MACARTHUR GARDENS NORTH - MASTERPLAN

Environmental noise and vibration assessment

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Landcom

TL100-05F01 Masterplan acoustic and vibration assessment (r1)

Sydney Melbourne Brisbane Gold Coast Kuwait Singapore
Renzo Tonin & Associates ABN 29 117 462 861
Level 1/418A Elizabeth St SURRY HILLS NSW 2010 | PO Box 877 STRAWBERRY HILLS NSW 2012
P (02) 8218 0500 F (02) 8218 0501 sydney@renzotonin.com.au www.renzotonin.com.au

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Prepared for:	Landcom
Address:	Level 14, 60 Station Street East, Parramatta NSW 2150
Attention:	Steve Zhou

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1 Introduction

Landcom is preparing a subdivision Masterplan Development Application (DA) at Macarthur Gardens North (MGN) located in Campbelltown. The site is in close proximity to Macarthur train station and is proposed to be transformed into a new residential precinct comprising four lots that will be primarily allocated to apartments.

Campbelltown City Council ('Council') has recently amended Campbelltown Local Environmental Plan 2015 (CLEP 2015), rezoning the MGN site to R4 High Density and B4 Mixed Use. As a result, Landcom is preparing to relodge a revised Masterplan DA which includes the apartment development at the eastern end of the site in accordance with the new R4 zoning.

Renzo Tonin & Associates was engaged to conduct an environmental noise assessment of rail and road noise and vibration impact onto the site from surrounding roads and the adjacent rail line. Noise impacts for road and rail traffic have been assessed in accordance the NSW State Environmental Planning Policy (Infrastructure) 2007 ('ISEPP'), and the NSW Department of Planning document Development near Rail Corridors and Busy Roads - Interim Guideline.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. APPENDIX A contains a glossary of acoustic terms used in this report.

2 Project description

2.1 Site description and development overview

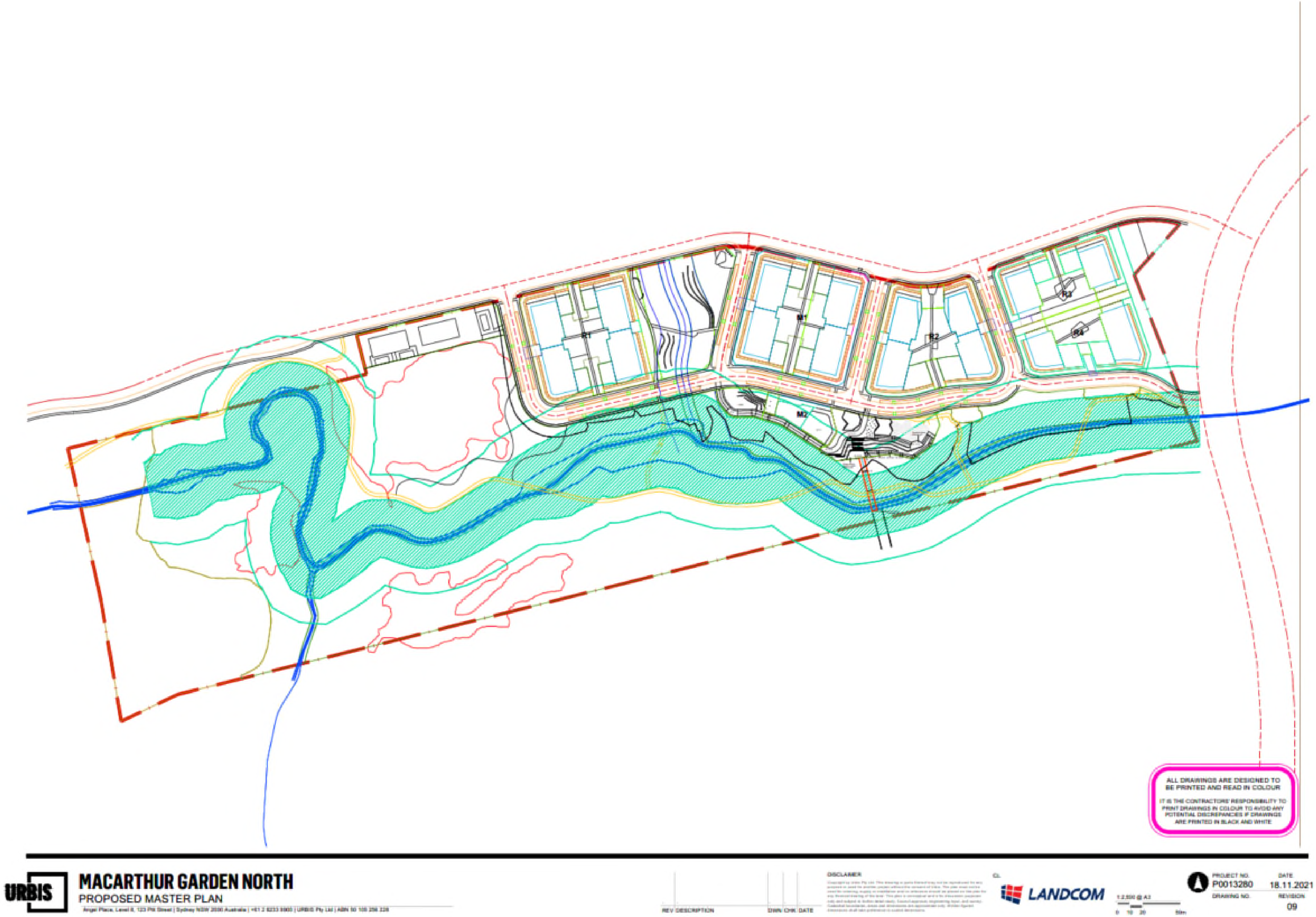
Macarthur Gardens North (MGN) in Campbelltown is located adjacent to Macarthur train station and is proposed to be transformed into a new residential precinct.

The site is bounded by;

- Goldsmith Avenue to the north, which is a two-lane divided road,
- Gilchrist Drive to the east which is a four-lane divided road,
- Southern Railway Line to the south which carries both passenger and freight trains, and
- open space to the west

There is Western Sydney University and TAFE NSW Campbelltown located to the north across Goldsmith Avenue. There are also existing residential properties to the south across the rail line. Figure 1 presents a layout of the Masterplan DA.

Figure 1: Masterplan DA Layout



2.2 Assessment Methodology

In order to assess the road and rail traffic noise impact on the subdivision site, the following methodology was used:

- Conduct noise and vibration monitoring on site to establish existing noise and vibration levels,
- Setup a 3D computer noise model and use the results of noise measurements to validate the model,
- Set appropriate noise and vibration criteria for the future residential receivers within the site
- Conduct predictive noise modelling and determine the extent of noise impact at future residential receivers,
- Identify where road and rail traffic noise emission onto the site might exceed the relevant criteria,
- Provide in-principle mitigation recommendations suitable for inclusion in the DCP and future design documents.

3 Existing Noise Environment

Long-term noise monitoring was conducted at the subject site between 31 October and 8 November 2019 to determine existing background noise conditions and to quantify the current noise impacting the site generated by existing road and rail. The noise monitoring methodology is presented in APPENDIX B.

Short-term attended noise and vibration measurements were also conducted on Friday 8 November 2019 to quantify existing vibration levels from train passbys.

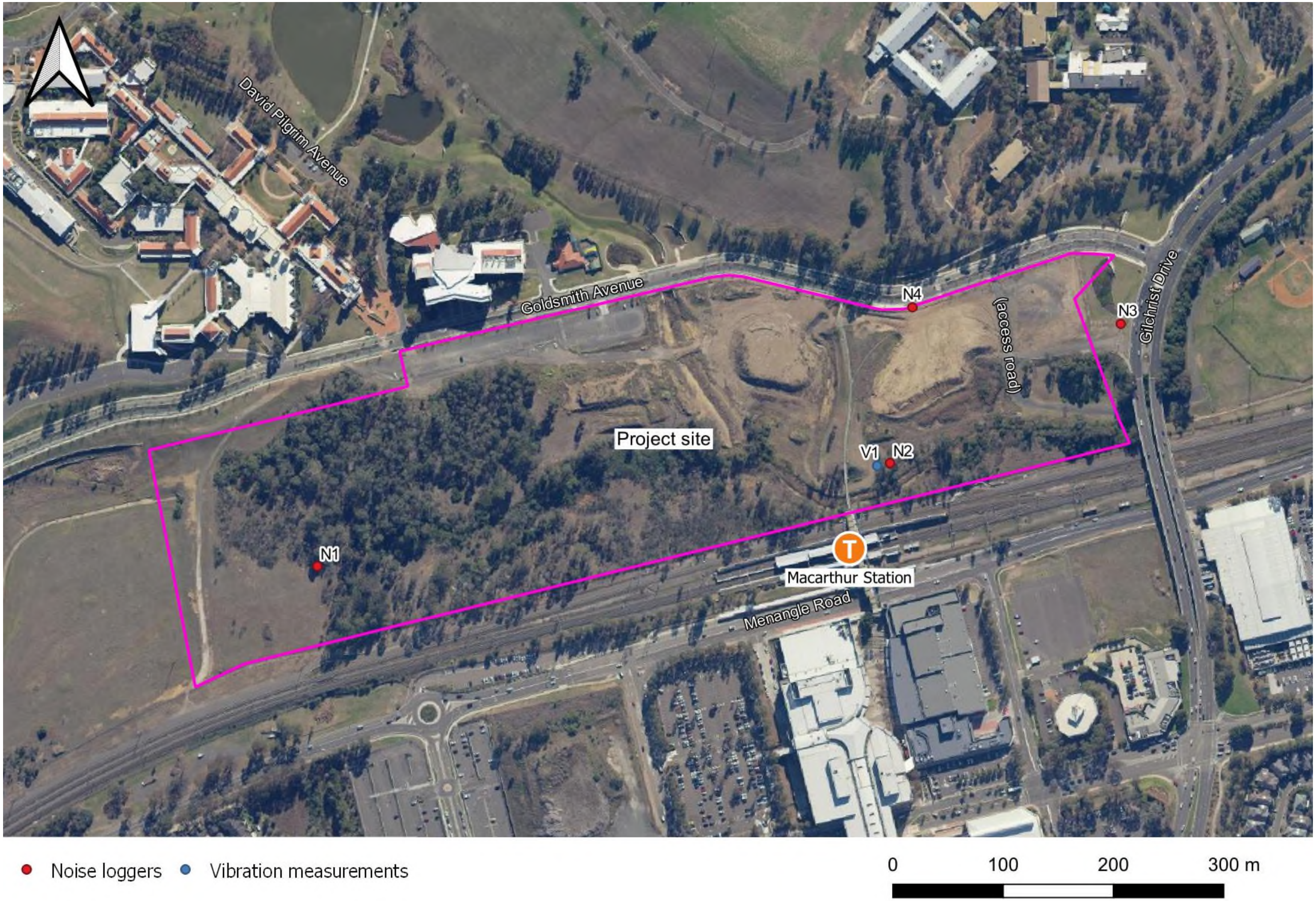
3.1 Noise and vibration measurement locations

The noise and vibration measurement locations are described in Table 1 and presented in Figure 2. The locations have been selected for the noise model validation and have measured noise levels from the critical road and rail noise sources.

Table 1: Noise and vibration measurement locations

ID	Location	Description
Long-term noise monitoring		
N1	MGN - Near rail corridor - West	The monitor was located in the free field approximately 77m to the north of the rail corridor. The noise environment was controlled by rail noise during train passbys, and by distant traffic noise at other times.
N2	MGN - Near rail corridor - East	The monitor was located in the free field approximately 36m to the north of the rail corridor. The noise environment was controlled by rail noise during train passbys, and by distant traffic noise at other times.
N3	MGN - Near Gilchrist Drive	The noise monitor was located in the free field approximately 10m west of Memorial Drive. The noise environment was controlled by traffic noise from Gilchrist Drive, with some traffic from Goldsmith Avenue and occasional passing passenger and freight trains also audible.
N4	MGN - Near Goldsmith Avenue	The noise monitor was located in the free field approximately 5m south of Goldsmith Avenue. The noise environment was controlled by traffic noise from Goldsmith Avenue with some traffic from Gilchrist Drive and occasional passing passenger and freight trains also audible.
Short term vibration monitoring		
V1	MGN - Near rail corridor - East	Operator attended rail vibration survey approximately 35m to the north of the rail corridor.

Figure 2: Noise and vibration measurement locations



3.2 Noise monitoring results

A summary of the long-term noise monitoring results are presented in Table 2 below. The noise monitoring graphs are in APPENDIX C. Vibration measurement results are presented in APPENDIX D.

Table 2: Noise monitoring results

ID	Location	L_{Aeq} Road/Rail noise levels3		L_{A90} Rating Background Level (RBL)		
		Day[1]	Night[2]	Day	Evening	Night
N1	MGN - Near rail corridor - West	55	55	43	44	36
N2	MGN - Near rail corridor - East	60	59	45	45	38
N3	MGN - Near Gilchrist Drive	63	60	51	51	41
N4	MGN - Near Goldsmith Avenue	63	58	46	47	41

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 Noise Criteria

4.1 State Environmental Planning Policy (Infrastructure) 2007 noise limits

In NSW the SEPP (Infrastructure) 2007, also known at the Infrastructure SEPP ('ISEPP'), facilitates the effective delivery of infrastructure across the state. The aim of the policy includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure.

4.1.1 ISEPP Guideline

To support the infrastructure SEPP, the NSW Department of Planning released the Development in Rail Corridors and Busy Roads – Interim Guideline (December 2008). The Guideline assists in the planning, design, and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality.

The Guideline clarifies the time period of measurement and assessment. As stated in the Guideline in Section 3.4 'What Noise and Vibration Concepts are Relevant' and Table 3.1 of Section 3.6.1, noise measurements are determined over the following relevant time periods:

- Daytime 7am - 10pm $L_{Aeq(15hr)}$
- Night-time 10pm - 7am $L_{Aeq(9hr)}$

L_{Aeq} is the Equivalent Continuous Noise Level and accounts for both the level of fluctuating noise and the number of noise events over the time period. The noise criteria nominated in the ISEPP are internal noise levels with windows and doors closed and the requirements are stated in the following table.

Table 3: ISEPP internal road and rail traffic noise criteria

Internal space	Time period	Noise metric	Internal criteria^
Bedrooms	7am - 10pm	$L_{Aeq(15hrs)}$	40*
	10pm - 7am	$L_{Aeq(9hrs)}$	35
Other Habitable Rooms	Any Time	$L_{Aeq(15hrs)}$ and $L_{Aeq(9hrs)}$	40

Notes: ^ With windows and doors closed.
* Whilst not specified in the ISEPP, daytime criteria for bedrooms are set to 40dB(A), as per the other habitable rooms.

The Guideline in Section 3.6.1 'Airborne Noise' states as follows:

> *"If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia."*

As noise modelling is undertaken for external locations, the above criteria and guidelines have been used to establish equivalent external noise criteria. This external noise criterion is used to determine which building facades may require specific acoustic treatment to meet the requirements of the ISEPP. External goals have been calculated based on a nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA 2011 requirements.

Table 4: ISEPP road and rail traffic noise criteria for new residential development

Room	Location	$L_{Aeq, 15hr}$ Day 7am - 10pm	$L_{Aeq\ 9hr}$ Night 10pm - 7am
Living rooms*	Internal, windows closed	40	40
	Internal, windows open	50	50
	External free-field (allowing windows to remain open)^	60	60
Bedrooms*	Internal, windows closed	40	35
	Internal, windows open	50	45
	External free-field (allowing windows to remain open)^	60	55

Notes: * Requisite for 40,000AADT Roads only under ISEPP 2007.

^ ISEPP Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open mechanical ventilation is required. External goals have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA 2011 requirements.

4.2 Campbelltown Council DCP 2015

The Campbelltown DCP 2015, states the following in Volume 1 SCDCP 2015 Amendments No 11 - Part 5 – Residential Flat Buildings and Mixed-Use Development:

Section 5.4.4 Acoustic Privacy

a) Residential flat buildings, and the residential component of a mixed-use development shall provide noise mitigation measures to ensure that the following LAeq levels are not exceeded:

i) in any bedroom in the building - 35 dB(A),

ii) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40dB(A)

b) Residential flat buildings, and the residential component of a mixed-use development near railway corridors and major roads shall demonstrate to Council's satisfaction compliance with the requirements under the Guidelines entitled Development Near Rail Corridors and Busy Roads – Interim Guideline, 2008),

These acoustic requirements within Section 5.4.4 part (b) of the Campbelltown DCP 2015 are consistent with the ISEPP guideline requirements, outlined in Section 4.1.

5 Noise Model Inputs and Validation

A 3D noise model was setup using the CadnaA noise modelling software package. The key inputs to this model included:

- Ground topography survey
- 3D building blocks obtained from Landcom
- Traffic movements along Gilchrist Drive, Goldsmith Avenue and Menangle Road.
- Passenger train and freight train movements along the Southern Railway Line

5.1 Road Traffic Noise Prediction Modelling

Road noise predictions are based on a method developed by the United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)" known as the CoRTN (1988) method. This method has been adapted to Australian conditions and extensively tested by the Australian Road Research Board and as a result it is recognised and accepted by the EPA. The model predicts noise levels for steady flowing traffic and noise from high truck exhausts is also taken into account. The CORTN algorithms are contained within the 'CadnaA' noise modelling software which has been used to calculate traffic noise levels at receivers. The noise model inputs are shown in Table 5.

Table 5: Road Noise Model Inputs

Input Parameters	Data Acquired From
Gradient of roadway	Topographic data obtained from ELVIS
Source height	0.5 metre for car exhaust, 1.5 metres for car and truck engines and 3.6 metres for truck exhaust and detailed within CORTN88
Ground topography at receiver (i.e. lot pad elevation) and road	Topographic data obtained from ELVIS and Landcom
Angles of view from receiver	Calculated in CadnaA
Reflections from existing barriers, structures and cuttings on opposite side of road	Calculated in CadnaA through CoRTN algorithm
Ground absorption	A global value of 1.0 has been used which represents soft ground A localised value of 0.0 is applied for water surfaces (future model only)
Receiver Heights	1.5 metre above ground level for ground floor and an additional 3 metres for every subsequent floor
Facade correction	No Facade Correction
Site specific road noise model emission level*	Determined from on site road noise monitoring

Note * Emission level based on traffic volumes and heavy vehicle percentage and vehicle speed

5.2 Rail Noise Prediction Modelling

Rail noise emissions have been predicted using Nordic Prediction Method (NPM) 1996. The NPM 1996 algorithms are contained within the 'CadnaA' noise modelling software which has been used to calculate rail noise levels at receivers. The noise model inputs are shown in Table 6.

Table 6: Rail Noise Model Inputs

Input Parameters	Details
Train Length	Standard lengths of 80m for passenger (4 cars), 650m for day freight and 1600m for night freight
Source Height	Contained within NPM 1996 and vary in height
Ground topography at receiver (i.e. lot pad elevation) and rail	Topographic data obtained from ELVIS and Landcom
Angles of view from receiver	Calculated in CadnaA
Reflections from existing barriers, structures and cuttings on opposite side of road	Calculated in CadnaA through NPM 1996 algorithm
Ground absorption	A value of 1.0 has been used which represents soft ground A value of 0.0 is applied for the water surfaces (future model only)
Receiver Heights	1.5 metre above ground level for ground floor and an additional 3 metres for every subsequent floor
Facade correction	No Facade Correction
Site specific rail noise model emission level (sound power per unit length*	Determined from on site rail noise monitoring

Note * Emission level based on train movements and train speed

5.3 Noise Validation

Based on the information within Table 5 and Table 6, noise levels were predicted to noise monitoring locations N1, N2, N3 and N4. The table below shows that the noise model is validating well, generally within 1dB of the measured noise levels. The model is therefore deemed to be appropriated validated and acceptable for predicting future noise levels across the site.

Table 7: Noise model validation (combined road and rail noise)

ID	Location	Measured		Modelled		Difference (Modelled minus measured)	
		Day	Night	Day	Night	Day	Night
N1	MGN - Near rail corridor - West	52.8	52.9	53.3	52.4	0.5	-0.5
N2	MGN - Near rail corridor - East	57.4	56.0	57.0	56.8	-0.4	0.8
N3	MGN - Near Gilchrist Drive	60.6	57.5	60.7	57.7	0.1	0.2
N4	MGN - Near Goldsmith Avenue	60.4	55.6	60.8	55.3	0.4	-0.3
					Average Difference	**0.2**	**0.0**

6 Noise Prediction Results and Treatment Recommendations

6.1 Noise Prediction Results

Noise predictions have been conducted for both the daytime and night-time periods. The coloured noise contour map in APPENDIX E show the resultant noise levels over the site due to traffic and rail noise. The predicted levels are “free field” levels and do not include facade correction.

Results from noise modelling was used to calculate internal noise levels within the future dwellings, based on standard building design assumptions contained within the ISEPP Guideline. Noise calculations were performed using acoustic design software which considers external noise levels, facade transmission loss and room sound absorption characteristics.

The noise contour map in APPENDIX E represents noise levels during the night-time period at a height of 4.5m above ground, which represents a receiver at Level 1 (one floor above ground level). The layout and arrangements of buildings is from Landcom.

With reference to the coloured noise contour map, the following outcomes were determined:

- Building facades within the ‘green’ shaded areas are predicted to meet the ISEPP internal noise criteria with no specific acoustic facade treatment. These buildings can be of ‘standard’ construction and will not require mechanical ventilation for acoustic reasons.
- The building facades that are not within the green areas will require some acoustic facade treatments to meet the ISEPP internal criteria (refer to Section 6.2 below).

6.2 Building Treatments

APPENDIX F indicates the indicative acoustic category treatments that would be required to meet the ISEPP internal criteria inside residences. These results assume no acoustic fencing is installed between the rail line and the development, nor between Gilchrist Drive and Goldsmith Avenue and the development.

The typical construction details for each category treatments are provided in APPENDIX F. These construction details are in broadly line with the standard measures recommended in Appendix C of the ISEPP “*Development near Rail Corridors and Busy Roads – Interim Guideline* (December 2008)”.

These treatment recommendations are for the purpose of the proposed updated Masterplan DA. They should be confirmed during design development as more detail about the building facade locations, orientations, window sizes, etc, detail becomes available.

6.3 Mechanical Ventilation

To meet the ISEPP internal noise level requirements, the following buildings are likely to require mechanical ventilation to allow windows to remain closed if so desired by the resident. This is due to the ISEPP requirement that …"*If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire".*

- Northern facade of building in Lot R1_1, Lot R1_2, Lot R1_7, Lot R1_8, Lot R2_1, Lot R2_6, Lot R3_1, Lot R3_2, Lot R3_3, Lot R3_4, Lot M1_1, Lot M1_2, Lot M1_7, Lot M1_8.
- Southern facade of buildings in Lot R1_3, Lot R1_4, Lot R1_5, Lot R1_6, Lot R2_2, Lot R2_3, Lot R2_4, Lot R2_5, Lot R3_4, Lot R4_1, Lot R4_2, Lot R4_3, Lot R4_4, Lot M1_3, Lot M1_6, Lot M2_1 (including southwest), Lot M2_2.
- Eastern facade of buildings in Lot R1_2, Lot R1_3, Lot R2_1, Lot R2_2, Lot R2_4, Lot R2_5, Lot R2_6, Lot R3_1 Lot R3_4, Lot R4_1 Lot R4_2, Lot M1_3, Lot M2_1.
- Western facade of buildings in Lot R2_1, Lot R2_2, Lot R2_3 Lot R3_1, Lot R3_4, Lot R4_1, Lot R4_3, Lot R4_4, Lot M2_1, Lot M2_2.

7 Rail Vibration Assessment

7.1 Vibration Criteria

7.1.1 Regenerated noise

The Department of Planning's "Development near Rail Corridors & Busy Roads – Interim Guideline" 2008 (DoP Guideline) provides recommended criteria for ground-borne or regenerated rail noise. Table 8 below provides a summary of the noise limits for sleeping and living spaces.

Table 8: Recommended Internal Noise Criteria for Regenerated Rail Noise

Occupancy	Period	L_{Amax} Noise Limit [1]
Sleeping areas (Bedrooms)	10pm – 7am	35 dB(A)
Other habitable rooms (excluding garages, kitchens, bathrooms, and hallways)	At any time	40 dB(A)

Notes:

1. L_{Amax} – is the-weighted maximum sound pressure level measures using a "slow" response time

7.1.2 Rail tactile vibration

Section 3.6.3 of the DoP Guideline provides recommended vibration criteria in accordance with the following documents:

1. Department of Environment and Conservation 2006 publication "Assessing Vibration: a technical guideline" (DEC Guideline)
2. German Standard DIN 4150 Part 3 1992
3. British Standard BS 7385 Part 2 1993
4. Australian Standard AS 2670.2 1990

The above documents have been reviewed and the criteria for assessment tactile vibration from train pass-byes affecting the proposed development is quantified in accordance with:

- Assessing Vibration: A technical guideline (Department of Environment and Conservation, 2006)
- British Standard BS6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)"

The criteria curves presented in BS6472:1992 are identical to those in Australian Standard AS2670.2 1990 and the International Standard 2631-2:1989.

Criteria for continuous vibration from the British Standard BS6472:1992 for residential spaces are shown in Figure 3 below.

Figure 3: Tactile Vibration Criteria for Residential Buildings

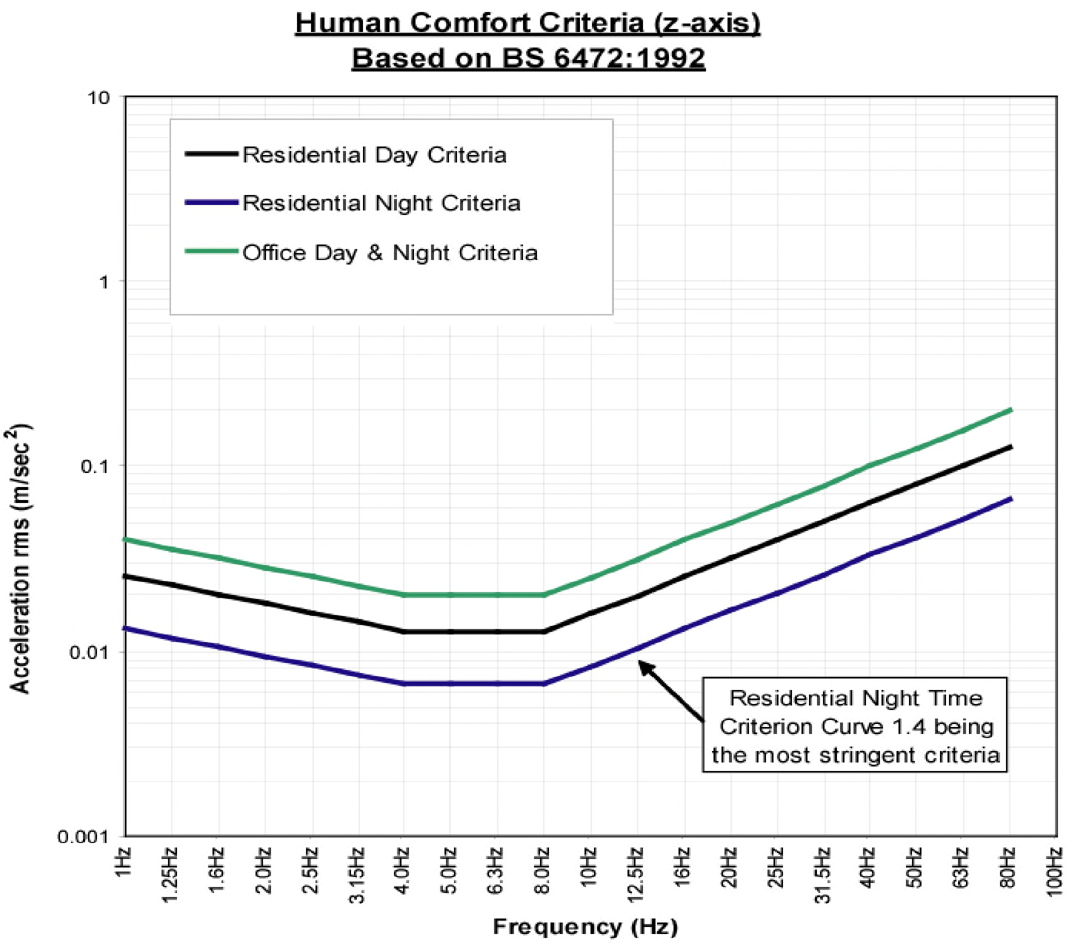


Table 2.4 of the DEC Guideline presents acceptable vibration dose values for intermittent vibration. Table 9 below outlines DEC's requirements.

Table 9: Acceptable VDVs for intermittent vibration in residential buildings $m/s^{1.75}$

Location	Period	Preferred VDV $m/s^{1.75}$
Residence	Day time (7am – 10pm)	0.20
	Night time (10pm – 7am)	0.13

7.2 Rail vibration monitoring locations

An operator attended rail vibration survey was undertaken on site**.** Vibration measurements were undertaken at one location approximately 35m north of the Southern Railway Line corridor. Results were analysed and predicted to the worst affected residential dwelling location, approximately 65m north of the rail corridor.

7.3 Vibration Instrumentation

Train vibration levels were measured using the Sinus SoundBook multi-channel analyser and Endevco accelerometers. Three accelerometers (x, y & z) were fixed to a steel bracket and metal spike impaled into the soil ground on site.

Weather conditions were fine during the operator-attended survey. All instruments were calibrated before and after measurement. No significant drift in calibration was observed.

7.4 Measured tactile train vibration and assessment to BS6472 and DEC

Results of the train vibration survey were plotted against night and day criterion of British Standard BS6472-1992 “Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)” as shown in APPENDIX D. In addition, the measured train vibration levels were used to calculate the vibration dosage values (VDV) and then compared to the acceptable levels from the Table 2.4 of DEC Guideline 2006.

Results from the measurements demonstrate that the floor induced vibration within the proposed worst-affected dwelling from each of the measured train pass-byes are predicted to be compliant with the British Standard BS6472:1997 for human comfort in a residential environment during the day and night. Similarly, the calculated vibration dosage values (VDV) complied with the preferred day and night VDV criterion as defined in the DEC guideline 2006.

Freight movements were not measured on site however measurements from a previous project were utilised. In accordance with Section 3.5.1 of the ISEPP guideline the proposed development is outside of the vibration assessment zone. Nevertheless, based on measurements conducted at a similar site (where compliance with freight movements was determined at a distance of 25 metres) compliance at the nearest proposed residence with approximately 65 metre setback is predicted.

7.5 Calculated ground-borne rail noise inside proposed development

Regenerated or ground-borne rail noise is the low rumble heard inside buildings with vicinity of railway lines due to ground vibration generated by passing trains which propagate through soil and rock and up into building elements such as foundation, wall and floors which re-radiates as audible sound.

Train vibration levels measured on site were used to predict the regenerated rail noise inside the proposed dwellings nearest to the rail corridor. These calculated internal noise levels are summarised in Table 10 below and compared to ground-borne noise criteria.

Table 10: Calculated Regenerated Rail Noise Levels Inside Residence

Floor Level	Proposed Occupancy/Space	Calculated Ground-borne Rail Noise inside residence	DoP Guideline 2008 Criteria[1] for Ground-borne Rail Noise inside Dwellings
Ground	Residential – sleeping areas	23 dB(A)	35 dB(A)

Floor Level	Proposed Occupancy/Space	Calculated Ground-borne Rail Noise inside residence	DoP Guideline 2008 Criteria[1] for Ground-borne Rail Noise inside Dwellings

Notes:

1. Ground-borne noise calculations were based upon the measured $L_{Max\ (Slow)}$ of 95% of train pass-events as per DOP Guideline 2008.

The calculated levels of ground borne rail noise comply with the DoP guideline criteria. In addition, It is likely that the air borne noise level at a residence facing the rail line during a train pass-by will exceed the ground borne noise level. Therefore, the ground borne rail noise contribution is not likely to be noticeable at the residence and would not be an impact. Ground-borne noise is more commonly an issue for rail tunnels where there is no air borne noise component to mask the ground borne noise.

As described above for tactical vibration, freight movements are also predicted to comply with the ground-borne criteria.

8 Conclusion

Renzo Tonin & Associates has conducted an environmental noise assessment of rail noise and vibration impact onto the updated Masterplan subdivision at Macarthur Gardens North (MGN) site to assist in understanding any constraints for residential uses.

The assessment has been undertaken in accordance with *NSW State Environment Planning Policy (Infrastructure) 2007*, the associated *Development in Rail Corridors and Busy Roads – Interim Guideline,* and other relevant vibration standards.

The findings of this study are:

- Some facades of proposed residential buildings with exposure to road and rail noise will require acoustic facade treatments to meet the ISEPP criteria. The affected lots have been identified and indicative facade treatment recommendations provided.
- Some building facades have been identified to require mechanical ventilation.
- Vibration impacts from the rail line have been found to be compliant with human comfort vibration criteria.
- Ground borne rail noise during train passbys is compliant.

In summary, noise and vibration issues do not present any constraint to the site being developed for residential use. Noise impacts can be suitably mitigated to achieve compliance through standard acoustic treatments. As such, the updated Masterplan Development Application can be supported in relation to potential noise and vibration impacts.

APPENDIX A Glossary of terminology

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

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 110dB Operating a chainsaw or jackhammer 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B 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
RTA04 (NTi Audio XL2)	Type 1	1/1	N4
RTA05 (NTi Audio XL2)	Type 1	1/1	N1, N2, N3

Note: 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 4230 calibrator. No significant drift in calibration was observed.

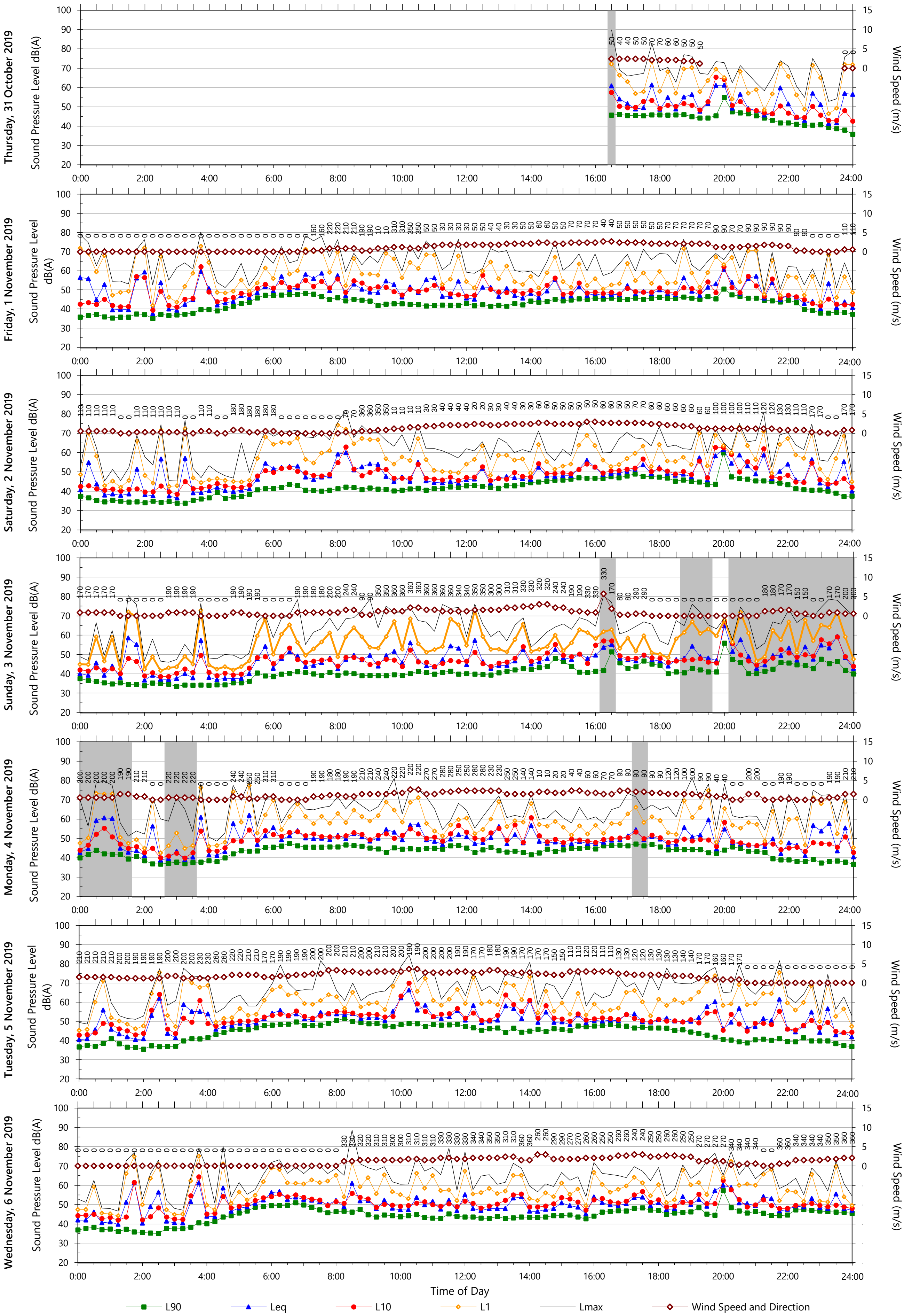
B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW INP. 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.

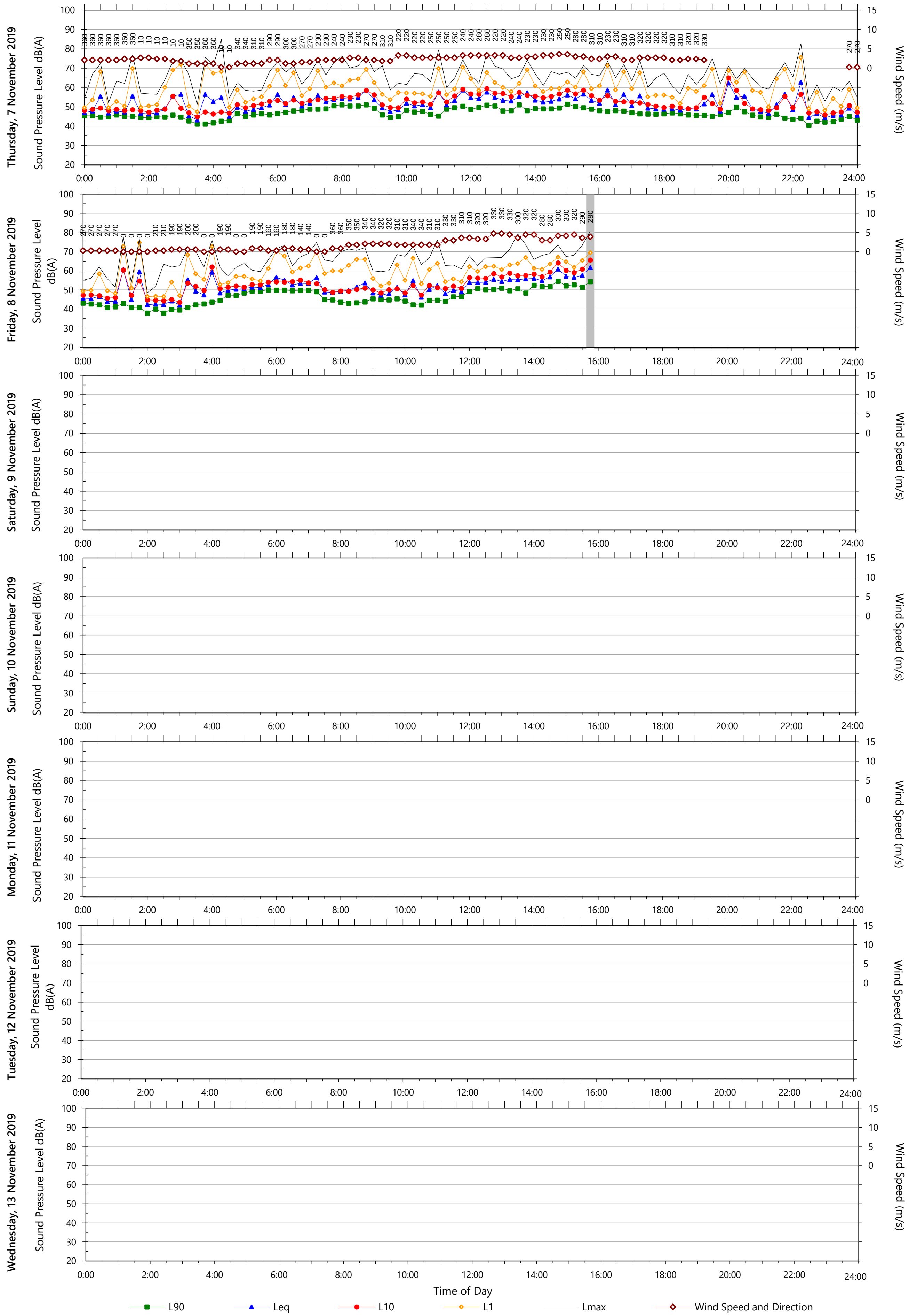
APPENDIX C Long-term noise monitoring results



Data File: 2019-10-31_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r31)

Unattended Monitoring Results **Location: Location 1 - Near Rail Corridor West**

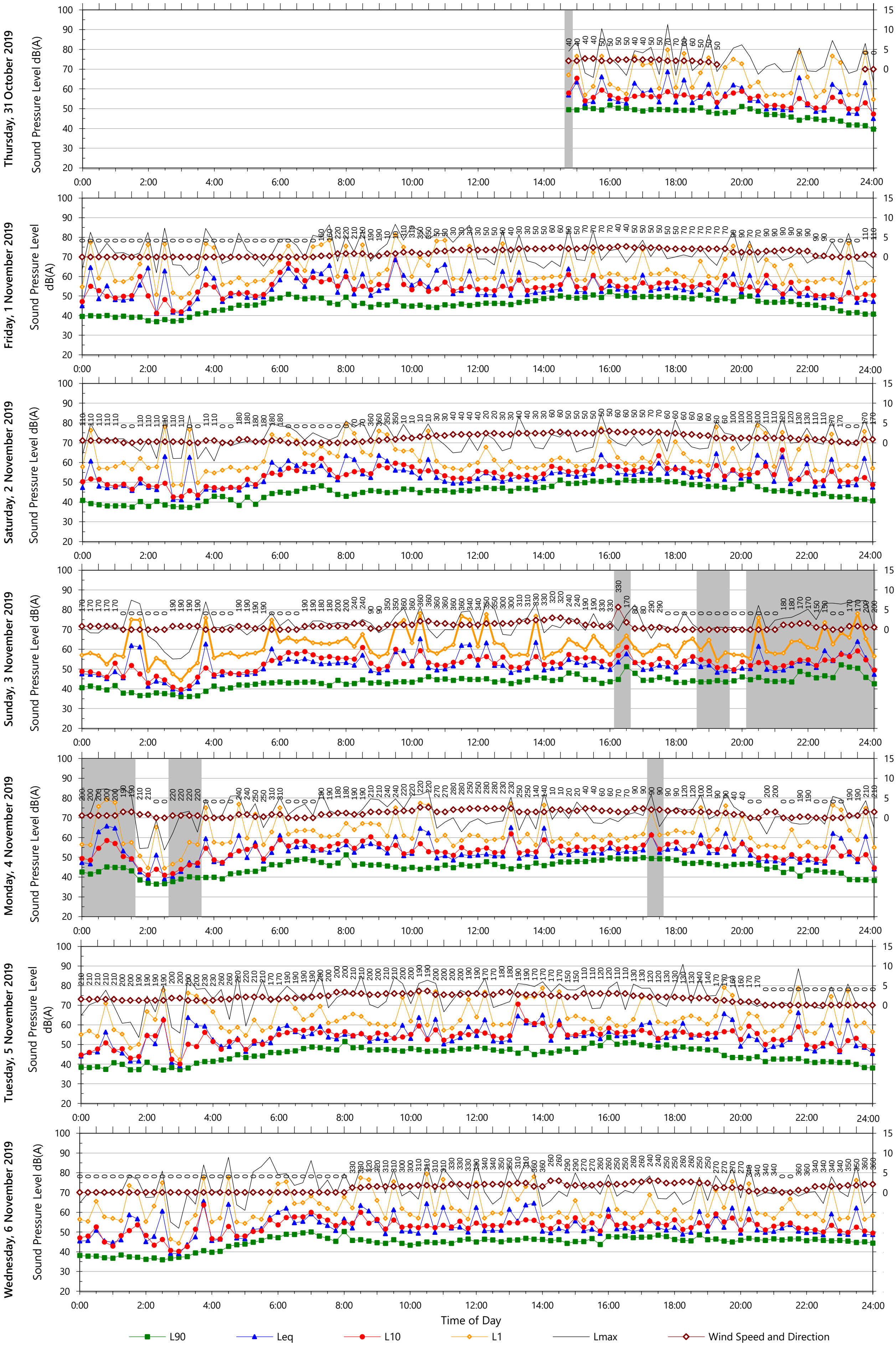


Data File: 2019-10-31_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r31)

Unattended Monitoring Results

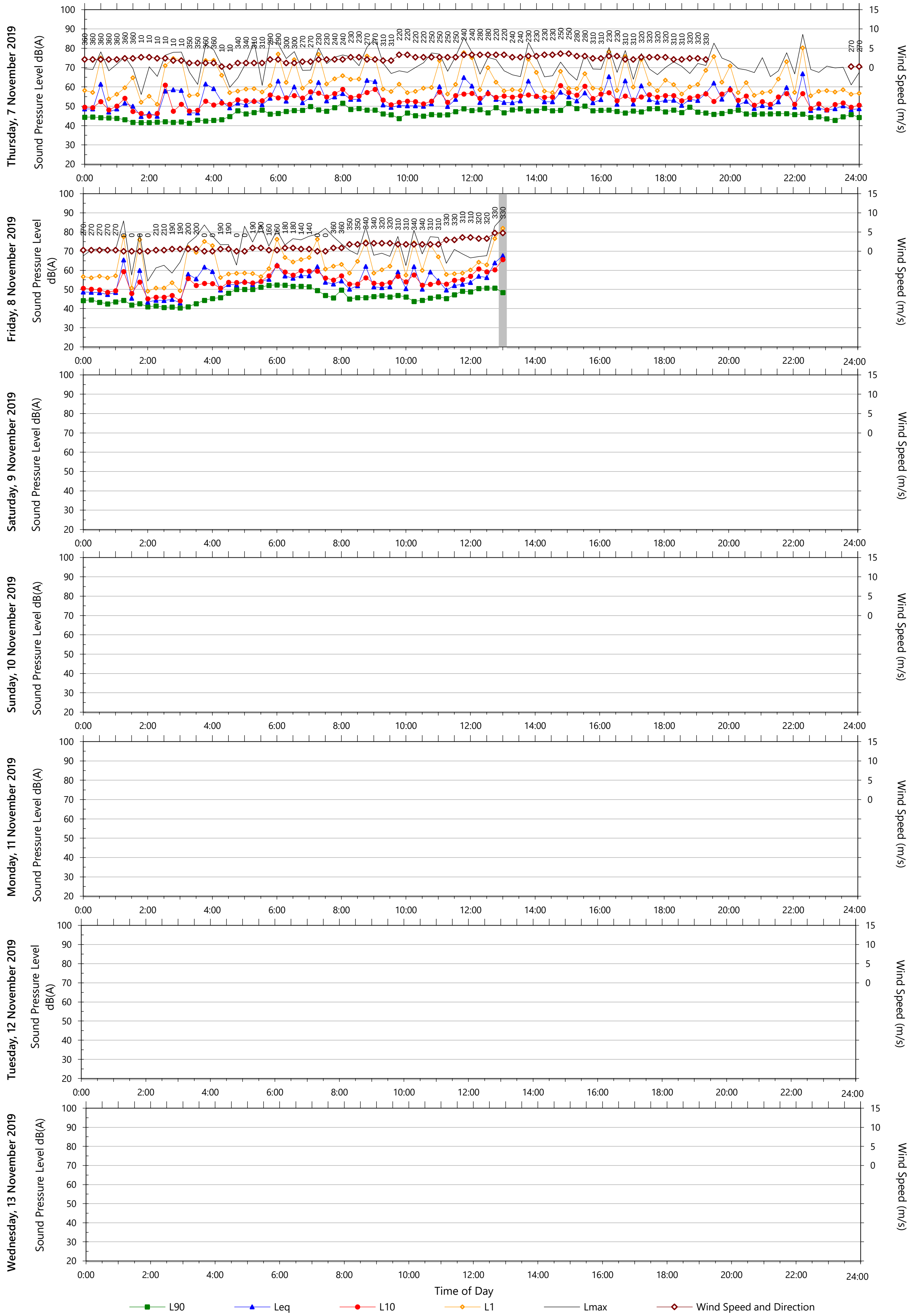
Location: Location 2 - Near Rail Corridor East



Data File: 2019-10-31_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r31)

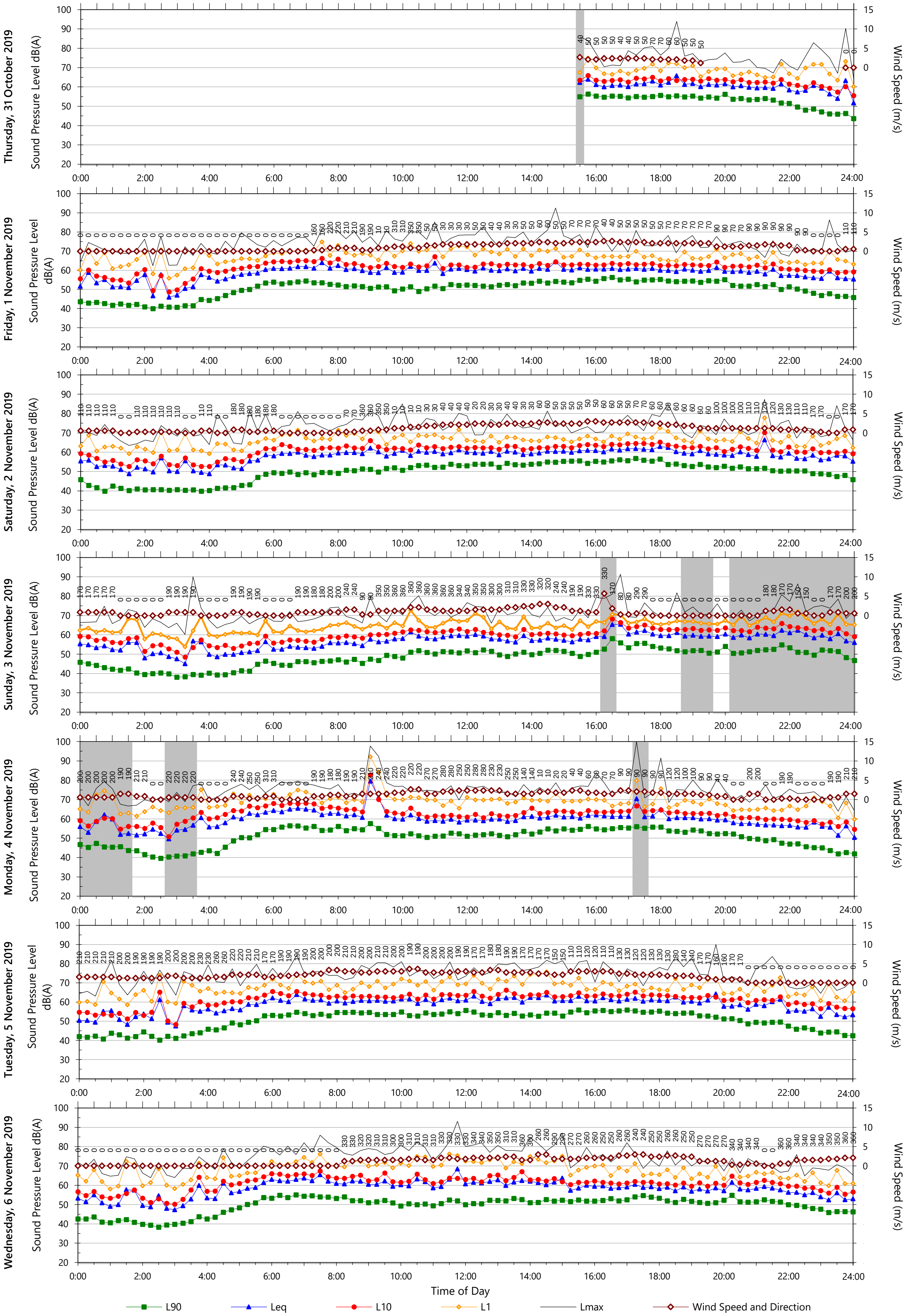
Unattended Monitoring Results **Location: Location 2 - Near Rail Corridor East**



Data File: 2019-10-31_SLM_000_123_Rpt_Report.txt

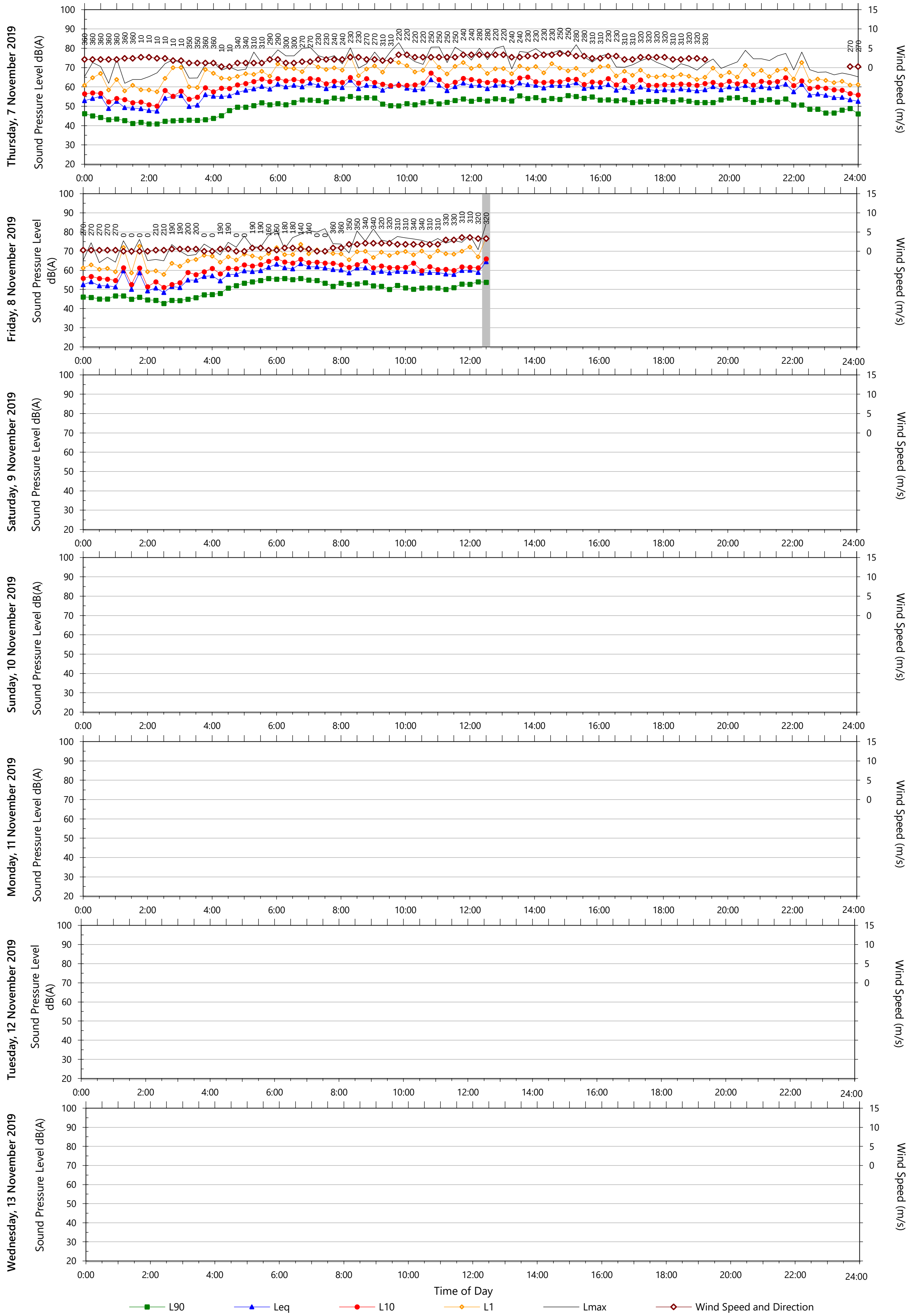
Template: QTE-26 Logger Graphs Program (r31)

Unattended Monitoring Results **Location: Location 2 - Near Gilchrest Drive**



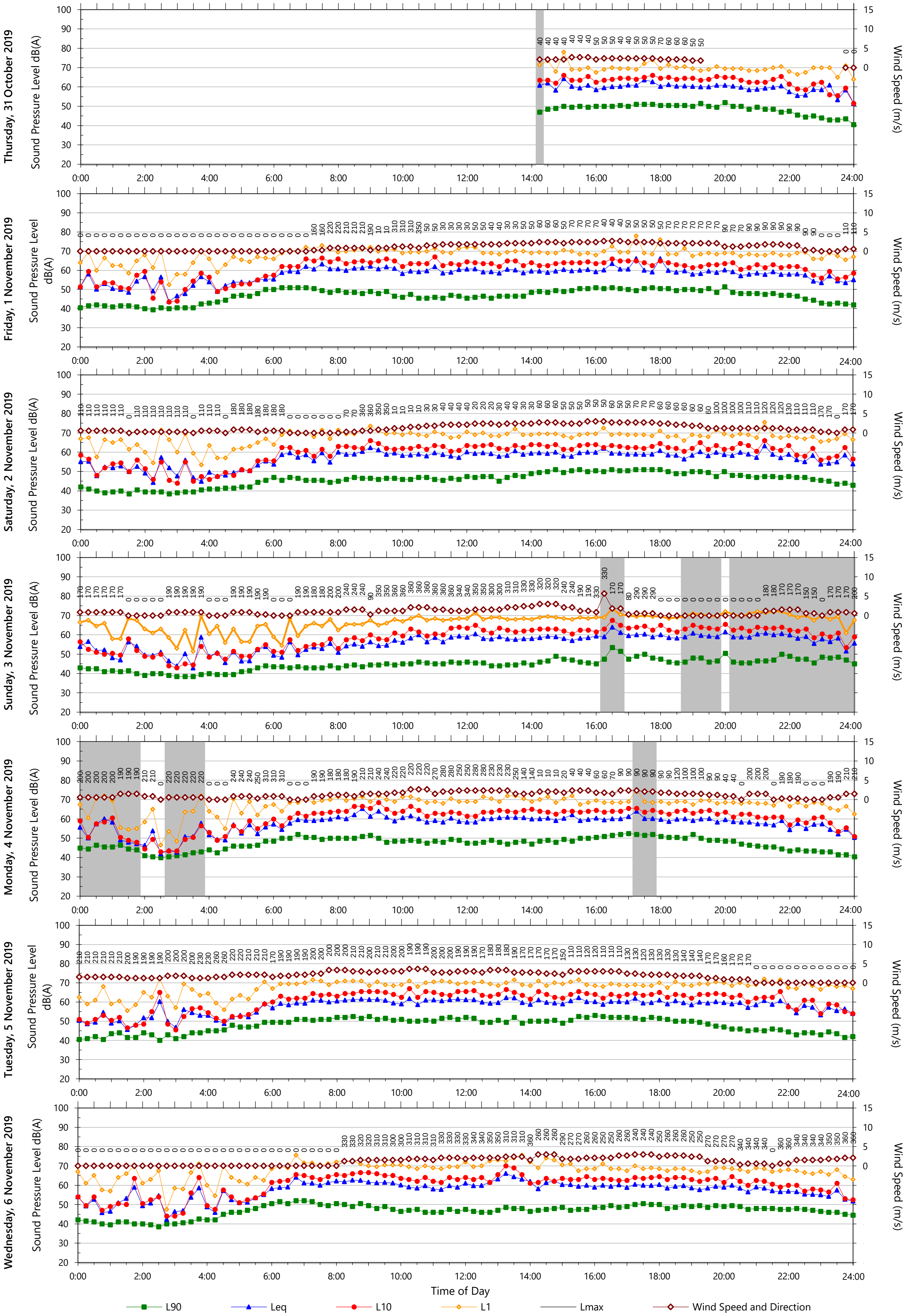
Data File: 2019-10-31_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r31)



Data File: 2019-10-31_SLM_000_123_Rpt_Report.txt

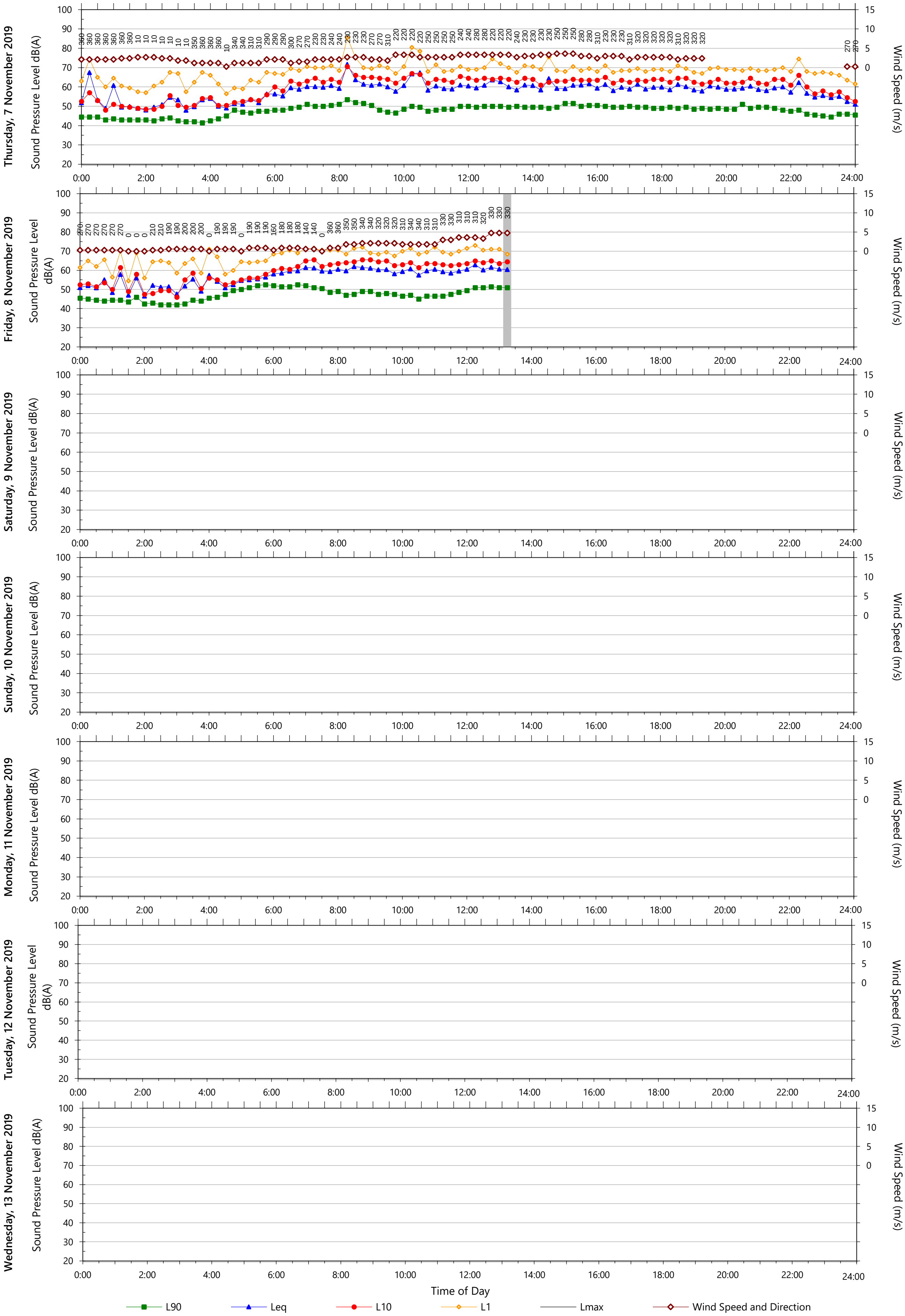
Template: QTE-26 Logger Graphs Program (r31)



Data File: R:\AssocSydProjects\TL051-TL100\TL100 mg Macarthur Gardens North\4 Field Work\2 Logger\04-013\2019-10-31_14-00-00_001_RTA.xls

Template: QTE-26 Logger Graphs Program (r31)

Unattended Monitoring Results **Location: Location 4 - Near Goldsmith Avenue**



Data File: R:\AssocSydProjects\TL051-TL100\TL100 mg Macarthur Gardens North\4 Field Work\2 Logger\04-013\2019-10-31_14-00-00_001_RTA.xls

Template: QTE-26 Logger Graphs Program (r31)

APPENDIX D Vibration monitoring results

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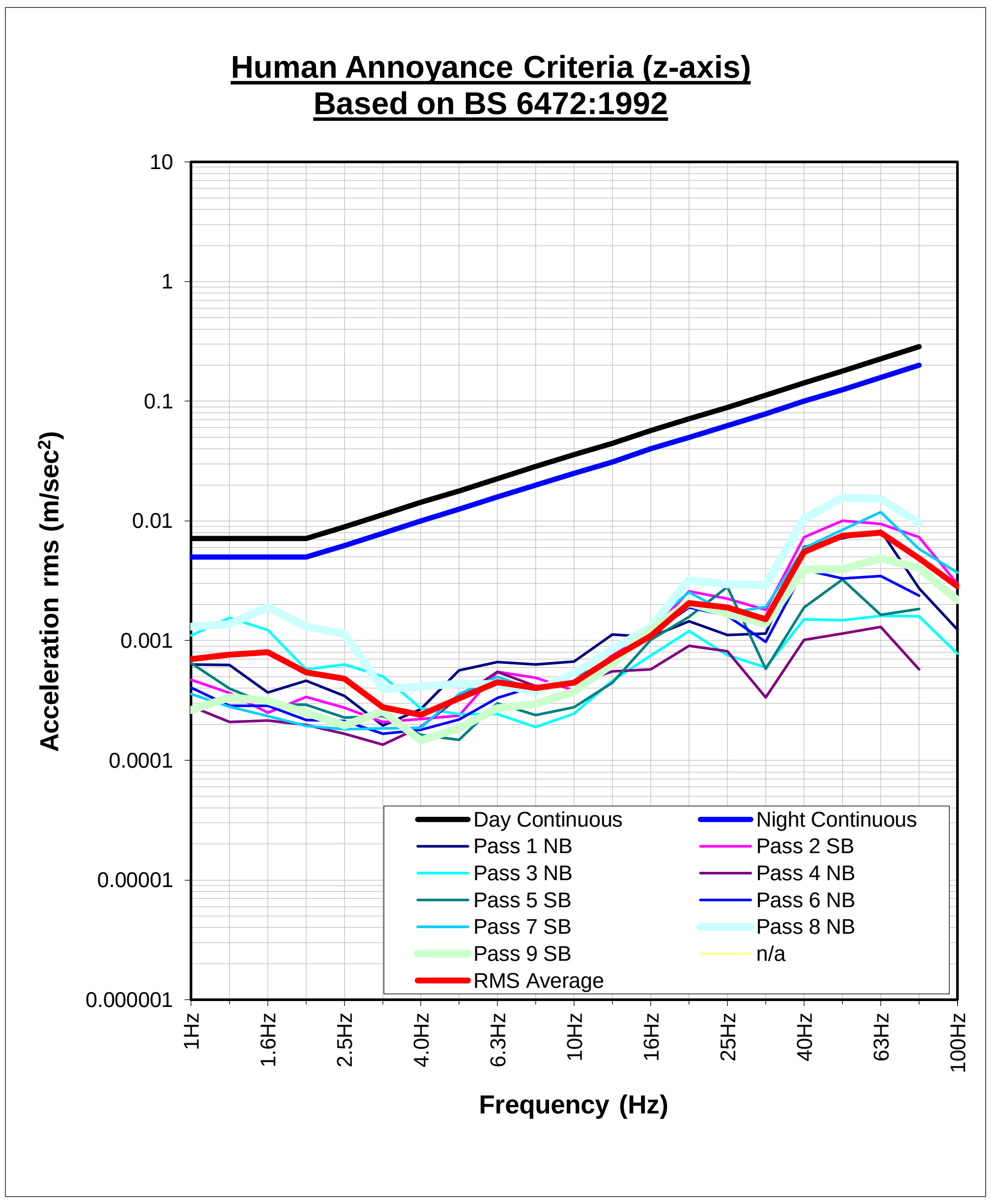
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	Project TL100 Macarthur Gardens North
Location:	Macarthur Gardens North - Monitoring Location V1
Source:	Passenger Trains

Assessment Location:	**Residential**	**Axis**	**X&Y**	**Total secs of Vib per Day (t):**	4,560
Type of Vibration:	**Intermittent**			**Total secs of Vib per Night (t):**	3,366



Legend / Measurement		Pass 1 NB	Pass 2 SB	Pass 3 NB	Pass 4 NB	Pass 5 SB	Pass 6 NB	Pass 7 SB	Pass 8 NB	Pass 9 SB	n/a	RMS Ave	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0006	0.0005	0.0011	0.0003	0.0007	0.0004	0.0004	0.0013	0.0003		0.0007		
	1.25Hz	0.0006	0.0004	0.0015	0.0002	0.0004	0.0003	0.0003	0.0014	0.0003		0.0008		
	1.6Hz	0.0004	0.0002	0.0012	0.0002	0.0003	0.0003	0.0002	0.0019	0.0003		0.0008		
	2.0Hz	0.0005	0.0003	0.0006	0.0002	0.0003	0.0002	0.0002	0.0013	0.0002		0.0005		
	2.5Hz	0.0003	0.0003	0.0006	0.0002	0.0002	0.0002	0.0002	0.0011	0.0002		0.0005		
	3.15Hz	0.0002	0.0002	0.0005	0.0001	0.0002	0.0002	0.0002	0.0004	0.0003		0.0003		
	4.0Hz	0.0003	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0004	0.0001		0.0002		
	5.0Hz	0.0006	0.0002	0.0002	0.0003	0.0001	0.0002	0.0004	0.0004	0.0002		0.0003		
	6.3Hz	0.0007	0.0005	0.0002	0.0005	0.0003	0.0003	0.0005	0.0004	0.0003		0.0004		
	8.0Hz	0.0006	0.0005	0.0002	0.0004	0.0002	0.0004	0.0004	0.0004	0.0003		0.0004		
	10Hz	0.0007	0.0004	0.0002	0.0004	0.0003	0.0004	0.0005	0.0005	0.0004		0.0004		
	12.5Hz	0.0011	0.0008	0.0005	0.0006	0.0004	0.0007	0.0006	0.0008	0.0006		0.0007		
	16Hz	0.0011	0.0012	0.0008	0.0006	0.0010	0.0011	0.0014	0.0013	0.0012		0.0011		
	20Hz	0.0014	0.0026	0.0012	0.0009	0.0016	0.0019	0.0025	0.0032	0.0021		0.0021		
	25Hz	0.0011	0.0022	0.0008	0.0008	0.0028	0.0016	0.0017	0.0030	0.0017		0.0019		
	31.5Hz	0.0011	0.0018	0.0006	0.0003	0.0006	0.0010	0.0019	0.0029	0.0014		0.0015		
	40Hz	0.0060	0.0073	0.0015	0.0010	0.0019	0.0039	0.0060	0.0104	0.0039		0.0055		
	50Hz	0.0072	0.0100	0.0015	0.0012	0.0032	0.0033	0.0085	0.0157	0.0040		0.0075		
	63Hz	0.0083	0.0094	0.0016	0.0013	0.0016	0.0035	0.0119	0.0153	0.0049		0.0080		
	80Hz	0.0027	0.0073	0.0016	0.0006	0.0018	0.0024	0.0058	0.0096	0.0040		0.0049		
	100Hz	0.0012	0.0030	0.0008	0.0003	0.0010	0.0010	0.0037	0.0064	0.0022		0.0028		
Weighted rms	Day	0.0013	0.0011	0.0024	0.0006	0.0010	0.0008	0.0010	0.0033	0.0008		0.0016	0.0071	0.0140
	Night	0.0013	0.0011	0.0024	0.0006	0.0010	0.0008	0.0010	0.0033	0.0008		0.0016	0.0050	0.0100
eVDV	Day	**0.0151**	**0.0128**	**0.0279**	**0.0067**	**0.0113**	**0.0091**	**0.0110**	**0.0384**	**0.0091**		**0.0186**	**0.20**	**0.40**
	Night	**0.0140**	**0.0119**	**0.0259**	**0.0062**	**0.0105**	**0.0084**	**0.0102**	**0.0356**	**0.0084**		**0.0172**	**0.13**	**0.26**

NOTE: Red indicates exceedence of Preferred DECCW Criterion

NOTE: Gray indicates continous vibration levels and criteria if intermittent criteria is selected

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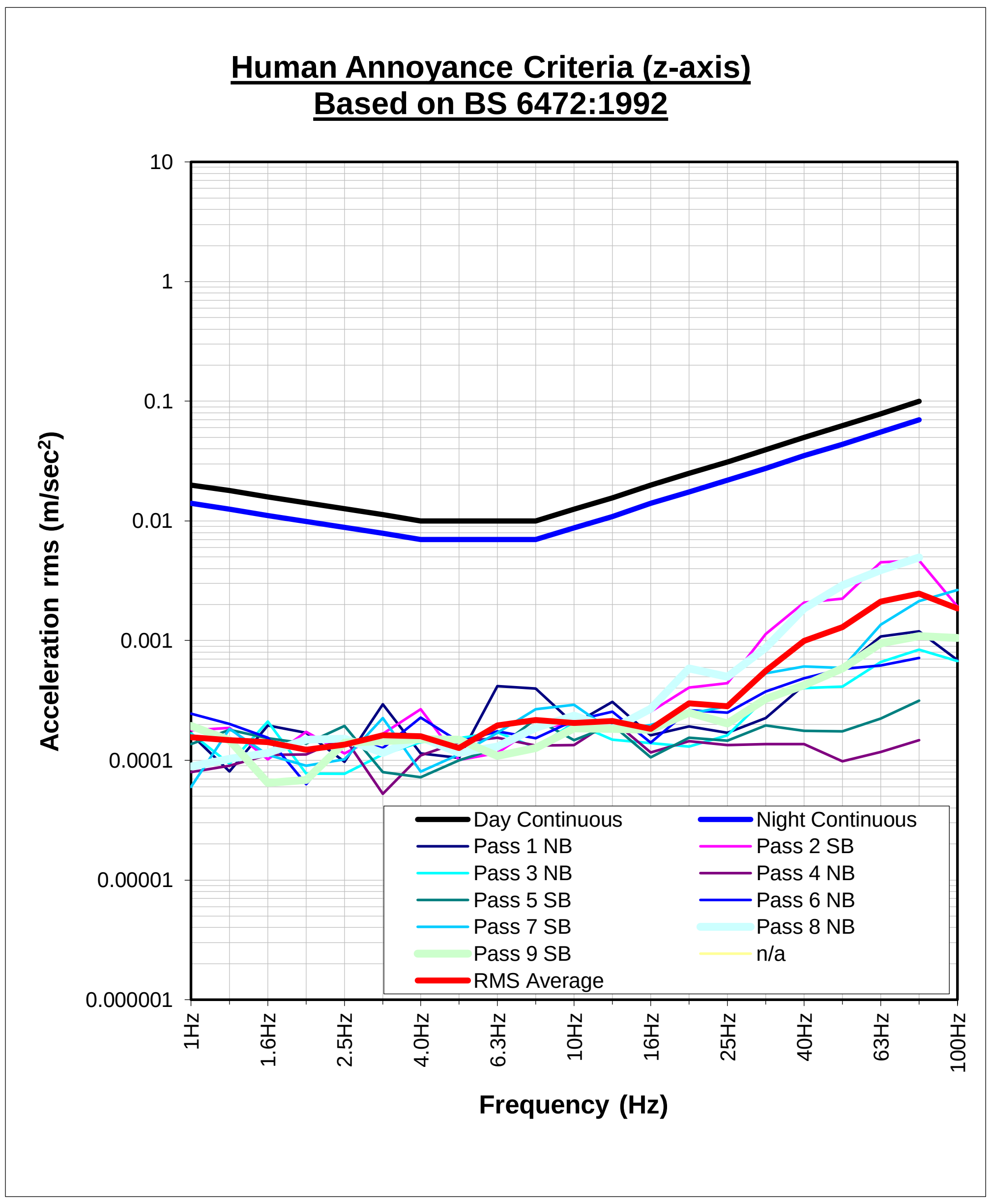
Vibration Survey Results

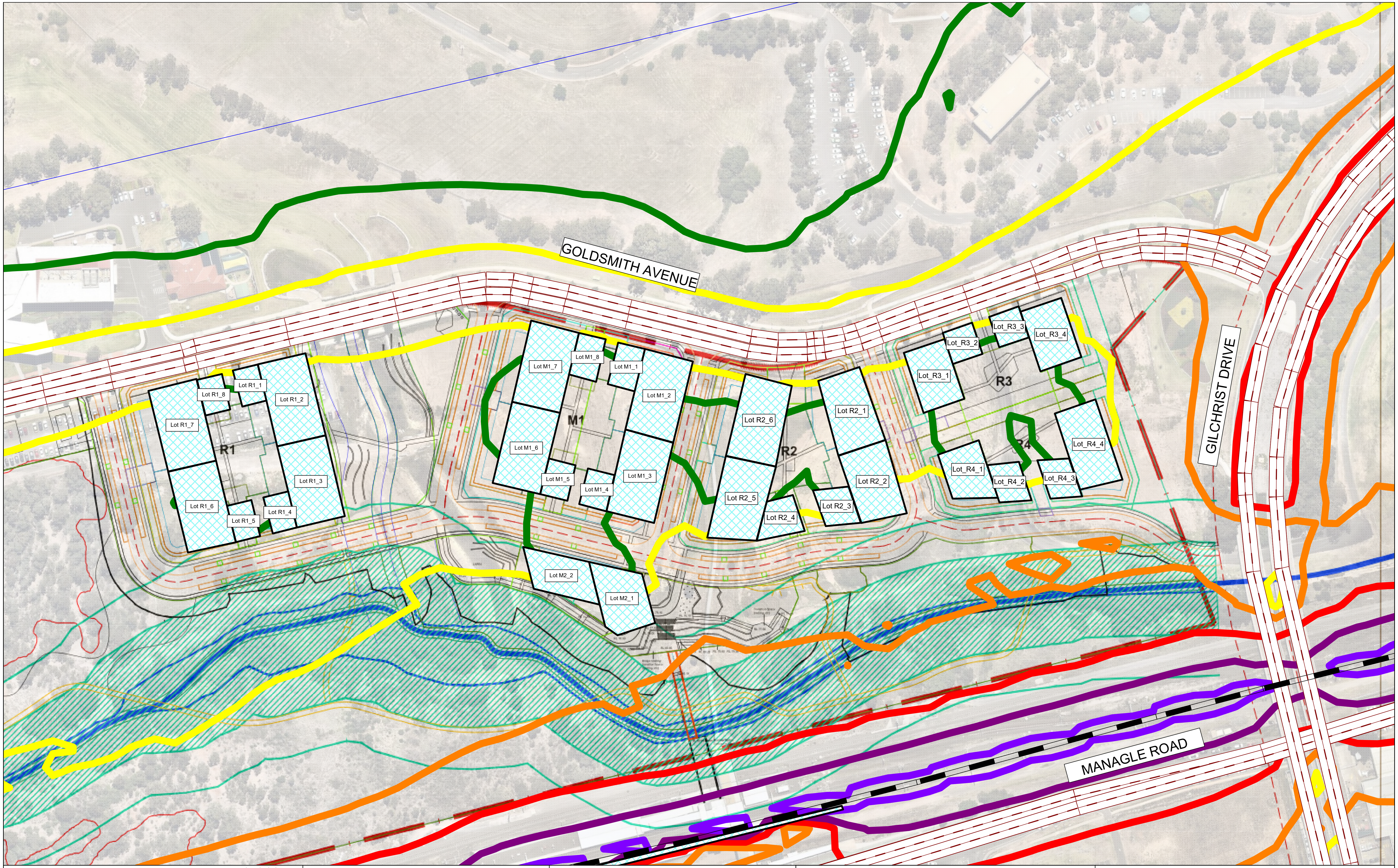
Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	Project TL100 Macarthur Gardens North
Location:	Macarthur Gardens North - Monitoring Location V1
Source:	Passenger Trains

Assessment Location:	**Residential**	**Axis**	**Z**	**Total secs of Vib per Day (t):**	4,560
Type of Vibration:	**Intermittent**			**Total secs of Vib per Night (t):**	3,366



APPENDIX E Noise modelling contour map



Legend:

- ROAD
- RAILWAY
- BUILDING

Noise Level - dB(A)

- = 50
- = 55
- = 60
- = 65
- = 70
- = 75
- = 80
- = 85

Consultant:

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Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait

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

Client:

LANDCOM

Project:

MACARTHUR GARDENS NORTH
RESIDENTIAL SUBDIVISION -
PROPOSED MASTERPLAN DA

Description:

ROAD & RAIL NOISE
LAEQ, 9H NIGHT TIME
4.5m NOISE CONTOUR

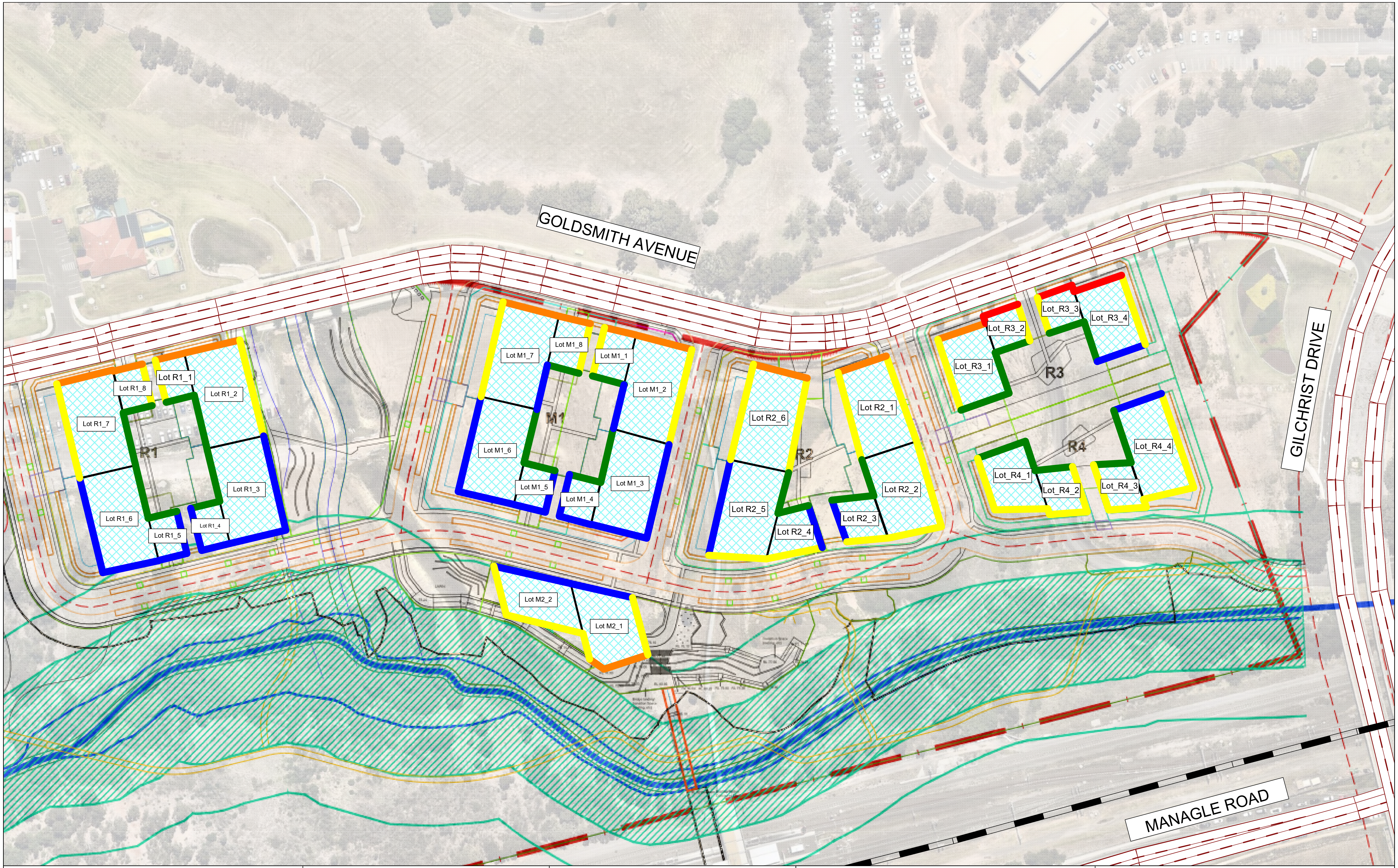
Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TL100-05	Created by:	LW
Fig Ref:	TL100-05.5.1.2P03 (r1)	Grid:	
Date:	03.12.2021	Scale:	1: 1750 A3

APPENDIX F Building treatment recommendations

The dwellings in the proposed development will require facade treatment to achieve suitable internal noise levels. The facade treatment recommendations are shown on the following attached figure.

Table 11 details the facade treatment categories and recommended constructions. The facade recommendations assume room volumes and areas as per Table B1 of the ISEPP Guideline.



Legend:

ROAD	
RAILWAY	
BUILDING	

Building Treatment Category

0
1
2
3
4
5

Consultant:

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Sydney Melbourne Brisbane Gold Coast Kuwait

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

Client:

LANDCOM

Project:

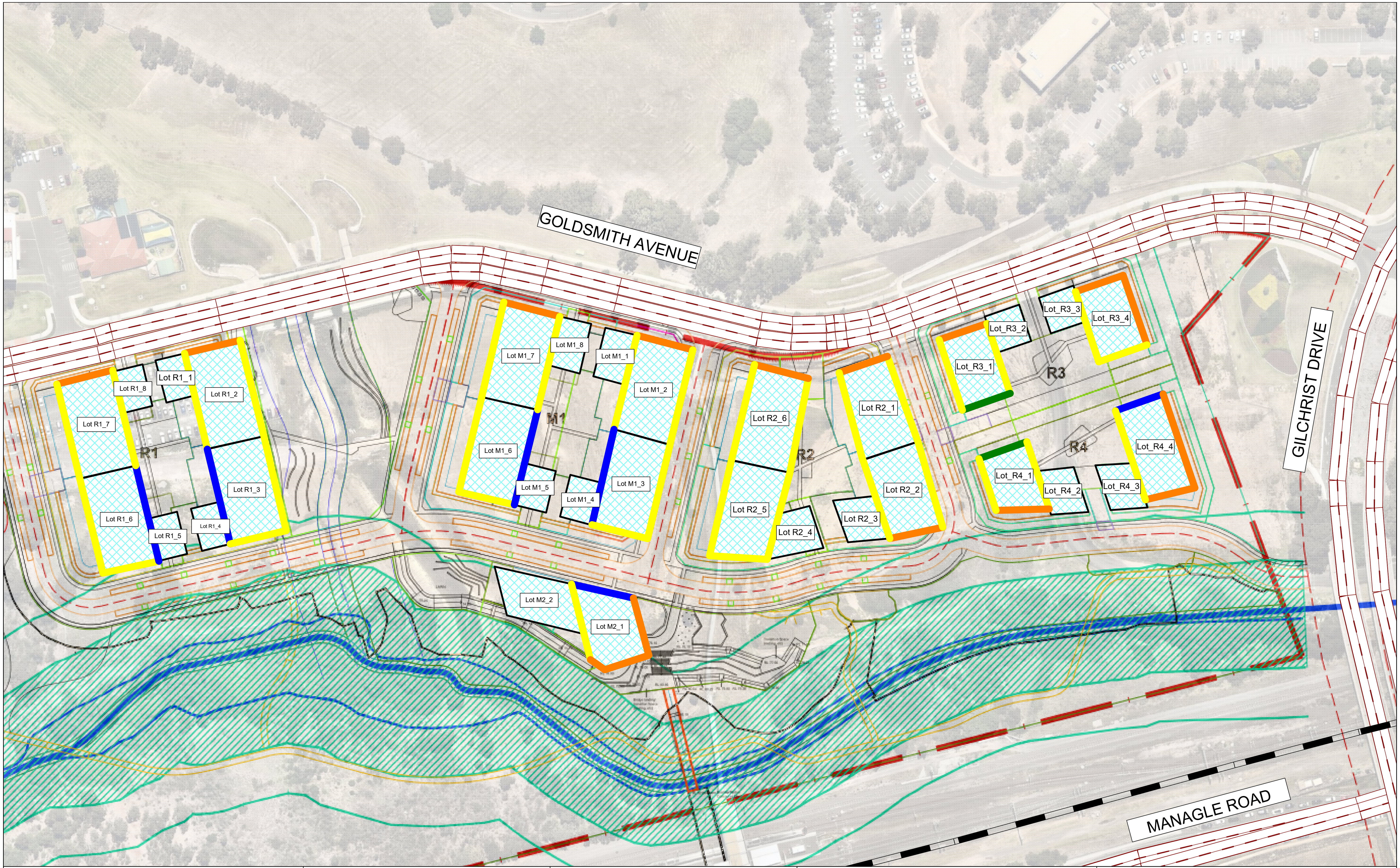
MACARTHUR GARDENS NORTH
RESIDENTIAL SUBDIVISION -
PROPOSED MASTERPLAN DA

Description:

FACADE TREATMENT
CATEGORY RECOMMENDATIONS
GROUND FLOOR TO SECOND FLOOR
LIVING ROOM

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TL100-05	Created by:	LW
Fig Ref:	TL100-05.5.1.2P11 (r0)	Grid:	
Date:	01.12.2021	Scale:	1: 1500 A3



Legend:

ROAD
RAILWAY
BUILDING

Building Treatment Category

0
1
2
3
4
5

Consultant:

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Sydney Melbourne Brisbane Gold Coast Kuwait

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

Client:

LANDCOM

Project:

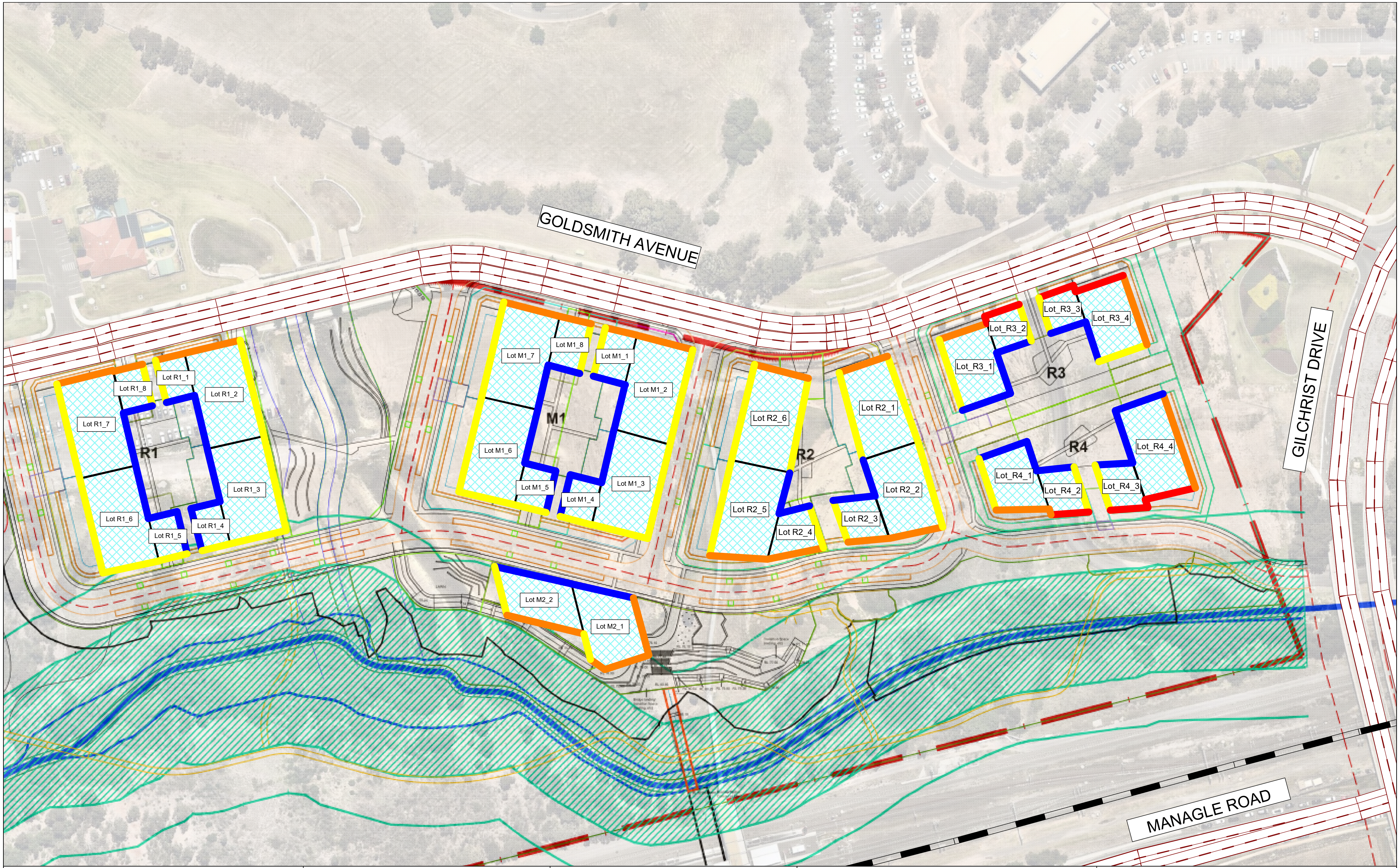
MACARTHUR GARDENS NORTH
RESIDENTIAL SUBDIVISION -
PROPOSED MASTERPLAN DA

Description:

FACADE TREATMENT
CATEGORY RECOMMENDATIONS
THIRD FLOOR AND ABOVE
LIVING ROOM

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TL100-05	Created by:	LW
Fig Ref:	TL100-05.5.1.2P12 (r0)	Grid:	
Date:	01.12.2021	Scale:	1: 1500 A3



Legend:

ROAD
RAILWAY
BUILDING

Building Treatment Category
0
1
2
3
4
5

Consultant:

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Sydney Melbourne Brisbane Gold Coast Kuwait

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

Client:

LANDCOM

Project:

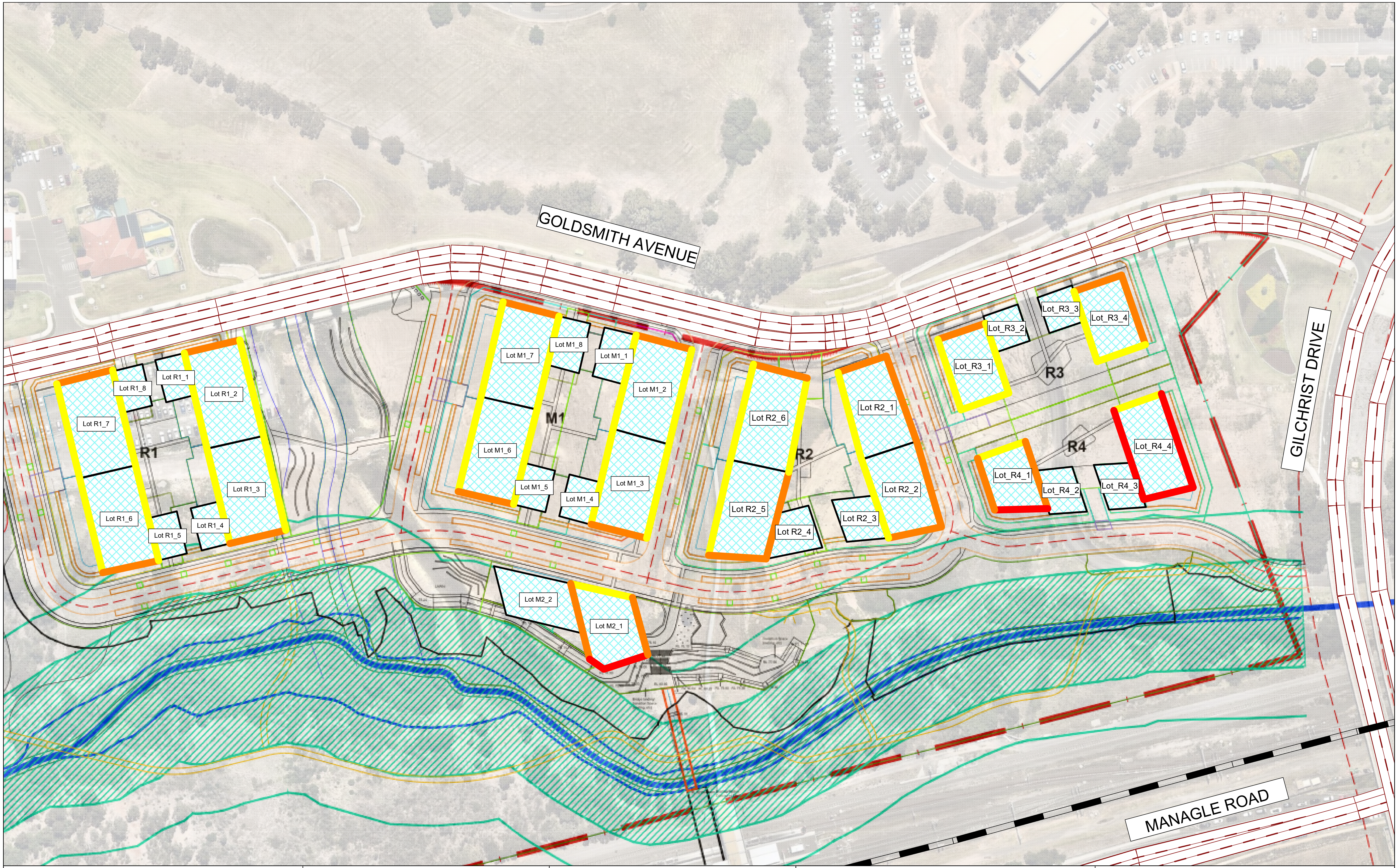
MACARTHUR GARDENS NORTH
RESIDENTIAL SUBDIVISION -
PROPOSED MASTERPLAN DA

Description:

FACADE TREATMENT
CATEGORY RECOMMENDATIONS
GROUND FLOOR TO SECOND FLOOR
BEDROOMS

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TL100-05	Created by:	LW
Fig Ref:	TL100-05.5.1.2P09 (r1)	Grid:	
Date:	03.12.2021	Scale:	1: 1500 A3



Legend:

- ROAD
- RAILWAY
- BUILDING

Building Treatment Category

- 0
- 1
- 2
- 3
- 4
- 5

Consultant:

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Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait

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

Client:

LANDCOM

Project:

MACARTHUR GARDENS NORTH
RESIDENTIAL SUBDIVISION -
PROPOSED MASTERPLAN DA

Description:

FACADE TREATMENT
CATEGORY RECOMMENDATIONS
THIRD FLOOR AND ABOVE
BEDROOMS

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TL100-05	Created by:	LW
Fig Ref:	TL100-05.5.1.2P10 (r1)	Grid:	
Date:	03.12.2021	Scale:	1: 1500 A3

Table 11: Acoustic treatment category details

Category No.	Building Element	Required Acoustic Rating of Building Element, Rw	Construction Recommendation		
1	Windows / Sliding Doors	24+	Openable with minimum 4mm monolithic glass and standard weather seals		
	Facade	38+	Cladding Construction: 9mm fibre cement sheeting or weatherboards or plank cladding externally, 90mm timber stud, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	40+	Pitched concrete or terracotta tile or metal sheet roof, 10mm plasterboard ceiling fixed to ceiling joists, bulk insulation in roof cavity.		
	Door	28+	35mm solid core timber door fitted with full perimeter acoustic seals		
2	Windows / Sliding Doors	27+	Openable with minimum 6mm monolithic glass and full perimeter acoustic seals		
	Facade	45+	Cladding Construction: 9mm fibre cement sheeting or weatherboards or plank cladding externally, 90mm timber stud, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	43+	Pitched concrete or terracotta tile or metal sheet roof, 10mm plasterboard ceiling fixed to ceiling joists, bulk insulation in roof cavity.		
	Door	30+	40mm solid core timber door fitted with full perimeter acoustic seals		
3	Windows / Sliding Doors	32+	Openable with minimum 6.38mm laminated glass and full perimeter acoustic seals		
	Facade	52+	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.		Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	48+	Pitched concrete or terracotta tile or sheet metal roof, 1 layer of 13mm sound-rated plasterboard fixed to ceiling joists, bulk insulation in roof cavity.		
	Door	33+	45mm solid core timber door fitted with full perimeter acoustic seals		
4	Windows / Sliding Doors	35+	Openable with minimum 10.38mm laminated glass and full perimeter acoustic seals		

Category No.	Building Element	Required Acoustic Rating of Building Element, Rw	Construction Recommendation	
	Facade	55+	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	52+	Pitched concrete or terracotta tile or sheet metal, 2 layers of 13mm sound-rated plasterboard fixed to ceiling joists, bulk insulation in roof cavity.	
	Door	33+	45mm solid core timber door fitted with full perimeter acoustic seals	

Notes:

- Where a room has different category recommendations on two or more facades, the roof recommendation for the highest category applies.
- Any wall, roof or ceiling penetrations shall be acoustically sealed so as not to reduce the acoustic performance of the element.
- The acoustic performance of glazed doors should be in accordance with the window glazing requirement of the applicable category.
- Development Near Rail Corridors and Busy Roads – Interim Guideline recommends solid core timber doors of 45mm thickness for treatment categories 3 and 4. To align with current industry construction methods, solid core door recommendations have been limited to no more than 40mm thickness.

The required acoustic rating is for the entire system. For example, for windows this includes the glass, frame and seals including the perimeter seal at the wall junction.

By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the glazing assembly, a higher rating implying a higher sound reduction performance.

Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.

The client is advised not to commence detailing or otherwise commit to systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of systems and assemblies is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved. No responsibility is taken for use of or reliance upon untested systems, estimates or opinions. The advice provided here is in respect of acoustics only.

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

NOTES FOR GLAZING CONSTRUCTIONS:

All openable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the Rw rating performance of the glazing to not be reduced.

The above glazing thicknesses should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

GENERAL

The sealing of all gaps in acoustic rated glazing assemblies and facades is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.

Check design of all junction details with acoustic consultant prior to construction.

Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.

The information provided in this table is subject to modification and review without notice.

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