential receivers nearby Banksia station are typically located in an urban environment, with the rail corridor along with major roads such as the Princes Highway contributing to ambient noise levels.

2.1 Noise monitoring location

Long term unattended noise monitoring was conducted for a continuous period between the Wednesday 8th and Wednesday 15th May 2019 to measure ambient and background noise levels in the vicinity of receivers around Banksia Station. Calibration of the noise monitors was conducted before and after the monitoring period, with no significant calibration drift observed. The unattended noise monitoring location and observed noise environment are summarised in the table below.

Table 2-1: Unattended noise monitoring locations

Noise logger #	Location description	Observed noise environment
M1	32 Railway Street, Banksia Noise logger was located in the front yard apartment, approximately 1 metre from the facade. The microphone was located 1.5 metres above ground level and approximately 25 metres from the T4 railway line.	Trains audible and dominant when present. General urban hum and trees rustling, with light traffic on Railway St. Aircraft observed taking off from Sydney Airport and passing overhead, approx. 79 dB(A).

The figures in APPENDIX B present the noise monitoring locations.

2.2 Existing background noise levels

The existing background noise levels measured at the location presented in Figure 3 are presented in Table 2-2 below.

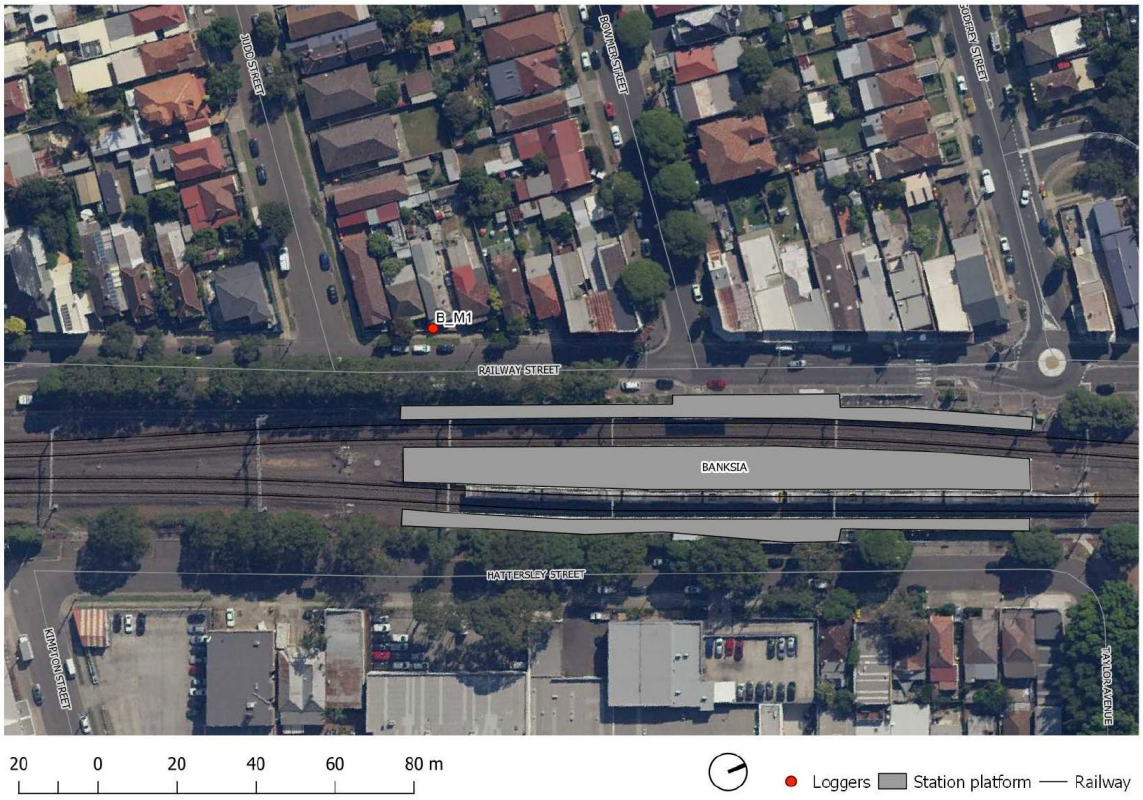
A summary of the unattended noise monitoring results along with a graphical recorded output from the long-term noise monitoring are included in APPENDIX C. The graphs in APPENDIX C were analysed in

accordance with the procedure outlined in the NPfI to determine an Assessment Background Level (ABL) for each day, evening and night period in each 24-hour period of noise monitoring. Based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NPfI.

Table 2-2: Measured existing ambient and background noise levels, dB(A)

Noise logger #	Location description	Rating background noise levels (RBL), $L_{A90,\ 15\ minute}$			Ambient noise levels, $L_{Aeq,\ 15\ minute}$		
		Day	Evening	Night	Day	Evening	Night
M1	32 Railway St, Banksia	47	49	39	63	64	60

Figure 3: Banksia Station – Unattended noise monitoring location



2.3 Noise and vibration-sensitive receivers

A desktop land use survey was carried out to identify the receiver types and uses of buildings around the project that could potentially be impacted by noise or vibration from the project. At detailed design further review of potentially impacted noise-sensitive receivers should be undertaken to confirm that impacts to all nearby receivers are mitigated and managed appropriately.

The noise and vibration-sensitive receivers are generally separated into the following major categories, with further details of the breakdowns of categories and noise and vibration objectives presented in Section 3:

- Residential receivers (including mixed use buildings and aged care facilities)
- Other noise and vibration-sensitive receivers, including:
    - Classrooms at schools and other educational institutions
    - Hospital wards and operating theatres
    - Places of worship
    - Childcare centres
    - Active recreation areas (eg. sports fields/activities which generate their own noise and are generally less sensitive to external noise)
    - Passive recreation areas (eg. areas used for low intensity and low noise producing activities which have the potential to be impacted by external noise such as reading or meditation)
    - Community centres
    - Special noise and/or vibration-sensitive receivers (eg. laboratories, recording studios)
- Commercial premises (including offices and retail outlets)
- Industrial premises.

All assessed noise and vibration-sensitive receiver types for the project are shown in APPENDIX B.

3 Noise and vibration objectives

3.1 Construction noise objectives

3.1.1 Noise management levels (NMLs)

The *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) provides guidelines for assessing noise generated during the construction phase of developments. There are two methods described for the assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the scale of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG and CNVS requirements.

Table 3-1 reproduced from the ICNG, sets out the airborne noise management levels and how they are to be applied for residential receivers.

Table 3-1: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$ [1]	How to apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays *(Refer to Note 2)*	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (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/ 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.

Time of day	Management level $L_{Aeq\ (15\ min)}$ [1]	How to apply
Outside recommended standard hours *(Refer to Note 2)*	Noise affected RBL + 5dB	• 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 5dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see *ICNG* section 7.2.2.

Notes:
1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metre above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.
2. The *Environmental Planning and Assessment COVID-19 Development – Infrastructure Construction Work Days) Order 2020* was in place at the time of issue of this report. This order impacts the definition of standard conduction hours for the project. Refer to Section 4.1.1.1 for further explanations of the changes as a result of the order.

Table 3-2 sets out the ICNG noise management levels for other noise sensitive receiver locations. Where premises are noise-sensitive and cannot be suitably classified by the categories in this table, it is recommended that the recommended 'maximum' internal noise levels presented in AS/NZS 2107:2016 are adopted.

Table 3-2: Noise management levels at other noise sensitive land uses, dB(A)

Land use	Time of day	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Childcare centre[2]	When in use	Outdoor noise level	50 [2]
Classrooms at schools and other educational institutions	When in use	Indoor noise level Outdoor noise level[1]	45 55
Hospital wards and operating theatres	When in use	Indoor noise level Outdoor noise level[1]	45 55
Places of worship	When in use	Indoor noise level Outdoor noise level[1]	45 55
Hotel/Motel/Hostel	When in use	Indoor noise level Outdoor noise level [5]	40 60
Community centres	When in use	Indoor noise level Outdoor noise level [6]	40 [6] 60 [6]
Active recreation areas [4]	When in use	Outdoor noise level	65
Passive recreation areas [3]	When in use	Outdoor noise level	60
Commercial premises	When in use	Outdoor noise level	70
Industrial premises	When in use	Outdoor noise level	75

Notes:
1. Outdoor noise level based on internal noise level in ICNG and assumes 10 dB loss through an open window
2. An external screening level of 50 dB(A) is adopted for assessing childcare centres, based upon the recommended noise levels in the Association of Australian Acoustical Consultants (AAAC) Guideline for Child Care Centre Acoustics Assessment (2013). This considers the centre has sleeping areas.
3. Passive recreation - Areas used for low intensity and low noise producing activities which could be impacted by external noise such as reading or meditation
4. Active recreation - Sports fields/activities which generate their own noise and are generally less sensitive to external noise
5. Based upon AS2107 (Sleeping areas: Hotels near major roads), and 20 dB(A) outside to inside difference (closed windows)
6. Community centres have been assessed to an external noise level of 60 dB(A). Depending on the intended use of the centre, the noise management level may vary.

3.1.2 Sleep disturbance

The ICNG recommends that where construction works are planned to extend over two or more consecutive nights, the Project should consider maximum noise levels and the extent and frequency of maximum noise level events exceeding the RBL. The potential for both sleep disturbance and awakenings should be considered in the assessment.

To assess the likelihood of sleep disturbance, an initial screening level of $L_{Amax} \leq L_{A90(15min)} + 15$ dB(A) is used. In situations where this results in an external screening level of less than 55 dB(A), a minimum screening level of 55 dB(A) is set. Note that this is equivalent to a maximum internal noise level of 45 dB(A) with windows open. A conservative 10 dB(A) reduction from external noise levels to internal noise levels has been assumed considering an open window in line with the ICNG, which is not always the case and could be greater especially in the case that the receivers have a closed windows/facade. Sealed facades or facades with windows closed can provide external to internal noise reductions much greater than 10 dB(A). Noise reductions greater than 20–25 dB(A) are achievable where facades consist of standard to thick glazing and heavy facade construction (eg. brick construction).

Where there are noise events found to exceed the initial screening level, further analysis is made to identify:

- The likely number of events that might occur during the night assessment period
- Whether events exceed an 'awakening reaction' level of L_{Amax} 65 dB(A).

The sleep disturbance assessment levels for the project are presented in Table 3-3.

3.1.3 Summary of construction noise management levels

Table 3-3 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring outlined in Section 2.

Table 3-3: Construction noise management levels at residential receivers, dB(A)

Rating background level (RBL)			Noise management level $L_{Aeq(15min)}$				Sleep disturbance[3] L_{Amax}	
Day	Evening	Night	Day (Standard) [1]	Day (OOH) [2]	Evening (OOH) [2]	Night (OOH) [2]	Screening level	Awakening reaction
47	49	39	57	52	52[4]	44	54	65

Notes:
1. Standard construction hours, as defined in Section 4.1.
2. OOH = outside standard construction hours, as defined in Section 4.1
3. Assessed during the night period only (10:00 pm to 7:00 am)
4. In line with the direction in Section 2.3 of the NPfI, as the community generally expects greater control of noise during the more sensitive evening and night-time periods than during the less sensitive daytime period, the project noise management levels for evening are set at no greater than daytime level, and the night-time is set to be no greater than the day or evening levels.

3.2 Construction-related road traffic noise

When trucks and other vehicles are operating within the boundary of a construction site, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction-related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site.

Construction-related traffic operating on the public road network, especially heavy vehicle movements travelling on roads located immediately adjacent to construction sites are likely to be associated to the Proposal by the community. However, once the heavy vehicles move further from Banksia Station onto major sub-arterial or arterial roads, the noise may be perceived as being part of the general road traffic.

Noise from construction traffic on public roads is not assessed under the ICNG, although the guideline does reference the Environmental Criteria for Road Traffic Noise (EPA 1999), which has been superseded by the RNP. The RNP states that 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. For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments (in this case the construction area), any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'without construction' scenario.

Where the road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration should be given to the actual noise levels associated with construction traffic and whether these levels comply with the road traffic noise criteria in the RNP presented in Table 3-4.

Table 3-4: Construction-related road traffic noise assessment criteria

Road type	Day criteria (7am – 10pm)	Night criteria (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	60 $L_{Aeq\ 15\ hour}$	55 $L_{Aeq\ 9\ hour}$
Local roads	55 $L_{Aeq\ 1\ hour}$	50 $L_{Aeq\ 1\ hour}$

3.3 Construction vibration objectives

Construction vibration is associated with three main types of impact:

- disturbance to building occupants
- potential damage to buildings
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to the buildings.

Construction vibration management levels have been determined in accordance with Section A.3 of CNVS.

3.3.1 Disturbance to buildings occupants

The acceptable vibration values to assess the potential for human annoyance from vibration are set out in the *Environmental Noise Management Assessing Vibration: A Technical Guideline* (AVTG) (DEC, 2006).

To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The screening test is based on the continuous vibration velocity (i.e. vibration that continues uninterrupted for a defined period). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

The initial screening test values and VDVs recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in Table 3-5. The 'Low probability of adverse comment eVDV' represent the preferred and maximum value presented in the AVTG.

Table 3-5: Vibration management levels for disturbance to building occupants

Place and Time	Initial screening test Velocity, PEAK, mm/s (>8Hz)	Low probability of adverse comment eVDV $m/s^{1.75}$	Adverse comment possible eVDV $m/s^{1.75}$	Adverse comment probable eVDV $m/s^{1.75}$
Critical areas (day or night)[1]	0.28	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day[2]	0.56	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night[2]	0.40	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions and places of worship (day or night)	1.10	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	2.20	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above
2. Daytime is 7:00 am to 10:00 pm and night-time is 10:00 pm to 7:00 am

3.3.2 Building damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard *BS 7385 Part 2 – 1993 Evaluation and measurement for vibration in buildings* and German Standard *DIN 4150-3: 2016 Structural Vibration – Part 3: Effects of vibration on structures*. There is no Australian Standard for assessment of structural building damage caused by vibration energy.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however, the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

Appendix A.3.3 of the CNVG references the British Standard, which sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from *BS 7385-2* for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 3-6.

Table 3-6: BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50

Notes:
1. Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.
2. PPV values increase between specified frequencies as detailed in BS7385-2
3. Values referred to are at the base of the building, as per Section 6.3 of BS7385-2

The standard states that the guide values in Table 3-6 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 3-6 may need to be reduced by up to 50%.

The Standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 3-6 and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 3-6 should not be reduced for fatigue considerations. It is noteworthy that, extra to the guide values nominated in Table 3-6, the standard states that: *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Regarding heritage buildings, heritage items are to be considered on a case by case basis, and care should be taken as these structures can be difficult to repair in the case of damage. However, it should be noted that *BS 7385-2* notes that *"a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive"* (p.39) when compared to other structures.

3.3.3 General vibration (building damage) screening criterion

In accordance with Appendix A.3.4 and A.3.5 of the CNVG, a conservative vibration damage screening level (peak component particle velocity) per receiver type is detailed in the CNVS and outlined below:

- reinforced or framed structures: 25.0 mm/s
- unreinforced or light framed structures: 7.5 mm/s
- heritage structures (structurally unsound): 2.5 mm/s.

Where the predicted and/or measured vibration is greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure will be completed to determine the applicable vibration limit. Heritage buildings found to be structurally sound should not be assumed to be more sensitive to vibration and should therefore be assessed to the screening criterion for reinforced or unreinforced structures, depending on the structure. If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150-3) would be considered.

3.3.4 Damage to vibration sensitive equipment

Some high technology manufacturing facilities, hospitals and laboratories utilise equipment that is highly sensitive and susceptible to vibration, for example scanning electron microscopes and micro-electronic manufacturing facilities. In addition, buildings housing sensitive computer or telecommunications equipment may require assessment against stricter criteria than those nominated for building damage.

There is no explicit guidance on acceptable vibration levels for such equipment, so recommended vibration levels should be obtained from instrument manufacturers. In the absence of equipment specific data provided by manufacturers, there are generic vibration criteria that can be used to assess the impact of vibration generating activities on buildings housing vibration sensitive equipment. For

example, the Vibration Criteria (VC) curves are often referred to as they are generic and apply to all tools/ equipment types within each category. The VC curves are defined over the frequency range 8 to 100 Hz.

Table 3-7 below summarises a range of suitable and conservatively stringent vibration limits that are applicable to buildings housing vibration sensitive equipment which may potentially be affected by construction vibration.

Table 3-7: Acceptable vibration limits for vibration measured on building structure housing sensitive equipment

Equipment Requirements	Vibration Limit[1] mm/s,		Description of Use[3]
	RMS[4]	Peak [5]	
Computer Areas[2]	0.7	1.0	Barely perceptible vibration. Adequate for computer equipment accommodation environments.
Medical[2, 3]	0.1	0.14	Vibration not perceptible. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity.
VC-A[3]	0.05	0.07	Vibration not perceptible. Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc

Notes: 1. As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz. Vibration measured on the building structure near vibrating equipment or in areas containing sensitive equipment.

2. Based on AS 2834 Computer Accommodation

3. Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment

4. Root Mean Square value representing the average value of a signal

5. In the absence of Peak limits, RMS limits are converted to Peak by conservatively assuming the vibration signal is sinusoidal and random with a nominal crest factor of 1.414

3.3.5 Damage to buried services

Section 5.3 of DIN 4150-3: 2016 also sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values, which apply at the wall of the pipe, are reproduced and presented in Table 3-8 below.

Table 3-8: DIN 4150-3: 2016 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50

For long-term vibration the guideline levels presented in Table 3-8 should be halved.

Recommended vibration goals for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s. It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch

blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment should be carried out. This may include a specific CNVIS addressing impact on the utility and consultation with the utility provider to confirm specific vibration requirements.

3.4 NSW Noise Policy for Industry

This assessment aims to quantify the change in operational noise levels associated with the Proposal, including the changes to the PA systems. Noise impact associated with the PA systems is assessed in accordance with the NPfI. The assessment procedure has two components:

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

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level which is the lower value of the project intrusiveness noise levels and project amenity noise levels.

3.4.1 Project intrusive noise levels

According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$L_{Aeq,15minute}$ Intrusiveness noise level = Rating Background Level ('RBL') plus 5 dB(A)

Based on the background noise monitoring results and the proposed operating hours of the facility, the intrusiveness noise levels for residential receivers are presented in Table 3-9 below.

Table 3-9 Project intrusiveness noise levels

Residential receivers near station	Project intrusiveness noise level, $L_{Aeq,15min}$		
	Day[1]	Evening[2]	Night[3]
Banksia	47 + 5 = 52	47[4] + 5 = 52	39 + 5 = 44

Notes:
1. Day: 7:00 to 18:00 Monday to Saturday and 8:00 to 18:00 Sundays & Public Holidays
2. Evening: 18:00 to 22:00 Monday to Sunday & Public Holidays
3. Night: 22:00 to 7:00 Monday to Saturday and 22:00 to 8:00 Sundays & Public Holidays
4. As per Section 2.3 of the NPfI, the community generally expects greater control of noise during the more sensitive evening and night-time periods than during the less sensitive daytime period. Therefore, in determining project noise trigger levels the project intrusiveness noise level for evening is set at no greater than the project intrusiveness noise level for daytime, and the night-time is set to be no greater than the project intrusiveness noise level for day or evening.

3.4.2 Project amenity noise levels

The project amenity noise levels for different time periods of day are determined in accordance with Section 2.4 of the NPfI. The NPfI recommends amenity noise levels ($L_{Aq,period}$) for various types of receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These "recommended amenity noise levels" represent the objective for total industrial noise experienced at receiver location, and not any individual industrial facility. As such, when assessing a single industrial development and its impact on nearby noise sensitive receivers the "project amenity noise levels" apply.

The recommended amenity noise levels applicable for the project area are reproduced in Table 3-10 below.

Table 3-10: Recommended amenity noise levels

Type of Receiver	Noise Amenity Area	Time of Day[1, 2]	Recommended amenity noise level, L_{Aeq}, dB(A)[3, 4, 5]
Residential	Urban	Day	60
		Evening	50
		Night	45
Active recreation (e.g. playing fields)	All	When in use	55
Commercial premises	All	When in use	65

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
2. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
4. The recommended amenity noise levels refers only to noise from industrial sources. However, they refer to noise from all such industrial sources at the receiver location, and not only noise due to a specific project under consideration.
5. The levels represent outdoor levels except where otherwise stated

As the project sites have existing industrial noise as part of the ambient noise environment, to ensure that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level that applies for each new industrial noise source is determined as follows:

$$L_{Aeq,period}\ \text{Project amenity noise level} = L_{Aeq,period}\ \text{Recommended amenity noise level} - 5\ \text{dB(A)}$$

Furthermore, given that the project noise trigger level is based on a 15 minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, to standardise the time periods for the intrusiveness and amenity noise levels, the NPfI provides the following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15minute}$ level in order to standardise the time periods.

$$L_{Aeq,15minute} = L_{Aeq,period} + 3\ \text{dB(A)}$$

The project amenity noise levels ($L_{Aeq,\ 15min}$) applied for this project are reproduced in Table 3-11 below.

Table 3-11 Project amenity noise levels

Type of Receiver	Noise Amenity Area	Time of Day	Recommended Noise Level, dB(A)	
			$L_{Aeq, Period}$	$L_{Aeq, 15min}$
Residential	Urban	Day	60 – 5 = 55	55 + 3 = **58**
		Evening	50 – 5 = 45	45 + 3 = **48**
		Night	45 – 5 = 40	40 + 3 = **43**
Active recreation area (playing fields)	All	When in use	55 – 5 = 50	50 + 3 = **53**
Commercial Premises	All	When in use	65 – 5 = 60	60 + 3 = **63**

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
2. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
4. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$

3.4.3 Project noise trigger levels

In accordance with the NPfI the project noise trigger levels, which are the lower (i.e. more stringent) value of the project intrusiveness noise level and project amenity noise level, have been determined as shown in Table 3-12 below.

Table 3-12 Project noise trigger levels

Receiver Location	Project noise trigger levels, $L_{Aeq, 15min}$ dB(A)		
	Day	Evening	Night
Residential	52	48	43
Active recreation (e.g. playing fields)	53	n/a	n/a
Commercial premises	63	63	n/a

3.4.4 Sleep disturbance from maximum noise level events

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. In accordance with NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 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.

Where there are noise events found to exceed the initial screening level, further analysis is undertaken to identify:

- the likely number of events that might occur during the night assessment period

- the extent to which the maximum noise level exceeds the rating background noise level.

The sleep disturbance noise levels for the project are presented in Table 3-13.

Table 3-13: Sleep disturbance assessment levels

Receiver type	Assessment Level $L_{Aeq,15min}$	Assessment Level L_{AFmax}
Residential	39 + 5 = 44	39 + 15 = 54

4 Construction noise and vibration assessment

4.1 Construction hours

4.1.1 Standard construction hours

The recommended standard hours for construction are defined in the ICNG and the CNVS. Whilst the standard construction hours are not mandatory, limiting construction works to within standard construction hours as much as practicable assists in managing noise or vibration impact and provides a lengthy respite period whilst people are most likely to be relaxing or sleeping.

4.1.1.1 COVID-19 extended construction hours

The *Environmental Planning and Assessment (COVID-19 Development – Infrastructure Construction Work Days) Order 2020*, is now in place and will continue until the COVID-19 pandemic is over or the advice of NSW Health changes. The order permits standard construction hours on this project to be extended as follows:

- Saturdays from 1:00pm to 6:00pm (no 'high noise work' permitted) [where these hours are not part of standard hours]
- Sundays from 8:00am to 6:00pm (no 'high noise work' permitted)
- Public holidays from 8:00am to 6:00pm (no 'high noise work' permitted).

The conditions that apply to standard hours would apply to the COVID-19 extended hours above, with the exception that 'high noise work' is not permitted during the extended hours. 'High noise work' means activities such as rock breaking, rock hammering, sheet piling, pile driving or similar noisy activities, unless an existing consent or approval already allows these works to occur on any of the extended days. All reasonable and feasible measures to minimise noise would need to be adopted during the extended hours period.

It is noted that appropriate noise management levels would need to be determined for the extended construction hours. The noise monitoring data presented in Section 2.2 and APPENDIX C is to be reviewed to confirm the Rating Background Level (RBL) for the extended hours period and an NML determined as outlined in Section 3.1.1.

4.1.2 Works outside standard construction hours

The ICNG identifies five categories of works that might be undertaken outside the recommended standard hours (OOH):

1. the **delivery of oversized plant or structures** that police or other authorities determine require special arrangements to transport along public roads

2. **emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
3. **maintenance and repair of public infrastructure** where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
4. **public infrastructure works** that shorten the length of the project and are supported by the affected community
5. works where a proponent demonstrates and justifies a **need to operate outside the recommended standard hours**.

All of the above categories may apply to the Proposal at different stages of the works. Mostly the last two categories will apply, and for these works clear justification for working outside standard hours for reasons other than convenience is required.

Construction hours, including OOH work periods are defined in Table 4-1 below.

Construction work for the Proposal would be completed during standard construction hours wherever reasonable and feasible and can be undertaken under work site protection measures. As the proposed works are to be undertaken within the rail corridor and on working station platforms, the existing rail traffic would impose major risks construction workers due to the extremely close proximity between all parties involved. Safe work areas will be established to ensure the proposed construction activities have minimal impact on the safety of commuters whilst keeping construction workers a safe distance from rail traffic.

Notwithstanding this, some activities due to their location and plant/equipment requirements will need to occur during rail shutdown possessions to minimise the risks of rail traffic, commuter and work site interaction.

4.1.3 Summary of construction hours and work periods

Table 4-1: Construction hours

Construction hours	Monday to Friday	Saturday	Sunday/ Public holiday
Recommended standard construction hours	**(refer to Note 2)**		
Standard hours	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work
Activities with special audible characteristics[1]	8:00 am to 6:00 pm	9:00 am to 1:00 pm	No work
Outside standard construction hours			
Out of Hours Day (OOHD)	N/A	1:00 pm to 6:00 pm	8:00 am to 6:00 pm
Out of Hours Evening (OOHE)	6:00 pm to 10:00 pm	6:00 pm to 10:00 pm	6:00 pm to 10:00 pm
Out of Hours Night (OOHN)	10:00 pm to 7:00 am	10:00 pm to 8:00 am	10:00 pm to 8:00 am

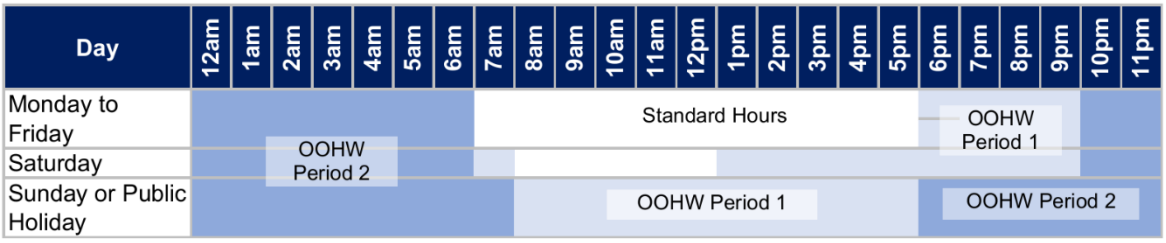
Note: 1. Special audible characteristics includes particularly annoying construction noise sources that may generate high noise impact, impulsive or tonal noise emissions, such as rock hammering. Where applicable, such activities should be limited to continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block, unless otherwise approved by TfNSW.

2. The *Environmental Planning and Assessment COVID-19 Development – Infrastructure Construction Work Days) Order 2020* was in place at the time of issue of this report. This order impacts the definition of standard conduction hours for the project. Refer to Section 4.1.1.1 for further explanations of the changes as a result of the order.

The CNVS provides a hierarchy of OOH work periods. The impact of OOH works may be reduced by scheduling work and activities with greater impact during the preferred periods when receivers are likely to be less sensitive to noise and vibration, such as in the OOHD and OOHE periods. Table 4-2 presents the construction work periods as:

- Standard Hours
- OOHW Period 1
- OOHW Period 2.

Table 4-2: Construction work periods



1. Standard construction hours are defined in the CNVS as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 1:00pm.
2. Work outside of standard construction hours is defined as Out-of-Hours Work (OOHW) and can be divided into 2 periods of sensitivity. **OOHW Period 1** is the least sensitive OOH period and is defined as Monday to Friday 6:00pm to 10:00pm (evenings), Saturday 7:00am to 8:00am and 1:00pm to 10:00pm (day & evening) and Sunday and public holidays 8:00am to 6:00pm (days). **OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (nights) and Sundays and public holidays 6:00pm to 8:00am (nights).

4.2 Construction noise and vibration activities and assumptions

4.2.1 Construction activities

The construction works associated with station upgrade are proposed to take place over about five possession periods and six non-possession periods. Of these periods, it is likely that night works will be required during each of the five possession periods.

An assessment of potential construction noise and vibration impact has been carried out to determine whether mitigation will be required and identify appropriate management controls. Specific construction equipment requirements are not yet known.

The construction staging and methodology, presented in Table 4-3, is indicative and is based on the current concept design and would be further developed during the detailed design of the Proposal by the nominated Construction Contractor in consultation with TfNSW. The construction assessment scenarios and the type and number of plant and equipment associated with the proposed works was assumed based upon the design details outlined in the construction methodology reference document developed for the tender phase of this project (TfNSW Construction Methodology, contract reference ISD-15-4742-11), experience assessing similar construction works, and advice from the design team. A further assessment will be required once final construction detail becomes available with progress of the detailed design.

Table 4-3: Indicative construction staging for key activities

Stage	Activities	Timing
Site establishment and enabling work	• establish site compounds and laydown areas (i.e. fencing, tree protection zones, site offices, amenities and plant/material storage areas) • establish temporary facilities as required (e.g. temporary access stairs, temporary toilets, temporary construction lights etc.) • erect site hoarding as required • services location and relocation • establish crane and piling rig.	Typically standard hours
Lift work	• excavation of lift pit (including temporary shoring if required) • piling works for lift • waterproof (as required), install reinforcement, formwork and concrete to form the lift pit • erect glass and steel shaft structure • install and commission lift, including fit-out.	Typically standard hours with some potential out-of-hours/ rail shutdown periods work, refer to Table 4-4 for the assumed split of work activities into rail possessions and standard and OOHW construction hours.
Canopy work	• piling works for canopy footings • concrete pour • erect steel framework and roof.	
Station building work	• reconfigure existing male and female toilets to allow for a new Family Accessible Toilet and unisex ambulant toilet	

Stage	Activities	Timing
Platform modification work	• regrade platform surface • install new yellow line and TGSIs along platforms • install new platform canopy • relocate seating and • adjust drinking fountain and telephone booth height • install new Opal card reader	Typically standard hours with some potential out-of-hours/ rail shutdown periods work, refer to Table 4-4 for the assumed split of work activities into rail possessions and standard and OOHW construction hours.
Installation of services and infrastructure	• install station services (SPI, CCTV, Emergency Help Points, PA system, lighting and ticketing machines) • relocate existing platform infrastructure (e.g. seating and bins) • install new seating.	
Finalisation works	• remove temporary construction hoardings and reinstate platform bitumen where required • site clean-up.	Typically standard hours

For each of the Proposal construction work sites the following construction activities have been modelled, which refer to assessment modelling scenarios presented in Section 4.2.2.

Table 4-4: Reference of assumed assessment activities during the project and applicable construction hours

Construction stage	Site laydown areas	Site preparation/ demobilisation	Platform works			Underpass/Stairs Ramps/Lifts works			Precinct works	Construction hours	
			Services works	Civil demolition/ foundation works	Platform furniture and station services	Civil demolition/ foundation works	Lifting works	Concreting works		Standard	OOHW
Enabling Works	●	●	●							◆	
Possession 1	●	●	●	●		●				◆	◆
Possession 1 to 2	●		●			●			●	◆	
Possession 2	●	●	●	●		●	●	●	●	◆	◆
Possession 2 to 3	●					●		●	●	◆	
Possession 3	●		●	●	●	●	●			◆	◆
Possession 3 to 4	●	●	●		●		●			◆	
Possession 4	●			●	●	●	●			◆	◆
Possession 4 to 5	●				●	●	●		●	◆	
Possession 5	●	●			●					◆	◆
After Possession 5	●	●									

4.2.2 Construction noise sources

Table 4-5 following summarises the likely plant and equipment and the assumed sound power levels for construction activities associated with the Proposal. The sound power levels for the majority of activities presented in Table 4-5 are based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', ICNG, information from past projects and information held in the Renzo Tonin & Associates library files.

Table 4-5: Noise modelling assumptions for construction - activities and equipment

Activity	Plant / Equipment	Operating weight kg	Assumed no. units	Sound Power Level (Lw re: 1pW), dB(A)	
				L_{Aeq}	L_{Amax}
Site laydown area general activities	Franna Crane	20 tonne	1	99	98
	Small Truck	<20 tonne	4 per hour	104	117
	Assumed combined activity noise level			**104**	**117**
Site preparation/ demobilise	Tracked excavator w bucket	20 tonne	1	107	120
	Franna Crane	20 tonne	1	99	98
	Hand tools		1	107	120
	Elevated work platform		1	106	102
	Truck with Hiab		1	96	99
	Small Truck	<20 tonne	4 per hour	104	117
	Assumed combined activity noise level			**109**	**120**
Services works	Franna Crane	20 tonne	1	99	107
	Elevated Work Platform (EWP)		2	95	102
	Truck with Hiab		1	96	100
	Concrete saw		(1)	119	123
	Tracked excavator w bucket	19 tonne	1	103	120
	Hand tools		1	107	120
	Assumed combined activity noise level			**109 (119)**	**120 (123)**
Civil demolition/ foundation works	Concrete agitator - discharging		1	108	117
	Concrete pump		1	103	-
	Small piling rig (rotary bored piling)	<6 tonne	1	104	-
	Compressor for small piling rig		1	103	-
	Tracked excavator w bucket	19 tonne	1	103	120
	Tracked excavator w hydraulic hammer	10 tonne	(1)	119	124
	Hand tools		1	107	120
	Assumed combined activity noise level			**113 (120)**	**120 (124)**
Platform furniture and station services	Franna Crane	20 tonne	1	99	107
	Elevated Work Platform (EWP)		2	95	102
	Hand tools		2	105	109
	Assumed combined activity noise level			**109**	**109**

Activity	Plant / Equipment	Operating weight kg	Assumed no. units	Sound Power Level (Lw re: 1pW), dB(A)	
				L_{Aeq}	L_{Amax}
Lifting works (components and shaft installation works)	Mobile crane	≤ 300 tonne	1	110	120
	Hand tools		1	107	120
	Truck with Hiab		1	96	117
	Truck (semi-trailer)	<20 tonne	4 per hour	108	117
	Assumed combined activity noise level			**113**	**120**
Concreting works	Concrete agitator - discharging		1	108	117
	Concrete pump		1	103	-
	Hand tools		1	105	109
	Small Truck	<20 tonne	4 per hour	104	117
	Assumed combined activity noise level			111	117
Footpaths, drainage and services upgrade works	Mobile crane	80 tonne	-	105	109
	Concrete agitator - discharging		1	108	117
	Concrete pump		1	103	-
	Trailer mounted compressor		1	102	-
	Jackhammer		-	114	124
	Tracked excavator w hydraulic hammer	10 tonne	(1)	119	124
	Front end loader	10 tonne	-	104	-
	Assumed combined activity noise level			**110 (120)**	**117 (124)**

Notes:
1. L_{Amax} levels only noted for equipment potentially used during the night period with high noise events
2. Number of units operating at any one time may change on site. Assumptions in table are for modelling purposes, based on a conservative, but realistic estimate of the likely number of units operating concurrently for each activity.
3. Assumed activity noise level in brackets () includes all noise sources for that activity, including high noise impact sources in brackets. Assumed activity noise level outside brackets assumes high noise impact sources in brackets is not operating.

4.2.3 Minimum working distances for vibration intensive plant

The pattern of vibration radiation is very different to the pattern of airborne noise radiation and is very site specific as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver. Accordingly, based on a database containing vibration measurements from past projects and library information, Table 4-6 below presents the recommended minimum working distances for vibration intensive plant.

Table 4-6: Recommended minimum working distances for vibration intensive plant

Plant item	Rating/ description	Minimum working distance		
		Cosmetic damage		Human response
		Unreinforced or light framed structures	Structurally unsound heritage structures	
Excavator with small hydraulic hammer	300kg (5-12 tonne excavator)	2 m	10 m	7 m
Piling rig (rotary bored)	≤800 mm	2 m (nominal)	5 m	N/A
Jackhammer	Handheld	1 m (nominal)	5 m	Avoid contact with structure

Notes: Source: TfNSW Construction Noise and Vibration Strategy - April 2018

4.3 Construction noise and vibration assessment

4.3.1 Predicted noise levels

Construction noise levels were predicted by modelling the noise sources, receiver locations, and operating activities across 13 construction scenarios based on the information presented in Section 4.2.1.

A 5 dB(A) penalty in accordance with the ICNG has been factored into the noise modelling levels where applicable to allow for particularly annoying activities, such as rock hammering, saw cutting and jack hammering. The following sections summarise predicted construction noise levels (without mitigation) at receivers from the construction of the Proposal.

Construction noise levels are assessed at the most noise affected facade and floor level of a receiver building. The predicted levels are conservative and represent the reasonable the equipment/plant that has been assessed operating simultaneously in any 15 minute period. Where plant items are not operating simultaneously, or for reduced times in a 15 minute period, noise impacts could be lower than predicted. Construction noise levels experienced at other points on the building may be lower.

Additionally, these noise levels assume that the assessed activities could occur anywhere within the assessed construction works area, while in practice, noise intensive construction works would generally only occur at a single location at any one time. This means that predicted noise levels are only likely to occur when works are at the closest point to each receiver. The noise impacts may be lower than predicted as the construction activities move around or progress around the construction site.

The upper end of the predicted noise level range presented in the summary tables is based on the worst affected receiver/s. The lower end of the predicted noise level range is based on the least affected receiver/s. The worst affected receivers are typically in the first row of houses and apartments back from the project area, with direct line of sight to the construction work area. Receivers in the next row of houses back from the Project, or receivers without direct line of sight to the construction area will

typically be exposed to construction noise levels 5 to 10 dB(A) lower than the levels predicted for the worst affected receivers.

APPENDIX D presents maps indicating the predicted construction noise level compared with the project NML for standard construction hours, and the OOHW (Night) period, to give receivers an indication of the likely noise impact from the different stages of construction. Both APPENDIX D and the following sections colour code the predicted levels of exceedance based upon Table 4-7 so that the levels of exceedance can be reviewed directly against the categories presented in the TfNSW CNVS provided in Section 4.4.4.

Table 4-7: Key to the predicted construction noise results tables

Assessment	Time of day	Key			
$L_{Aeq(15min)}$	Standard hours[1]	0-10 dB(A) over NML (light blue) Clearly audible	11-20 dB(A) over NML (mid blue) Moderately intrusive	>20 dB(A) above NML (dark blue) Highly intrusive	
	Outside standard hours	1-5 dB(A) above NML (green) Noticeable	6-15 dB(A) above NML (yellow) Clearly audible	16-25 dB(A) above NML (orange) Moderately intrusive	>25 dB(A) above NML (purple) Highly intrusive
Sleep Disturbance	Night only	L_{Amax} above sleep disturbance screening criterion (yellow)		**L_{Amax} above awakening level (>65 dB(A), bold and purple)**	

Notes: 1. Highly noise affected (HNA) which is greater than 75dB(A) is shown with **Bold** text and applies to residential receiver buildings only during standard construction hours.

4.3.1.1 Standard construction hours

During a substantial portion of the construction program, the predicted noise levels indicate that receivers directly adjacent to the station along Hattersley Street and Railway Street could have construction noise impacts ranging from clearly audible to highly intrusive. However, these noise levels will only occur when construction works are working at the closest point to these receivers, and when they are working at other locations the noise levels will likely be less.

The predictions indicate that during typical works, construction noise levels could range between clearly audible (i.e. within 10 dB of the NML) and moderately intrusive (i.e. within 20 dB of the NML) at the nearest residential receivers closest to the station to both the east and west. Most of the impacts greater than 10 dB above the NML only predicted for the receivers directly adjacent to the station along Hattersley Street and Railway Street.

During high impact services works and civil works such as demolition, some residential receivers along Hattersley Street and Railway Street could experience construction noise levels that are highly intrusive (i.e. greater than 20 dB above the NML) and be potentially highly noise affected [i.e. greater than 75 dB(A)]. However, this would only occur during periods when high noise impact equipment such as rock hammering and saw cutting.

Two childcare centres are predicted to exceed the external screening level during high impact services works and civil works and may require further investigation during detailed design.

The commercial receivers adjacent to the station could also experience moderately intrusive impacts at times depending on the location and type of plant and equipment in use.

As such, further mitigation and management measures are to be investigated during detailed design to reduce noise impacts on nearby noise sensitive receivers, as detailed in Section 4.4.

A summary of the predicted construction noise levels is presented in Table 4-8. Table 4-8 presents the predicted reasonable worst-case construction noise impacts from the Proposal. For construction works during standard construction hours APPENDIX D presents maps indicating the predicted construction noise level compared with the project NML in to give receivers an indication of the likely noise impact from the different stages of construction.

Table 4-8: Predicted construction noise levels ($L_{Aeq\ 15\ minute}$, dB(A)) – standard hours construction activities

Receiver type	NML dB(A)	Site laydown areas	Site preparation/ demobilisation	Platform works					Underpass/Stairs Ramps/Lifts works				Precinct works	
				Services works (inc. OHW)		Civil demolition/ foundation works			Civil demolition/ foundation works				Footpaths, drainage, and services works	
		Site laydown area activities	Site preparation/ demobilisation	Low impact	High impact	Low impact (ie. piling works)	High impact (ie. demolition)	Platform furniture and station services	Low impact (ie. piling works)	High impact (ie. demolition)	Lifting works	Concreting works	Low impact	High impact
Residential-West	57	<40 - 65	<40 - 69	<40 - 68	<40 - **78**	<40 - 71	<40 - **78**	<40 - 67	<40 - 63	<40 - 69	<40 - 63	<40 - 61	<40 - 71	<40 - **80**
Residential-East	57	<40 - 64	<40 - 69	<40 - 69	<40 - **79**	<40 - 72	<40 - **79**	<40 - 69	<40 - 73	<40 - **80**	<40 - 73	<40 - 72	<40 - **76**	<40 - **85**
Childcare[2]	50	≤42	≤44	≤44	≤54	≤47	≤54	≤43	≤49	≤55	≤49	≤47	≤43	≤53
Place of worship[2]	50	≤36	≤39	≤39	≤49	≤43	≤50	≤39	≤41	≤48	≤41	≤39	≤39	≤49
Commercial[2]	70	<40 - 74	<40 - 81	<40 - 81	<40 - 91	<40 - 84	<40 - 91	<40 - 80	<40 - 78	<40 - 84	<40 - 78	<40 - 76	<40 - 74	<40 - 83

Notes:

1. Construction noise level cells are shaded based on the predicted worst case NML exceedance as follows:

   No shading indicatives the NML is achieved, Light blue is ≤ 10 dB(A) above NML, Mid blue is 11 to 20 dB(A) above NML, Dark blue is >20 dB(A) above NML, **Bold** text is highly noise affected (HNA) (i.e. above 75 dB(A)) for residential receivers

2. These noise levels and predicted level of impact apply only when the receiver is in use, which may extend outside of standard construction hours.

4.3.1.2 Outside of standard construction hours

As the works are to be carried out within an active rail corridor, some of the activities will need to be completed outside standard construction hours during rail possession periods or during the midnight to dawn shutdown period.

For works that are to take place outside of standard construction hours, APPENDIX D also presents maps indicating the predicted construction noise level compared with the project NML in to give receivers an indication of the likely noise impact from the different stages of construction. A summary of the predicted construction noise levels is presented in Table 4-9.

Table 4-9 presents the predicted reasonable worst-case construction noise impacts from the Proposal works assessed against the OOHW NMLs. The predictions indicate that construction noise will be clearly audible (i.e. within 15 dB of the NML) to moderately intrusive (i.e. within 25 dB of the NML) at the receivers closest to the station and may at times be highly intrusive (i.e. greater than 25 dB above the NML). Care will need to be taken during OOHW period to ensure noise generating activities and equipment that cannot be undertaken during the daytime period, operate equipment behind close fitting site hoardings or temporary noise barriers, where practicable which will provide 5 to 10 dB(A) noise reduction, where line of sight is broken between the noise source and receiver. In addition, works should be scheduled such that high noise impact plant and equipment (e.g. hydraulic hammer and road saw) should not be used at night, and for rail possession and non-possession periods these activities could be scheduled to take place during the daytime or evening period (prior to 10:00pm or not beyond midnight, where practicable).

Noise mitigation measures are described in Section 4.4 to further reduce noise levels, where reasonable and feasible, or to manage impacts where they occur. Where all reasonable and feasible mitigation measures have been applied and noise levels are still above the relevant noise objectives, additional noise management measures are provided to manage the impact on the community surrounding the station as detailed in Section 4.4.4.

The potential for sleep disturbance at night has also been considered. The predicted noise levels indicate that without noise mitigation, there is potential for noise levels from instantaneous noise events at the residential receivers closest to the work areas to be above the sleep disturbance screening level. Predicted instantaneous noise levels may also exceed the awakening reaction external noise level of 65 dB(A) L_{Amax}.

These identified noise events with the potential to disturb sleep are high instantaneous noise events such as metal-on-metal clangs/bangs (ie, excavator buckets), air-releases from equipment with compressed air or high instantaneous noise events caused by hand tools. Where these events can be managed or the items are not required for OOHW, predicted noise levels from instantaneous noise events are more likely to be within the sleep disturbance NML.

Across each of the construction works it will be important to implement management measures as detailed in Section 4.4.3 to minimise the number and level of maximum noise events associated with the

construction works. Management measures should be implemented where feasible and reasonable such as limiting acceleration/engine revving on site, use of broadband reversing alarms on heavy vehicles/equipment and managing works to prevent metal-on-metal bangs for works where this could occur. Construction mitigation and management measures are provided in Section 4.4 to assist in reducing OOHW construction noise impacts to receivers.

Table 4-9: Predicted construction noise levels ($L_{Aeq\ 15\ minute}$, dB(A)) – OOH construction activities

Receiver type	NML dB(A)	Site laydown areas	Site preparation/ demobilisation	Platform works					Underpass/Stairs Ramps/Lifts works				Precinct works	
				Services works (inc. OHW)		Civil demolition/ foundation works			Civil demolition/ foundation works				Footpaths, drainage, and services works	
		Site laydown area activities	Site preparation/ demobilisation	Low impact	High impact	Low impact (ie. piling works)	High impact (ie. demolition)	Platform furniture and station services	Low impact (ie. piling works)	High impact (ie. demolition)	Lifting works	Concreting works	Low impact	High impact
Day (OOHW)														
Residential-West	52	<40 - 65	<40 - 69	<40 - 68	<40 - 78	<40 - 71	<40 - 78	<40 - 67	<40 - 63	<40 - 69	<40 - 63	<40 - 61	<40 - 71	<40 - 80
Residential-East	52	<40 - 64	<40 - 69	<40 - 69	<40 - 79	<40 - 72	<40 - 79	<40 - 69	<40 - 73	<40 - 80	<40 - 73	<40 - 72	<40 - 76	<40 - 85
Evening (OOHW)														
Residential-West	52	<40 - 65	<40 - 69	<40 - 68	<40 - 78	<40 - 71	<40 - 78	<40 - 67	<40 - 63	<40 - 69	<40 - 63	<40 - 61	<40 - 71	<40 - 80
Residential-East	52	<40 - 64	<40 - 69	<40 - 69	<40 - 79	<40 - 72	<40 - 79	<40 - 69	<40 - 73	<40 - 80	<40 - 73	<40 - 72	<40 - 76	<40 - 85
Night (OOHW)														
Residential-West	44	<40 - 65	<40 - 69	<40 - 68	<40 - 78	<40 - 71	<40 - 78	<40 - 67	<40 - 63	<40 - 69	<40 - 63	<40 - 61	<40 - 71	<40 - 80
Residential-East	44	<40 - 64	<40 - 69	<40 - 69	<40 - 79	<40 - 72	<40 - 79	<40 - 69	<40 - 73	<40 - 80	<40 - 73	<40 - 72	<40 - 76	<40 - 85

Notes: 1. Construction noise level cells are shaded based on the predicted worst case NML exceedance of the controlling time period as follows:

2. No shading indicatives the NML is achieved, Green is ≤ 5 dB(A) above NML, Yellow is 6 to 15 dB(A) above NML, Orange is 16 to 25 dB(A) above NML., Purple is >25 dB(A) above NML

Table 4-10: Predicted construction noise levels at residential receivers (L_{Amax}, dB(A)) – sleep disturbance

Receiver type	NML dB(A)	Site laydown areas	Site preparation/ demobilisation	Platform works					Underpass/Stairs Ramps/Lifts works				Precinct works	
				Services works (inc. OHW)		Civil demolition/ foundation works			Civil demolition/ foundation works				Footpaths, drainage, and services works	
		Site laydown area activities	Site preparation/ demobilisation	Low impact	High impact	Low impact (ie. piling works)	High impact (ie. demolition)	Platform furniture and station services	Low impact (ie. piling works)	High impact (ie. demolition)	Lifting works	Concreting works	Low impact	High impact
Residential-West	54	<45 - 78	<45 - 80	<45 - 79	<45 - 82	<45 - 79	<45 - 83	<45 - 68	<45 - 69	<45 - 73	<45 - 69	<45 - 66	<45 - 78	<45 - 85
Residential-East	54	<45 - 77	<45 - 80	<45 - 80	<45 - 83	<45 - 80	<45 - 84	<45 - 69	<45 - 80	<45 - 84	<45 - 80	<45 - 77	<45 - 83	<45 - 90

Notes: 1. Construction noise level cells are shaded based on the predicted worst case NML exceedance of the controlling time period as follows:

2. No shading indicatives the screening level is achieved, Yellow is above the sleep disturbance screening level (RBL +15dB(A)), Purple is above the awakening reaction level of 65 dB(A).

4.3.2 Construction-related road traffic

The proposed construction packages does not include a large number of associated heavy vehicles movements. During the project the following construction-related road traffic activities are expected:

- During non-possession periods, the highest levels of traffic generated during construction works is expected to be 15 light vehicles and 3 heavy vehicles during the day
- During rail possession periods, vehicle movements would be no more than 20 light and 15 to 20 heavy vehicles

Construction vehicles are expected to travel along the Princess Highway, before using local roads to access the construction site. Considering the proximity of the Princes Highway, which currently experiences approximately 39,000 annual average daily traffic (AADT) (TfNSW traffic count station ID: 23019), it is unlikely that traffic noise levels would increase by more than 2 dB as a result of the project. As such, impacts from construction traffic associated with the works are considered to be insignificant. Construction heavy vehicles and delivery vehicles should be scheduled during standard construction hours where feasible and reasonable.

4.3.3 Construction vibration assessment

As a screening assessment, items potentially impacted by vibration were identified if they were located within the relevant minimum working distances from the various proposed vibration intensive activities. Non-heritage structures of heritage items or heritage curtilages were classified as heritage for this review in order to identify the potential for heritage items within the minimum works distances.

The numbers of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 4-11.

Table 4-11: Number of buildings within minimum working distances for vibration impact

Plant item	Number of buildings[1]		Number of receivers[1]
	Screening criteria for non-heritage structures	Screening criteria for heritage structures	Human response
Excavator with small hydraulic hammer	0	1	0
Piling rig (rotary bored)	0	1	0
Jackhammer	0	1	0

Note 1. Initial screening test based on Section 3.3.3

2. Banksia Railway Station Group on the NSW State Heritage Register (SHR), identified as a complex/group and so there may be multiple heritage items within this area. For the screening assessment this is identified, however, this should be reviewed during detailed design to determine what/if heritage items fall within vibration minimum working distances during the specific sets of construction works.

The heritage listed items that have been identified within the minimum working distances are presented in Table 4-12.

Table 4-12: Number of vibration sensitive items within minimum working distances for vibration

Station	Register(s) listed	Heritage significance	Distance from the Proposal
Banksia Railway Station Group	Section 170 Heritage Register	Local	Within the extent of construction works

Review of the work area and nearby sensitive buildings indicates there is low risk of vibration impact as a result of the works, with the exception of the station buildings/structure itself. The station buildings have been assessed in this report as 'structurally unsound' heritage buildings, and so should be reviewed in more detail during detailed design. Measures for managing vibration impacts are described in Section 4.4.2.

4.4 Construction mitigation and management measures

4.4.1 Highly noise affected receivers

Some of the nearest residential receivers near the Proposal construction areas may be 'highly noise affected' [i.e. exposed to noise levels that exceed 75 dB(A)] as a result of concrete saw and hydraulic hammers during general site establishment and civil work activities.

To limit the impact, high noise impact activities will be carried out with respite periods, such that:

- high noise impact activities will only carried out between:
  - High noise impact activities will be carried out in continuous blocks 8:00 am and 6:00 pm Monday to Friday; and
  - 8:00 am and 1:00 pm Saturday
- high noise impact activities will be carried out in continuous blocks of up to 3 hours. Respite from high noise impact activities will be provided between each block for at least 1 hour. No high noise impact activities will be carried out during this 1 hour respite period.

In addition to the above, high noise generating plant and equipment will not be used during the night period (OOHW Period 2).

4.4.2 Vibration sensitive structures

Condition surveys of all the vibration affected buildings/structures identified in Table 4-11 would be completed prior to the commencement of construction work. The building condition reports will also confirm of appropriate vibration criteria (i.e. reinforced or unreinforced structures, structurally sound or unsound heritage buildings).

Site specific minimum working distances for vibration significant plant items will be measured on site where plant and equipment is likely to operate close to or within the recommended minimum working distances for cosmetic damage (Table 4-6). Where plant is required to operate within site specific minimum working distances, vibration monitoring is recommended to verify that vibration levels achieve compliance with the structural damage objectives.

Where monitoring above identifies that vibration is likely to exceed the structural damage objectives, a different construction method with lower source vibration levels should be considered.

4.4.3 Other noise and vibration control measures

Table 4-13 summarises actions that can be applied to manage the potential for noise and vibration to impact on sensitive receivers near the Proposal construction works, to be applied where reasonable and feasible.

Table 4-13: Other noise and vibration mitigation and management measures

Action required	Applies to	Details
At-source mitigation measures		
Equipment selection	Airborne noise Vibration	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable
Maximum noise levels	Airborne noise	The noise levels of plant and equipment (including rental plant) must have operating Sound Power or Sound Pressure Levels compliant with the allowable noise levels in Appendix C of the TfNSW Construction Noise and Vibration Strategy – April 2018.
Use and siting of plant	Airborne noise	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.
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.
Minimise disturbance arising from delivery of goods	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Path mitigation measures		
Construction hoarding as noise barrier	Airborne noise	Any construction hoarding shall be installed on each worksite shall be constructed as a noise barrier, where practicable to screen the work areas from commuters using the station platforms during construction works, and to provide shielding to the nearest affected receivers. Construction hoarding acting as noise barriers can achieve 5 to 10 dB(A) noise reduction where they break line of sight between the noise source and the receiver.
Shield stationary noise sources such as pumps, compressors 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.

Action required	Applies to	Details
Temporary noise barriers		Where works are to be completed as OOHW outside the construction hoarding area, relocatable noise barriers e.g. acoustic blankets hung from temporary construction fencing would be used, where practicable. Relocatable noise barriers can achieve 5 to 10 dB(A) noise reduction where they break line of sight between the noise source and the receiver.
Mobile noise screens	Airborne noise	Where practicable, a mobile noise screen/tent would be used to reduce noise from moving plant items e.g. concrete saw, road saw. Mobile noise screens utilise aluminium mobile scaffold (or similar), with acoustic blanket/ quilt (e.g. Echo-barrier, FlexShield or similar) attached on up to 4 sides (including the top, where no solid platform). Mobile noise screens can provide 5 to 10 dB noise reduction, where they can break line of sight.
Management measures		
Implement stakeholder consultation measures	Airborne noise	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 to notify the community of upcoming works: • Project Specific Website • Project Infoline • Email Distribution List • Web-based Surveys • Social Media • Community and Stakeholder Meetings.
Register of noise and vibration sensitive receivers	Airborne 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: • 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.
Construction hours and scheduling	Airborne noise	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating noise with special audible characteristics should be scheduled during less sensitive time periods.
Site inductions	Airborne noise Vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All relevant project specific and standard noise and vibration mitigation measures • Permissible hours of work • Any limitations on noise generating activities with special audible characteristics • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.

Action required	Applies to	Details
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air.
Monitoring	Airborne noise	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 conditions.
Attended vibration measurements	Vibration	Attended vibration measurements shall be undertaken at all buildings where vibration intensive plant operates within the minimum working distance specified in Table 4-6. Monitoring must be carried out prior to when these activities commence working within the minimum working distance to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.

4.4.4 Additional mitigation measures

In accordance with the ICNG and the CNVS, all feasible and reasonable mitigation measures outlined in Section 3.4.4 to minimise noise and vibration levels at the nearest receivers will be implemented, where practicable. The implementation of these measures should significantly reduce the noise and vibration impacts on nearby sensitive receivers.

Nevertheless, due to the highly variable nature of construction activities and the likelihood of work needing to be undertaken outside the standard construction hours, exceedances of construction noise objectives are likely to occur. Where construction noise and vibration levels are still predicted to exceed the noise objectives after the application of the standard mitigation measures the Additional Mitigation Measures Matrices (AMMM) shall be used to determine the additional measures and implementation where reasonable and feasible, and in consultation with TfNSW communications representatives.

Table 4-14: Additional airborne noise management measures matrix

Construction hours	Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures
	Receiver perception	dB(A) above RBL	dB(A) above NML	
Standard Hours	Noticeable	5 to 10	0	-
	Clearly Audible	10 to 20	≤ 10	-
	Moderately intrusive	20 to 30	> 10 to 20	LB, V
	Highly intrusive	> 30	> 20	LB, V
	75dBA or greater	N/A	N/A	LB, SN, V
OOHW Period 1	Noticeable	5 to 10	≤ 5	-
	Clearly Audible	10 to 20	> 5 to 15	PN
	Moderately intrusive	20 to 30	> 15 to 25	PN, V, SN, RO
	Highly intrusive	> 30	> 25	PN, V, SN, RO, RP#, DR#

Construction hours	Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures
	Receiver perception	dB(A) above RBL	dB(A) above NML	
OOHW Period 2	Noticeable	0 to 10	≤ 5	PN
	Clearly Audible	10 to 20	> 5 to 15	PN, V
	Moderately intrusive	20 to 30	> 15 to 25	PN, V, SN, RP, DR
	Highly intrusive	> 30	> 25	LB, V, SN, AA, RP, DR

Notes: PN = Project notification; RO = Project specific respite offer; RP = Project specific respite offer
V = Verification monitoring; AA = Alternative accommodation; DR = Duration reduction
SN = Specific notifications, individual briefing or phone call
[#] Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6am-7am & 1pm-6pm, Sundays / Public Holidays 8am-6pm)

Table 4-15: Additional vibration noise management measures matrix

Construction hours	Predicted airborne $L_{Aeq(15min)}$ noise level at receiver		Additional mitigation measures
	Receiver perception	above VML	
Standard Hours	Human disturbance	> HVML	PN, V, RO
	Building damage	> DVML	V, AC
OOHW Period 1	Human disturbance	> HVML	PN, V, SN, RO, RP, DR
	Building damage	> DVML	V, AC
OOHW Period 2	Human disturbance	> HVML	PN, V, SN, RO, RP, DR, AA
	Building damage	> DVML	V, AC

Notes: PN = Project notification; RO = Project specific respite offer; RP = Project specific respite offer
V = Verification monitoring; AA = Alternative accommodation; DR = Duration reduction
SN = Specific notifications, individual briefing or phone call
AC = Alternative construction methodology

Reasonable measures to ameliorate noise and/or vibration impact will need to be considered based on the level of impact and duration of the works, including:

- short term residual impacts from specific construction activities that generate noise or vibration above the management levels, where these works are not in the highly sensitive night period and occur over a shorter timeframe (e.g. 1 to 2 weeks). Consideration should be given to offering respite in the form of movie tickets, coffee/meal vouchers or similar
- short term residual impacts where a specific phase of the construction work generates noise or vibration that exceeds the management levels within the highly sensitive night period. Consideration should be given to offering alternative accommodation for the duration of the noise or vibration impact.

5 Industrial noise assessment

5.1 Operational noise sources

The Proposal forms part of two government initiatives, the TAP and the More Trains, More Service Program. The Proposal includes new canopies along much of Platforms 2 and 3 and Platform 4 and new public announcement (PA) system speakers that will be spread along these canopies as well as comparable locations on Platform 1. This will result in some PA speakers being closer to sensitive receivers, which are currently located adjacent to the existing station buildings.

The PA systems provide announcements on network status information, impending train arrivals and emergency messages. The duration and infrequency of announcements from the PA system means that they are unlikely to significantly contribute to the overall average L_{Aeq} noise levels, provided they are designed appropriately.

PA systems are typically controlled by software which allows for automatic adjustment of announcement volume to account for ambient noise level via appropriately located sensors. These systems will automatically reduce the announcement volumes when ambient noise levels are low, while still maintaining a sufficient level of audibility for commuters. Conversely when noise levels are higher, the PA volume adjusts accordingly. These self-adjusting systems are particularly important for periods with the most potential for annoyance, such as during the night time.

Due to the close proximity of residential receivers to the station, it will also be important that the PA system is designed to minimise noise spill from the station platform, even where self-adjustment is incorporated.

Noise impacts at nearby receivers due to PA announcements has been assessed assuming the noise level during an announcement would be 10 dB above the ambient noise at receivers standing along the station platform. This is typical of a self-adjusting system to ensure sufficient speech intelligibility on the platform. Ambient noise levels for the station locations have been based on noise logger results for monitoring locations with similar exposure to noise sources, such as traffic. The assumed PA announcement noise level on the station platform are summarised in the table below.

Table 5-1 Assumed PA announcement $L_{Aeq\ (announcement)}$ noise level on the platform, dB(A)

Location	Day	Evening	Night
Standing person on station platform	63 + 10 = 73	64 + 10 = 74	60 + 10 = 70

Notes: Day: 7:00am to 6:00pm Monday to Saturday and 8:00 to 18:00 Sundays & Public Holidays
Evening: 6:00pm to 10:00pm Monday to Sunday & Public Holidays
Night: 10:00pm to 7:00am Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays

5.2 Operational noise results

Predicted noise levels from the PA system operations are presented in Table 5-2 below.

Table 5-2: Predicted PA noise levels – Operational noise emissions

Receiver type	Project noise trigger levels, $L_{Aeq, 15min}$ dB(A)			Predicted PA $L_{Aeq, 15min}$ noise levels, dB(A)		
	Day	Evening	Night	Day	Evening	Night
Residential	52	48	43	**55**	**56**	**52**

Notes
1. Exceedances of project trigger levels are indicated by bolded text
2. Predicted noise levels include a 5 dB(A) penalty for annoying characteristics of PA system noise
3. Assumed that there may be up to 2 announcement in a 15 minute period, each of approximately 30 seconds in length.
4. No speaker directivity has been taken into account in the predicted noise levels
5. Assumes all speakers along one platform would operate concurrently, but not concurrently with other platforms.

The predicted noise levels in Table 5-2 show that noise due to operation of PA systems based on current assumptions have the potential for noise levels to exceed the project trigger levels during the day, evening and night periods.

Predicted noise levels from the PA system operations compared against maximum noise event assessment levels are presented in Table 5-3 below.

Table 5-3: Predicted PA noise maximum noise level events assessment

Station	Receiver type	Maximum noise level event assessment screening levels, dB(A)		Predicted PA noise levels	
		$L_{Aeq, 15min}$	L_{Amax}	$L_{Aeq, 15min}$	L_{Amax}
Banksia	Residential	44	54	**52**	**59**

Notes:
1. Exceedances of project trigger levels are indicated by bolded text
2. No speaker directivity has been taken into account in the predicted noise levels

The results presented in Table 5-3 show that at Banksia Station predicted noise levels are above the $L_{Aeq\ 15min}$ and the L_{Amax} maximum noise level event assessment levels.

Noise from the new PA system can be mitigated through appropriate design to ensure sound coverage of the platform with minimal noise spill. Appropriate performance criteria for the PA system along the railway platform would be specified as part of detailed design to ensure compliance with the noise emission requirements at nearby noise sensitive receivers presented in this study.

6 Conclusion

This noise and vibration impact assessment has been prepared as part of the Review of Environmental Factors (REF) to describe and assess the noise and vibration impacts associated with the Banksia Station Upgrade (the Proposal). The Proposal works are part of as part of both the Transport Access Program and More Trains More Services Program.

The noise and vibration assessment has investigated potential impacts from:

- Construction noise and vibration impacts from the Banksia Station upgrade works
- Operational noise impact from reconfiguration of the public announcement (PA) system at Banksia Station.

6.1 Construction noise and vibration assessment

An assessment of construction noise impact from the Proposal construction works has been undertaken. Noise emissions from the proposed construction works have been predicted and assessed against the relevant noise management levels set by the ICNG during the recommended standard hours for construction. Potential impacts from out of hours construction works during rail possession periods has also been assessed.

The construction works associated with Proposal are likely to take place over about five rail possession periods and six non-possession periods. Of these periods, there is potential for the requirement for night works during each of the five rail possession periods. Construction noise levels were predicted by modelling the noise sources, receiver locations, and operating activities across 13 construction scenarios.

During standard construction hours, the assessment found that residential receivers located near to the construction works areas are likely to be noise affected by the works, with potentially moderate to high levels of construction noise during typical works and potentially high levels of construction noise during worst-case works, with some residential receivers near to the station predicted to be highly noise affected (i.e. above 75 dB(A)) when high noise impact plant and equipment are used (e.g. hydraulic hammer and road saws).

As the works are to be carried out within an active rail corridor, some of the activities will need to be completed outside standard construction hours during rail possession periods or during the midnight to dawn shutdown period. During these periods, predictions indicate that construction noise will be clearly audible to moderately intrusive at the receivers closest to the station and may at times be highly intrusive. If not mitigated and managed, there is potential for high noise events to exceed sleep disturbance noise management levels at nearby residential receivers during the night period.

Potential vibration impact to residential, commercial/ industrial and heritage receivers has been reviewed against the relevant guidelines for structural damage from vibration and for human

disturbance. The risk of structural damage to property is assessed as very low to negligible for most receivers, with the exception of heritage structures on the station platforms/buildings themselves. Further assessment of vibration impact will be required at the detailed design phase to ensure vibration impact is managed and mitigated where feasible.

Construction traffic noise has been assessed in accordance with the RNP, and the noise increase from construction-related traffic is expected to be negligible.

Due to the predicted impacts determined in this assessment, recommendations to manage and/or minimise noise and vibration impacts where they occur have been provided in Section 4.4 and are to be reviewed and incorporated during detailed design where feasible and reasonable.

6.2 Industrial noise assessment

Potential noise impact from reconfiguration of the existing public announcement (PA) system at Banksia Station have been assessed against the NPfI. The assessment found that predicted noise levels will potentially exceed the relevant criteria at Banksia Station during the day, evening and night period.

Noise from the PA system can be mitigated through appropriate system design to ensure sound coverage of the platform with minimal noise spill. Appropriate performance criteria for the PA system to achieve along the railway platform would be specified as part of detailed design to ensure compliance with the noise emission requirements at nearby noise sensitive receivers presented in this study.

References

1. Environment Protection Authority (2013), *Rail Infrastructure Noise Guideline* (RING)
2. Environment Protection Authority (2016), *Noise Policy for Industry* (NPfI)
3. Transport for NSW (2018), *Construction Noise and Vibration Strategy* (CNVS)
4. Department of Environment and Climate Change (2009), *Interim Construction Noise Guideline* (ICNG)
5. Department of Environment Conservation (2006), *Assessing Vibration; a technical guideline* (AVTG)
6. British Standard (2008), *BS 6472-2008: Evaluation of human exposure to vibration in buildings (1-80Hz)*
7. British Standard (1993), *BS 7385: Part 2-1993 Evaluation and Measurement for Vibration in Buildings*
8. German Standard (2016), *DIN 4150-3: 2016-02, Structural vibration - Effects of vibration on structures*
9. ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40
10. BS5228.2 2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration
11. Australian Standard AS/NZS 2107:2000 *Acoustics - Recommended design sound levels and reverberation times for building interiors*

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our daytime environment:

threshold of hearing	0 dB	The faintest sound we can hear
	10 dB	Human breathing
almost silent	20 dB	
	30 dB	Quiet bedroom or in a quiet national park location
generally quiet	40 dB	Library
	50 dB	Typical office space or ambience in the city at night
moderately loud	60 dB	CBD mall at lunch time
	70 dB	The sound of a car passing on the street
loud	80 dB	Loud music played at home
	90 dB	The sound of a truck passing on the street
very loud	100 dB	Indoor rock band concert
	110 dB	Operating a chainsaw or jackhammer
extremely loud	120 dB	Jet plane take-off at 100m away
threshold of pain	130 dB	
	140 dB	Military jet take-off at 25m away

dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.

Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Locality Map and Land Use Survey

Legend

- Residential
- Chilcare centre
- Education
- Medical
- Mixed use
- Place of worship
- Other sensitive receiver
- Outdoor active recreation
- Outdoor active recreation (open space)
- Outdoor passive recreation
- Outdoor passive recreation (open space)
- Commercial
- Industrial
- Non-sensitive
- Station platforms
- Railway

50 0 50 100 150 200 m

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve

1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Land use identification and noise sensitive receivers

Figure No: TK877-03-01-01
Date: 24.06.2020
Created by: ALe
Rev: R2
Sheet: A3
Scale: 1:4000

APPENDIX C Existing acoustic environment

RENZO TONIN & ASSOCIATES
inspired to achieve

Acoustics
Vibration
Structural Dynamics

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32 Railway St Banksia

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017

	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Wednesday-08-May-2019	-	44	37	-	65	61
Thursday-09-May-2019	46	50	41	63	64	61
Friday-10-May-2019	48	-	39	63	-	60
Saturday-11-May-2019	-	-	42	-	-	59
Sunday-12-May-2019	46	50	39	62	62	59
Monday-13-May-2019	47	47	37	63	63	58
Tuesday-14-May-2019	46	48	39	63	63	60
Wednesday-15-May-2019	47	50	38	63	63	60
Thursday-16-May-2019	-	-	-	-	-	-
Representative Weekday[5]	**47**	**48**	**39**	**63**	**64**	**60**
Representative Weekend[5]	**46**	**50**	**40**	**62**	**62**	**59**
Representative Week[5]	**47**	**49**	**39**	**63**	**64**	**60**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times 2. Evening is 6:00pm to 10:00pm 3. Night is the remaining periods

4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for LA90 and logarithmic average for LAeq 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.

32 Railway St Banksia

Road / Rail Noise Monitoring Results (at one metre from façade)

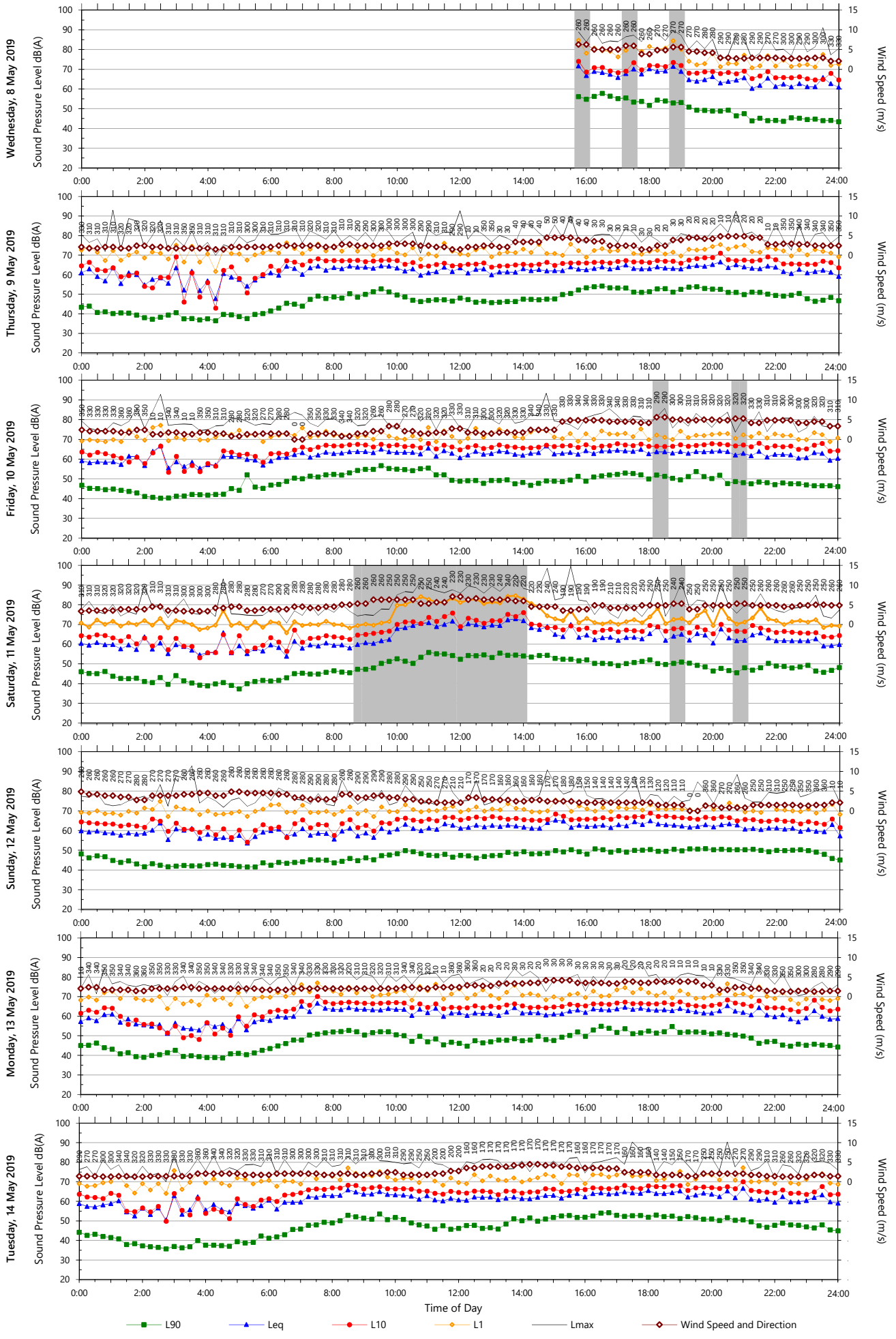
	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	**Day[1]**	**Night[2]**	**Day - Up[4]**	**Day - Low[5]**	**Night - Up[4]**	**Night - Low[5]**
Wednesday-08-May-2019	69	63	72	66	65	60
Thursday-09-May-2019	66	63	67	64	65	61
Friday-10-May-2019	66	62	66	65	64	60
Saturday-11-May-2019	67	62	69	62	64	60
Sunday-12-May-2019	64	61	66	62	63	57
Monday-13-May-2019	65	61	66	64	62	60
Tuesday-14-May-2019	66	62	67	64	64	59
Wednesday-15-May-2019	66	62	67	64	64	59
Thursday-16-May-2019	66	-	67	64	-	-
Representative Weekday[3]	**66**	**62**	**67**	**64**	**64**	**60**
Representative Weekend[3]	**66**	**62**	**67**	**62**	**63**	**59**
Representative Week[3]	**66**	**62**	**67**	**64**	**64**	**60**

Notes:

1. Day is 7:00am to 10:00pm 2. Night is 10:00pm to 7:00am 3. Median of daily L_{Aeq}

4. Upper 10th percentile $L_{Aeq\ 1hr}$ 5. Lower 10th percentile $L_{Aeq\ 1hr}$

6. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field



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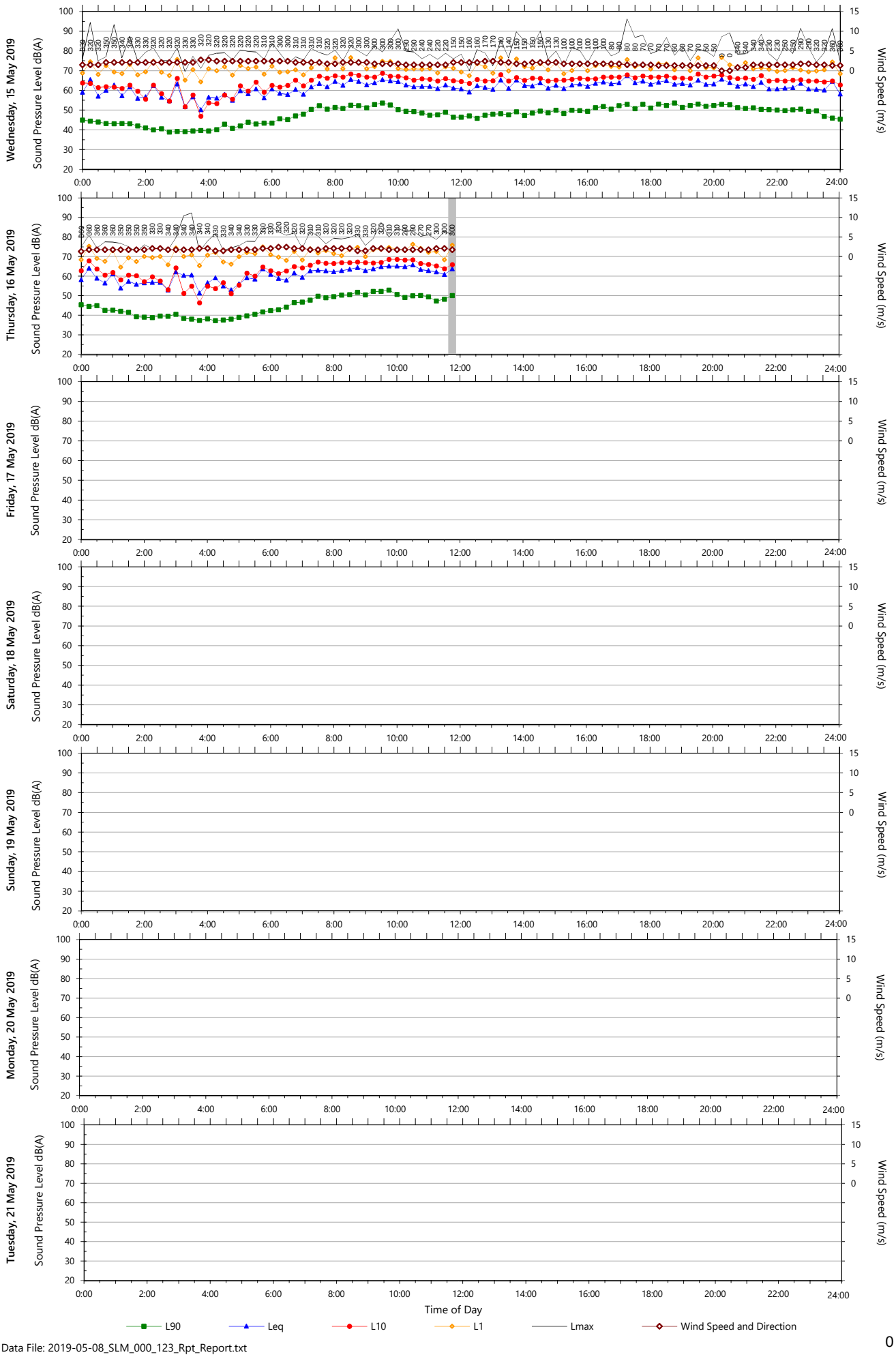


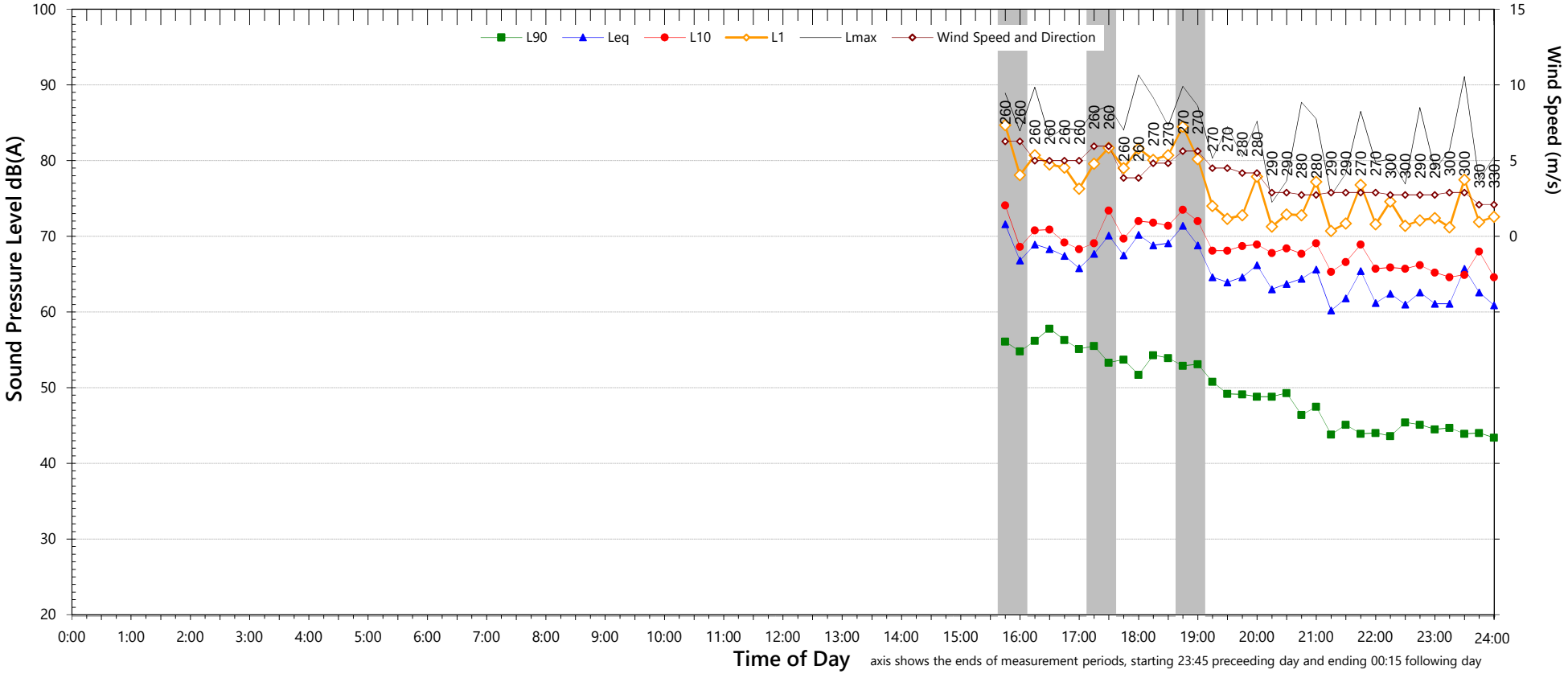
Data File: 2019-05-08_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r28)

Unattended Noise Monitoring Results

32 Railway St Banksia

Wednesday, 8 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	44	37
LAeq	-	65	61

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	80	to	93
L_{Max} - L_{eq} (Range)	22	to	32

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	69	63
$L_{eq\ 1hr}$ upper 10 percentile	72	65
$L_{eq\ 1hr}$ lower 10 percentile	66	60

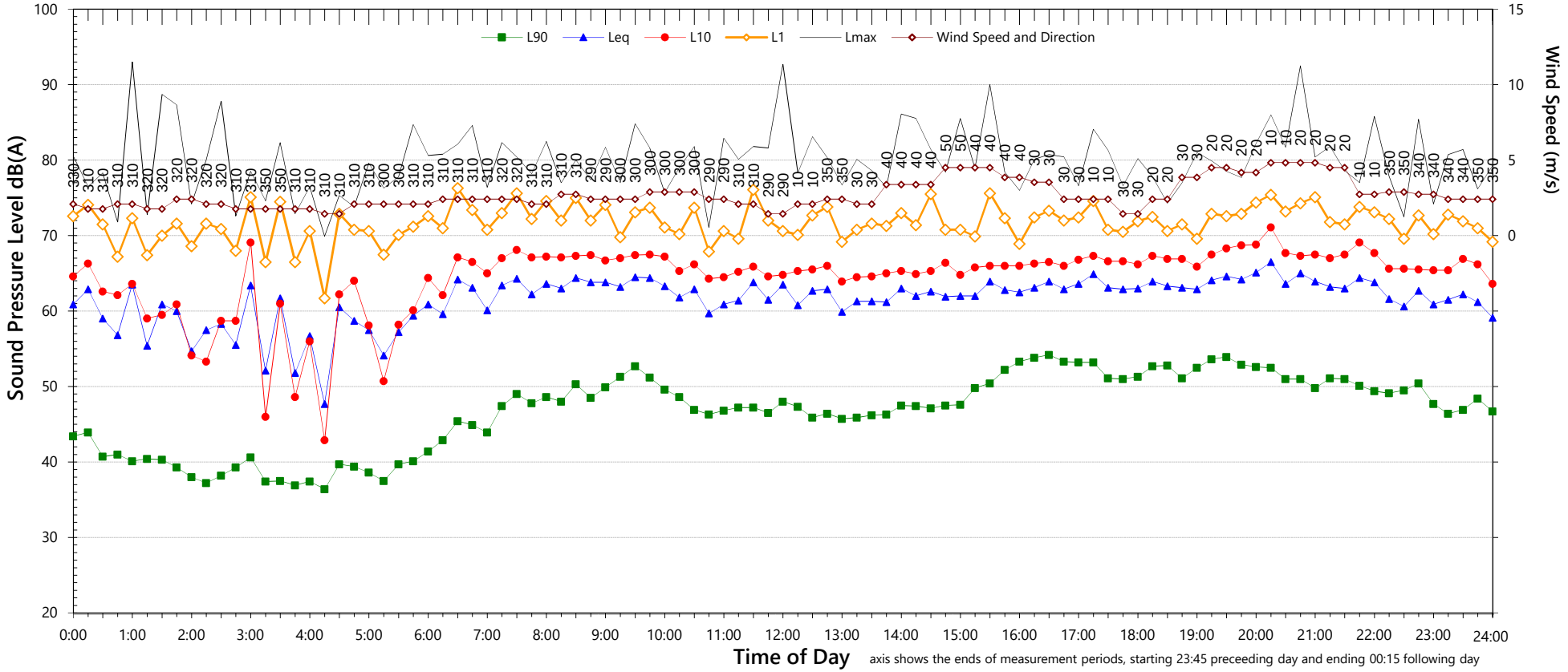
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Thursday, 9 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	46	50	41
LAeq	63	64	61

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	66	63
$L_{eq\ 1hr}$ upper 10 percentile	67	65
$L_{eq\ 1hr}$ lower 10 percentile	64	61

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	78	to	93
L_{Max} - L_{eq} (Range)	20	to	30

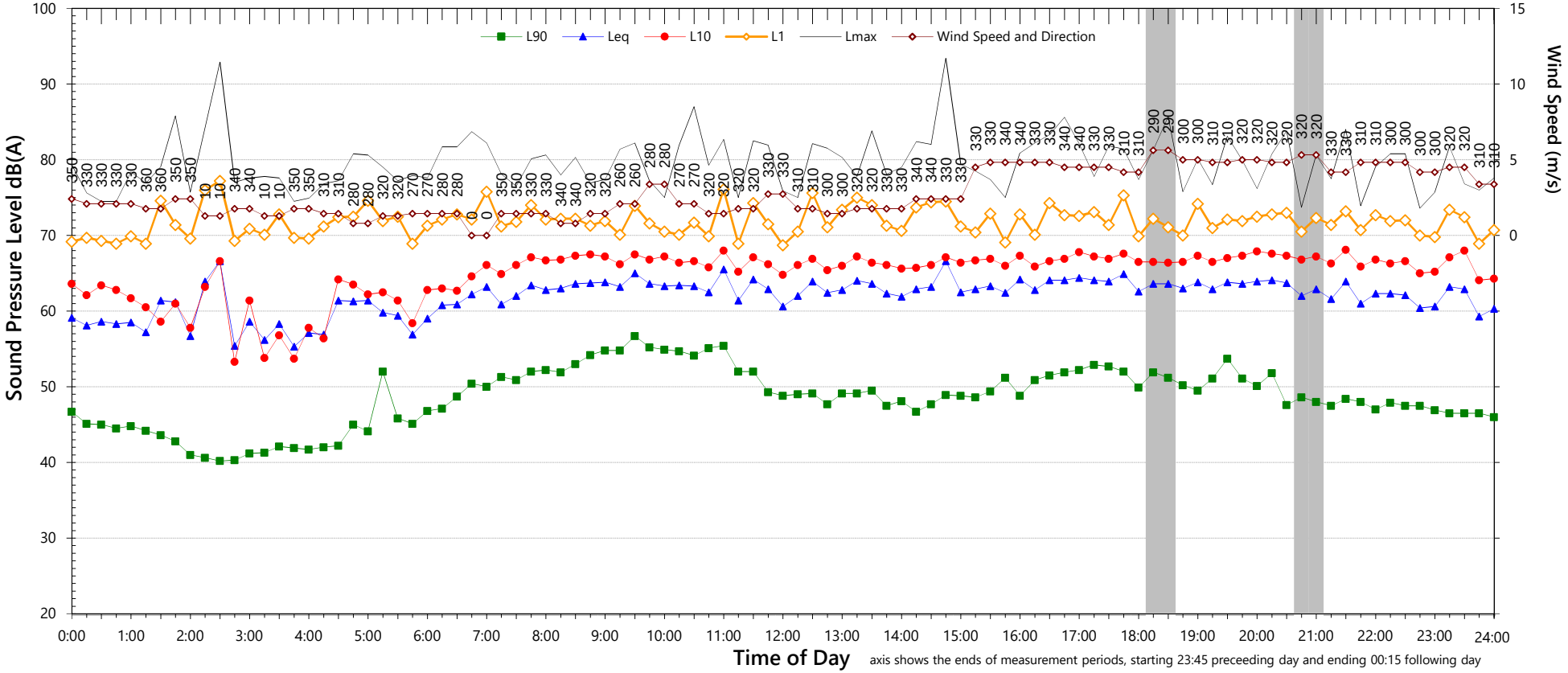
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Friday, 10 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	48	-	39
LAeq	63	-	60

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	66	62
$L_{eq\ 1hr}$ upper 10 percentile	66	64
$L_{eq\ 1hr}$ lower 10 percentile	65	60

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	77	to	93
L_{Max} - L_{eq} (Range)	18	to	32

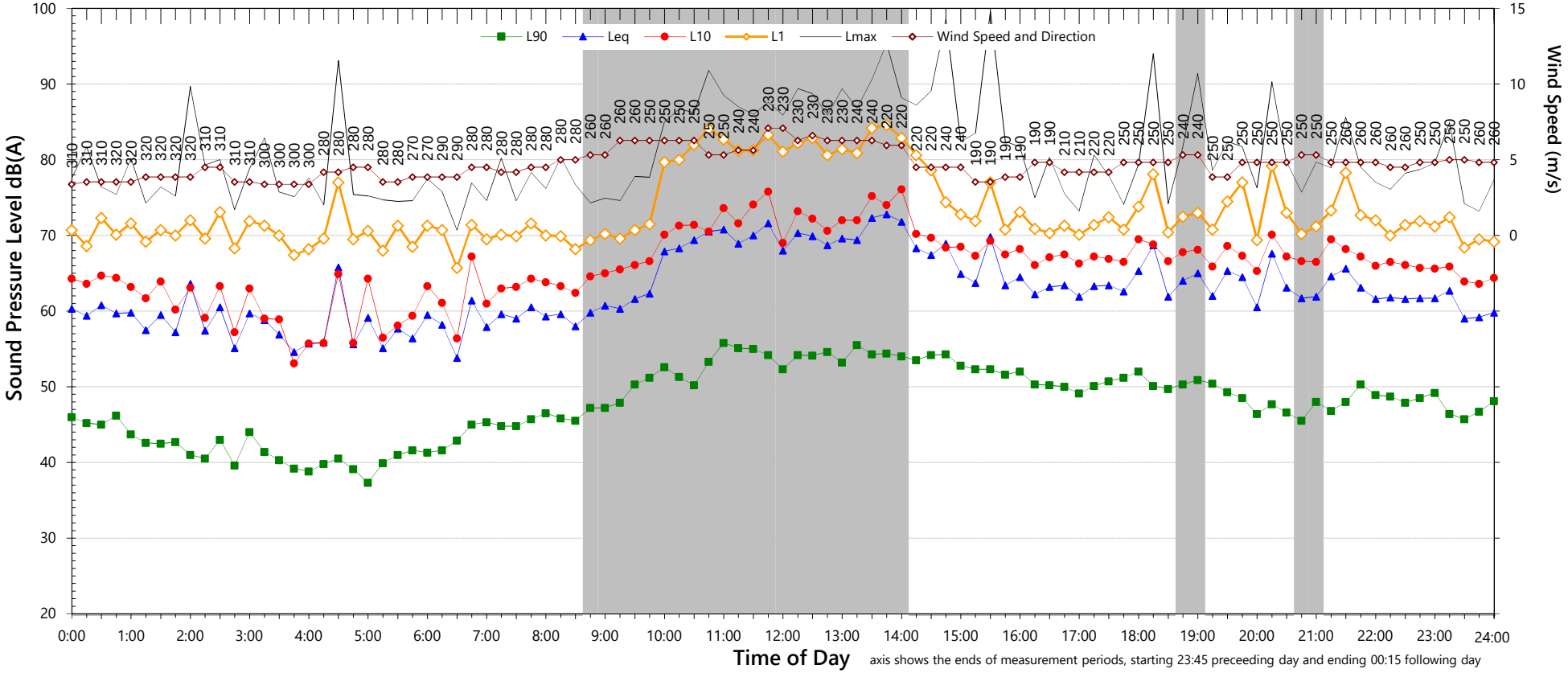
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Saturday, 11 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	-	42
LAeq	-	-	59

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	67	62
$L_{eq\ 1hr}$ upper 10 percentile	69	64
$L_{eq\ 1hr}$ lower 10 percentile	62	60

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	77	to	93
L_{Max} - L_{eq} (Range)	18	to	34

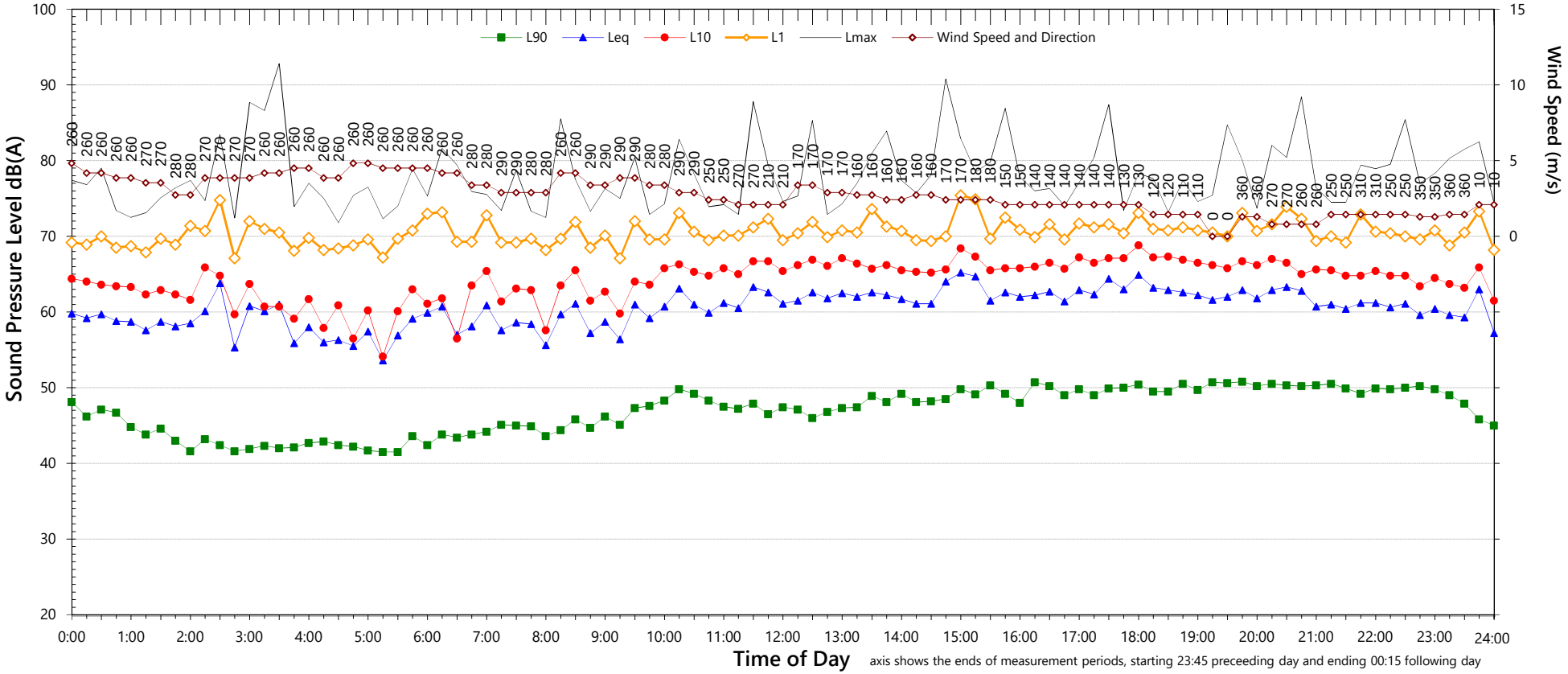
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Sunday, 12 May 2019



axis shows the ends of measurement periods, starting 23:45 preceeding day and ending 00:15 following day

NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	46	50	39
LAeq	62	62	59

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	78	to	85
L_{Max} - L_{eq} (Range)	21	to	26

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64	61
$L_{eq\ 1hr}$ upper 10 percentile	66	63
$L_{eq\ 1hr}$ lower 10 percentile	62	57

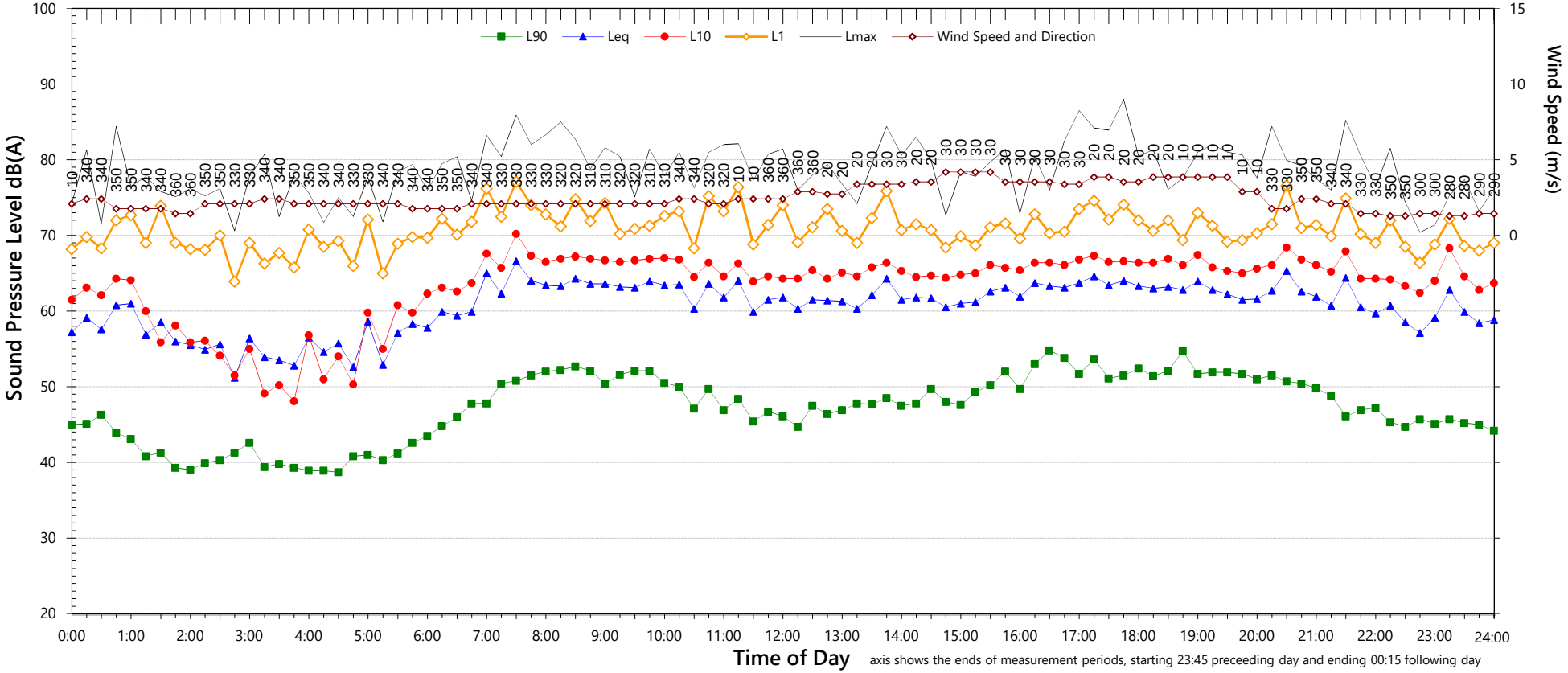
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Monday, 13 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	47	47	37
LAeq	63	63	58

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65	61
$L_{eq\ 1hr}$ upper 10 percentile	66	62
$L_{eq\ 1hr}$ lower 10 percentile	64	60

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	77	to	85
L_{Max} - L_{eq} (Range)	17	to	26

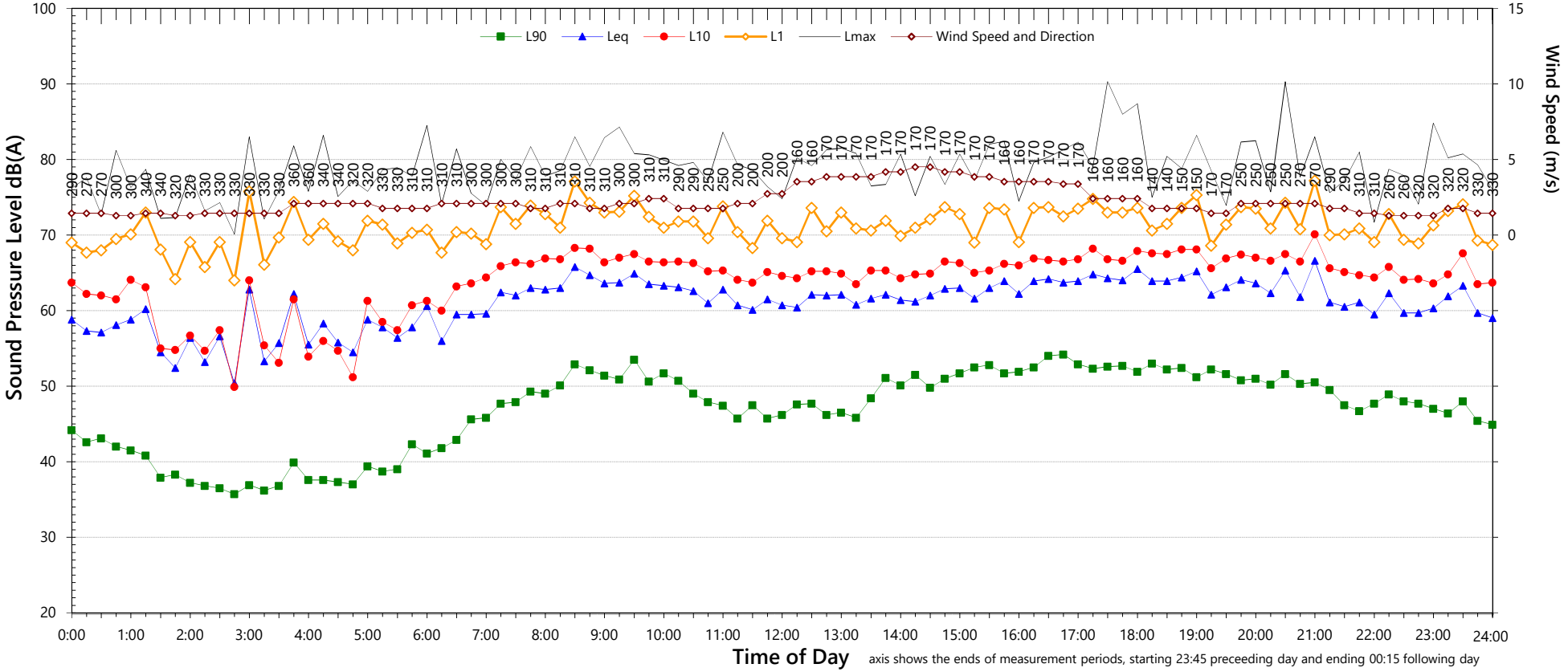
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Tuesday, 14 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	46	48	39
LAeq	63	63	60

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	66	62
$L_{eq\ 1hr}$ upper 10 percentile	67	64
$L_{eq\ 1hr}$ lower 10 percentile	64	59

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	78	to	94
L_{Max} - L_{eq} (Range)	19	to	32

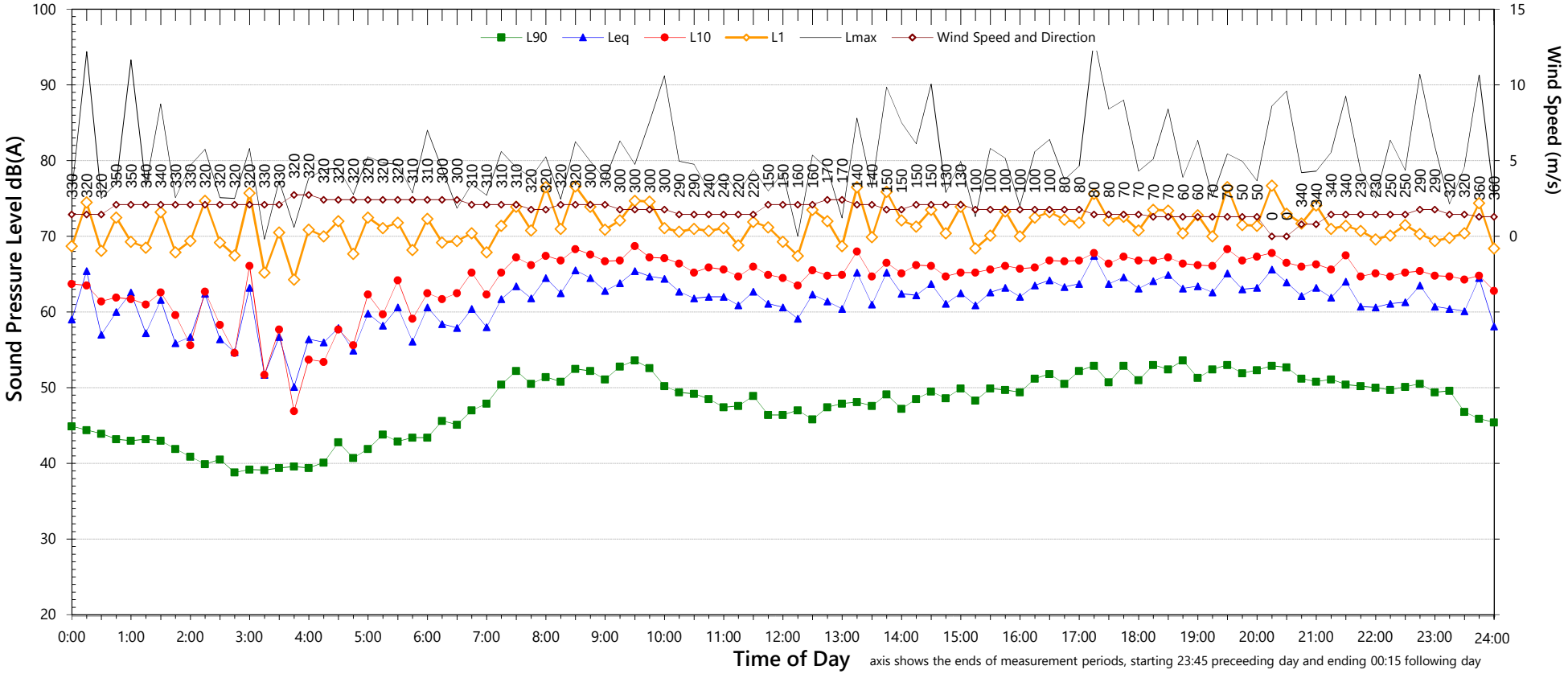
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Wednesday, 15 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	47	50	38
LAeq	63	63	60

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	66	62
$L_{eq\ 1hr}$ upper 10 percentile	67	64
$L_{eq\ 1hr}$ lower 10 percentile	64	59

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	77	to	92
L_{Max} - L_{eq} (Range)	20	to	34

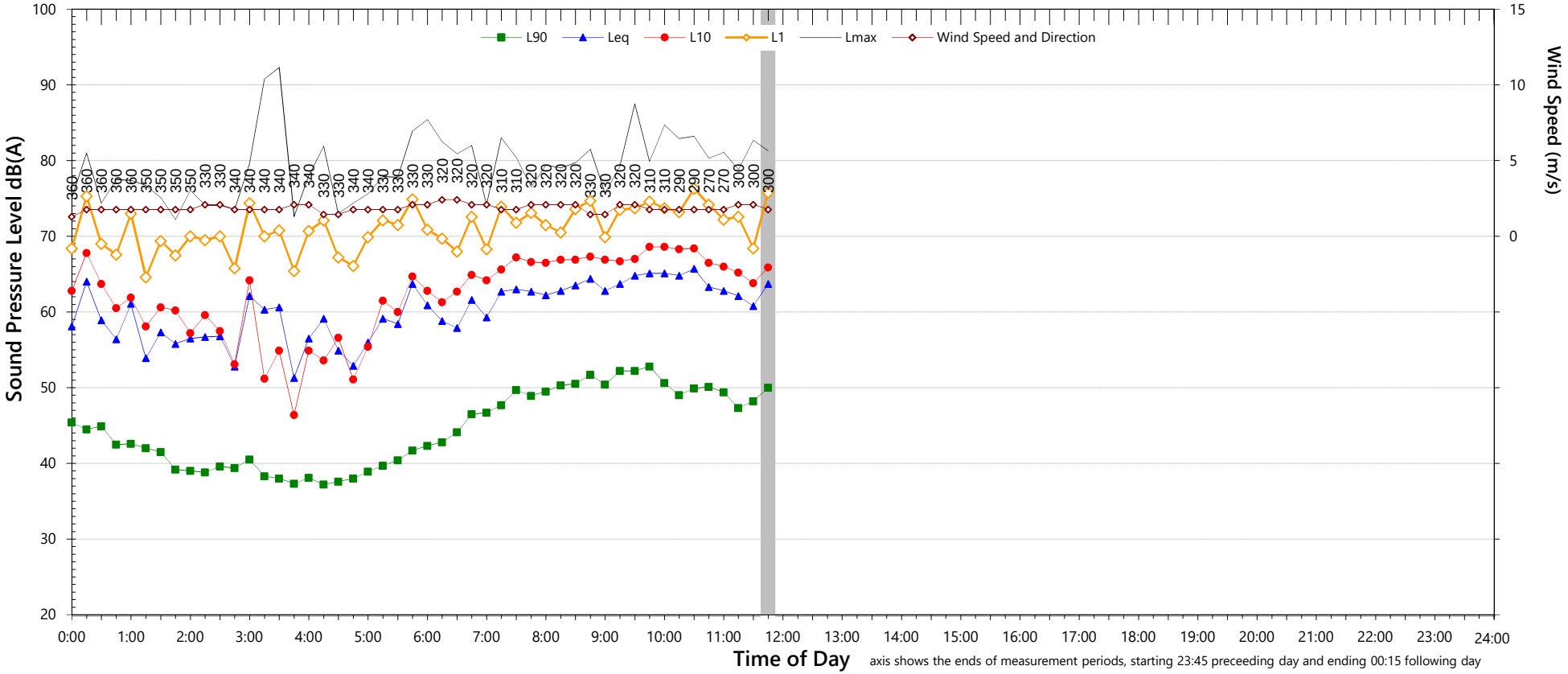
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

32 Railway St Banksia

Thursday, 16 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	-	-
LAeq	-	-	-

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	66	-
$L_{eq\ 1hr}$ upper 10 percentile	67	-
$L_{eq\ 1hr}$ lower 10 percentile	64	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

APPENDIX D Predicted construction noise impacts

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Site laydown area activities

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-1 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Site preparation and mobilisation

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-2 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Services works (inc. OHW) - Typical

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-3 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Services works (inc. OHW) - Worst case

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve

1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-4 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Civil works (Typical)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-5 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Civil works (Worst case)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-6 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform furniture and station services

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-7 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Underpass/Stairs/Ramps - Civil works (Typical)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-8 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Underpass/Stairs/Ramps - Civil works (Worst case)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-9 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Lifting works

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve

1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-10 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Concreting works

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-11 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Precinct works - Footpaths, drainage and services (Typical)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-12 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 10 dB above NML (Clearly audible)
- 11-20 dB above NML (Moderately intrusive)
- > 20 dB above NML (Highly intrusive)
- Above 75 dB(A) and residential

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Precinct works - Footpaths, drainage and services (Worst case)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Standard hours

Figure No: TK877-03-02-13 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Site laydown area activities

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-1 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Site preparation and mobilisation

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-2 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Services works (inc. OHW) - Typical

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-3 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Services works (inc. OHW) - Worst case

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-4 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Civil works (Typical)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-5 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform works - Civil works (Worst case)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-6 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Platform furniture and station services

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-7 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Underpass/Stairs/Ramps - Civil works (Typical)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-8 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Underpass/Stairs/Ramps - Civil works (Worst case)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-9 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Lifting works

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve

1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-10 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Concreting works

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-11 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Precinct works - Footpaths, drainage and services (Typical)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-12 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56

Predicted level of exceedance (LAeq 15 min), dB(A)

- Below NML
- < 5 dB above NML (Noticeable)
- 6 - 15 dB above NML (Clearly audible)
- 16 - 25 dB above NML (Moderately intrusive)
- > 25 dB above NML (Highly intrusive)

50 0 50 100 150 200 m

Receiver category

- Commercial/Industrial
- Other sensitive receiver
- Residential

Legend

- Station platforms
- Railway
- Construction works area

Construction scenario: Precinct works - Footpaths, drainage and services (Worst case)

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
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P: 02 8218 0500 F: 02 8218 0501

Client: Jacobs Group (Australia) Pty Ltd

Project: Transport Access Program 3 Banksia Station

Description: Construction noise results - BANKSIA Outside standard construction hours (Night)

Figure No: TK877-03-03-13 Rev: R4
Date: 24/06/2020 Sheet: A3
Created by: ALe Scale: 1:4000
Co-ordinate system: GDA 1994 MGA Zone 56