

# CORRIMAL COKE WORKS STAGE 2-4 CIVIL WORKS

## Construction Noise and Vibration Management Plan

10 November 2025

Legpro 70 Pty Ltd ATF Legpro 70 Unit Trust c/- Legacy Property c/- Chester Project  
Management Pty Ltd

TK577-14F02 Stage 2-4 Civil Works (r2)

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## Document control

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## Executive summary

This Construction Noise and Vibration Impact Assessment has been prepared by Renzo Tonin & Associates to accompany a State Significant Development Application (SSDA) which seeks development consent for facilitating civil works and subdivision to support a concurrent Stage 2a Built Form SSDA (SSD-83789711) and the future redevelopment of Stages 2-4 of the Corrimal Coke Works Precinct. The civil works proposed by this SSDA include the construction of the Central Park, the Southern Park, and roads, drainage and stormwater infrastructure, and paper subdivision.

This Construction Noise and Vibration Impact Assessment has been prepared to address the requirements of Item 10 of the SEARS which is reproduced below.

### **10. Noise and Vibration**

- *Provide a noise and vibration impact assessment prepared in accordance with the relevant NSW Environmental Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.*

The assessment of construction noise impacts to the surrounding residential receivers has considered the shielding effects of site boundary hoardings / temporary barriers shown in APPENDIX G. Any remaining exceedances of the noise objectives after the implementation of site boundary hoardings will be addressed through the noise mitigation and management measures presented in Section 5.3 to provide additional noise reduction benefits.

The assessment of vibration levels from the civil works found the highest risk of vibration impacts relate to potential structural damage of the heritage items within the Corrimal Coke Works site that are to be retained / conserved. Vibration management measures have been presented in Section 6.3.1 to aid in minimising the likelihood of structural damage from vibration impacts. In general, the vibration management measures involve the conduct of on-site measurements at the commencement of civil works to confirm minimum working distances. Where vibration intensive work must occur within the site-specific minimum working distances, then a permanent vibration monitoring system is to be installed on the heritage structures to warn plant operators when vibration levels are approaching / exceed the vibration limits for structural / cosmetic damage.

Procedures for managing noise / vibration complaints are provided in Section 7 and APPENDIX F to ensure complaints are dealt with accordingly.

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# 1 Introduction

Renzo Tonin & Associates was engaged to prepare a Construction Noise & Vibration Impact Assessment (CNVIA) to be submitted with the State Significant Development Application (SSDA) for Stages 2-4 of the civil works at the Corrimal Coke Works site (SSD-83789711).

This Construction Noise and Vibration Impact Assessment has been prepared to address the requirements of Item 10 of the SEARS which is reproduced below.

## **10. Noise and Vibration**

- *Provide a noise and vibration impact assessment prepared in accordance with the relevant NSW Environmental Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.*

To assess the noise and vibration impacts of the proposed civil works, this report will:

- Identify the site, proposed works and nearby noise / vibration sensitive receivers;
- Present information about ambient noise levels in the vicinity of the site;
- Identify construction noise and vibration criteria relevant to the proposed earthworks;
- Assess likely noise and vibration impacts from the works; and
- Provide advice with respect to noise and vibration mitigation where necessary.

APPENDIX A contains a glossary of acoustic terms used in this report.

## 2 Site description

The former Corrimal Coke Works site at 27 Railway Street, Corrimal, is bound by:

- Memorial Drive to the west which is a four-lane divided road;
- South Coast Rail Line to the east which carries both passenger and freight trains;
- Railway Street to the north with is a two-lane undivided road; and
- Towragdi Creek to the south. Further to the south are existing residential properties fronting Carr Street, Towragdi.

The scope of this assessment covers civil construction works, which includes detailed civil works associated with the construction of local roads and drainage works relevant to future Stages 2-4, construction of the Central Park, construction of the Southern Park, public domain works (landscaping, street tree planting, paving) and reticulation of site services and infrastructure (electricity, telecommunication, water and sewer).

We are advised that there will be no construction activities associated with other development stages of the Corrimal Coke Works site that will be undertaken concurrently with the Stage 2-4 Civil Works.

The proposed civil works is to occur during the standard construction hours as follows:

- Mondays to Fridays                      7:00am to 6:00pm
- Saturdays                                      8:00am to 1:00pm
- Sundays and public holidays      No work performed

The extent of the civil work areas are illustrated in the Civil Works Layout Plans prepared by Maker Consulting Services (drawing no. MKR00452-11-C0100, MKR00452-11-C0101 and MKR00452-11-C0102, Revision 1, dated 19 June 2025).

### 3 Summary of existing ambient noise monitoring

Criteria for the assessment of construction noise are usually derived from the existing noise environment of an area. To determine the background noise levels of the area and establish construction noise management levels in accordance with the NSW *Interim Construction Noise Guideline* (see Section 3.2), this assessment relies upon previous long-term noise measurements conducted for the planning proposal to rezone the former Corrimal Coke Works site and enable residential development (PP-2021-472).

For the planning proposal, an assessment of noise and vibration impacts onto the Corrimal Coke Works site from the adjacent South Coast Rail Line corridor and surrounding road network was undertaken in accordance with the NSW State Environmental Planning Policy (Infrastructure) 2007 ('ISEPP') to determine any potential constraints with rezoning the site for residential use (ref: TK577-01F03 Corrimal acoustic and vibration assessment r4, dated 20 May 2019). As part of the planning proposal assessment, long-term noise monitoring was conducted at three residential premises surrounding the Corrimal Coke Works site (Locations N1 – N3) between 12 November and 20 November, 2018 to quantify the existing background noise levels and ambient  $L_{eq}$  noise levels from road / rail traffic.

Additional long-term noise monitoring was conducted between 25 June and 7 July, 2025 to confirm rail traffic noise intrusion levels for Stage 1 of the Corrimal Coke Works site (ref: TK577-03F02 DA acoustic and vibration assessment (r7), dated 25 July 2025). The monitoring was conducted adjacent to the eastern boundary of the Stage 1 area (Location N4) to capture ambient background noise levels and rail traffic noise associated with trains arriving / departing Corrimal Station.

#### 3.1 Measurement locations

The long-term noise monitoring locations are described in Table 3-1 and presented in Figure 1.

**Table 3-1: Long-term noise monitoring locations**

ID	Location	Description
N1	60 Duff Parade, East Corrimal	The monitor was located approximately 22m to the east of the rail line. The acoustic environment was controlled by rail noise from passing trains, and by distant road traffic noise at other times.
N2	33 Railway Street, Corrimal	The noise monitor was located on the front veranda of the property approximately 20m from Railway Street. The acoustic environment was controlled by road traffic noise from Railway Street and Memorial Drive.
N3	12 Carr Street, Towradgi	The noise monitor was located approximately 90m east of Memorial Drive. The acoustic environment was controlled by road traffic noise from Memorial Drive, with occasional passing passenger and freight trains also audible.

ID	Location	Description
N4	Eastern boundary of Stage 1 development	<p>The monitor was located at the eastern boundary of the Stage 1 development and utilised an extension pole to elevate the microphone above the boundary fence so that measurements had a direct line-of-sight to the rail traffic noise.</p> <p>The acoustic environment was controlled by rail noise from passing trains and trains arriving / departing Corrimal Station, with distant road traffic noise at other times. Construction works at the Corrimal Coke Works site were paused during this noise monitoring.</p>

Figure 1: Noise and vibration measurement locations



### 3.2 Noise monitoring results

A summary of the long-term noise monitoring results are presented in Table 3-2. The noise monitoring methodology and noise monitoring graphs are reproduced in APPENDIX B and APPENDIX C respectively.

**Table 3-2: Noise monitoring results**

ID	Location	L <sub>Aeq</sub> road/rail noise levels <sup>3</sup>		L <sub>A90</sub> Rating Background Level (RBL)		
		Day <sup>1</sup>	Night <sup>2</sup>	Day	Evening	Night
N1	60 Duff Parade	58	60	39	39	36
N2	33 Railway Street	60	55	50	45	37
N3	12 Carr Street	57	54	46	44	37
N4	Corrimal Coke Works site (eastern boundary)	64	62	45	45	40

- Notes:
1. Day is 7:00am to 10:00pm
  2. Night is 10:00pm to 7:00am
  3. Noise levels include +2.5dB facade correction

## 4 Criteria

The NSW *Interim Construction Noise Guideline* (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- Use of  $L_{Aeq}$  as the descriptor for measuring and assessing construction noise.

NSW noise policies, including the INP, RNP and RING have moved to the primary use of  $L_{Aeq}$  over any other descriptor. As an energy average,  $L_{Aeq}$  provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the  $L_{A10}$  descriptor.

- Application of reasonable and feasible noise mitigation measures
- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.
- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods for 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 a 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 proposed Stage 2-4 civil works, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

Table 4-1, reproduced from the ICNG, sets out the noise management levels and how they are to be applied for residential receivers.

**Table 4-1: Noise management levels at residential receivers**

Time of day	Management level L <sub>Aeq</sub> (15 min) *	How to apply
<b>Recommended standard hours:</b> Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> <li>Where the predicted or measured L<sub>Aeq</sub> (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.</li> <li>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.</li> </ul>
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. <ul style="list-style-type: none"> <li>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:               <ol style="list-style-type: none"> <li>times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences)</li> <li>if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</li> </ol> </li> </ul>
<b>Outside recommended standard hours</b>	Noise affected RBL + 5dB	<ul style="list-style-type: none"> <li>A strong justification would typically be required for works outside the recommended standard hours.</li> <li>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</li> <li>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.</li> <li>For guidance on negotiating agreements see section 7.2.2 <i>[of the ICNG]</i>.</li> </ul>

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

## 4.1 Residential assessment locations

Due to the size of the Corrimal Coke Works site, there are a large number of residential dwellings surrounding the site that could potentially be impacted by the proposed civil works. Therefore, the residential receivers have been grouped into noise catchment areas according to shared background noise conditions (controlled by road traffic noise from Railway Street and Memorial Drive) and common exposure to the noise emanating from the proposed civil works.

Figure 2 and Table 4-2 present the noise catchment area groupings and the identified assessment locations (considered representative of the most affected receiver locations in each noise catchment area) used for this assessment of noise emission from civil works at the Corrimal Coke Works site.

Figure 2: Residential noise catchment areas and assessment locations



Table 4-2: Assessment locations - residential

ID	Address
NCA 1	54-62 Railway Street, Corrimal
NCA 2	6 Duff Parade, East Corrimal
NCA 3	16 Duff Parade, East Corrimal
NCA 4	26 Duff Parade, East Corrimal
NCA 5	6 Carr Street, Towradgi
NCA 6	79 Cross Street, Corrimal

## 4.2 Construction noise management levels

Construction noise management levels for the identified noise catchment areas are set out in Table 4-3 which have been established from the ICNG and the measured ambient background noise levels set out in Section 3.

**Table 4-3: Construction noise management levels at residential receivers**

ID	Daytime $L_{A90}$ rating background level (RBL)	Construction noise management level $L_{Aeq(15min)}$	Highly noise affected level
NCA 1	50	60	75
NCA 2	45	55	75
NCA 3	45	55	75
NCA 4	39	49	75
NCA 5	46	56	75
NCA 6	50	60	75

## 4.3 Construction vibration criteria

Construction vibration is associated with three main types of impact:

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

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

Vibration amplitude may be measured as displacement, velocity, or acceleration.

- Displacement ( $x$ ) measurement is the distance or amplitude displaced from a resting position. The International System of Units (SI unit) for distance is the metre (m), although common industrial standards include mm.
- Velocity ( $v=\Delta x/\Delta t$ ) is the rate of change of displacement with respect to change in time. The SI unit for velocity is metres per second (m/s), although common industrial standards include mm/s. The Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis (x, y, and z) then the resultant PPV is the vector sum (i.e. the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.
- Acceleration ( $a=\Delta v/\Delta t$ ) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is metres per second squared (m/s<sup>2</sup>). Construction vibration goals are summarised below.

Construction vibration goals are summarised below.

### 4.3.1 Disturbance to buildings occupants

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the EPA's (ex DEC's) 'Assessing Vibration; a technical guideline' (DEC, 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 'Evaluation of human exposure to vibration in buildings (1-80Hz)'. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. Table 4-4 provides definitions and examples of each type of vibration.

**Table 4-4: Types of vibration**

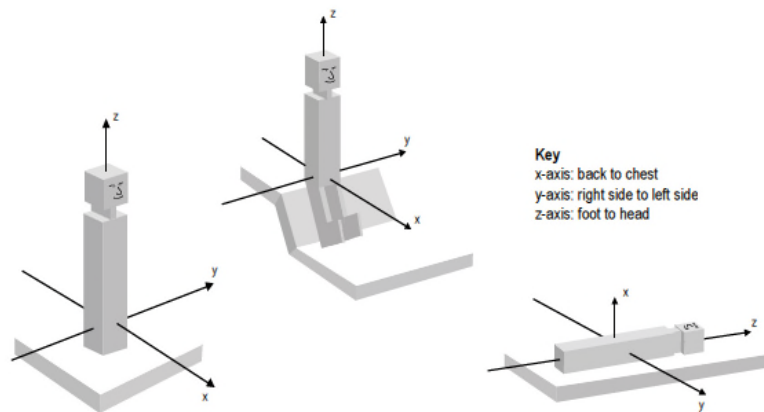
Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers.  Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

*'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'*

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore, application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 3. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

**Figure 3: Orthogonal axes for human exposure to vibration**

The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 4-5.

**Table 4-5: Preferred and maximum levels for human comfort (weighted RMS acceleration,  $m/s^2$ )**

Location	Assessment period <sup>[1]</sup>	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
<b>Continuous vibration (weighted RMS acceleration, <math>m/s^2</math>, 1-80Hz)</b>					
Critical areas <sup>2</sup>	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
<b>Impulsive vibration (weighted RMS acceleration, <math>m/s^2</math>, 1-80Hz)</b>					
Critical areas <sup>2</sup>	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

- Notes:
- Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
  - 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. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

Similarly, the preferred and maximum levels for human comfort can be expressed in velocity (mm/s) and decibel levels (dBv re 1mm/s). These are defined in Table C1.1 of the guideline and reproduced in Table 4-6.

**Table 4-6: Preferred and maximum levels for human comfort**

Location	Assessment period <sup>[1]</sup>	Preferred values		Maximum values	
<b>Continuous vibration (velocity, mm/s, 1-80Hz)</b>					
Critical areas <sup>2</sup>	Day- or night-time	0.10	0.29	0.20	0.57
Residences	Daytime	0.20	0.57	0.40	1.14
	Night-time	0.14	0.40	0.28	0.80
Offices, schools, educational institutions, and places of worship	Day- or night-time	0.40	1.14	0.80	2.28
Workshops	Day- or night-time	0.80	2.28	1.60	4.56
<b>Continuous vibration (velocity, dB<sub>v</sub> re 1nm/s, 1-80Hz)</b>					
Critical areas <sup>2</sup>	Day- or night-time	100	109	106	115
Residences	Daytime	106	115	112	121
	Night-time	103	112	109	118
Offices, schools, educational institutions, and places of worship	Day- or night-time	112	121	118	127
Workshops	Day- or night-time	118	127	124	133

- Notes:
1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
  2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 4-7.

**Table 4-7: Acceptable vibration dose values for intermittent vibration (m/s<sup>1.75</sup>)**

Location	Daytime <sup>1</sup>		Night-time <sup>1</sup>	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas <sup>2</sup>	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

- Notes:
- Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
  - Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.  
Source: BS 6472-1992

For vertical vibration and for frequencies greater than 8 Hz, the estimated Vibration Dose Value (eVDV) can be calculated using the following formula:

$$eVDV = 0.07 \times v_{rms} \times t^{0.25} \text{ m/s}^{1.75}$$

where

$v_{rms}$  = vibration level in mm/s; and

$t$  = time in seconds

### 4.3.2 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 7385 Part 2 and German Standard DIN4150-3. Currently there is no existing 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.

Within British Standard 7385 Part 1: 1990, different levels of structural damage are defined:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

The vibration limits in Table 1 of British Standard 7385 Part 2 (1993) are for the protection against cosmetic damage, however guidance on limits for minor and major damage is provided in Section 7.4.2 of the Standard:

#### *7.4.2 Guide values for transient vibration relating to cosmetic damage*

*Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*

*Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as "any permanent consequence of an action that reduces the serviceability of a structure or one of its components" (p.4). The Standard also outlines:

*"For buildings as in lines 2 and 3 of Tables 1, 4 or B.1, the serviceability is considered to have been reduced if, for example*

- *cracks form in plastered or rendered surfaces of walls;*
- *existing cracks in a structure are enlarged;*
- *partitions become detached from load-bearing walls or floor slabs.*

*These effects are deemed 'minor damage.' " (DIN4150.3:2016, p.6)*

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

#### 4.3.2.1 British Standard

British Standard 7385: Part 2 'Evaluation and measurement of vibration in buildings', can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%. Table 4-8 sets out the BS7385 criteria for cosmetic, minor and major damage.

**Table 4-8: BS 7385 structural damage criteria**

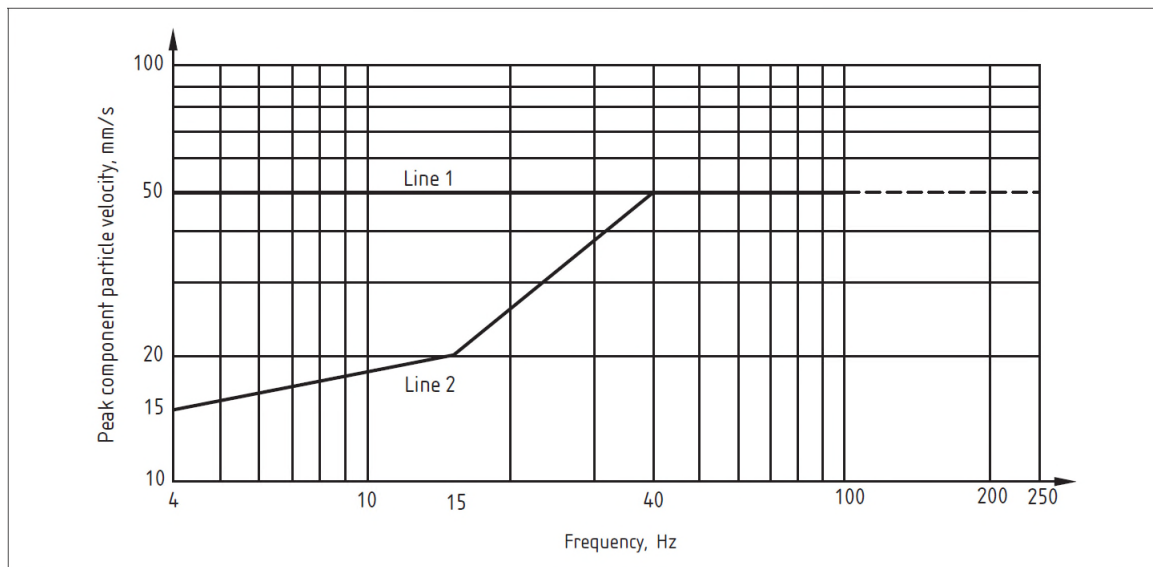
Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor*	100		
		Major*	200		

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor*	30 to 40	40 to 100	100
		Major*	60 to 80	80 to 200	200

Notes: 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.

\* Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

Figure 4: BS 7385:2 (1993) structural damage criteria



**Vibration screening criteria – Rail infrastructure and residential dwellings**

The limits presented in Table 4-8 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 gives rise to dynamic magnification due to resonance, then the guide values in Table 4-8 may need to be reduced by up to 50 percent. This is especially applicable at the lower frequencies where lower guide vales apply.

On this basis, a conservative vibration screening criteria per receiver type is given below:

- Reinforced or framed structures (Group 1): 25.0mm/s
- Unreinforced or light framed structures (Group 2): 7.5mm/s

**4.3.2.2 German Standard**

German Standard DIN 4150 - Part 3 (2016) 'Vibration in buildings - Effects on Structures' (DIN 4150-3:2016), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3:2016 presents the recommended maximum limits over a range of frequencies (Hz), measured at the foundations, in the plane of the uppermost floor of a building or structure or vertically on floor slabs. The vibration limits at the foundations increase as the frequency content of the vibration increases. The criteria are presented in Table 4-9.

**Table 4-9: DIN 4150-3:2016 structural damage criteria**

Group	Type of structure	Vibration velocity, mm/s				
		At foundation in all directions at frequency of			Plane of floor uppermost storey in horizontal direction	Floor slabs, vertical direction
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that because of their particular sensitivity to vibration, cannot be classified under Groups 1 and 2 <u>and</u> are of great intrinsic value (eg listed buildings)	3	3 to 8	8 to 10	8	20

#### **Vibration screening criteria – Heritage structures**

As noted in BS 7385, heritage building and structures should not be assumed to be more sensitive to vibration, unless structurally unsound.

The more stringent criterion in German Standard DIN 4150 of 3mm/s (peak component particle velocity) has been used in this assessment as a conservative vibration damage screening level for heritage buildings / structures. This screening level will allow potentially impacted heritage buildings to be identified. If a heritage building is predicted to be exposed to vibration levels above the conservative screening level of 3mm/s, further investigation would be undertaken to determine whether the building is structurally unsound. Where a heritage structure is deemed to be sensitive to vibration impacts, the more stringent DIN 4150 3 guideline values can be applied. Otherwise, structural damage vibration limits based on BS 7385 (Section 4.3.2 and 4.3.2.1) can be applied.

## 5 Civil works noise assessment

### 5.1 Proposed civil works noise sources

A schedule of equipment / machinery likely to be used for Stage 2-4 civil works at the Corrimal Coke Works site (as advised by Chester Project Management Pty Ltd) is set out in Table 5-1.

The sound power levels for the civil work equipment are based on maximum noise levels given in Table A1 of Australian Standard 2346 – 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Site', the Interim Construction Noise Guideline (ICNG), and information from past projects.

**Table 5-1: Typical civil works equipment and sound power levels**

Plant item	Equipment / machinery	Sound power level, dB(A) re 1pW
1	20T – 57T excavators with bucket attachment	103
2	20T – 57T excavators with hammer / saw attachment	121
3	Truck and dog	106
4	11T – 15T smooth drum roller	109
5	11T – 15T vibratory roller	112
6	Delivery trucks	106
7	Hand vibration equipment	108
8	Concrete Agitator	108
9	Asphalt Paver	105
10	Emulsion Truck	106
11	12T Pneumatic-tyred roller	108

### 5.2 Predicted noise levels

Noise levels at any receiver location resulting from the civil works would depend on the location of the receiver with respect to the location of the civil works equipment, shielding from intervening structures / topography and the type / duration of the civil works being undertaken. Furthermore, noise levels at receivers would vary significantly over the total civil works program due to the transient nature and large range of plant and equipment that could be used.

Table 5-2 presents noise levels likely to be experienced at the nearby affected receivers based on the plant / equipment associated with the proposed civil works, where the range represents the plant items operating at a location furthest away and a location closest to each receiver. The predictions include the acoustic shielding effects from existing fences and hoardings / temporary barriers recommended for the previous construction work at the site (illustrated in APPENDIX G and described below).

- The Corrimal Coke Works site has existing corrugated metal fences with an approximate height of 1.8m along a portion of the northern boundary (from the existing entry gate to the north-eastern corner of the site) and along the common boundaries with the residential premises fronting Cross Street, Corrimal (NCA 6). Along the eastern boundary of the Corrimal Coke Works site is an existing

corrugated metal fence with an approximate height of 2.5m (extending from the north-eastern corner of the site to the alignment of the Powerhouse building).

- 2.4m high hoarding (constructed from 17mm plywood or similar solid material) have been installed along the eastern site boundary adjacent to the Powerhouse building and brick stack heritage structures for the previous demolition stage of the project which are to be retained for the Stage 2-4 civil works.
- Hoardings or temporary acoustic barriers (eg. 17mm plywood, Echo Barrier, etc) with a height of 2.0m were recommended along the northern, western and eastern site boundaries for the previous stages of bulk earthworks. These hoardings are to be retained for the Stage 2-4 civil works.

Results for the assessment of airborne construction noise from the proposed Stage 2-4 civil works were determined using a CadnaA computer noise model developed for the project. The CadnaA model takes into account sound radiation patterns, ground elevation contours, acoustic shielding and potential reflections from intervening building elements and noise attenuation due to distance to predict the noise of the civil works in accordance with International Standard ISO 9613.

**Table 5-2: Predicted LAeq,15min noise levels at residential receivers for typical civil works plant, dB(A) – with hoardings / temporary barriers**

Plant item	Plant description	Predicted LAeq,15min construction noise levels					
		NCA 1	NCA 2	NCA 3	NCA 4	NCA 5	NCA 6
	Noise management level	60	55	55	49	56	60
<b>Stage 2-4 civil works</b>							
1.	20T – 57T excavators with bucket attachment	24-42	22-42	34-50	35-55	29-42	31-50
2.	20T – 57T excavators with hammer / saw attachment	42-60	40-60	52-68	53-73	47-60	49-68
3.	Truck and dog	27-45	25-45	37-53	38-58	32-45	34-53
4.	11T – 15T smooth drum roller	30-48	28-48	40-56	41-61	35-48	37-56
5.	11T – 15T vibratory roller	33-51	31-51	43-59	44-64	38-51	40-59
6.	Delivery trucks	27-45	25-45	37-53	38-58	32-45	34-53
7.	Hand vibration equipment	29-47	27-47	39-55	40-60	34-47	36-55
8.	Concrete Agitator	29-47	27-47	39-55	40-60	34-47	36-55
9.	Asphalt Paver	26-44	24-44	36-52	37-57	31-44	33-52
10.	Emulsion Truck	27-45	25-45	37-53	38-58	32-45	34-53
11.	12T Pneumatic-tyred roller	29-47	27-47	39-55	40-60	34-47	36-55
	Up to three equipment (noisiest) operating concurrently	<b>43-61</b>	<b>41-61</b>	<b>53-69</b>	<b>54-74</b>	<b>47-61</b>	<b>50-68</b>

Based on the predicted noise emission levels from Stage 2-4 civil works presented in Table 5-2, the noise management levels will generally be exceeded in NCAs 3 and 4 when works are conducted at the closest proximity to the nominated receiver locations (as is often the case when construction works occur near residential areas).

In NCAs 1, 2, 5 and 6 which are further away from the Stage 2-4 civil works area, the noise management levels will likely be exceeded when saw cutting / hammering (using an excavator) is occurring or multiple noisy equipment are operating in close proximity to the residential receivers.

Section 5.3 sets out noise management measures to address the remaining exceedances of the noise management levels.

The Stage 2-4 civil works are not proposed to be conducted concurrently with other development stages of the Corrimal Coke Works site. Therefore, there is not expected to be any cumulative construction noise impacts.

## 5.3 Civil works noise mitigation measures

### 5.3.1 General engineering noise controls

Implementation of noise control measures such as those suggested in Australian Standard 2436-2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', are expected to reduce predicted civil works noise levels.

Reference to Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C presents typical examples of noise reduction achievable after treatment of various noise sources. Table C2 in Appendix C presents the relative effectiveness of various forms of noise control treatment.

Table 5-3 presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

**Table 5-3: Relative effectiveness of various forms of noise control**

Noise control method	Practical examples	Typical noise reduction possible in practice, dB(A)		Maximum noise reduction possible in practice, dB(A)	
		AS2436	Renzo Tonin & Assoc.	AS2436	Renzo Tonin & Assoc.
Distance	Doubling of distance between source and receiver	6	6	6	6
Screening	Acoustic barriers such as temporary or permanent noise barriers where barriers break line-of-sight between the source and receiver	5 to 10	5 to 10	15	15
Acoustic enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 25	10 to 20	50	30
Engine silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25	-	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low, and should be referred to in preference to those of AS2436.

With respect to the above noise control methods, we note in general that:

- Increasing distance as a noise control method is not feasible for this project as the work locations (future roads, infrastructure, etc.) and the surrounding residential receiver locations are fixed. However, the difference distances between the work locations and residential receivers have been taken into account and reflected in the range of predicted levels presented in Table 5-2. The assessment reveals that the occurrence of civil works furthest from the residential receiver is likely to result in noise emission levels less than the noise management levels.
- Predicted construction noise levels with hoardings / temporary barriers along the site boundary are set out in Table 5-2. If there are plant / equipment that will be in a fixed location for long periods of time, additional temporary barriers could be considered adjacent to the plant / equipment to provide further screening.
- Due to the size and movement of equipment undertaking the proposed civil works, the use of acoustic enclosures is not feasible for this project.
- Engine silencing and substitution by alternative process is feasible to an extent by using smaller / quieter equipment where possible.

### 5.3.2 Noise management recommendations

The following recommendations provide feasible and reasonable noise control solutions to reduce noise impacts to sensitive receivers. A strong justification must be required for not implementing the proposed measures if they are later determined on-site to not be feasible or reasonable.

The advice provided here is in respect to acoustics only. Supplementary professional advice may need to be sought in respect to fire ratings, structural design, buildability, fitness for purpose and the like.

#### General noise management measures

The following general noise management measures are recommended for all receiver locations:

- Regularly inspect and maintain equipment to ensure it is in good working order.
- Provide special attention to any use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Simultaneous operations of noisy plant within discernible range of a sensitive receiver is to be limited / avoided where possible.
- The offset distance between noisy plant and adjacent sensitive receivers is to be maximised where practical.

- Where practical, plant and equipment that are used intermittently are to have throttle setting reduced or shut down when not in use. Any plant and equipment that will not be used for extended periods of time are to be switched off.
- Truck engines should be turned off as opposed to idling, if feasible. Also, non-tonal reversing beacons should be considered for the on-site vehicles.
- In addition to the noise mitigation measures outlined above, a management procedure will need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint will need to be investigated, and appropriate noise amelioration measures put in place to mitigate further occurrences, where the noise in question is in excess of allowable limits. See APPENDIX D for detailed noise monitoring procedures and APPENDIX F for an example of a complaint handling form.
- Good relations with people living and working in the vicinity of the Corrimal Coke Works site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community must be adequately trained and experienced in such matters.

#### Specific noise management measures

Other potential mitigation measures include:

- Neighbour notification
  - Community consultation procedures and site point-of-contact must be established.
  - Notify surrounding residential areas (at a minimum, NCAs 1 to 6) of the estimated dates, locations during each day and typical duration of noisy activities so a given receiver will have an understanding of the duration of works that is in closest proximity to them.
  - If feasible and reasonable, the use of noisy plant could alternatively be restricted to certain times of the day with periods of respite in between (to be negotiated with surrounding noise sensitive receivers). For example, noisy activities such as saw cutting / hammering (using an excavator) could be limited to weekdays when the surrounding residents are likely to not be at home. It is also noted however that respite periods can have the effect of increasing the overall duration of the construction works, and the community may prefer to have the works completed as quickly as possible.
- All employees, contractors and subcontractors are to receive site induction, toolbox talks and ongoing training so that the above noise management measures are implemented accordingly. Content within toolbox talks should include the location of nearest noise sensitive receivers, relevant project specific and standard noise / vibration mitigation measures, permissible hours of work, truck route and truck loading restrictions and employee parking areas.

## 6 Civil works vibration assessment

### 6.1 Proposed vibration generating activities

Vibration levels at the receiver locations from the Stage 2-4 civil works of the Corrimal Coke Works site will vary depending upon the type of activity being carried out, separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and construction / structure of the receiver building.

With respect to the typical plant and equipment we are instruction that would be on site for the works (set out in Table 5-1), this assessment considers the critical vibration generating activities to be the compaction of soil and pavement layers using vibratory rollers and hand vibration equipment (wacker packer / plate compactors), and saw cutting / hammering of rock during excavation activities. The recommended minimum working distances for vibration intensive plant are presented in Table 6-1.

**Table 6-1: Recommended minimum working distances for vibration intensive plant**

Plant item	Rating / description	Minimum working distance (m)		
		Structural damage		Human response
		Rail infrastructure	Heritage structures	Residential premises
Vibratory roller <sup>1</sup>	13T smooth drum roller (high vibration)	5	15	55
Excavator <sup>1</sup>	Rock saw attachment on a medium sized excavator	5	10	25
	50T with hydraulic hammer attachment	5	20	45
Hand vibration equipment <sup>1</sup>	Wacker packer	1	2	10

Notes: 1. Renzo Tonin & Associates project files, databases and library

Site specific buffer distances for vibration significant plant items must be measured on-site where plant and equipment are likely to operate close to or within the minimum working distance for structural damage.

Unlike noise, vibration cannot be readily 'predicted' due to many variables from site to site, for example soil type and conditions, subsurface rock, building types and foundations and actual plant on site. The data relied upon in this assessment (set out above) is taken from a database of vibration levels measured at different sites. They are not specific to this project as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and receiver.

### 6.2 Potential vibration impacts

Based on the proposed plant items presented, vibration generated by the civil works was estimated and potential vibration impacts are summarised in Table 6-2 below.

**Table 6-2: Potential vibration for nearest sensitive receivers**

Receiver location	Approx. distance to nearest building from works	Type of nearest sensitive building	Assessment of potential vibration impacts		
			Structural damage	Human disturbance	Vibration monitoring
NCA 1	175m	Residential	Very low risk of structural damage from civil works	Very low risk of adverse comments from civil works	Vibration monitoring not required
NCA 2	120m	Residential	Very low risk of structural damage from civil works	Very low risk of adverse comments from civil works	Vibration monitoring not required
NCA 3	40m	Residential	Very low risk of structural damage from civil works	Medium risk of adverse comments from civil works	Vibration monitoring shall be conducted in response to complaints where required
NCA 4	45m	Residential	Very low risk of structural damage from civil works	Medium risk of adverse comments from civil works	Vibration monitoring shall be conducted in response to complaints where required
NCA 5	190m	Residential	Very low risk of structural damage from civil works	Very low risk of adverse comments from civil works	Vibration monitoring not required
NCA 6	65m	Residential	Very low risk of structural damage from civil works	Low risk of adverse comments from civil works	Vibration monitoring not required
Rail corridor	15m	Rail infrastructure	Low risk of structural damage from civil works	N/A	Vibration monitoring shall be conducted at commencement to confirm safe working distances
Heritage items of former Corrimal Coke Works to be retained	Adjacent	Heritage structures / buildings in poor to fair condition	High risk of structural damage to Powerhouse building and brick stack from civil works	N/A	Vibration monitoring shall be conducted at commencement to confirm safe working distances

Based on the above assessment, the main risks relate to:

- Potential structural damage to the Powerhouse building and brick stack heritage structures within the Corrimal Coke Works site that are to be retained as these structures are adjacent to the north-eastern corner of the work area.

### 6.3 Vibration mitigation measures

The following vibration mitigation measures are recommended to minimise vibration impacts from Stage 2-4 civil works.

- A management procedure is to be implemented to deal with vibration complaints. Consultation with occupants and property owners is recommended and should be aimed at providing a communication path directly to the contractor. Each complaint is to be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences. An example of a vibration complaint management procedure and complaint form is presented in APPENDIX F of this report.
- Carry out vibration testing of actual equipment on site prior to the civil works to determine acceptable buffer distances to sensitive receivers. Where subdivision work activities are within the acceptable buffer distances determined from site testing, additional vibration monitoring is to be undertaken which signals to the contractor (by way of buzzer, flashing lights, etc.) when vibration levels approach / exceed the recommended limits. Further details of the monitoring procedures are set out in Section 6.3.1.
- Where vibration is found to be excessive, management measures must be implemented to ensure vibration compliance is achieved. Management measures may include:
  - Using smaller equipment or modifying the construction methodology (eg. using a rock saw preferentially to a hydraulic hammer, using a lower roller vibration setting, etc.) where feasible;
  - Establishment of safe buffer zones; and
  - Time restrictions to the operation of vibration intensive plant to address human comfort.
- Notification by letter drop should be carried out for the nearest surrounding residential properties in NCAs 3, 4 and 6 to address potential community concerns that perceived vibration may cause damage to property. Notification is to be provided to these receivers prior to the commencement of civil works.

### 6.3.1 Vibration monitoring and methodology

To minimise the potential risk of vibration generating activities causing damage to rail corridor infrastructure and heritage items within the Corrimal Coke Works site, vibration monitoring is required to verify the actual vibration levels and site-specific buffer distances.

#### Prior to civil works

Prior to the start of vibration intensive civil works, attended vibration measurements are to be conducted within the site to confirm the source vibration levels of the plant and attenuation of the vibration with distance. To minimise the potential for structural damage risks from the civil works, the initial vibration intensive works and measures are to occur towards the centre of the Corrimal Coke Works site so that they are removed from the rail infrastructure, sensitive heritage items and surrounding residential dwellings.

Measurements shall be undertaken at multiple distances from the vibration generating plant while it is operating. The peak particle velocity (PPV) results are to be used to determine the source vibration levels of the plant, create a site law for attenuation with distance and establish site-specific minimum working distances for the most vibration significant plant items.

The potential vibration impacts are to be reassessed against the site-specific minimum working distances. This may include further detailed analysis based on the frequency content of the vibration levels.

Permanent strengthening works to the heritage items within the Corrimal Coke Works site are included in a separate Development Application. Prior to vibration generating civil works, a structural engineer is to be consulted to confirm the sensitivity of the heritage items to vibration and inform the appropriate vibration limits to be adopted, as noted in Section 4.3.2.1 and 4.3.2.2.

### During civil works

Adjacent to the north-eastern corner of the civil works area is the Powerhouse building and brick stack which are heritage items within the Corrimal Coke Works site to be retained / conserved.

The following vibration management measures are provided to minimise vibration impact from civil work activities to the adjacent residential dwellings and heritage items:

1. Permanent strengthening works to the heritage structures at the Corrimal Coke Works site are covered in a separate Development Application. Prior to the commencement of vibration generating civil works, a structural engineer is to be consulted to confirm the sensitivity of the heritage structures to vibration impacts and determine whether vibration limits applicable to the heritage structures can then be updated in accordance with Section 4.3.2.1 and 4.3.2.2.
2. If vibration intensive work is proposed to occur within the site specific acceptable minimum working distance, then the following would be carried out:
  - a. Evaluate whether alternative construction methods, plant or equipment can be utilised for the works and re-assess potential impacts (if required).
  - b. If there is any risk of exceeding the vibration objectives after all of the above options have been considered, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc.) when vibration levels are approaching the structural / cosmetic damage limits. It is recommended that for the operator alerts, that multiple alert levels are set. Typically, this would be an alert trigger level at 75% of the vibration criteria (ie. amber alert), and an alert trigger level at 100% of the vibration criteria (ie. red alert).

Detailed vibration monitoring procedures are outlined in APPENDIX E.

- c. A management procedure would be developed prior to the works taking place to determine the response to each trigger level. It is recommended that this includes a pause and management measures for an alert trigger level at 75% of the vibration criteria, and stop work at an alert trigger level at 100% of the vibration criteria. Where stop work is triggered, it is recommended that the following are undertaken

#### **STOP WORKS PROCEDURE**

- i. Investigate cause of exceedance
- ii. Visual inspection of the vibration sensitive building/structure/item including photos
- iii. If no cosmetic damage is found, works and vibration monitoring can be resumed
- iv. If cosmetic damage has been identified, repair damage and use a different construction method with lower source vibration levels

## 7 Complaints management and community liaison

Noise and vibration levels generated by the civil works should aim to comply with the noise and vibration goals set by the relevant regulations and guidelines.

The building contractor is responsible for ensuring that all reasonable measures recommended in this Construction Noise and Vibration Impact Assessment are implemented, such as the provision of a Noise and Vibration Complaints Program, to minimise the generation of excessive noise and/or vibration levels.

Owners and occupants of nearby affected properties are to be provided a direct telephone line and contact person (via mail / letter drop) where any noise and vibration complaints related to the civil works can be recorded. Additionally, occupants are to be notified of any periods of noisy or vibration intensive civil works (such as soil compaction and rock breaking activities) at least 24 hours prior to their commencement.

All noise and vibration complaints shall be investigated in accordance with the Noise / Vibration Complaint Management Procedure identified in APPENDIX F of this report. Where a site investigation is required to address the complaint, APPENDIX D and APPENDIX E provide detailed procedures for conducting noise and vibration monitoring.

## 8 Conclusion

A Construction Noise and Vibration Impact Assessment has been prepared for the proposed Stage 2-4 civil works at the Corrimal Coke Works site. Specifically, this report has been prepared to address:

- Noise emission criteria in the NSW *Interim Construction Noise Guideline* (ICNG, 2009);
- Potential distance from vibration on the occupants of the surrounding residential dwellings in accordance with the DECC '*Assessing Vibration: a technical guideline*' (DECC, 2006); and
- Potential structural damage from vibration to surrounding residential dwellings, rail corridor infrastructure and heritage items within the site in accordance with the limits in British Standard 7385 Part 2 and German Standard DIN4150-3.

Site-specific noise and vibration levels from the civil work activities are currently unknown. Based on similar developments, noise and vibration impacts from the civil works equipment that will be used at the Corrimal Coke Works site have been predicted and presented in Sections 5.2 and 6.2.

Where the assessment has found potential exceedances of the noise objectives, site boundary hoardings have been considered to provide acoustic shielding to the surrounding residential receivers. Any remaining exceedances after the implementation of site boundary hoardings will be addressed through the noise mitigation and management measures presented in Section 5.3 to provide additional noise reduction benefits.

The assessment of vibration levels from the civil works provides recommended buffer distances for vibration compliance. The assessment found the proposed civil works to have a low risk of causing structural damage to the surrounding residential dwellings and rail infrastructure. However, buffer distances should be confirmed prior to the start of the civil works through on-site measurements of vibration.

With respect to the heritage items within the Corrimal Coke Works site that are to be retained / conserved, vibration management measures have been presented in Section 6.3.1 to aid in minimising the likelihood of structural damage from vibration impacts.

Procedures to manage complaints are also provided in Section 7 and APPENDIX F to ensure complaints are dealt with accordingly.

## 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.																																														
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]	<p>The units that sound is measured in. The following are examples of the decibel readings of common sounds in our daytime environment:</p> <table border="0"> <tr> <td>threshold of hearing</td> <td>0 dB</td> <td>The faintest sound we can hear</td> </tr> <tr> <td></td> <td>10 dB</td> <td>Human breathing</td> </tr> <tr> <td>almost silent</td> <td>20 dB</td> <td></td> </tr> <tr> <td></td> <td>30 dB</td> <td>Quiet bedroom or in a quiet national park location</td> </tr> <tr> <td>generally quiet</td> <td>40 dB</td> <td>Library</td> </tr> <tr> <td></td> <td>50 dB</td> <td>Typical office space or ambience in the city at night</td> </tr> <tr> <td>moderately loud</td> <td>60 dB</td> <td>CBD mall at lunch time</td> </tr> <tr> <td></td> <td>70 dB</td> <td>The sound of a car passing on the street</td> </tr> <tr> <td>loud</td> <td>80 dB</td> <td>Loud music played at home</td> </tr> <tr> <td></td> <td>90 dB</td> <td>The sound of a truck passing on the street</td> </tr> <tr> <td>very loud</td> <td>100 dB</td> <td>Indoor rock band concert</td> </tr> <tr> <td></td> <td>110 dB</td> <td>Operating a chainsaw or jackhammer</td> </tr> <tr> <td>extremely loud</td> <td>120 dB</td> <td>Jet plane take-off at 100m away</td> </tr> <tr> <td>threshold of pain</td> <td>130 dB</td> <td></td> </tr> <tr> <td></td> <td>140 dB</td> <td>Military jet take-off at 25m away</td> </tr> </table>		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
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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 <sub>Max</sub>	The maximum sound pressure level measured over a given period.
L <sub>Min</sub>	The minimum sound pressure level measured over a given period.
L <sub>1</sub>	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L <sub>10</sub>	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L <sub>90</sub>	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 <sub>eq</sub>	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 L <sub>eq</sub> 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 Long-term noise monitoring methodology

### B.1 Noise monitoring equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave band data	Logger location(s)
RTA05-008 (NTi Audio XL2)	Type 1	1/3	60 Duff Parade, East Corrimal (Location N1)
RTA07-008 (NTi Audio XL2)	Type 1	1/3	33 Railway Street, Corrimal (Location N2)
RTA07-009 (NTi Audio XL2)	Type 1	1/3	12 Carr Street, Towradgi (Location N3)
RTA07-032 (NTi Audio XL2)	Type 1	1/3	Eastern boundary of Stage 1 development (Location N4)

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

### B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW NPfl. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

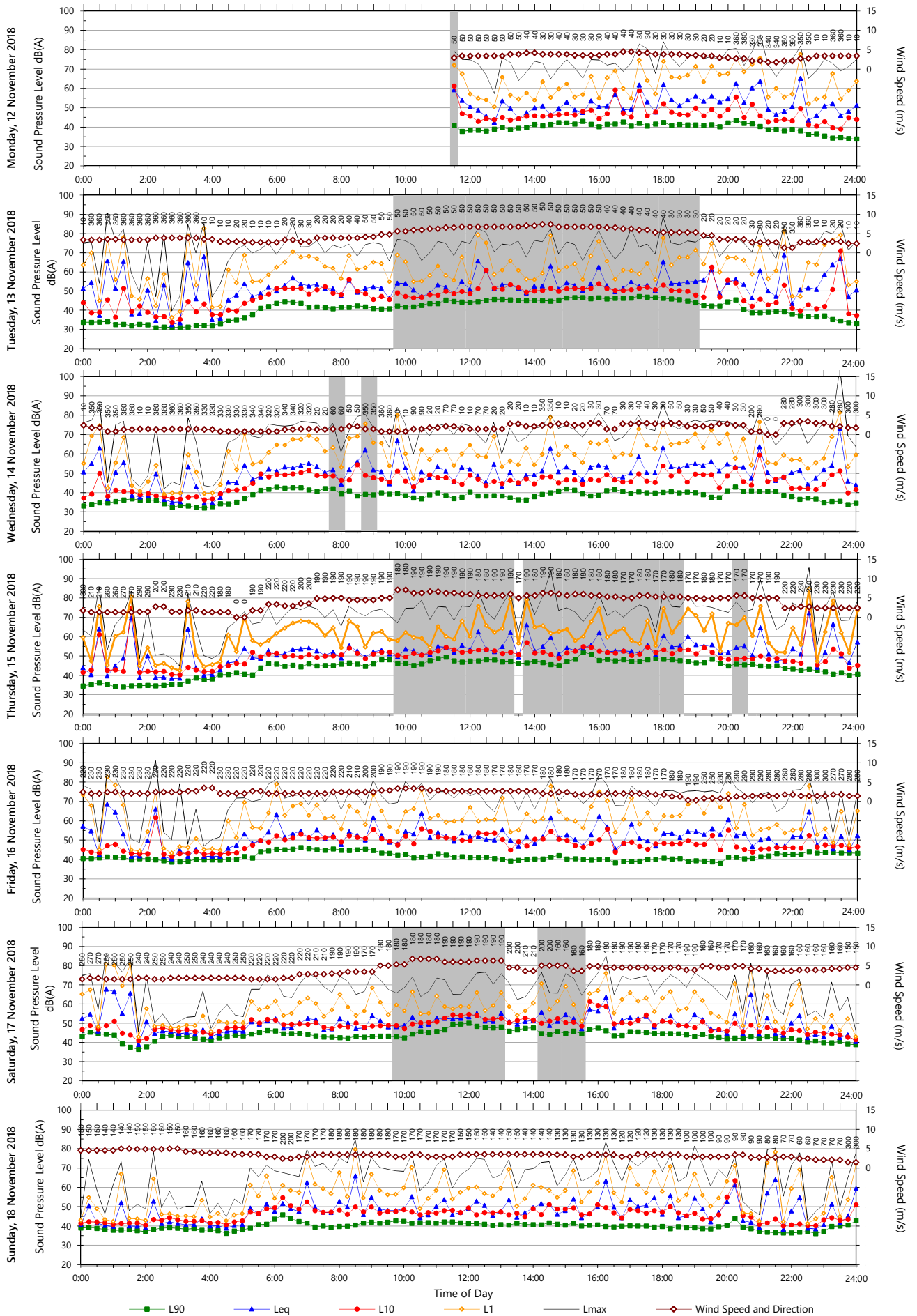
### B.3 Noise vs time graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the  $L_{10}$ ,  $L_{90}$ , and  $L_{eq}$  levels. The statistical descriptors  $L_{10}$  and  $L_{90}$  measure the noise level exceeded for 10% and 90% of the sample measurement time. The  $L_{eq}$  level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

## APPENDIX C Long-term noise monitoring results

Unattended Monitoring Results

Location: 60 Duff Parade, East Corrimal



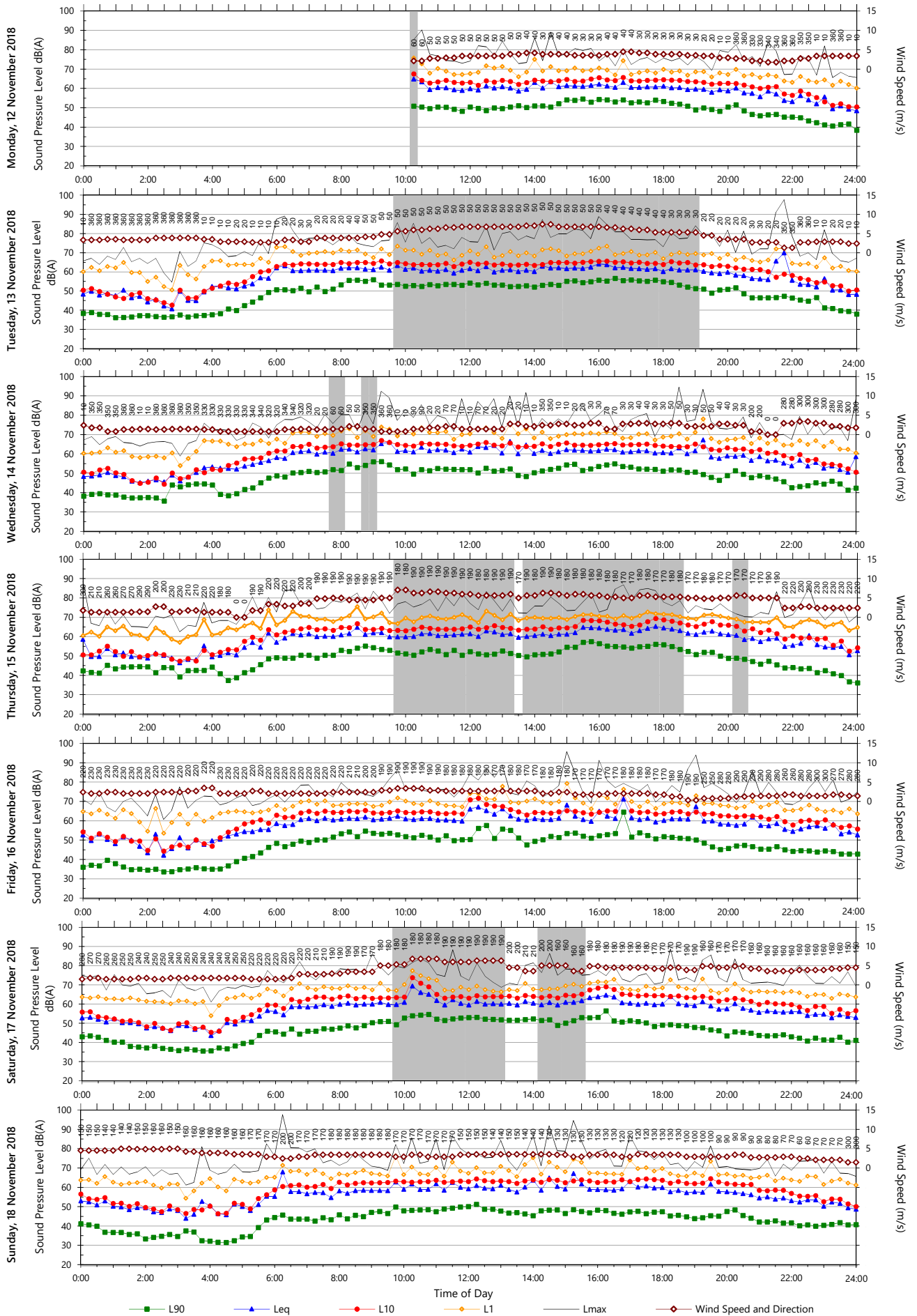
Data File: 2018-11-12\_SLM\_000\_123\_Rpt\_Report.txt

Template: QTE-26 (rev 22) Logger Graphs Program



Unattended Monitoring Results

Location: 33 Railway Street, Corrimal

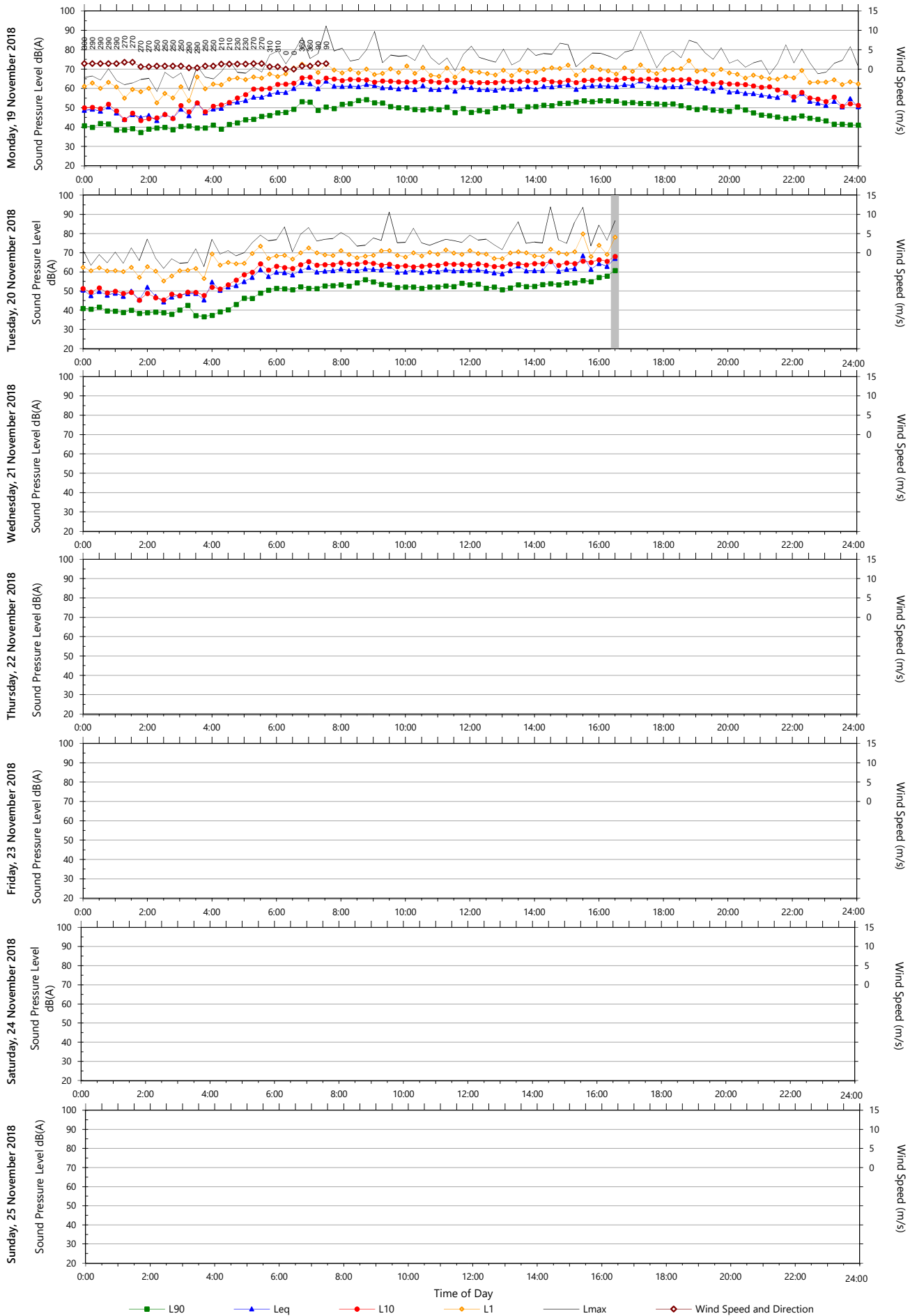


Data File: 2018-11-12\_SLM\_000\_123\_Rpt\_Report.txt

Template: QTE-26 (rev 22) Logger Graphs Program

Unattended Monitoring Results

Location: 33 Railway Street, Corrimal

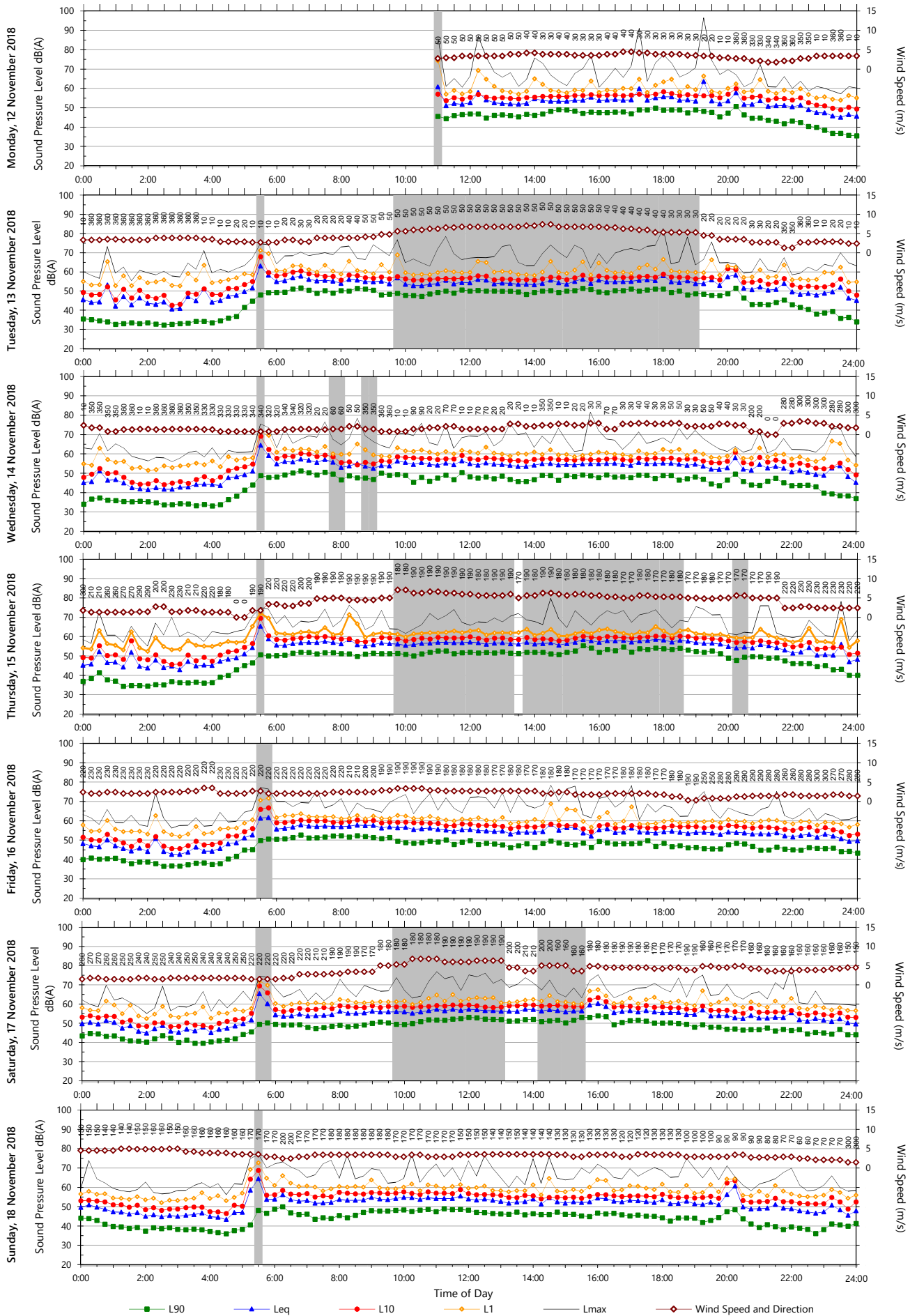


Data File: 2018-11-12\_SLM\_000\_123\_Rpt\_Report.txt

Template: QTE-26 (rev 22) Logger Graphs Program

Unattended Monitoring Results

Location: 12 Carr Street, Corrimal

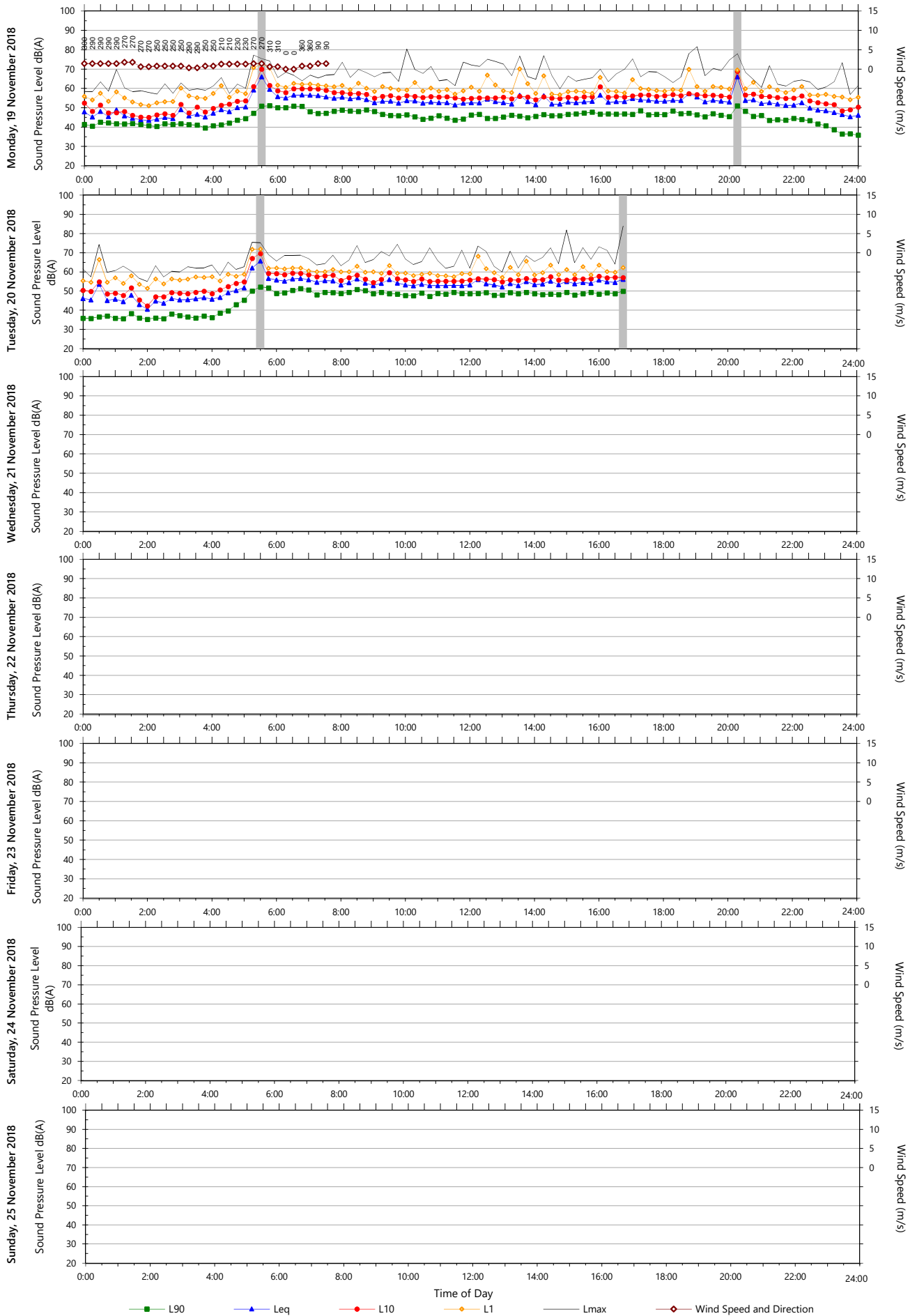


Data File: 2018-11-12\_SLM\_000\_123\_Rpt\_Report.txt

Template: QTE-26 (rev 22) Logger Graphs Program

Unattended Monitoring Results

Location: 12 Carr Street, Corrimal

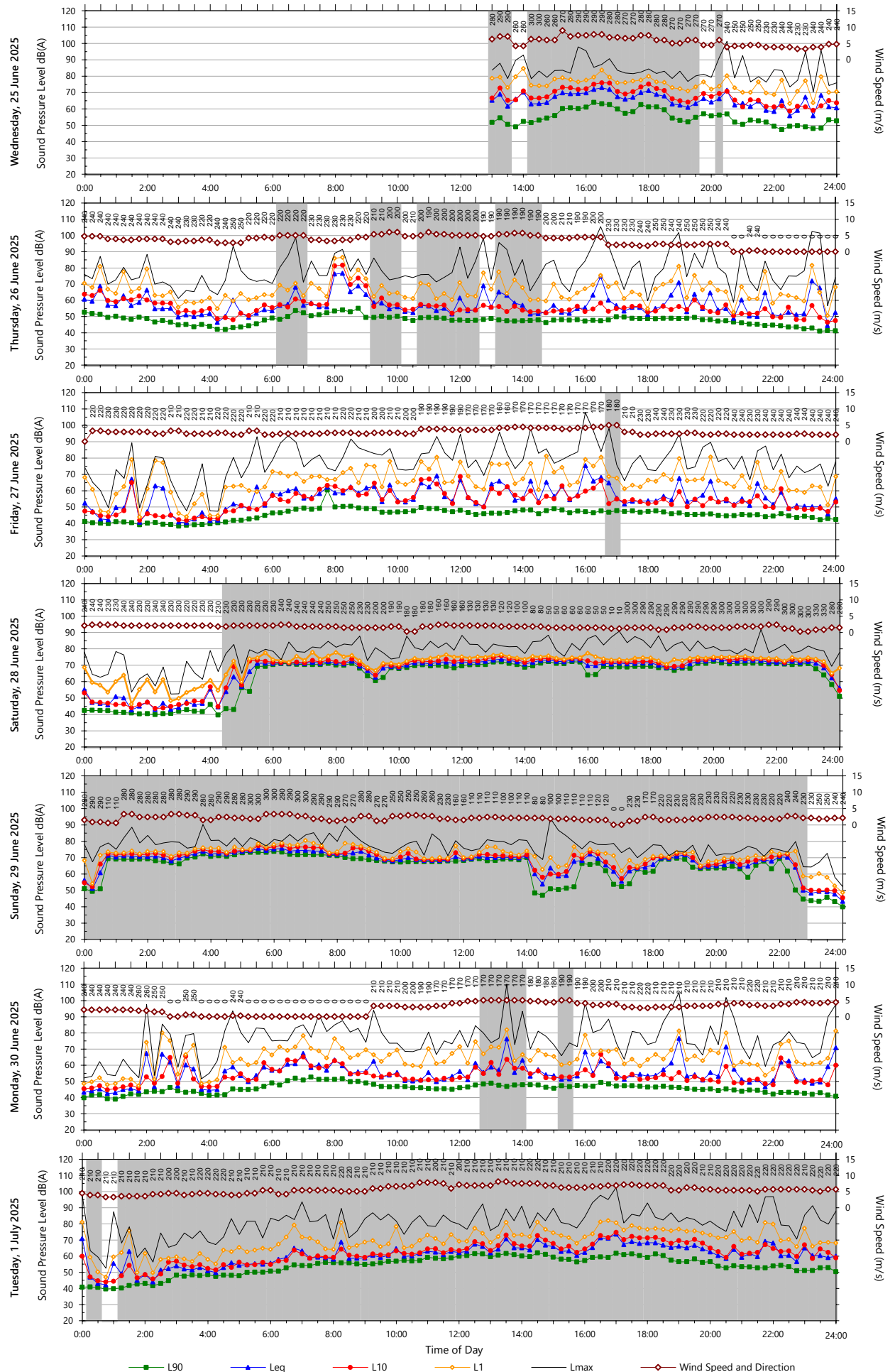


Data File: 2018-11-12\_SLM\_000\_123\_Rpt\_Report.txt

Template: QTE-26 (rev 22) Logger Graphs Program

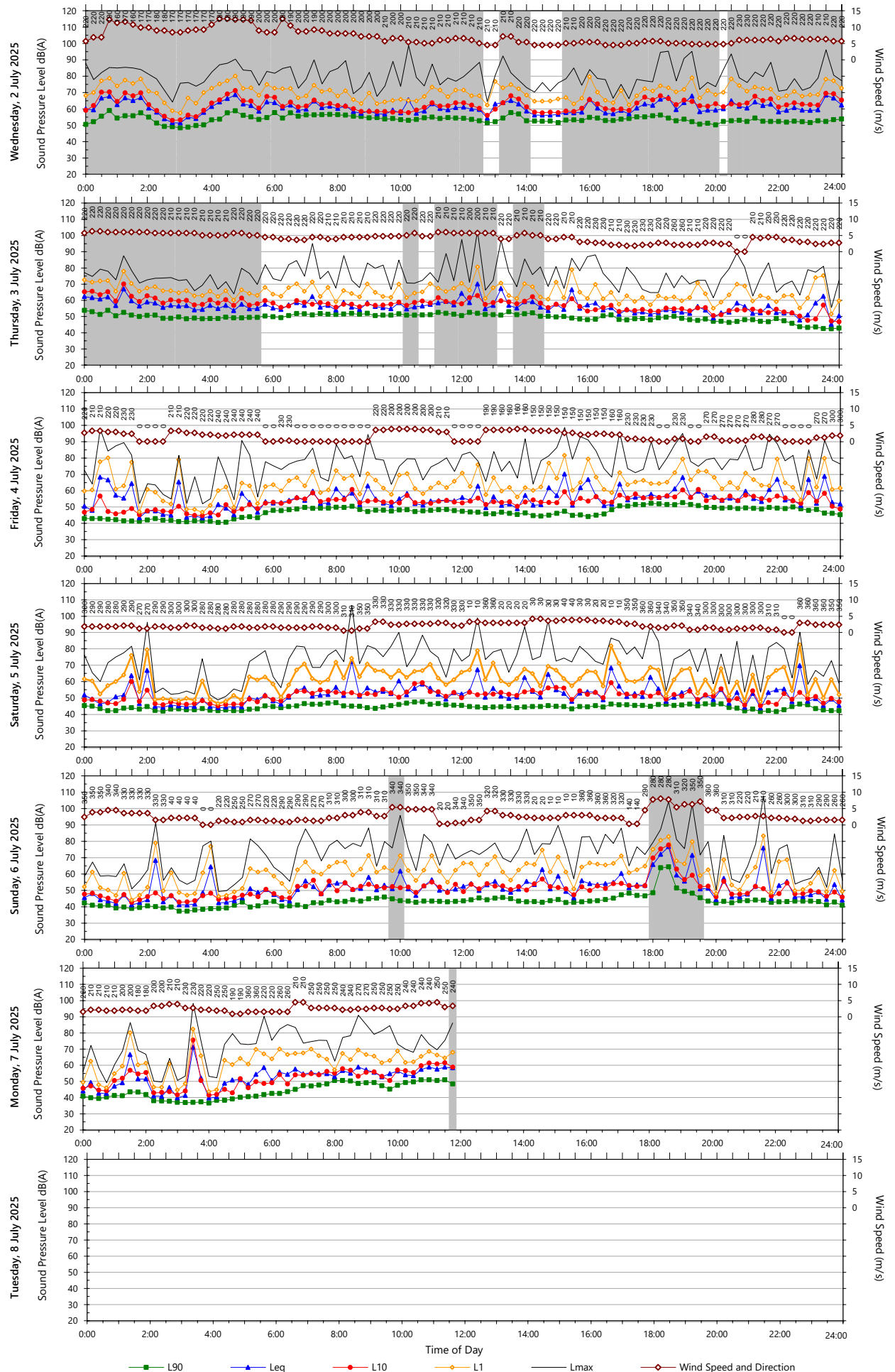
Unattended Monitoring Results

Location: Corrimal Coke Works site - Eastern boundary



Unattended Monitoring Results

Location: Corrimal Coke Works site - Eastern boundary



## APPENDIX D Specification for construction noise monitoring

### D.1 Scope

This document specifies methods for undertaking noise monitoring during the construction phase of the project.

### D.2 Referenced standards and guidelines

- Australian Standard AS IEC 61672.1 2004 '*Electroacoustics - Sound Level Meters - Specifications*'
- Australian Standard AS 1259.2-1990 '*Acoustics - Sound Level Meters*'
- Australian Standard AS 1055-1997 '*Acoustics - Description and Measurement of Environmental Noise*'
- NSW '*Interim Construction Noise Guideline*' (Department of Environment and Climate Change 2009)
- NSW '*Noise Policy for Industry*' (Environment Protection Authority 2017)

### D.3 Testing procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All noise monitoring equipment used must be at least Type 2 instruments as described in AS 1259.2-1990 and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the monitoring equipment shall also be checked in the field before and after the noise measurement period, and in the case of long-term noise monitoring, calibration levels shall be checked at minimum weekly intervals.

Long-term noise monitoring equipment or Noise Loggers, consist of sound level meters housed in weather resistant enclosures. The operator may retrieve the data at the conclusion of each monitoring period in person or remotely if the logger is fitted with mobile communications.

All environmental noise measurements shall be taken with the following meter settings:

- Time constant: FAST (ie 125 milliseconds)
- Frequency weightings: A-weighting
- Sample period: 15 minutes

All outdoor noise measurements shall be undertaken with a windscreen over the microphone. Windscreens reduce wind noise at the microphones.

Measurements of noise should be disregarded when it is raining and/or the wind speed is greater than 5m/s (18km/h).

#### **D.4 Long-term (unattended) monitoring**

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

Noise monitoring equipment shall be placed at positions which have unobstructed views of general site activities, while acoustically shielded as much as possible from non-construction site noise (eg. road traffic, rail noise and other surrounding noise).

Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory for later retrieval is the following A-weighted noise levels:  $L_{min}$ ,  $L_{90}$ ,  $L_{eq}$ ,  $L_{10}$ ,  $L_1$  and  $L_{max}$ .

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Meteorological conditions including wind velocity, wind direction and rainfall shall be monitored over the entire noise monitoring period, either on site or recorded from the nearest weather station to the project site.

#### **D.5 Short-term (attended) monitoring**

Where noise complaints or requests from relevant authorities are received, attended short-term noise monitoring shall also be conducted at the requested outdoor location (unless the issue is related to regenerated noise from tunnelling and driveage works) and at any other relevant noise receiver location with closest proximity to the construction activities.

Short-term noise monitoring shall be used to supplement long-term noise monitoring undertaken at nearby locations, and to establish whether noise levels measured by the long-term noise monitors are determined by construction activities carried out on site.

All attended short-term noise monitoring shall be recorded over 15 minute sample intervals. Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory and reported is the following A-weighted noise levels:  $L_{min}$ ,  $L_{90}$ ,  $L_{eq}$ ,  $L_{10}$ ,  $L_1$  and  $L_{max}$ .

In addition to measuring and reporting overall A-weighted noise levels, statistical  $L_{90}$ ,  $L_{eq}$ ,  $L_{10}$  noise levels shall be measured and reported in third-octave band frequencies from 31.5Hz to 8kHz.

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Outdoor noise monitoring is to be undertaken with the microphone at a height of 1.2 – 1.5m from the ground, unless noise measurements are taken from a balcony or veranda, in which case the same microphone height shall apply off the floor.

Noise measurements inside buildings should be at least 1m from the walls or other major reflecting surfaces, 1.2 m to 1.5m above the floor, and 1.5m from windows.

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

The following information shall be recorded:

- Date and time of measurements;
- Type and model number of instrumentation;
- Results of field calibration checks before and after measurements;
- Description of the time aspects of each measurement (ie sample times, measurement time intervals and time of day);
- Sketch map of area;
- Measurement location details and number of measurements at each location;
- Weather conditions during measurements, including wind velocity, wind direction, temperature, relative humidity and cloud cover
- Operation and load conditions of the noise sources under investigation
- Any adjustment made for presence or absence of nearby reflecting surfaces; and
- Noise due to other sources (eg traffic, aircraft, trains, dogs barking, insects etc).

## APPENDIX E Construction vibration monitoring specification

### E.1 Scope

This document specifies methods for undertaking vibration monitoring during the construction phase of the project. Vibration monitoring during construction activities may be carried out for the following reasons:

- To confirm acceptability of construction techniques, or confirm compliance with limits for structural or cosmetic damage of buildings; or
- To assess compliance with vibration limits for human exposure to vibration.

Monitoring may be carried out in response to specific conditions of approval or complaint. However, the recommended work practice is to conduct proactive monitoring and establish procedures that provide greater assurance of compliance with relevant policy guidelines and Standards throughout all phases of the project works.

#### E.1.1 Requirements for vibration monitoring

Vibration monitoring is to be carried out at the following times in accordance with this Impact Assessment:

- At the commencement of operation of each piece of plant equipment or site activity which has the potential to generate significant vibration levels. The objective of this monitoring is to refine the indicative working distances for vibration generating equipment and provide site-specific minimum working distances. Refer to procedure below for establishment Vibration Minimum Working Distances.
- Where vibration complaints or requests from relevant authorities, at the requested location and at any other relevant vibration receiver location with closest proximity to the construction activities. This may be carried out with short-term or long-term monitoring methods.

Vibration amplitude may be measured as displacement, velocity, or acceleration.

- **Displacement** ( $x$ ) measurement is the distance or amplitude displaced from a resting position. The SI unit for distance is the meter (m), although common industrial standards (including the TfNSW vibration limits) include mm.
- **Velocity** ( $v = \Delta x / \Delta t$ ) is the rate of change of displacement with respect to change in time. The SI unit for velocity is meters per second (m/s), although common industrial standards (including the TfNSW vibration limits) include mm/s. The Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis ( $x$ ,  $y$ , and  $z$ ) then the resultant PPV is the vector sum (i.e. the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.

- **Acceleration** ( $a=\Delta v/\Delta t$ ) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is meters per second squared ( $m/s^2$ ).

## E.2 Referenced standards and guidelines

- AS 2775-2004 *Mechanical vibration and shock – Mechanical mounting of accelerometers*
- AS 2670.2-1990 *Evaluation of human exposure to whole body vibration*
- BS 6472-1992 *Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*
- BS 6841-1987 *Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock*
- BS 7482-1991 Parts 1 and 3: *Instrumentation for the measurement of vibration exposure of human beings*
- BS 7385:1 *Evaluation and Measurement for Vibration in Buildings – Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings*
- BS 7385:2 *Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground borne Vibration*
- DIN 4150-1999 Part 3 *Structural vibration – Effects of vibration on structures*
- ISO 4866 *Mechanical Vibration & Shock – Vibration of Buildings – Guidelines for the Management of the Vibrations and Evaluation of their Effects on Buildings*
- NSW DEC (EPA) 2006 *Assessing Vibration: A technical guide*

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference Standards and guidelines listed above; however, the following notes of importance are included herein.

## E.3 Vibration minimum working distances

Minimum working distances are to be established for each vibration generating item of equipment, as identified in this Plan, to provide a site-specific minimum working distances.

The testing regime should commence at a suitable time to allow sufficient time to amend construction techniques as necessary, without affecting the overall construction program.

Minimum working distances are to be established using identical equipment or simulated practices at a location removed from the sensitive structure or receiver.

Sufficient measurements are to be carried out in accordance with the relevant Standards to confirm the minimum working distances and confirm the acceptable work practices that are likely to be compliant given the proximity of actual works to sensitive receivers and structures.

Consultation between consultants, engineers and the construction team may be required where revision to work practices is required.

### E.3.1 Personnel and equipment

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking vibration measurements.

All vibration monitoring equipment used must be checked for accuracy (to manufacturer's specification) at least every two years against a reference vibration transducer that is calibrated at least every three years [ref: NATA General Accreditation Guidance - General Equipment - Calibration and Checks, General Equipment Table (January 2018)].

Vibration monitors consist of a computer unit connected by cable to a tri-axial vibration transducer which senses vertical, axial and horizontal vibration, or three separate uni-axial vibration transducers positioned in the vertical, axial and horizontal axes. The parameters to be measured differ dependent upon the relevant Standards but may include:

Assessment type	Type of vibration	Relevant standard/guideline	Measurement parameters
Human comfort	Continuous and impulsive	DECC guideline BS 6472-1992	RMS acceleration, 1-80Hz. 1/3 octave weighted as defined in BS6841-1987
	Intermittent vibration	DECC guideline BS 6472-1992	RMS acceleration, 1-80Hz Vibration Dose Values (VDVs) in accordance with BS6472-1992
Structural damage	Non-blasting	DIN 4150-1999 Part 3	Peak-particle velocity (PPV), 1-100Hz
	Non-blasting	BS 7385 Part 2	Peak-particle velocity (PPV), 4-250Hz
Structural damage – sensitive structures	Non-blasting	DIN 4150-1999 Part 3	Peak-particle velocity (PPV), 1-100Hz

Short-term vibration monitors should allow real-time analysis of vibration levels to assist assessment and feedback on the subject operations and procedures.

### E.3.2 Monitoring procedure

Vibration monitoring equipment should be installed in accordance with the following guidance:

- At a location equivalent to the site and ground conditions at the sensitive receiver location. The working distances should not be established via immediate measurement and activities near the sensitive structure.
- The surface should be solid and rigid in order to best represent the vibration levels entering the building/structure under investigation.
- The vibration sensor or transducer should not be mounted on loose gravel or other unstable surfaces.

- The vibration geophone or transducer(s) should be directly mounted to the vibrating surface using bees wax, double sided adhesive tape, or magnetically fixed to a mounting plate fastened to the vibrating surface.
- Where a suitable mounting surface is unavailable, a metal stake (at least 300mm in length) with a mounting plate should be driven into solid ground adjacent to the building of interest. The vibration sensor or transducer shall be fixed on top of the mounting plate.

The following information shall be recorded:

- Date and time of measurements;
- Type and model number of instrumentation;
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day);
- Sketch map of area;
- Measurement location details (including distance from vibrating source) and number of measurements at each location;
- Operation and load conditions of the vibrating plant under investigation and distance from the measurement location; and
- Possible vibration influences from other sources (e.g. other mechanical plant, traffic, railway).

#### **E.4 Long-term (unattended) monitoring**

Long-term unattended vibration monitoring shall be undertaken continuously whilst the vibrating plant is operational within the pre-determined 'minimum working distances' from potentially affected buildings or sensitive structures. Long-term unattended vibration monitoring is generally carried out for the assessment of structural or cosmetic damage rather than human exposure.

##### **E.4.1 Personnel and equipment**

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking vibration measurements.

All vibration monitoring equipment used must be checked for accuracy (to manufacturer's specification) at least every two years against a reference vibration transducer that is calibrated at least every three years [ref: NATA General Accreditation Guidance - General Equipment - Calibration and Checks, General Equipment Table (January 2018)].

Vibration monitors consist of a computer unit connected by cable to a tri-axial vibration transducer which senses vertical, axial and horizontal vibration, or three separate uni-axial vibration transducers positioned in the vertical, axial and horizontal axes.

Long-term monitoring for the management of structural and cosmetic damage should include the following:

- Vibration levels are to be monitored continuously with the following parameters being stored at a maximum interval period of 5 minutes:
  - Peak-particle velocity (PPV) between 1 Hz and 100 Hz for each direction of the tri-axial geophone (or transducers) and vector-sum peak-particle velocity [DIN4150.3];
  - Peak-particle velocity (PPV) between 4 Hz and 250 Hz for each direction of the tri-axial geophone (or transducers) and vector-sum peak-particle velocity [BS 7385.2].
- Vibration levels are to be stored at the pre-defined intervals in the logger memory for record, data analysis or post-processing. Data may be retrieved at the conclusion of each monitoring period either by operator download or remotely via a telephone modem if the logger is fitted with a remote communications option.
- Monitors should be fitted with an audible, visual, SMS or email alert system, triggered to provide warning when the measured level of vibration approaches or exceeds the limits defined by the relevant Standard.
- Where the trigger limits are exceeded, a detailed waveform recording should be stored including a detailed frequency spectrum for assessment against the frequency limit curve.

#### **E.4.2 Monitoring location and mounting**

Vibration monitoring equipment should be installed in accordance with the following guidance:

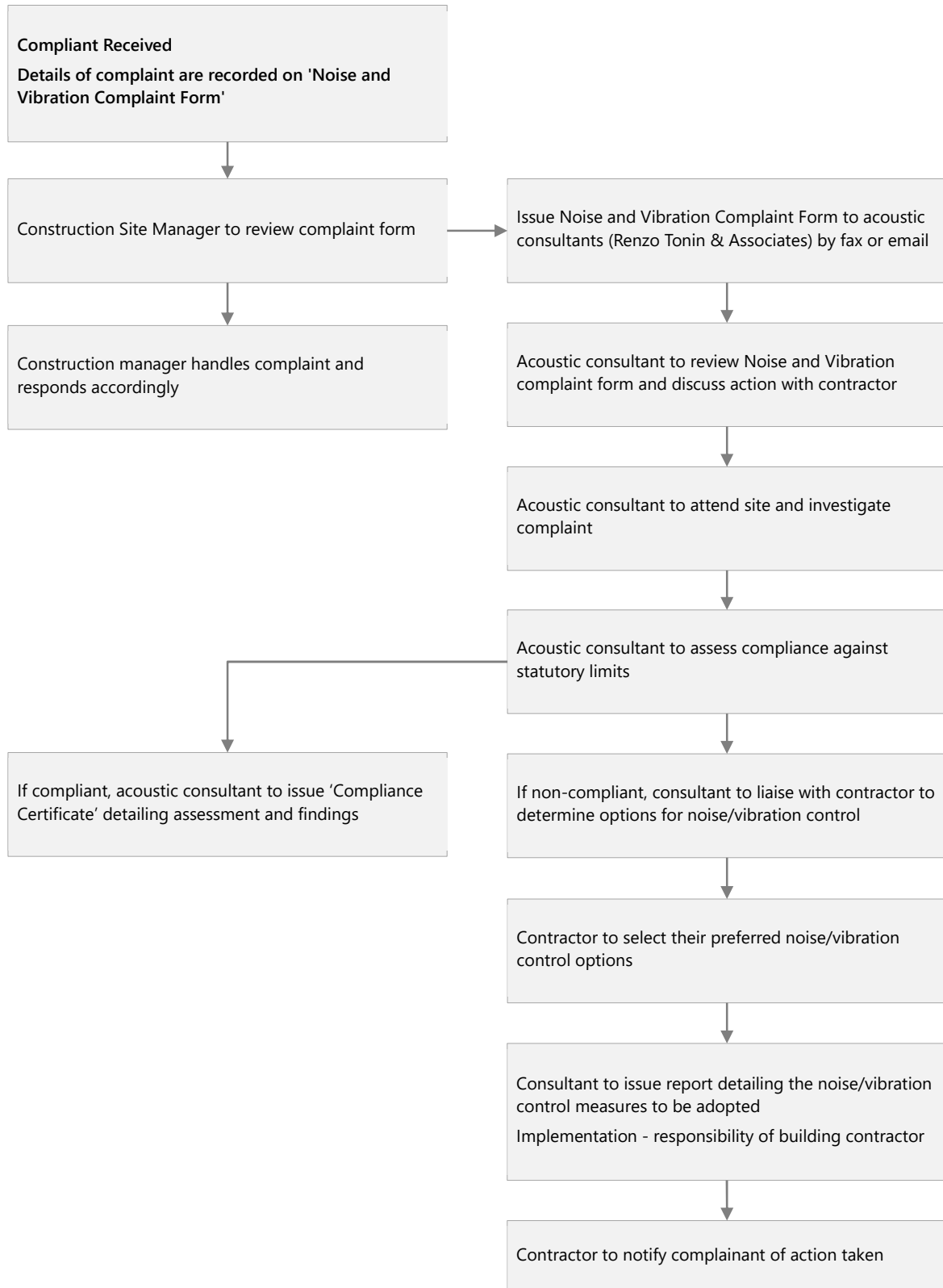
- Equipment should be positioned at the footings or foundations of the building of interest, closest to the vibrating plant.
- The mounting surface should be solid and rigid in order to best represent the vibration levels entering the structure of the building under investigation.
- The vibration geophone or transducer(s) should not be mounted on loose tiles, loose gravel or other unstable surfaces.
- The vibration geophone or transducer(s) should be directly mounted to the vibrating surface using bees wax, double sided adhesive tape, or magnetically fixed to a mounting plate fastened to the vibrating surface.
- Where a suitable mounting surface is unavailable, a metal stake (at least 300mm in length) with a mounting plate should be driven into solid ground adjacent to the building of interest. The vibration sensor or transducer shall be fixed to the mounting plate.

#### **E.5 Vibration measurements in response to complaints**

Proactive vibration monitoring and establishment of procedures that comply with the policy guidelines and Standards is the recommended work practice to reduce the risk of complaint regarding vibration from the site.

There may however be cases where specific monitoring is required to investigate a complaint or issue identified during the project works. Vibration monitoring may be carried out using either short-term or long-term methodologies depending on the nature of the complaint. Short-term attended manned procedures would generally be carried out when measurements are required inside a property or where immediate action and detailed observations are required to be made at the time of measurements. Short-term monitoring would generally follow the procedures outlined for the establishment of Minimum Working Distances. Long-term monitoring would be carried out as described in Section D.4 above.

## APPENDIX F Noise/vibration complaint management procedure



### NOISE/ VIBRATION COMPLAINT FORM

**Project title:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Site contractor:** \_\_\_\_\_ **Phone:** \_\_\_\_\_

**Site contact:** \_\_\_\_\_ **Email:** \_\_\_\_\_

### Complaint details

**Received by (circle):** Phone / Email / In person / Other: \_\_\_\_\_

**Name:** \_\_\_\_\_ **H Ph:** \_\_\_\_\_

**Address:** \_\_\_\_\_ **W Ph** \_\_\_\_\_

**Email:** \_\_\_\_\_ **M Ph** \_\_\_\_\_

Describe when the problem occurred (date and time), what equipment caused the complaint (if known) and where person was standing when he/she experienced the noise/vibration:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### Investigation

Question foreman responsible on site and obtain information on what equipment or processes would most likely have caused the complaint:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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**Following approval from the Project Manager, email/fax this form to Renzo Tonin & Associates**

## APPENDIX G Proposed hoarding/temporary barrier locations

