

Sydney Water Planning Partnership

RP03 Water Main Reinstatement

Construction Noise and Vibration Impact Assessment

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1. Introduction

The Prospect North and Ryde Water Delivery Systems are currently servicing a population of 1.6 million with the population expected to increase to 2.1 million by 2031 and 2.4 million by 2056.

Ryde Pipeline 03 (RP03) is a 10km pipeline, part of which runs along the M2 and through a national park. In 2014, RP03 was decommissioned due to its poor condition and an unacceptable risk of failure. Under the existing system demands, PT01 has sufficient capacity to supply the peak day conditions, with RP03 offline. However, growth forecast in the supply zone has identified that PT01 will become a capacity constraint, triggering extensive capital investments in heavily populated areas. Furthermore, failure of the PT01 main or RP01, would cut-off the primary supply to Wahroonga, Pymble and adjacent supply zones.

As a result, Sydney Water plans to reinstate RP03 using a DN900 pipe, increasing the reliability and capacity of the original main to ensure the pipeline will be able to supply Wahroonga Reservoir during the forecasted peak day conditions. As a result, this will likely be reinstated through a combination of open trenching and trenchless construction methods. The subsequent result will reduce the possibility of failure for the Ryde to Prospect System, adding a redundancy for RP01, a main which currently supplies a population of 350,000 in the Northern Beaches.

Construction activities for the Project include trenching, tunnelling in the Ryde and Ku-ring-gai Local Government Areas. It is anticipated at this stage that works would primarily be carried out during and outside standard construction hours. Overall duration of construction works for the Project is anticipated to be approximately 2 years.

As part of the Sydney Water Planning Partnership, Arup has been engaged to conduct a Construction Noise and Vibration Impact Assessment (CNVIA) of the Project works.

This CNVIA:

- Identifies location of the proposed construction works and the reasonably nearest affected sensitive receivers;
- Establishes construction noise management levels and vibration criteria in accordance with NSW Policies and Guidelines, relevant Australian and International Standards and noise measurements taken on site;
- Assesses predicted noise and vibration impacts against established criteria; and
- Identifies reasonable and feasible noise and vibration mitigation and management measures required to minimise construction noise and vibration impacts onto nearest sensitive receivers.

This CNVIA has been prepared with reference to the following:

- NSW Department of Environment and Climate Change (DECC) *Interim Construction Noise Guideline* (ICNG), 2009 [1]
- NSW Department of Environment and Conservation (DEC) *Assessing Vibration: a technical guideline* (AVATG), 2006 [2]
- NSW Environment Protection Authority (EPA) *Noise Policy for Industry* (NPfI), 2017 [3]
- NSW Department of Environment, Climate Change and Water (DECCW) *Road Noise Policy* (RNP), 2011 [4]
- Transport for NSW (TfNSW) *Construction Noise and Vibration Guideline Public Transport Infrastructure* (CNVG), 2023 [5]
- Australian Standard AS 1055-2018 – Acoustics—Description and measurement of environmental noise, 2018 [6]
- Australian Standard AS IEC 61672.1-2019 – Electroacoustics – Sound Level Meters Specifications, 2019 [7]

- Australian Standard AS 2436-2010 – Guide to noise and vibration control on construction, demolition and maintenance sites, 2010 [8]
- British Standard BS 5228: Part 1 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise, 2009 including Amendment 1, 2014 [9]
- British Standard BS 6472: Evaluation of human exposure to vibration in buildings (1-80 Hz), 1992 [10]
- British Standard BS 7385: Part 2 1993 Evaluation and Measurement of Vibration in Buildings, 1993 [11]
- German Institute for Standardisation DIN 4150: Part 3 2016 Vibration in Buildings – Effects of Structures, 2016 [12]

A glossary of the acoustic terminology used in this document is presented in Appendix A.

2. Project description

It is understood that a Joint Venture (JV) will undertake the proposed construction works, which include the following activities:

- Potholing and utilities investigation
- Open trenching – excavation, exhuming existing pipe (if required) and installation of new pipe
- Backfilling and reinstatement of surface
- Microtunnelling (including excavation of launch and retrieval shafts)
- Tunnelling across the M2 Motorway and Lane Cove National Park using the Direct Pipe method
- Ancillary site / compound site operation including offices, material storage, stockpiling and equipment/plant laydown

Figure 1, Figure 2 and Figure 3 present an aerial view of the JV proposed pipeline alignment and ancillary site work areas.

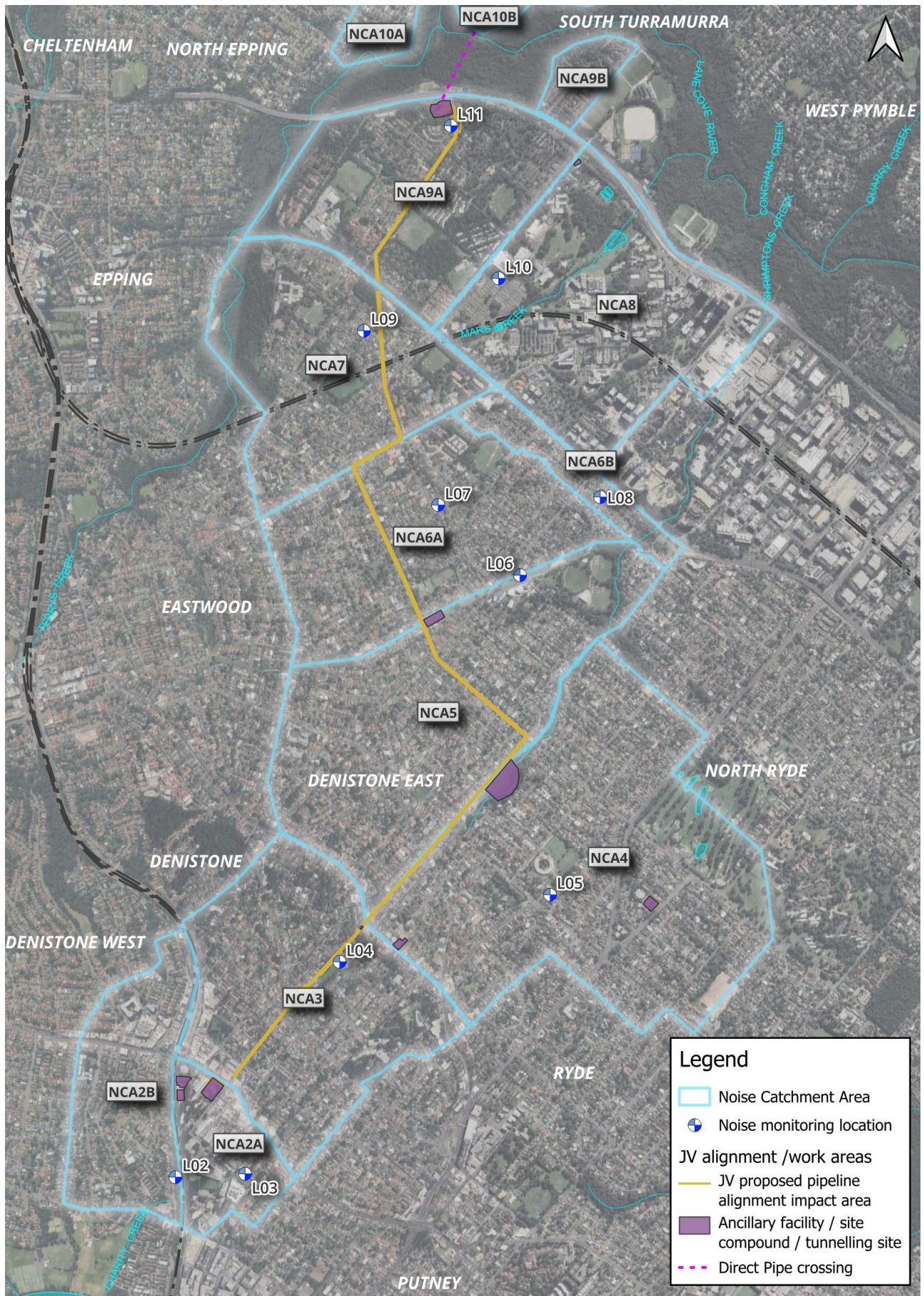


Figure 1: Overview of JV construction scenarios, NCAs and noise monitoring locations – South

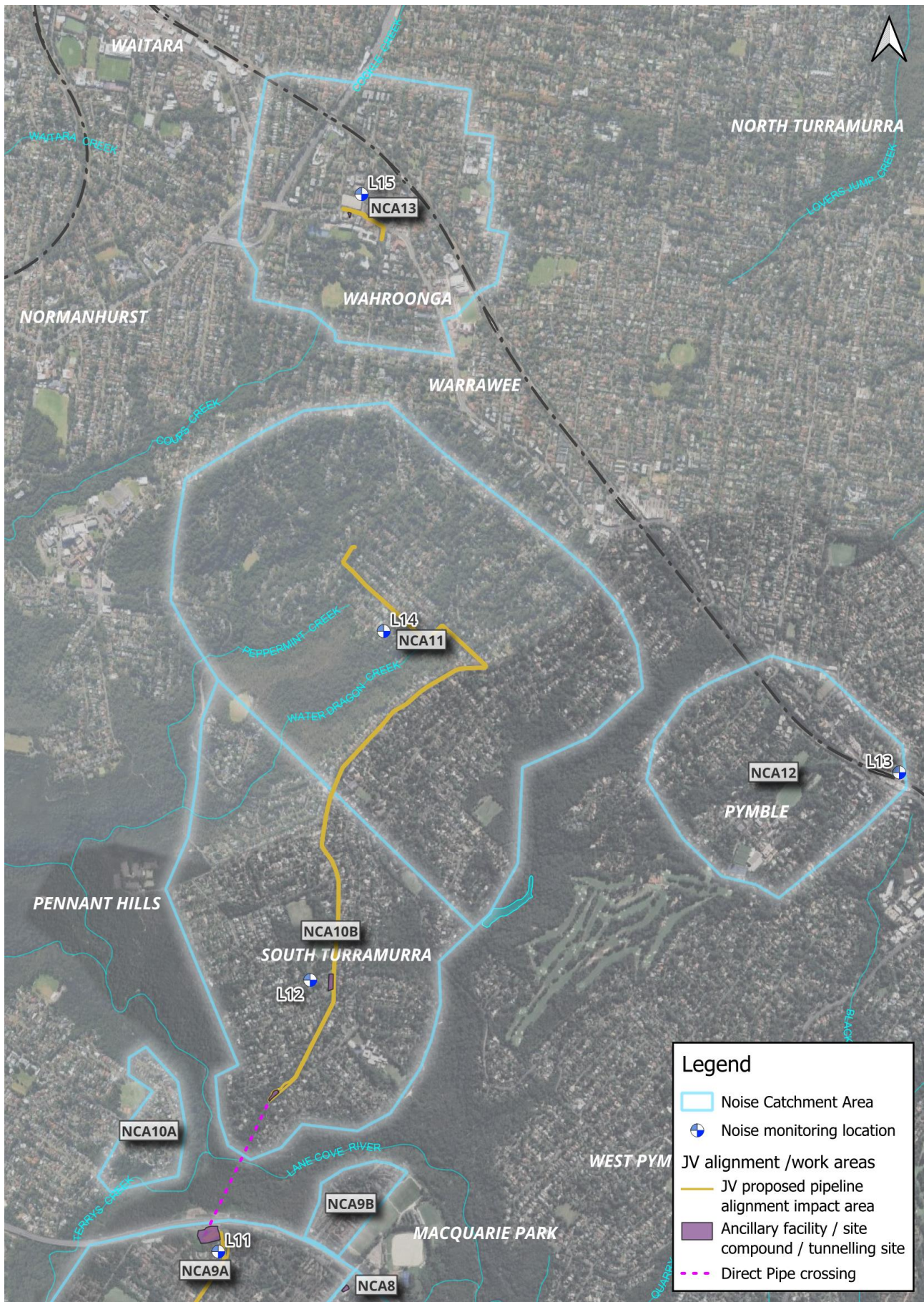


Figure 2: Overview of JV construction scenarios, NCAs and noise monitoring locations – North



Figure 3: Overview of JV construction scenarios, NCAs and noise monitoring locations – Potts Hill

3. Existing acoustic environment

3.1 Sensitive receivers and land uses

Receivers potentially impacted by the construction of the Proposal are defined based on the type of occupancy and their corresponding sensitivity to noise and vibration.

The study area primarily encompasses the suburbs of West Ryde, Ryde, Marsfield, South Turramurra, Turramurra and Wahroonga within the Ryde and Ku-ring-gai Local Government Areas. Noise sensitive receivers include residential, mixed use, community use, educational, places of worship, recreational, commercial and industrial land uses.

A nominal study area of 500 m from the construction works has been adopted for this assessment as a screening analysis for any sensitive receivers that are reasonably expected to be impacted by construction noise and vibration.

Sensitive receivers have been identified based on site observations and the most up to date building footprint, height/LIDAR, aerial imagery and zoning information as obtained from Geoscape Australia at the time of the preparation of this assessment. Noise sensitive receivers and their corresponding land uses within approximately 500m of the proposed construction work areas are presented in Appendix E.

Residential receivers have been grouped into Noise Catchment Areas (NCAs) based on their likely similar acoustic environment. NCAs are presented in Figure 1 to Figure 3 and Appendix E.

Prior to the start of the works, noise sensitive receivers and land uses are to be reviewed.

3.2 Background noise levels

For residential receivers, construction noise targets are derived from the background noise levels in the affected areas. Unattended noise monitoring surveys were conducted in and around the proposed construction work areas. Where available, existing noise monitoring survey results were utilised to inform the existing background noise levels for residential receivers. Five (5) additional unattended noise monitoring have been conducted to quantify existing background noise levels.

All other non-residential sensitive receivers have fixed criteria.

Additional short term measurements were conducted at Lane Cove National Park, north of the M2 Motorway (north of Vimiera Road, Marsfield) to quantify existing background noise levels for potential protected species / fauna located within the national park.

Noise criteria are further detailed in Section 4.

3.3 Noise monitoring survey

Noise monitoring locations are shown in Figure 1 to . Results of the long-term noise monitoring are detailed in Table 1.

Further details regarding the noise monitoring and noise monitoring graphs are presented in Appendix B.

Table 1: Unattended long term noise monitoring results, dB(A)

ID	Location	NCA	Measurement period	Rating Background Level – dBA ¹		
				Day	Eve	Night
L01 ²		NCA1	13 – 22 February 2018	45	45	39
L02 ²		NCA2B	November 2022	39	36	32
L03 ²		NCA2A	November 2022	45	40	35
L04		NCA3	3 – 10 April 2025	39	39	35

ID	Location	NCA	Measurement period	Rating Background Level – dBA ¹		
				Day	Eve	Night
L05 ²		NCA4	17 – 24 July 2017	38	37	29
L06 ²		NCA5	26 July – 7 August 2018	45	42	32
L07 ²		NCA6A	20 – 27 March 2024	38	38 (43) ¹	38 (41) ¹
L08 ²		NCA6B	10 – 20 March 2020	42	42	33
L09		NCA7	3 – 10 April 2025	37	37 (40) ¹	32
L10 ²		NCA8 ²	3 – 10 September 2020	43	37	33
L11		NCA9	3 – 10 April 2025	45	43	36
L12		NCA10	3 – 10 April 2025	37	35	28
L13 ²		NCA12	27 August – 11 Sep 2020	51	48	37
L14		NCA11	3 – 10 April 2025	36	36 (38) ¹	29
L15 ²		NCA13	5 – 18 July 2022	45	43	38

Notes:

- Where evening or night background noise levels exceed that of the previous period (shown in parentheses), they have been set at the background noise level of the previous period, in line with the NPfI, to reflect community's expectation for greater noise control during more sensitive periods.
- Existing noise data in adopted in NCA have been extracted from reports and referenced in the list below:
 - L01 - Potts Hill to Alexandria transmission cable project Construction Noise Vibration Impact Assessment [13]
 - L02 - Meadowbank Schools out of school hours - Noise Impact Assessment [14]
 - L03 - Meadowbank Schools out of school hours - Noise Impact Assessment [14]
 - L05 - TTM New Public School, Smalls Road, Ryde SEARS – Noise Impact Report [15]
 - L06 - Kent Road Public School Development, Kent Road, Marsfield [16]
 - L07 - Proposed Childcare Centre - 62 Agincourt Road Marsfield [17]
 - L08 - Macquarie Park Data Centre – Noise Vibration Impact Assessment [18]
 - L10 - RIDBC Centre of Excellence – Macquarie University – Noise Impact Assessment [19]
 - L13 - Pymble Station Upgrade REF Supporting Study [20]
 - L15 - Wahroonga Stage 2 Noise and Vibration Impact Assessment [21]

Short-term attended noise monitoring was conducted on Tuesday 10th of June 2025 to quantify existing background and ambient noise levels at Lane Cove National Park. The measurement was conducted over a 15-minute period. Skies were generally clear with scattered clouds and conditions were calm throughout the duration of the short-term monitoring.

A summary of the short-term monitoring results is presented in Table 2.

Table 2: Short-term monitoring results – Lane Cove National Park

Measurement location	Date / time	Measured noise level, dB(A)		Description of noise environment
		LA90, 15min	LAeq, 15min	
Lane Cove National Park north of M2 Motorway (north of Vimiera Road, Marsfield)	10/06/25 10:35am	58	63	Noise environment dominated by traffic noise from the M2 Motorway. Indicative transient vehicle passby noise levels: - Light vehicle: 67 – 68 dB(A) - Motorbikes and large heavy vehicles: 69 – 70 dB(A)

4. Construction noise criteria

4.1 Airborne construction noise management levels (NMLs)

Construction noise management levels (NML) are derived in accordance with the ICNG [1], criteria for residential / mixed use receivers (commercial / residential) and non-residential sensitive receivers are tabulated in Table 3 and Table 4, respectively. Refer to Appendix C for further details on the derivation of these noise targets.

For residential / mixed use receivers, to simplify the derivation of noise targets where criteria are related to the baseline noise environment, noise catchment areas (NCAs) have been established based on their likely similar noise environment. NMLs have been derived for residential receivers for each NCA. NCAs are shown in Figure 1 to and Appendix E.

Table 3: Residential and mixed use receivers noise management levels - external noise levels

NCA	Standard Hours ¹ dBL _{Aeq} (15min)	Out of Hours – Period 1 Day ¹ dBL _{Aeq} (15min)	Out of Hours – Period 1 Evening ¹ dBL _{Aeq} (15min)	Out of Hours – Period 2 ¹ dBL _{Aeq} (15min)	Highly noise affected
NCA1	55	50	50	44	75
NCA2A	55	50	45	40	
NCA2B	49	44	41	37	
NCA3	49	44	44	40	
NCA4	48	43	42	34	
NCA5	55	50	47	37	
NCA6A	48	43	43	43	
NCA6B	52	47	47	38	
NCA7	47	42	42	37	
NCA8	53	48	42	38	
NCA9	55	50	48	41	
NCA10	47	42	40	33	
NCA11	46	41	41	34	
NCA12	61	56	53	42	
NCA13	55	50	48	43	

Notes:

1. Construction hours are extracted from Table 1 of the CNVG [5]

Standard Hours: Monday – Friday 7:00 am – 6:00 pm, Saturday 8:00 am to 1:00 pm.

Out of hour Period 1 Day: Saturday 7:00 am – 8:00 am, 1:00 pm to 6:00 pm, Sunday and Public Holiday 8:00 am to 6:00pm.

Out of hour Period 1 Evening: Monday to Saturday 6:00 pm – 10:00 pm.

Out of hour Period 2: Monday to Friday 10:00 pm to 7:00 am, Saturday 12:00 am to 7:00 am and 10:00 pm to 12:00 am, Sunday and Public holiday 12:00 am– 8:00 am and 6:00 pm to 12:00 am.

Table 4: Non-residential receivers noise management levels - external noise levels

Type of receiver	Time period	Noise management level, dBL _{Aeq} (15min)
Active recreation	When in use	65
Commercial	When in use	65
Community Use	When in use	55
Educational	When in use	55
Health	When in use	55
Industrial	When in use	70

Type of receiver	Time period	Noise management level, dBL _{Aeq(15min)}
Passive Recreation	When in use	60
Place of Worship	When in use	55

4.2 Ground-borne noise management levels (GBNMLs)

Ground-borne noise is generated by vibration transmitted through the ground into a structure. Ground-borne construction noise is usually present on tunnelling projects when equipment such as micro-tunnelling, tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. The ground-borne noise inside buildings initially propagates as ground-borne vibration, before entering the building, which may cause floors, walls and ceilings to vibrate and hence radiate noise.

Ground borne noise is dependent on the ground substrate properties, the distance between the source of the vibration and the receiver and the energy transmitted into the ground from the source.

Ground-borne noise can be masked by higher ambient levels during daytime periods, which can reduce the audibility of ground-borne noise emissions. During night-time periods however, when ambient noise levels are often much lower, ground-borne noise is typically more prominent and may result in adverse impacts on building occupants.

In accordance with the ICNG [1], predictions of ground-borne noise levels are undertaken for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

Where tunnelling works are proposed as part of the project, there are significant surface works occurring simultaneously. The airborne construction noise from surface works will be dominant over ground-borne noise generated by proposed tunnelling activities. Hence, noise mitigation measures identified as part of the airborne noise assessment is considered to effectively address cumulative noise impacts. As such, impacts from ground-borne noise for the Project are not assessed further in this report.

4.3 Construction traffic noise criteria

When trucks and other vehicles are operating within the boundaries of the various construction sites, vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction related traffic moves onto the public road network, traffic generated noise is assessed in accordance with the NSW *Road Noise Policy* (RNP) [4].

When assessing off-site traffic noise generated on an existing road network, an initial screening test is adopted that evaluates whether existing road traffic noise levels are expected to increase by more than 2 dBA due to the additional traffic generated by the Project. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

Where noise levels are predicted to increase by more than 2 dBA (i.e. 2.1 dBA or greater) more detailed assessment is required in accordance with the RNP and against the criteria outlined in Table 5 (reproduced from Table 3 of the RNP).

Table 5: Road traffic criteria for traffic generating development – residential receivers

Road category	Type of project / land use	Assessment criteria – dBL _{Aeq}	
		Day (7:00am-10:00pm)	Night (10:00pm-7:00am)
Freeway/ arterial/sub- arterial roads	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments	L _{Aeq,(15 hour)} 60 (external)	L _{Aeq,(9 hour)} 55 (external)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	L _{Aeq,(1hour)} 55 (external)	L _{Aeq,(1hour)} 50 (external)

Note: These criteria are for assessment against façade corrected noise levels 1 metre in front of a building façade.

5. Construction noise assessment

5.1 Assessment methodology

The following methodology has been used to assess airborne construction noise:

- Construction scenarios and equipment to be used were provided by and discussed with Sydney Water.
- A noise model was developed using the environmental noise modelling software package SoundPLAN version 9.1 to predict airborne noise impacts at the nearest receivers. The model was used to predict noise levels at the nearest surrounding receiver locations. The model includes:
 - Existing topography
 - Existing building structures
 - Noise sources
 - Noise sensitive receivers – receiver locations were set at the building façade for the façade located closest to the proposed works location. Each floor has been assessed for multi-storey buildings.
 - Ground and air absorption
- ISO 9613-2:2024 [22] was used to predict construction noise levels at the receivers for typical scenarios of construction activity. This includes corrections for screening, topographical effects, atmospheric absorption, and reflective surfaces.
- For the proposed pipeline alignment trenching works (as detailed in Section 5.2.1), the loudest single items of plant and equipment were assessed at the worst-case on-site location to each individual receiver location along the pipeline alignment for a 15-minute assessment period.
- For proposed construction compounds (ancillary facilities, tunnelling sites, etc. as detailed in Section 5.2.1), all plant and equipment was assumed to be operating concurrently across a compound sites throughout a 15-minute assessment period.
- No noise mitigation measures were included in the assessment.
- Predicted construction noise levels were used to generate building noise exceedance maps to establish if/where noise management levels as defined in Section 4 are predicted to be exceeded. It is noted that daytime works were assessed against the *Standard Hours* criteria and night works were assessed against the *Out of Hours – Period 2* criteria.
- Exceedances of the criteria are presented in Appendix F as colour coded buildings. The results shown in Appendix F are indicative and present the maximum predicted construction noise level for each building. It should be noted that different floors and facades may be impacted by different levels of construction noise.

Construction noise levels for trenching construction works along the alignment has been predicted for each receiver location at a distance closest to the proposed pipeline alignment. This presents a worst case scenario where construction works are in closest proximity and noise impacts would be highest. In reality, plant and equipment will move along the proposed pipeline alignment as the proposed works progress, changing noise impacts in relation to the nearby individual sensitive receivers.

Construction noise levels are expected to be transient and will rise and fall at a particular receiver location in accordance with the varying offset distance of the works, the intensity and location of construction activities, the intervening terrain and structure and the type of equipment used. It is unlikely that all construction equipment will be operating at their maximum sound levels simultaneously. In any given period, typically construction equipment would be used with maximum sound levels for only a brief amount of time and at other times the equipment may emit lower sound levels carrying out activities.

Hence, the assessment methodology above is considered to be conservative.

5.2 Construction activities and assessment scenarios

Construction assessment scenarios have been based on construction work methodologies and equipment schedules provided for the proposed construction works and our understanding of the proposal (as described in Section 1). These scenarios include construction works along the pipeline alignment and construction activities conducted concurrently at compound sites and ancillary facilities (as presented in Figure 1 to Figure 3).

The assessed airborne construction scenarios for surface works are summarised as follows:

- JV proposed construction works (for standard hours and out-of-hours):
 - Pipeline alignment trenching works
 - Pipeline microtunnelling works
 - Direct Pipe tunnelling site works
 - Ancillary sites / compound sites

Equipment sound power levels (L_w) have been sourced from AS2436 [8], CNVG [5], DEFRA [23] and Arup databases.

Assessed construction scenarios for JV proposed construction works are presented in Section 5.2.1.

5.2.1 JV proposed construction works

Table 6 provides a summary of JV proposed construction works and corresponding work hours.

The assessed construction scenarios and the associated equipment and sound power levels for those activities are detailed in Table 7.

Table 6: JV proposed construction work hours

Works location	Chainage	Standard hours works	Out-of-hours works
Surface works (trenching and microtunnelling)			
Ryde pump station to Hermitage Lane (including microtunnelling across Victoria Road)	CH000 – CH250 (microtunnelling CH075 – CH150)	Yes	-
Hermitage Lane to Herbert Street	CH 250 – CH500	-	Yes
Herbert Street to Herring Road (including microtunnelling across Blaxland Road)	CH500 – CH3000 (microtunnelling CH1125 – CH1250)	Yes	-
Herring Road Intersection Crossing	CH3000 – CH3050	Yes	Yes
Herring Road to Balaclava Road	CH2050 – CH4050	Yes	-
Abuluka Road and Balaclava Road Intersection Crossing	CH4050 – CH4100	Yes	Yes
Abuklea Road to Agincourt Road	CH4100 – CH4380	-	Yes
Agincourt Road to Vimiera Road (including microtunnelling across Epping Road)	CH4380 – CH5300 (microtunnelling CH5100 – CH5150)	Yes	-
Agincourt Road to Waterloo Road	CH5300 – CH5800	-	Yes
Waterloo Road Crossing	CH5800 – CH5850	Yes	Yes
Waterloo Road to Vimiera Road	CH5850 – CH6150	Yes	-
Retrieval Site (Kissing Point Road) to Canoon Road	CH6900 – CH8400	Yes	-
Canoon Road to the Comenarra Parkway	CH8400 – CH8600	Yes	Yes

Works location	Chainage	Standard hours works	Out-of-hours works
The Comenarra Parkway to Roland Avenue and Moneith Street	CH8600 – CH9600	Yes	-
Ada Avenue to Wahroonga Reserve	-	Yes	Yes
Marsfield Reserve Connection	-	Yes	-
Ancillary facilities			
Ryde pump station	-	Yes	Yes
Hermitage Reservoir No. 3	-	Yes	-
Abuklea Road – Transport Corridor	-	Yes	-
Santa Rosa Park	-	Yes	-
Culloden Road (Macquarie University)	-	Yes	Yes
Vimiera Road - M2 Direct Pipe South	-	Yes	-
Vimiera Road (dead end road) - Adjacent M2	-	Yes	-
Kissing Point Rd - Retrieval North	-	Yes	-
Kissing Point Rd - Pipeline	-	Yes	-
Wahroonga Reservoir	-	Yes	Yes
Potts Hill Reservoir	-	Yes	-

Table 7: JV proposed construction works, equipment / plant and Sound Power Levels (SWL)

Equipment / Plant	SWL, dBL _{Aeq} (15min)	Penalty ¹ , dB	Ancillary facilities / compound sites (quantity of plant and anticipated % use in worst case 15 minute period)																						Micro-tunnelling site		Trenching	
			Ryde Pump Station		Hermitage Reservoir 3		Abuklea Road		Santa Rosa Park		Culloden Road		Vimiera Road - M2 Direct Pipe South		Vimiera Road - adjacent M2		Kissing Point Road – Retrieval North		Kissing Point Road - Pipeline		Wahroonga Reservoir		Potts Hill Reservoir		Shaft excavation & micro- tunnelling		Excavation and new pipe installation	
			No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use
20/25T Hammer	122	5																						1	20			
Bobcat - profiling head	117	5															1	25										
36T Excavator	115																							1	50	1	100	
45T Excavator	115																							1	50			
Excavator 31-35T w bucket	115		1	100	1	100	1	100	1	100	1	100	1	100	1	100			1	100	1	100	1	100				
Backhoe	111																							1	25			
Drill Rig	111																1	100										
20T Moxy dumper	110																									1	50	
Welding Rig	110		1	25	1	25	1	25	1	25	1	25	1	25	2	25	1	25	1	25			1	25	1	25	1	25
30T Excavator	110																							1	100			
Micro-tunnelling - Vacuum Truck	109																							1	100			
Mud Plant	109																1	100										
Mud Pump	109																1	100										
Slurry Pump	109												1	50														
Slurry Separation Unit	109												1	50														
Truck and Dog	108		1	25	1	25	1	25	1	25	1	25	1	25					1	25							1	50
Bogie Truck	108														2	50	1	25							1	25	1	50
Micro-tunnelling - Crane Truck	108																							1	100			
Semi trailer	108		1	25	1	25	1	25	1	25	1	25	1	25	1	50	1	50					2	25				
Truck & Dog	108																		1	25					1	25		
Roller	107																							1	25	1	50	
2T Tipper	107																							1	25	1	50	
Pantech Truck & Tools	107																							1	25	1	25	
Tipper Truck	107		2	50	1	50	1	50	1	50	1	50	1	50					1	50	1	50	2	25				
Hydraulic Power Unit	106												1	100														
20T Excavator	105																							1	100	1	100	
13.5T Excavator	105																							1	50			
Generator	103						1	100					1	100			1	100	1	100	1	100	1	100				
4.5T Excavator	100																							1	50			
Crawler crane 100t	98												1	100														
Bentonite mixer and pump	95												1	100														
TBM control cabin	92												1	100														
Desander plant	91												1	100														
Centrifuge	89												1	100														

Equipment / Plant	SWL, dBL _{Aeq(15min)}	Penalty ¹ , dB	Ancillary facilities / compound sites (quantity of plant and anticipated % use in worst case 15 minute period)																						Micro-tunnelling site		Trenching	
			Ryde Pump Station		Hermitage Reservoir 3		Abuklea Road		Santa Rosa Park		Culloden Road		Vimiera Road - M2 Direct Pipe South		Vimiera Road - adjacent M2		Kissing Point Road – Retrieval North		Kissing Point Road - Pipeline		Wahroonga Reservoir		Potts Hill Reservoir		Shaft excavation & micro- tunnelling		Excavation and new pipe installation	
			No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use	No.	% use
Mobile Lighting tower	80		4	100							4	100									4	100			4	100		
Direct pipe – pipe thruster	- ²												1	100														
Micro-tunnelling - Semi trailer	- ²																								1	-		
Handtool - non- powered	- ²		1	-	1	-	1	-	1	-	1	-	1	-					1	-	1	-	1	-				
Float - low loader	- ²		1	-	1	-	1	-	1	-	1	-	1	-			1	-	1	-								
Total Assessed Sound Power Level ³ L _{Aeq(15min)}			116		116		116		116		116		116		117		119		116		116		116		122		117	

- Notes:
- 1. Penalty applied as addition to SWL to account for impulsive nature of generated noise
 - 2. Sound power level expected to be negligible
 - 3. Total assessed sound power level based on quantity of equipment/plant and percentage (%) usage in worst case 15 minute period

5.3 Assessment results

Construction noise scenarios as presented in Section 5.2 have been utilised to predict construction noise impacts at surrounding receiver locations. The outcomes of the assessment have been presented graphically based on the predicted exceedance of each receiver's NML for both *Standard Hours* and *Out-of-hours (OOHW) Period 2* works for the scenarios as detailed in Table 8.

Table 8: Assessed construction works scenarios

Proposed construction work scenario	Standard Hours figures	OOHW Period 2 figures
JV proposed construction works		
Pipeline alignment trenching works	Appendix F.1	Appendix F.2
Pipeline microtunnelling works	Appendix F.3	OOHW not proposed
Direct Pipe tunnelling site (surface works)	Appendix F.4	OOHW not proposed
Ancillary sites / compound sites (surface works)	Appendix F.5	Appendix F.6

It is noted that the maximum predicted façade noise level for each building has been presented. In some instances, this has resulted in taller buildings that are further away from the construction activity having higher predicted noise levels than receivers closer to the activity that also benefit from shielding of intervening buildings.

The level of exceedance above the NML for each assessment scenario for sensitive receivers in each NCA has been presented corresponding to the receiver perception and the mitigation level based on the TfNSW CNVG [5] as summarised in Table 9.

Table 9: CNVG receiver perception categories triggering additional mitigation measures

Receiver Perception	Standard Hours dB(A) above NML	OOHW Period 2 dB(A) above NML
Noticeable	0	≤5
Clearly audible	≤10	>5 to ≤15
Moderately intrusive	>10 to ≤20	>15 to ≤25
Highly intrusive	>20	>25
Highly Noise Affected (HNA)	Predicted noise level ≥75 dB(A)	

Further details regarding additional mitigation measures triggered by the receiver perception category are presented in Section 7.2.

Table 10 present the number of sensitive receivers predicted to be impacted by construction noise from the proposed works.

Pipeline trenching works are predicted to have the highest number of impacted receivers. This is to be expected given the extent of trenching works along the entire alignment. However, noise impacts from trenching works are expected to be transient and short in duration as works progress along the proposed alignment, changing noise impacts in relation to individual sensitive receivers.

Microtunnelling works are proposed at three road crossings with high number of impacted receivers. It would be expected that noise impacts from microtunnelling works would be short in duration as the highest impact works are during the excavation of the launch and retrieval shafts. The highest noise impact activities would be recommended to be undertaken during less sensitive time periods.

Direct Pipe tunnelling sites were predicted to have relatively less noise impacts although work duration may be extended. Longer term construction activities are recommended to incorporate site specific noise mitigation measures and should be detailed in the Construction Noise and Vibration Management Plan.

Noise impacts have also been predicted for ancillary sites. These sites are primarily to be used for stockpiling and equipment laydown. Predicted noise impacts are based on the highest impact activities (e.g. site establishment) and would be expected to be short in duration. Nevertheless, the highest noise impact

activities would be recommended to be undertaken during less sensitive time periods and site specific noise mitigation should be considered in the Construction Noise and Vibration Management Plan.

Given the significant noise impacts, noise mitigation and management measures are warranted and have been further detailed in Section 7.

Table 10: JV construction noise assessment results – number of sensitive receivers predicted to exceed NMLs

Number of receivers (within study area) where noise levels are predicted to exceed the NMLs															
Pipeline trenching works				Pipeline microtunnelling works (surface works)				Direct Pipe tunnelling sites (surface works)				Ancillary sites / compound sites			
Standard Hours		Out of Hours – Period 2		Standard Hours		Out of Hours – Period 2		Standard Hours		Out of Hours – Period 2		Standard Hours		Out of Hours – Period 2	
0 – 10 dB above NML	3639	0 – 5 dB above NML	1531	0 – 10 dB above NML	1402	Out of hours works not proposed	0 – 10 dB above NML	317	Out of hours works not proposed	0 – 10 dB above NML	2761	0 – 5 dB above NML	516		
10 – 20 dB above NML	1727	5 – 15 dB above NML	1966	10 – 20 dB above NML	344		10 – 20 dB above NML	93		10 – 20 dB above NML	623	5 – 15 dB above NML	849		
>20 dB above NML	1343	15 – 25 dB above NML	885	>20 dB above NML	74		>20 dB above NML	49		>20 dB above NML	124	15 – 25 dB above NML	186		
HNA ¹	888	>25 dB above NML	377	HNA ¹	32		HNA ¹	24		HNA ¹	46	>25 dB above NML	141		
		HNA ¹	137									HNA ¹	2		

- Notes:
1. Highly Noise Affected receivers where prediction construction noise level is above 75 dB(A) and are included in the receivers incremental NML exceedance count

5.4 Construction traffic

The construction of the Project will generate an increase in vehicle movements on the surrounding road network. Additional vehicle movements will potentially be generated by the arrival and departure of construction plant/equipment, material and vehicles including:

- The haulage and delivery of road work materials, and removal of waste to and from the construction zones and between works / ancillary sites;
- The arrival and departure of construction workers at the start and end of each work day/night shift; and
- Potential traffic diversion due to lane closures because of construction works.

The potential for traffic noise levels to meet the 2 dB increase screening criteria and/or the RNP [4] criteria will depend on the access and haulage routes used to access construction sites, the existing traffic travelling on those roads and the traffic generated by the construction works.

Depending on the type of roads used to access work areas, additional traffic generated by the proposed construction works may impact on the amenity of the nearby sensitive receivers. Expected construction traffic to be generated by the proposed works is summarised in Table 11.

Table 11: Expected number of construction traffic movements for JV proposed construction works

ID	Location	Number of expected traffic movements per day/night shift	
		Light vehicle	Heavy vehicle
7	Ryde Pump Station	48	24
14	Hermitage Reservoir	9	6
13	West Ryde Reservoir	9	6
11	Santa Rosa Park	18	12
1	Abuklea Road Corridor	48	24
2, 3, 4	Corner Culloden and Talavera Road	24	8
11	283 Vimiera Road, 250 Vimiera Road, Vimiera Road Cul-de-sac	0	0
6	346 Kissing Point Road	0	0
12	245 Kissing Point Road	48	28

Where construction traffic is directed to arterial or collector roads (such as Victoria Road, Blaxland Road, Lane Cove Road, Epping Road and Pacific Highway), any increase in traffic noise is likely to be negligible. On local roads, there is greater potential for impacts, especially during the night period. A worst-case night-period assessment representative of residential dwellings on local road based on the expected number of traffic movements is presented in Table 12. The assessment has been undertaken based on the volume of expected construction traffic as it is anticipated that existing traffic volumes during the night period would be minimal.

Table 12: Predicted traffic noise levels on local roads due to the proposed construction works

Tenderer	Representative location	Night criteria on local roads	Expected hourly traffic movements ²		Predicted traffic noise level, $L_{Aeq}(1hour)^3$	Exceedance
			Total vehicle movements	Heavy vehicle %		
JV	Residential dwelling on local roads to be utilised by proposed construction works ¹	$L_{Aeq}(1, hour)$ 50 (external)	8	37%	51 dB(A)	Marginal, 1dB(A)

Note:

1. Based on representative residential receiver façade location 10 metres away from road carriageway
2. Based on worst case expected number of traffic movements as per Table 11 distributed across 9 hour night period (10pm – 7am)
3. Includes a +2.5 dB façade correction

Construction traffic noise generated by the proposed JV works is predicted to exceed the RNP night-time criteria for residential dwellings on local roads by 1 dB(A). This is a negligible exceedance of the criteria based on worst-case expected traffic volumes and it would not be considered reasonable and feasible to implement noise treatment given the potential significant number of residential dwellings located on local roads to be utilised for construction works.

Nevertheless, potentially impacted residential receivers along locals road should be notified and construction traffic should be planned to minimise impact on sensitive receivers on local roads wherever practicable. Drivers should be educated to minimise noise generating behaviour and avoid the use of engine compression brakes. Refer to Section 7 for further noise mitigation measures.

5.5 Cumulative impacts

The assessment has been undertaken for four (4) separate assessment scenarios:

- Pipeline alignment trenching works (surface works)
- Microtunnelling (surface works)
- Direct Pipe tunnelling (surface works)
- Ancillary sites / compounds sites

The assessment includes cumulative impacts from all ancillary sites / compound sites operating concurrently (where proposed for relevant work hours).

Where trenching works are proposed near ancillary sites, microtunnelling sites and/or tunnelling sites, the trenching works would be dominant at the receiver locations. The cumulative impact of both scenarios would not be likely to significantly increase from noise impacts predicted for trenching works alone.

Where there are microtunnelling or Direct Pipe tunnelling sites adjacent to ancillary sites, the microtunnelling or Direct Pipe tunnelling noise impacts would be dominant at receiver locations and cumulative impact would be unlikely to increase.

Microtunnelling and Direct Pipe tunnelling sites are not within close proximity of each other and are unlikely to cumulatively contribute to noise impacts to nearby receivers.

Nevertheless, the contractor(s) should consider the proposed construction methodology and the relative phasing of different construction activities in different areas such that cumulative impacts from concurrent project activities are minimised.

There could be a risk of cumulative acoustic impacts where other construction works unrelated to this Project are being undertaken in the area concurrently. Should other construction works be scheduled simultaneously, the contractor(s) should liaise with other project teams to minimise cumulative noise impacts.

6. Vibration

6.1 Criteria

The effect of vibration in buildings can be divided into three main categories:

1. **Human perception of vibration:** when the occupants or users of the building are potentially disturbed by vibration. Relevant guidance is provided in NSW *Assessing Vibration: a technical guideline* [2]. This document is based on BS 6472:1992 [10].
2. **Effects on building contents:** People can perceive floor vibration at levels well below those likely to cause damage to typical building contents. However, some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives [24, 25, 26, 27].

No receivers have been identified as containing any sensitive equipment. This may require review following the consultation process.

3. **Effects of vibration on structures:** A level of vibration where the integrity of the building or the structure itself may be affected, ranging from cosmetic to major structural damage. The relevant criteria are typically well above the level of vibration which people may consider intrusive. Guidance may be found in AS 2187:Part 2 [28], BS 7385 Part 2 [11], DIN 4150 Part 3 [12], and SW SEA Procedure [29] which also has criteria of particular reference for heritage structures and buried pipework. DIN 4150 Part 3 [12] is generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings.

Heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound and should otherwise be assessed in accordance with BS7385 Part 2 [11]. Heritage areas and structures as per the NSW State Heritage Register have been identified in the study area and are presented in Appendix G.

4. **Effects on buried services and Sydney Water assets:** Guidance is provided in DIN 4150-2:2016 for vibration effects on buried pipework.

Sydney Water specifies vibration limits for Sydney Water assets based on the asset type (as per the Sydney Water Specialist Engineering Assessment [29]). The susceptibility of Sydney Water assets to vibration damage depends on a range of factors including the nature of the ground, the geometry, materials and condition of the structure, the nature of the vibrations and their proximity to the structure and whether they are long acting or intermittent.

Vibration criteria are described further in Appendix D.

6.2 Vibration assessment

The minimum working distances in Table 16 provide an indication of the possibility of impact on nearby receivers due to vibration generating plant and equipment. The minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions. Notwithstanding, if receivers were to be located within the recommended minimum distance for cosmetic damage, mitigation measures should be implemented.

Details of exact construction plant/equipment items and locations are yet to be finalised, however a preliminary screening assessment has been undertaken for cosmetic damage and human comfort based on the following equipment:

- Roller (<200 kN; ~4 to 6t) for trenching works

- Tunnel boring machine or horizontal direction drilling for the M2 Motorway and Lane Cove National Park crossing
- Micro-tunnelling for Victoria Road crossing, Blaxland Road crossing and Epping Road crossing.
- Large hydraulic hammer (1600kg; 18-34t excavator) for micro-tunnelling shaft excavation locations

The screening assessment is presented graphically in Appendix G and also identifies state heritage items that where cosmetic damage due to vibration may be more problematic.

Review of the sites, receiver locations and proposed equipment to be operating within the sites indicates that some receivers located close to the sites could fall within the minimum working distance. Many sensitive receivers are potentially at risk of cosmetic damage and human discomfort. Hence, construction vibration mitigation and mitigation measures should be considered.

Mitigation measures as described in Section 7 should be considered and implemented where relevant.

7. Mitigation and management measures

It should be emphasised that the Construction Contractor(s) will have a key role in managing potential noise and vibration impacts during the works and should review and implement the following noise mitigation and management measures in Table 13 and Table 14 below where feasible and reasonable. The mitigation measures in Table 13 are Sydney Water safeguards. The mitigation measures in Table 14 are Project specific construction noise mitigation and management measures.

Prior to the start of the works mitigation measures to reduce noise and vibration impacts are to be reviewed.

7.1 Sydney Water Safeguards

Table 13: Construction noise mitigation and management measures – Sydney Water Safeguards

Noise and vibration	
8.1	Works must comply with Interim Construction Noise Guideline (ICNG) [1], including scheduling work and deliveries during standard daytime working hours of 7am to 6pm Monday to Friday and 8am to 1pm Saturday. No work to be scheduled on Sunday nights or public holidays. Any proposed work outside of standards hours of construction must be justified. The Proposal will also be carried out in accordance with: - Sydney Water's Noise Management Procedure SWEMS0056 which outlines the behaviours required to minimise noise impacts on the community when working outside standard hours and on public holidays All reasonable and feasible noise mitigation measures should be justified, documented and implemented on-site to mitigate noise impacts. Work may sometimes need to be scheduled outside of standard hours in certain situations, including: - delivery of oversized equipment / structures - where an ROL is required for an activity impacting on traffic flow - emergency work to protect human health or avoid loss of life or damage to property - maintenance and repair of public infrastructure where disruption to essential services (such as water/ sewer) require work out of hours - any other work which can be justified (work schedule, convenience or cost are not considered sufficient justification) If justified, the following hierarchy should be implemented for out of (standard) hours works (OOHW) (from most to least preferable, in accordance with the ICNG [1] and TfNSW CNVG [5]): - Saturday afternoons (1pm to 5pm) - Sunday daytime (8am to 6pm) - weekday evening periods (6pm to 10pm) - weekday nights (10pm to 7am) - all other times (eg Sunday night)
8.2	Incorporate standard daytime hours noise management safeguards into the CEMP, including but not limited to: - identify and consult with the potentially affected residents prior to the commencement: - describe the nature of works; the expected noise impacts; approved hours of work; duration, complaints handling and contact details. - determine need for, and appropriate timing of respite periods (eg times identified by the community that are less sensitive to noise such as mid-morning or mid-afternoon for works near residences) - implement a noise complaint handling procedure (Guidance regarding noise and vibration complaints management process is included in Section 7.3) - plant or machinery will not be permitted to warm-up near residential dwellings before the nominated working hours - appropriate plant will be selected for each task, to minimise the noise impact (eg all stationary and mobile plant will be fitted with residential type silencers) - engine brakes will not be used when entering or leaving the work site(s) or within work areas - regularly inspect and maintain equipment in good working order - arrange work sites where possible to minimise noise (eg generators away from sensitive receivers, site set up to minimise use of vehicle reversing alarms, site amenities and/ or entrances away from noise sensitive receivers) - use natural landforms/ mounds or site sheds as noise barriers - schedule noisy activities around times of surrounding high background noise (local road traffic or when other noise sources are active)

Noise and vibration	
8.3	As/if works beyond standard daytime hours are needed, the Contractor(s) would: - justify the need for out of hours work (OOHW) and why it is not possible to carry out the works during standard daytime hours - consider potential noise impacts and: implement the relevant standard daytime hours safeguards; Sydney Water's Noise Management Code of Behaviour (SWEMS0056.01) and document in the CEMP all reasonable and feasible management measures to be implemented - identify additional community notification requirements and outcomes of targeted community consultation - seek approval from the Sydney Water Project Manager in consultation with the environment and communications representatives. SWEMS0056.01 suggests some additional safeguards such as: - truck radios (commercial) switched off upon arrival at site - truck CB radios used with the truck cabin doors closed - extra care taken while loading or unloading trucks - no unnecessary loud voices (eg using CB radios, mobile phones or conversing).
8.4	As/if night works are needed, the Contractor(s) would: - justify the need for night works - consider potential noise impacts and implement the relevant standard daytime and out of hours safeguards and document consideration of all reasonable and feasible management measures into the CEMP. - identify community notification requirements (ie for scheduled night work (not emergency works)), - notify all potentially impacted residents and sensitive noise receivers not less than one week prior to commencing night work. - seek approval from the Sydney Water Project Manager in consultation with the environment and communications representatives.
8.5	As/if works on Sundays or public holidays are required, the Contractor(s) would: - justify why all other times are not feasible - consider potential noise impacts and, implement relevant standard daytime, out of hours and night-time safeguards and other reasonable and feasible management measures - identify community notification requirements - seek approval from the Sydney Water Project Manager in consultation with the environment and communications representatives. Noise and vibration management safeguards for those works should be documented into the CEMP.
8.6	Conduct a dilapidation survey / asset condition assessment prior to works which have potential to damage existing structures.
8.7	Monitor compliance with the recommended vibration levels in DIN 4150-3 2016: <i>Structural Vibration – Part 3; Effects of vibration on structures for heritage buildings and other potentially at-risk structures</i> [12] following confirmation by the contractor(s) prior to start of any works of the sensitivity of those buildings/structures.
8.8	Consider less vibration intensive methodologies where practicable and use only the necessary sized and powered equipment.

7.2 Project specific noise and vibration mitigation and management measures

Table 14: Project specific construction noise and vibration mitigation and management measures

Item	Detail
On-site measures to be implemented as best practice	
Construction noise and vibration management plan (CNVMP)	A Construction Noise and Vibration Management Plan (CNVMP) and/or Construction Environmental Management Plan (CEMP) shall be prepared. This will specify the actual plant to be used and will include updated estimates of the likely levels of noise and the scheduling of activities. The CNVMP/CEMP should include but not be limited to the following: • Roles and responsibilities • Noise and vibration sensitive receiver locations and structures • Identify works that have the potential to cause impact, accompanied by an appropriate assessment (predictive assessment or risk evaluation) • Mitigation and management strategy • Monitoring methodology (as relevant) • Community engagement strategy.
Non-tonal and ambient sensitive reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Staffing	• Appoint a named member of the site staff who will act as the Responsible Person with respect to noise and vibration; • Site managers to periodically check the site and subjectively assess emissions to nearby receivers to proactively manage works. • All employees, contractors, and subcontractors to receive an environmental induction which should include: – Standard noise and vibration mitigation measures – Permissible hours of work – Limitations on high noise and vibration generating activities – Location of nearest sensitive receivers • Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise, including driving on local roads; • Ensure good work practices are adopted to avoid issues such as noise from dropped items, noise from communication radios is kept as low as is practicable; • Avoid the use of radios or stereos outdoors; and • Avoid shouting and minimise talking loudly and slamming vehicle doors.
Equipment location/site planning/Temporary screen and shed	General recommended provisions which should be implemented initially include: • Situate noisy equipment away from noise-sensitive areas. • Consideration should be given to the installation of onsite barriers such as hoardings or temporary screens at any specific locations where necessary to provide attenuation between particularly noisy construction works and nearby sensitive receptors. Type of screens could include noise curtains or hoarding (plywood board, panels of steel sheeting or compressed fibre cement board). This mitigation measure should be considered as a minimum, and wherever practicable, for noisy works in areas where sensitive receivers are predicted to be highly affected for extended periods of time. • Screens should be considered (where feasible) during trenching works particularly during the OOH work periods.

Item	Detail
Plant and equipment	• Use quieter construction methods where feasible and reasonable. • Use only the necessary size and power of equipment • All plant and equipment used on site must be: – maintained in a proper and efficient condition; and – operated in a proper and efficient manner. • Turn off all plant and equipment when not in use • Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable. • Where vibration from tunnelling activities are considered excessive, the tunnelling operations could be operated at a slower speed. Note that a slower operation of the tunnelling operations may result in an increase of duration of works and should be considered in conjunction with community views to complete works in shorter duration.
Traffic and loading areas	• Plan traffic flow, parking and loading/unloading areas to minimise reversing movements and idling traffic within the site and before entering site. • Route heavy vehicle movements on major arterial roads and highways away from noise sensitive areas where possible. • Provide driver training to minimise loud noise generating vehicle behaviour and to avoid engine compression braking near sensitive receivers.
Silencers on mobile plant	Where possible reduce noise from mobile plant through additional fittings including: • Residential grade mufflers • Damped hammers such as “City” Model Rammer Hammers
Rental plant and equipment	The noise levels of plant and equipment items are to be considered in rental decisions
Structural surveys (dilapidation surveys)	• Select equipment to minimise vibration. Where nearby buildings/structures are located within the safe working distance, pre-construction surveys and/or minimum work distance trials should be conducted as per Section 7.1 and Section 7.4. • The findings of the survey may require amendment to proposed vibration criteria or management measures and therefore should be undertaken in suitable advance of the start date. • The sensitivity of heritage buildings and other potentially at-risk structures are subject to confirmation by the contractor prior to start of any works.
Building and buried services (and Sydney Water assets) condition surveys	• Structures should be considered in the Construction Noise and Vibration Management Plan (CNVMP). Property surveys (or dilapidation surveys) should be conducted before start of construction works where it has been established that the property, structure or utility is at risk of damage during the construction work. • This could be where a property, structure, utility or Sydney Water asset is located within the minimum working distance for example (refer to Section 7.4). The survey findings could require amendment to proposed vibration criteria or management measures and therefore should be undertaken in suitable advance of when the works start. • Where Sydney Water assets are located within minimum working distances risking exceedance of Sydney Water threshold vibration limits further asset protection measures may be applicable as per the Sydney Water Specialist Engineering Assessment procedure [29]. Further details on Sydney Water vibration limits are provided in Appendix D.3.4.

Item	Detail
Off-site measures, dependent on predicted noise impacts / exceedances	
Community consultation – process (PN; SN)	Community consultation should occur prior to, and during works as follows: • Notify affected stakeholders (through methods such as letterbox drops, individual briefings or phone calls) of upcoming works with details of what the works will entail (such as the works purpose, duration, expected impacts and mitigation measures, complaints procedure, who is responsible for undertaking the works) • Notification should be as specific as practicable regarding nature and timing of works and any scheduled respite periods • Discuss with affected receivers about any atypical sensitivities and review how scheduling of activities and other mitigation measures may aid to minimise impacts – (affected receivers = receivers mapped as experiencing non-compliant noise impacts) – (atypical sensitivities = such as vibration sensitive equipment/processes in medical establishments, exam periods or school holidays for education establishments) • Establish long-term personnel or processes (e.g. project email, phone number) to centralise project enquiries • Periodic notification (PN) should be sent out to the community at a reasonable frequency for all impacted receivers to provide information on the proposed construction schedule and mitigation measures to be implemented to minimise the potential impacts. Impacted receivers have been identified up to approximately 500 metres of the construction impact area. Notifications should be sent a minimum of seven (7) days prior to start of works. Where works progress along the proposal alignment, specific notifications could be provided indicating more specific dates during which impacts would be expected. • Phone calls and individual briefings (SN) are not considered practical given the large number of impacted receivers. • Follow the complaints management process in section 7.3 of this report for any complaints, including complaints registers and standard response times.
Community consultation – assessment (DR; RO; RP)	• Project-specific mitigation measures will be determined based on a reasonable and feasible assessment performed by suitably qualified project representatives (eg community and stakeholder, project management, environment) and refined through community feedback. • Community views should be taken into consideration when offering respite periods (RO and RP). – It may be considered beneficial to increase the number of work shifts to allow for a duration reduction (DR). – Respite periods when scheduling work Example includes: – scheduling highest noise generating activities during the least sensitive times, where practicable, – conducting activities in blocks of 3 hours block – Noisy works cut-off times
Noise monitoring (V)	• Where high impact construction activities are proposed noise and vibration measurements should be conducted to verify noise impacts. • Short-term attended measurements should be conducted in response of a complaint and to confirm alignment with predicted noise levels in the impact assessment and management measures.
Alternative accommodation (AA)	• Applies only to residential receivers for works proposed during the late night and early morning time periods. AA is generally not considered to be practicable given the high number of impacted noise sensitive receivers. Consideration should be given to scheduling high noise activities such as saw-cutting and jack-hammering before midnight. Provision of AA should be further reviewed and could be considered on a case by case basis under exceptional circumstances.

Table 15 below provides a summary of project specific noise management measures to be considered depending on the extent of the NML exceedances. These measures have been informed by Table 9 and Table 10 of the CNVG [5].

Table 15: Indicative additional noise management measures

Construction hours	Receiver perception	Above NML	Management Measures ¹
Standard Hours Mon – Fri: 7am-6pm Sat: 8am-1pm	Noticeable	0	-
	Clearly audible	≤10	-
	Moderately intrusive	>10 to ≤20	PN, V
	Highly intrusive	>20	PN, V
OOHW Period 1 Mon-Fri: 6pm-10pm Sat: 7am-8am & 1pm-10pm Sun/PH: 8am-6pm	Noticeable	≤5	-
	Clearly audible	>5 to ≤15	PN, RP, DR
	Moderately intrusive	>15 to ≤25	PN, V, SN, RO, RP, DR
	Highly intrusive	>25	PN, V, SN, RO, RP, DR
OOHW Period 2 Mon-Sat: 12am-7am & 10pm-12am Sun/PH: 12am-8am & 6pm-12am	Noticeable	≤5	PN
	Clearly audible	>5 to ≤15	PN, V, SN, RO, RP, DR
	Moderately intrusive	>15 to ≤25	PN, V, SN, RO, RP, DR
	Highly intrusive	>25	PN, V, SN, RO, RP, DR, AA
All periods	High noise affected (75 dBA or greater)	≥ 75 dBA	PN, V, SN

Notes:

- | | |
|-------------------------------------|---|
| 1. PN = Periodic notification; | SN = Specific notification, individual briefings or phone calls |
| V = Verification monitoring | DR = Duration reduction |
| RO = Project specific respite offer | RP = Respite period |
| AA = Alternative accommodation | |

A preliminary review feasible and reasonable additional noise mitigation measures has been undertaken and summarised in Table 14. They should be reviewed and refined closer to construction and documented in the project-specific Construction Noise and Vibration Management Plan (CNVMP).

7.3 Complaint management

Complaints handling will be performed in accordance with Sydney Water's Complaints Handling Process and Sydney Water's Stakeholder Engagement Policy.

Noise or vibration complaints, once received, will be recorded in complaints register. Information recorded will include:

- the name and address of the complainant (if provided);
- the time and date the complaint was received;
- the nature of the complaint and the time and date the noise was heard;
- the name of the employee who received the complaint;
- actions taken to investigate the complaint, and a summary of the results of the investigation;
- required remedial action, if required;
- validation of the remedial action; and
- summary of feedback to the complainant.

All complaints received will be fully investigated and reported to management. The complainant will also be notified of the results and actions arising from the investigation.

The investigation of a complaint will involve where applicable:

- noise or vibration measurements at the affected receiver;
- an investigation of the activities occurring at the time of the incident;

- inspection of the activity to determine whether any undue noise or vibration is being emitted by equipment; and
- whether work practices were being carried out either within established guidelines or outside these guidelines.

Where an item of plant is found to be emitting excessive noise or vibration, the cause is to be rectified as soon as possible.

Site investigation, site inspection and /or measurements may be used to validate the results of any corrective actions arising from a complaint where applicable.

Further guidance regarding noise and vibration complaints management process is included in Appendix H.

7.4 Vibration – minimum working distances

As a guide, the recommended minimum working distances for vibration intensive plant in Table 16 (derived from Table 20 of the CNVG [5]) provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby sensitive receivers. While the minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions, if a receiver is located within the minimum working distance, vibration monitoring may be required, and equipment selection and/or method of construction should be reviewed.

Vibration minimum work distance trials may be undertaken to establish new minimum working distances specifically for the proposed work activity/equipment at a particular receiver location where ground conditions may vary.

For residential receivers, it is anticipated that the minimum working distance for cosmetic damage corresponding to BS 7385 – Line 2 criteria would apply.

Should heritage buildings and other potentially at-risk structures be identified as being more sensitive to vibration (such as Sydney Water assets), the minimum working distance for cosmetic damage corresponding to DIN 4150 criteria would apply.

Table 16: Recommended minimum working distances for vibration generating plant

Plant Item	Rating / Description	Minimum working distance (m)			
		Cosmetic damage			Human response – disturbance to building occupants [2]
		BS 7385 – Line 1 ¹	BS 7385 – Line 2 ²	DIN 4150 ³	
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	1 m	2 m	5 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	3 m	7 m	15 m	23 m
Large Hydraulic Hammer	1600 kg- 18 to 34t excavator)	9 m	22 m	44 m	73 m
Piling – Vibratory	Sheet piles	9 m	22 m	44 m	73 m
Piling – Bored	≤ 800 mm	1 m (nominal)	2 m	5 m	10 m
Vibratory roller	< 50 kN (~ 1 to 2t)	2 m	5 m	11 m	15 m to 20 m
	< 100 kN (~ 2 to 4t)	2 m	6 m	13 m	20 m
	< 200 kN (~ 4 to 6t)	5 m	12 m	26 m	40 m
	< 300 kN (~ 7 to 13t)	6 m	15 m	31 m	100 m
	> 300 kN (~ 13 to 18t)	8 m	20 m	40 m	100 m
	> 300 kN (> 18t)	10 m	25 m	50 m	100 m
Compactor ⁴	Jumping Jack and plate compactor	3 m	5 m	9 m	55 m

Plant Item	Rating / Description	Minimum working distance (m)			
		Cosmetic damage			Human response – disturbance to building occupants [2]
		BS 7385 – Line 1 ¹	BS 7385 – Line 2 ²	DIN 4150 ³	
Jackhammer	Hand-held	1 m (nominal)	1 m (nominal)	3 m	5 m
Mechanised bored tunnelling works (Tunnel Boring Machine, Horizontal Directional Drilling, Micro-tunnelling) ⁵	-	5 m	12 m	21 m	40 m

Notes:

1. Refer to Table 26 Line 1. Minimum working distance based screening criterion of 25 mm/s as per Section D.3. Type of structure: Reinforced or framed structures, Industrial and heavy commercial buildings.
2. Refer to Table 26 Line 2. Minimum working distance based screening criterion of 7.5 mm/s as per Section D.3. Type of structure: Un-reinforced of light framed structures, residential or light commercial type buildings.
3. Refer to Table 27 Line 3. Minimum working distance based on screening criterion of 3 mm/s as per Section D.3. Type of structure: Structures that because of their particular sensitivity to vibration, cannot be classified under:
 - buildings used for commercial purposes, industrial buildings and buildings of similar design or
 - residential buildings and buildings of similar design and/or occupancy and are of great intrinsic value (e.g. listed buildings under a preservation order)
4. Based on data for previous project.
5. Based on TRL document [30] using Godio et al formula, equation 24

7.4.1 Monitoring

Attended vibration measurements would be required at the commencement of vibration generating activities that are proposed within the minimum working distances, identified in Section 7.4.

Where works are at risk of exceeding criteria, long-term monitoring would be required. The monitors should provide ‘real-time’ alerts when vibration criteria are exceeded.

An exceedance of the vibration criterion may necessitate a change in work method. This could include:

- Re-evaluation of the vibration criterion based on results of the initial condition investigation and inspections of the structure following the commencement of works.
- Maintain vibration monitoring throughout works within ‘minimum working distances’.
- Reduce the size of demolition and construction equipment and develop alternative methodologies to minimise vibration.
- Use less vibration emitting demolition methods if necessary closer to the sensitive building or structure
- Reduction of tunnelling operation speed
- Balance variable speed vibrating plant and operate at speeds that do not produce resonance.

8. Conclusion

This report presents an assessment of predicted airborne noise and vibration impacts associated with the proposed construction works of the RP03 water main reinstatement within the Ryde and Ku-ring-gai areas.

The assessment identified noise and vibration receivers impacted by the construction works. The impacts are shown as exceedances maps showing the extent of the impacts. Mitigation measures to be implemented to reduce the impacts have been identified in Section 7.

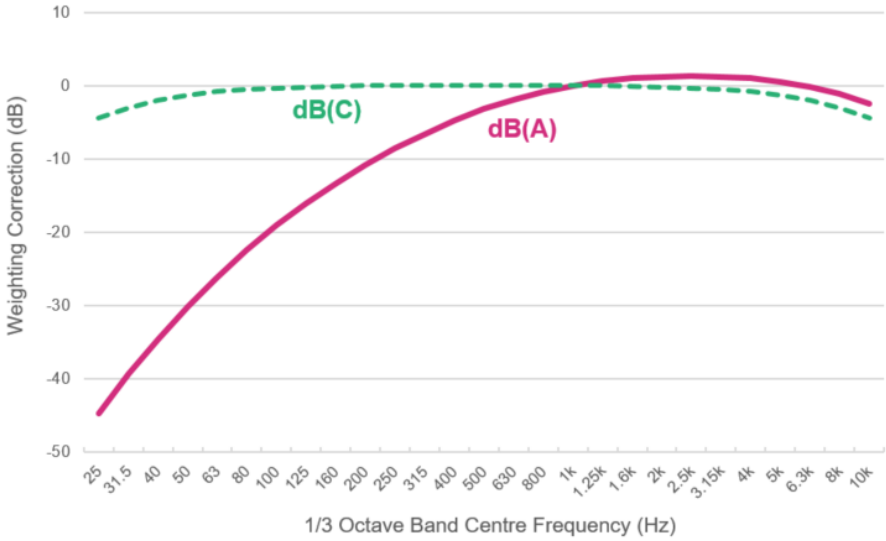
9. References

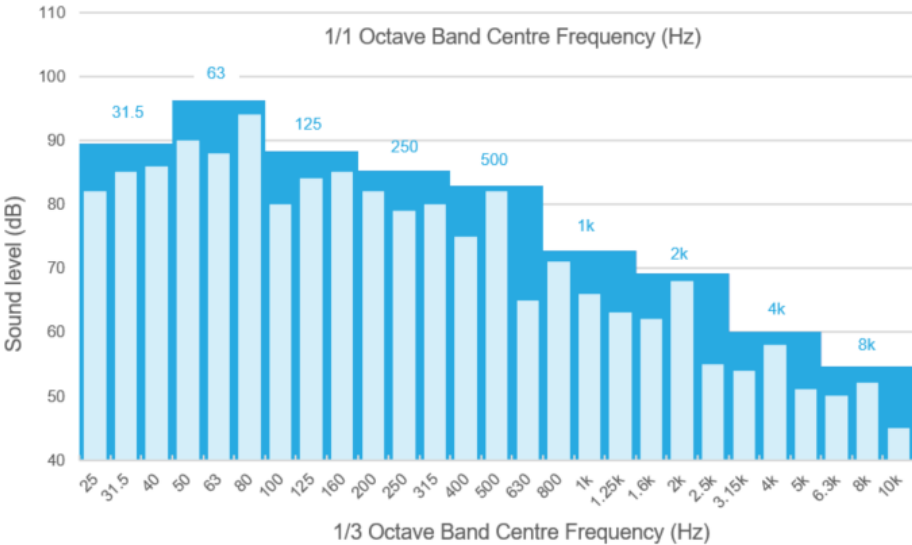
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Appendix A

Acoustic glossary

Term	Definition
Ambient noise level	The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a building is being investigated, the ambient noise level is the noise level from all other sources without the fan operating, such as traffic, birds, people talking and other noise from other buildings.
Background noise level	The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects. Assessment Background Level (ABL): A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time. Rating Background Level (RBL / $\min L_{A90,1\text{hour}}$): A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.
Decibel (dB)	The logarithmic scale used to measure sound and vibration. Human hearing is not linear and involves hearing over a large range of sound pressures, which would be challenging to present on a linear scale. A logarithmic scale allows all sound levels to be expressed based on how loud they are relative to a reference sound (typically 20 μPa, which is the approximate human threshold of hearing). For sound in other media (e.g. underwater noise) a different reference level (1 μPa) is used instead. An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.
dB weighting curves	The frequency of a sound affects its perceived loudness and human hearing is less sensitive at low and very high frequencies. When seeking to represent the summation of sound pressure levels across the frequency range of human hearing into a single number, weighting is typically applied. Most commonly, A-weighting, denoted as dB(A), is used for environmental noise assessment. This is often supplemented by the linear or C-weighting curves, where there is the potential for excess low-frequency sound at higher sound pressure levels. 
dB(A)	dB(A) denotes a single-number sound pressure level that includes a frequency weighting ('A-weighting') to reflect the subjective loudness of the sound level.

Term	Definition
	The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).
dB_{peak}	The peak value is the maximum amplitude identified during a measurement period.
dB_{rms}	The root mean squared (rms) value takes into account both time history variation and energy content. The rms value is typically equal to 0.707 (1/√2) times the peak value
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as ‘pitch’. Sounds towards the lower end of the human hearing frequency range are perceived as “bass” or ‘low-pitched’ and sounds with a higher frequency are perceived as ‘treble’ or ‘high pitched’. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A thousand Hz is generally denoted as kHz. Human hearing ranges approximately from 20 Hz to 20 kHz. While single weighted sound pressure levels simplify the assessment and evaluation of sound levels, frequency analysis is often undertaken. ‘Octave bands’, either 1/1 or 1/3 octave bands are most commonly utilised and are referred to by the nominal centre frequency of the band (e.g. 31.5 Hz), while being the summation of all frequencies between a defined lower and upper frequency. 
L₁(period)	The sound level exceeded for 1% of the measurement period. For example, 65 dBL_{A1,1min} indicates that the A-weighted sound level would not exceed 65 dB for more than 0.6 seconds in the 1-minute measurement period.
L₁₀(period)	The sound level exceeded for 10% of the measurement period, or alternatively, the sound levels would be lower for 90% of the time. The L₁₀ is often defined as the ‘average maximum’ sound levels, as in AS1055-2018 with the advent of statistical sound level meters.
L₉₀(period)	The sound level exceeded for 90% of the measurement period. The L₉₀ is often defined as the ‘average minimum’ or ‘background’ noise level for a period of measurement. For example, 45 dBL_{A90,15min} indicates that the sound level is higher than 45 dB(A) for 90% of the 15-minute measurement period.
L_{eq}(period)	The equivalent (‘eq’) continuous sound level, used to describe the level of a time-varying sound or vibration measurement. The L_{eq} is often defined as the ‘average’ level, and mathematically, is the energy-average level over a measurement period – i.e. the level of a constant sound that contains the same sound energy as the measured sound.
L_{max}	The L_{max} is the ‘absolute maximum’ level of a sound or vibration recorded over the measurement period. As the L_{max} is often caused by an instantaneous event, it can vary significantly between measurements.
Noise Management Level (NML)	Construction noise management levels (NMLs) are noise levels determined in accordance with the Interim Construction Noise Guideline (ICNG). The NML are noise levels above which all

Term	Definition
	‘feasible and reasonable’ work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a ‘screening’ criterion – if predicted or measured construction noise exceeds the NMLs levels then the construction activity must implement all ‘feasible and reasonable’ work practices to reduce noise levels.
Peak Particle Velocity (PPV)	The highest velocity of a particle (such as part of a building structure) as it vibrates. PPV is commonly used as a vibration criteria, and is often interpreted as a PPV based on the $L_{\max}$ or $L_{\max, \text{spec}}$ index.
Sound Power and Sound Pressure	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of the environment and distance from a source. The sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.
Structureborne noise	The transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, i.e. expansion joints and floating floors.
Vibration	Waves in a solid material are called ‘vibration’, as opposed to similar waves in air, which are called ‘sound’ or ‘noise’. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage. A vibrating structure (e.g. a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space. Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s²) or else using a decibel scale.

Appendix B

Background and ambient noise survey

B.1 Unattended long-term noise monitoring

B.1.1 Noise monitoring equipment

Unattended monitoring was carried out at five (5) locations using the equipment in Table 17 in general accordance with the NPfI [3] and AS1055.2018 [6].

Table 17: Unattended noise monitoring equipment information

Monitoring location ID	Equipment / model ¹	Serial No.	Logger / SLM Type
L04	ARL Ngara	8780A2	Type 1 Environmental noise logger
L09	ARL Ngara	8780B0	Type 1 Environmental noise logger
L11	ARL Ngara	878042	Type 1 Environmental noise logger
L12	ARL Ngara	87807B	Type 1 Environmental noise logger
L14	ARL Ngara	8780F0	Type 1 Environmental noise logger

Short-term monitoring was conducted using equipment detailed in Table 18. All noise monitoring equipment was checked for calibration using the sound calibrator detailed in Table 18.

Table 18: Additional noise monitoring equipment details

Monitoring equipment	Model	Serial number
Sound level meter	Brüel and Kjær 2250 Type 1	3029878
Sound calibrator	Brüel and Kjær 2431 calibrator	2445716

All noise monitoring instrumentation used was compliant with the requirements of AS IEC 61672.1-2004: Electroacoustics - Sound level meters – Specifications [7] and carried appropriate and current National Association of Testing Authorities (NATA) (or manufacturer) calibration certificates. The calibration of the equipment was checked both before and after the survey and no significant drift in calibration (± 0.5 dB) was noted at any location.

Noise monitoring details and graphs conducted at the above five locations are presented within this report. Other noise monitoring background noise monitoring data have been obtained from existing available noise monitoring data representative of the study area. Refer to Table 19 for further information and references to other noise monitoring data.

Table 19: Existing available noise monitoring data obtained from existing documentation for relevant nearby projects

Monitoring location ID	Project / document	Reference
L01	Potts Hill to Alexandria transmission cable project Construction Noise Vibration Impact Assessment	[13]
L02	Meadowbank Schools out of school hours - Noise Impact Assessment	[14]
L03	Meadowbank Schools out of school hours - Noise Impact Assessment	[14]
L05	TTM New Public School, Smalls Road, Ryde SEARS – Noise Impact Report	[15]
L06	Kent Road Public School Development, Kent Road, Marsfield	[16]
L07	Proposed Childcare Centre - 62 Agincourt Road Marsfield	[17]
L08	Macquarie Park Data Centre – Noise Vibration Impact Assessment	[18]
L10	RIDBC Centre of Excellence – Macquarie University – Noise Impact Assessment	[19]
L13	- Pymble Station Upgrade REF Supporting Study	[20]
L15	Wahroonga Stage 2 Noise and Vibration Impact Assessment	[21]

B.1.2 Extraneous/weather affected data

Measurement samples affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the procedures outlined in Fact Sheet A of the NSW Noise Policy for Industry (NPfI) [3].

The noise long-term noise monitoring results were processed to exclude weather affected data following consultation of weather reports from the Bureau of Meteorology (BOM) Sydney Olympic Park Weather Station (Station ID 066212).

The noise level-vs-time graphs of the data are included in Section B.1.3.

B.1.3 Noise monitoring graphs

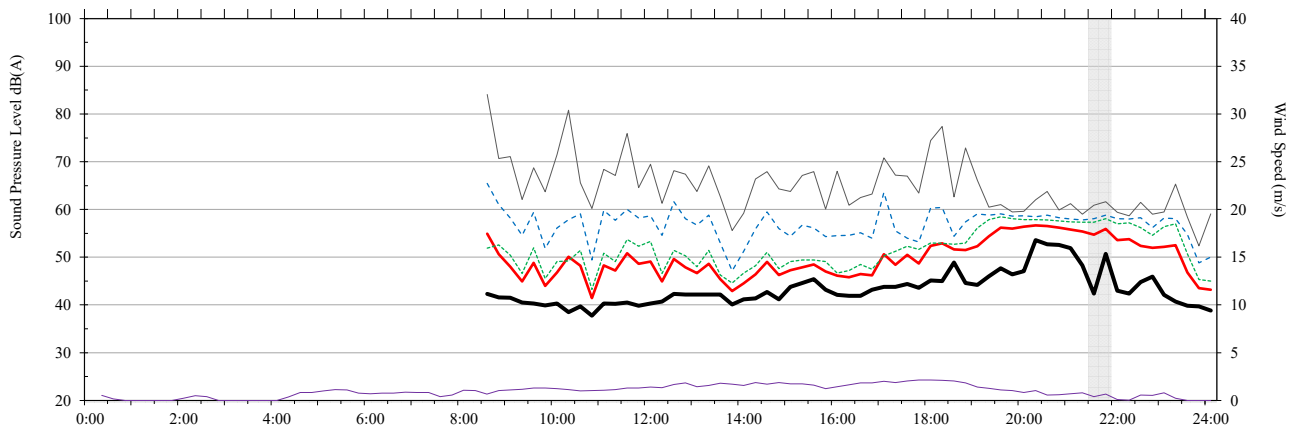
The following noise level vs time graphs present overall dB(A) levels recorded by the unattended logger(s) for a range of noise descriptors, including L_{Aeq} , L_{A90} , L_{A10} and L_{Amax} . While line graphs are presented, sampling is at 15-minute intervals.

Wind speeds are also shown where relevant, and periods of excluded data are shaded grey.

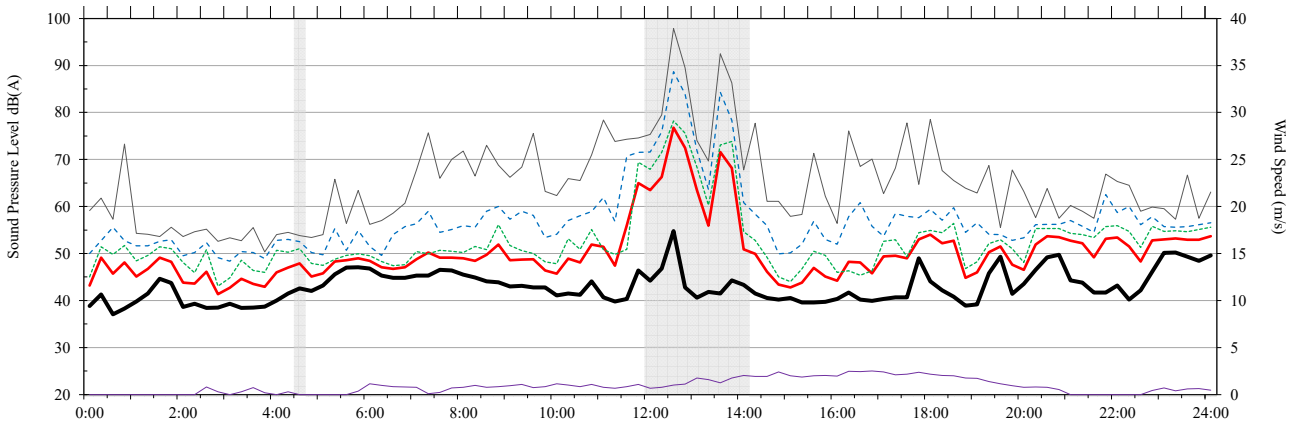
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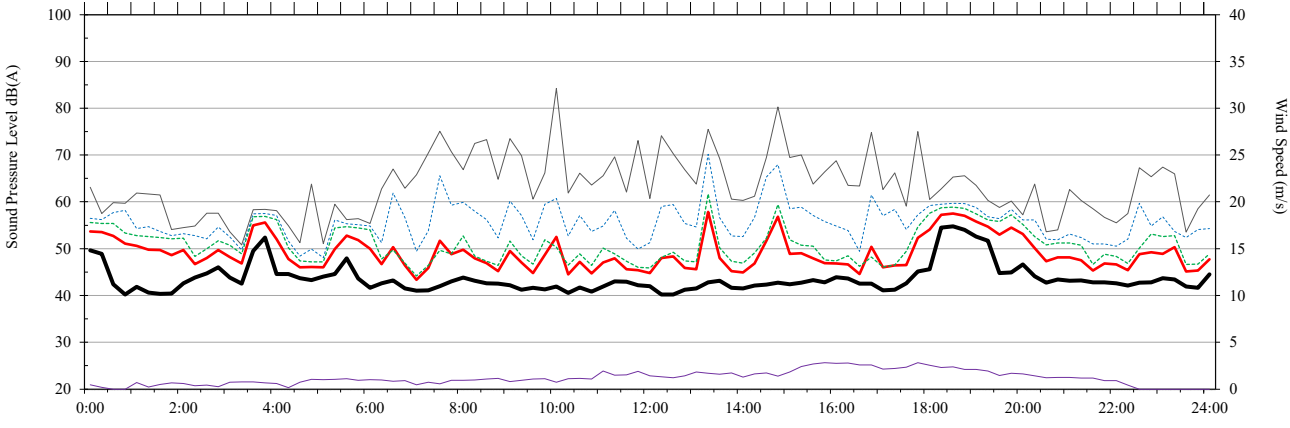
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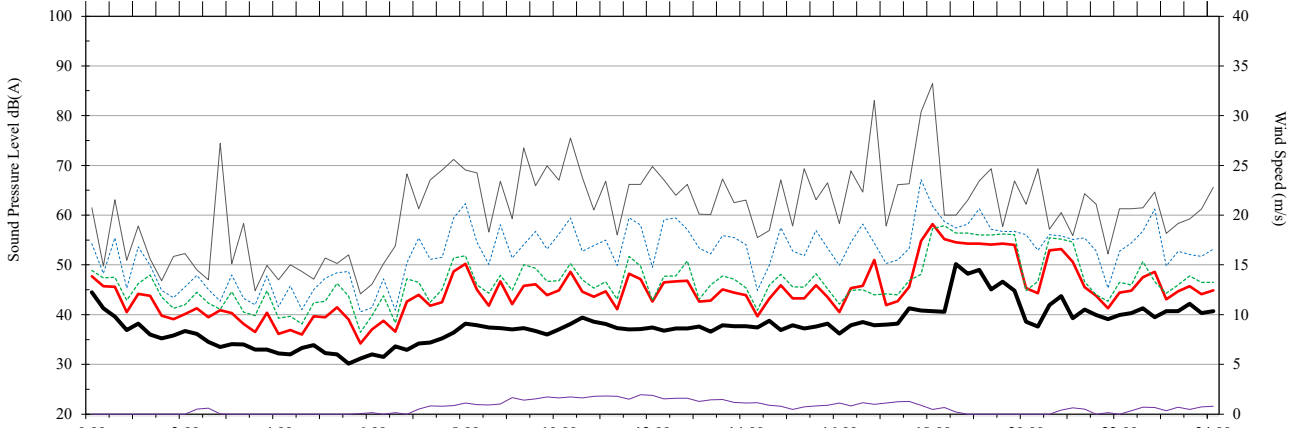
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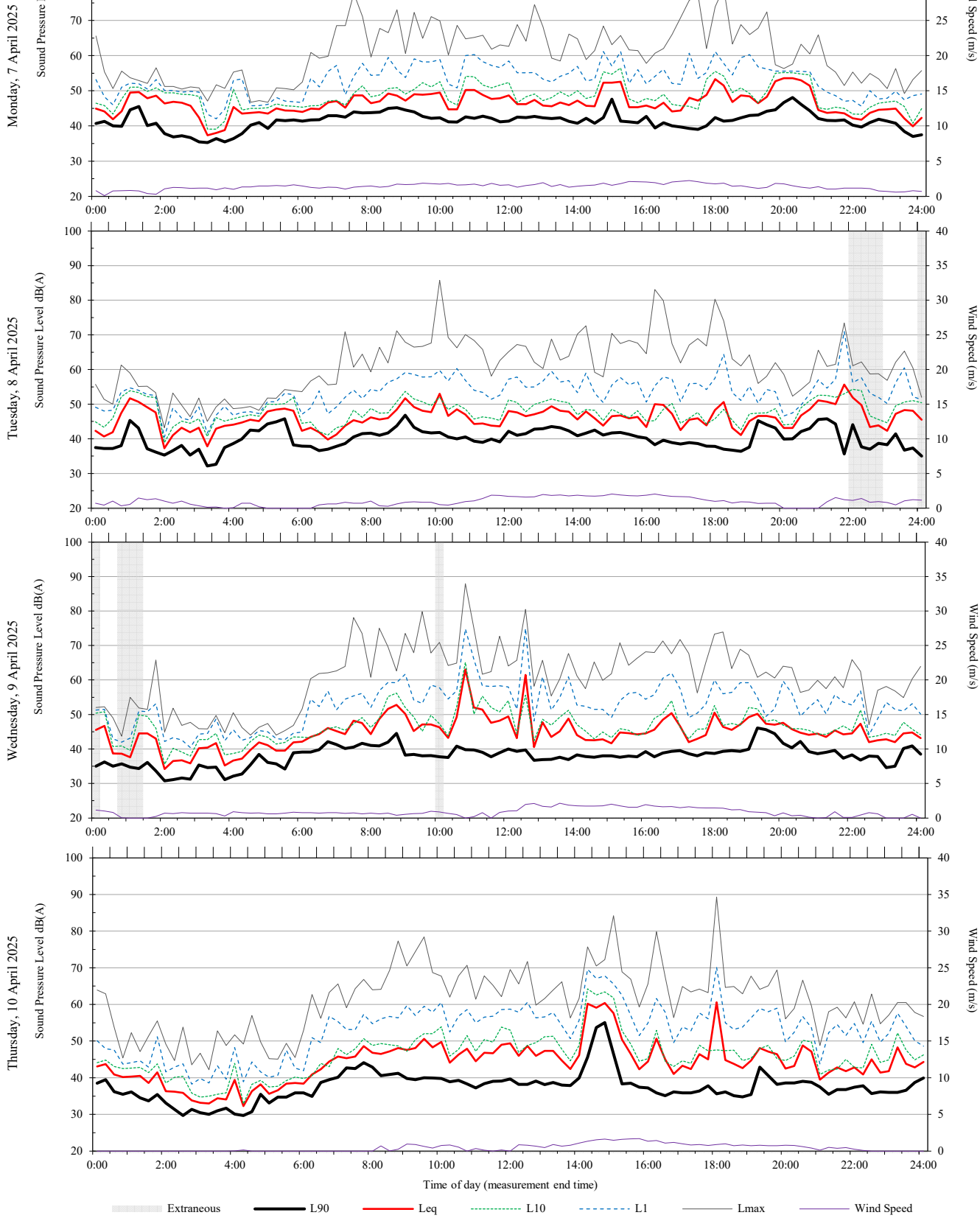
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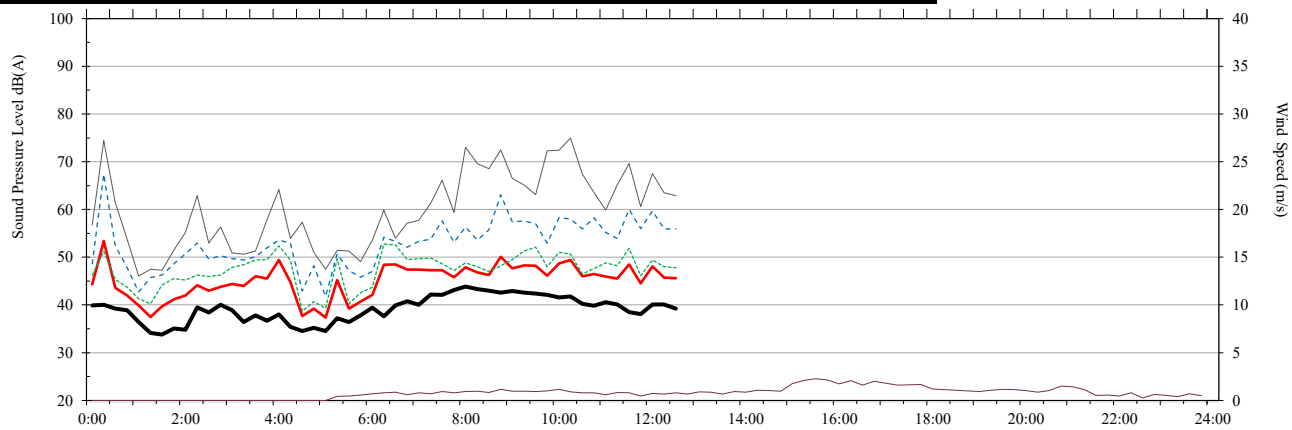
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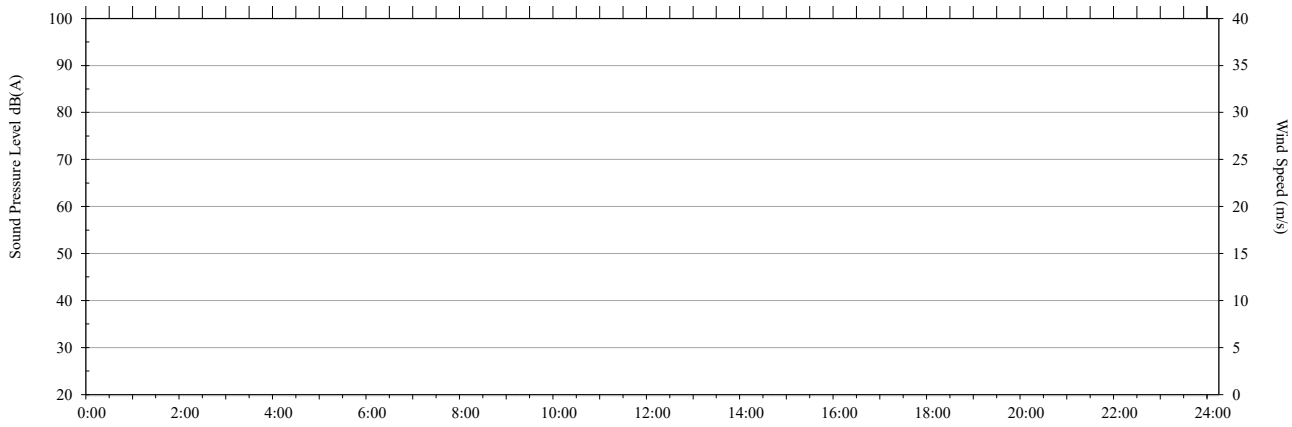
Extraneous L90 Leq L10 L1 Lmax Wind Speed



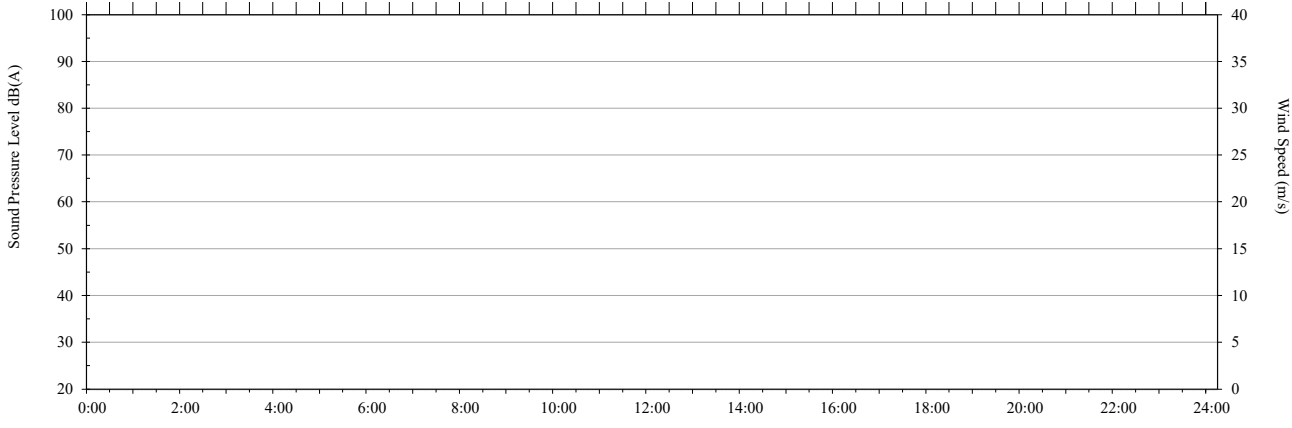
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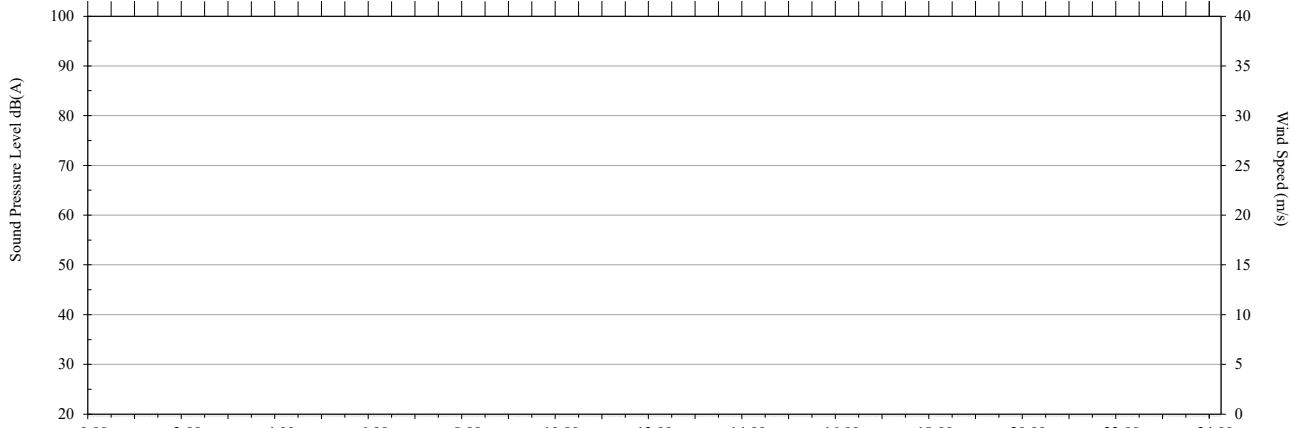
Saturday, 12 April 2025



Sunday, 13 April 2025



Monday, 14 April 2025



Extraneous L90 Leq L10 L1 Lmax Wind Speed

Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L _{A90} Background noise levels ⁴			L _{Aeq} Ambient noise levels		
	Day ¹	Evening ²	Night ³	Day ¹	Evening ²	Night ³
Thursday-03-April-2025			33			48
Friday-04-April-2025	36	39	31	53	62	42
Saturday-05-April-2025	37	38	29	52	60	45
Sunday-06-April-2025	36	40	30	55	60	43
Monday-07-April-2025	37	39	30	51	58	42
Tuesday-08-April-2025	37	40		52	62	
Wednesday-09-April-2025	37	41	32	51	62	43
Thursday-10-April-2025	35	40	32	59	59	43
Friday-11-April-2025						
Representative Weekday⁵	37	40	32	55	61	45
Representative Weekend⁵	37	39	30	54	60	44
Representative Week⁵	37	40	31	54	61	44

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times

2. Evening is 6:00pm to 10:00pm

3. Night is the remaining periods

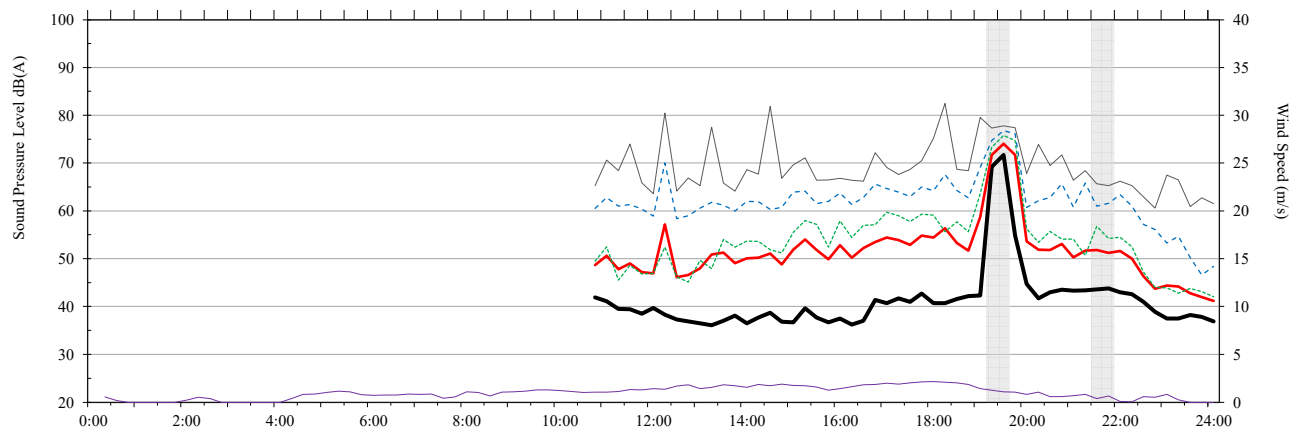
4. Assessment Background Level (ABL) for individual days

5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

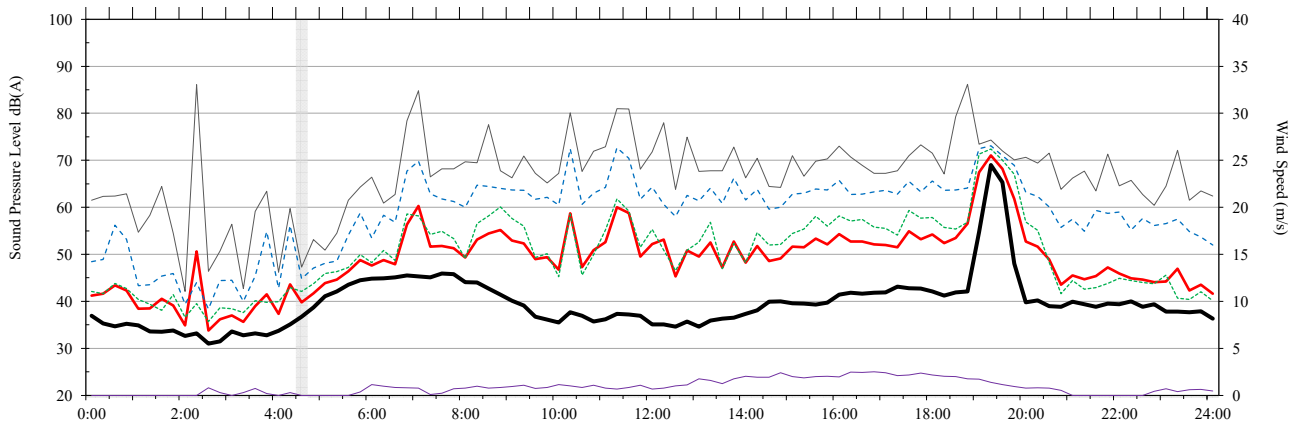
Road / Rail noise monitoring results

Date	L _{Aeq} Noise levels		L _{Aeq 1hr} Noise levels (upper 10th percentile)	
	Day ¹	Night ²	Day	Night
Thursday-03-April-2025	57	48	56	56
Friday-04-April-2025	58	42	62	46
Saturday-05-April-2025	56	42	60	46

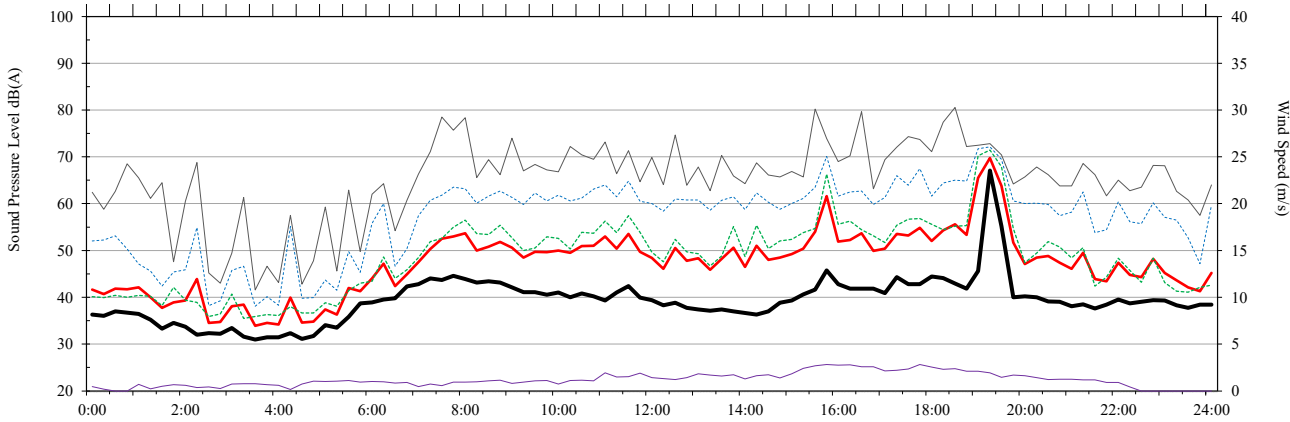
Thursday, 3 April 2025



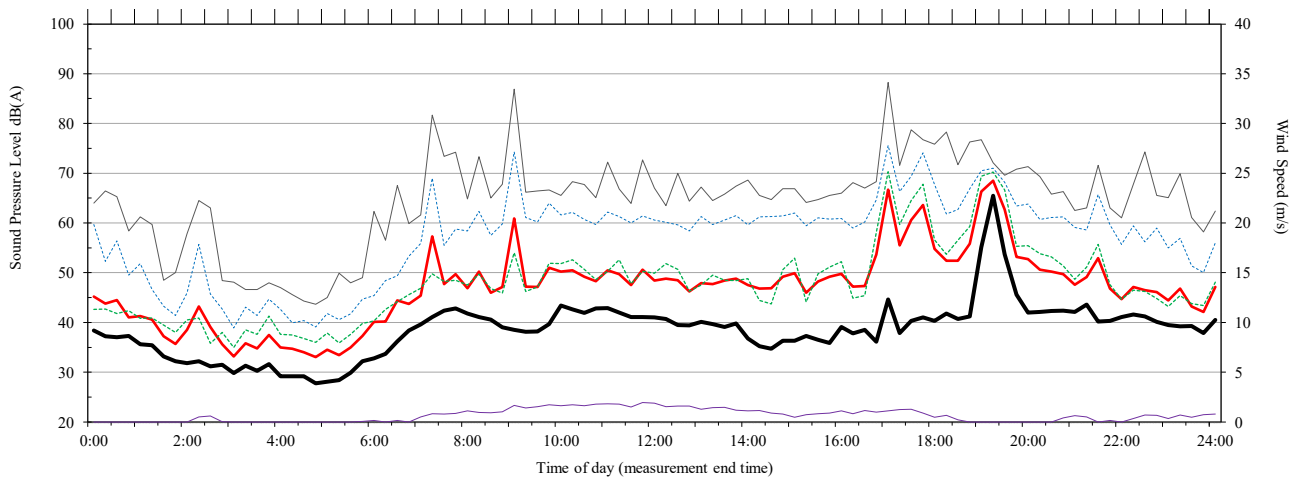
Friday, 4 April 2025



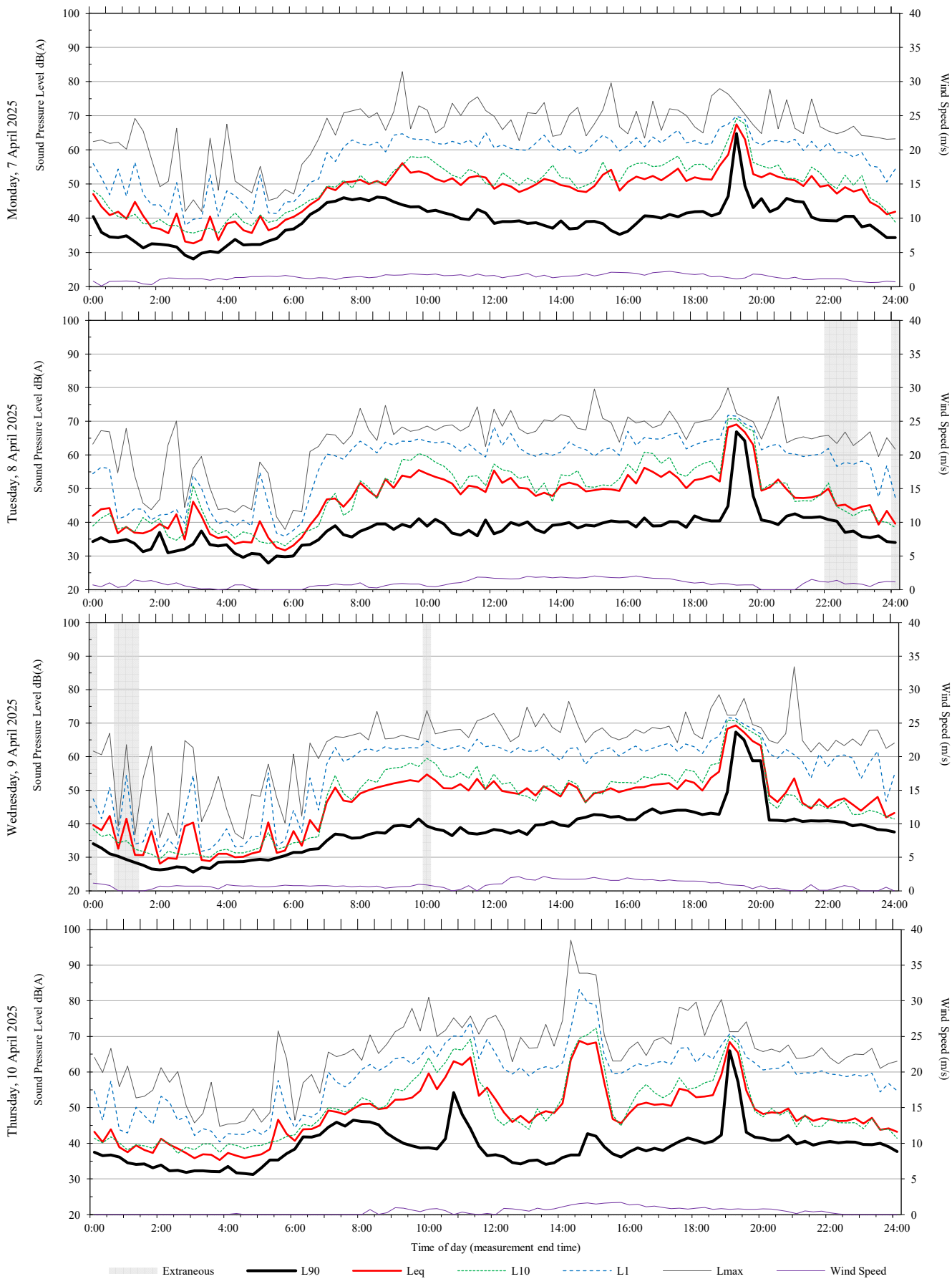
Saturday, 5 April 2025

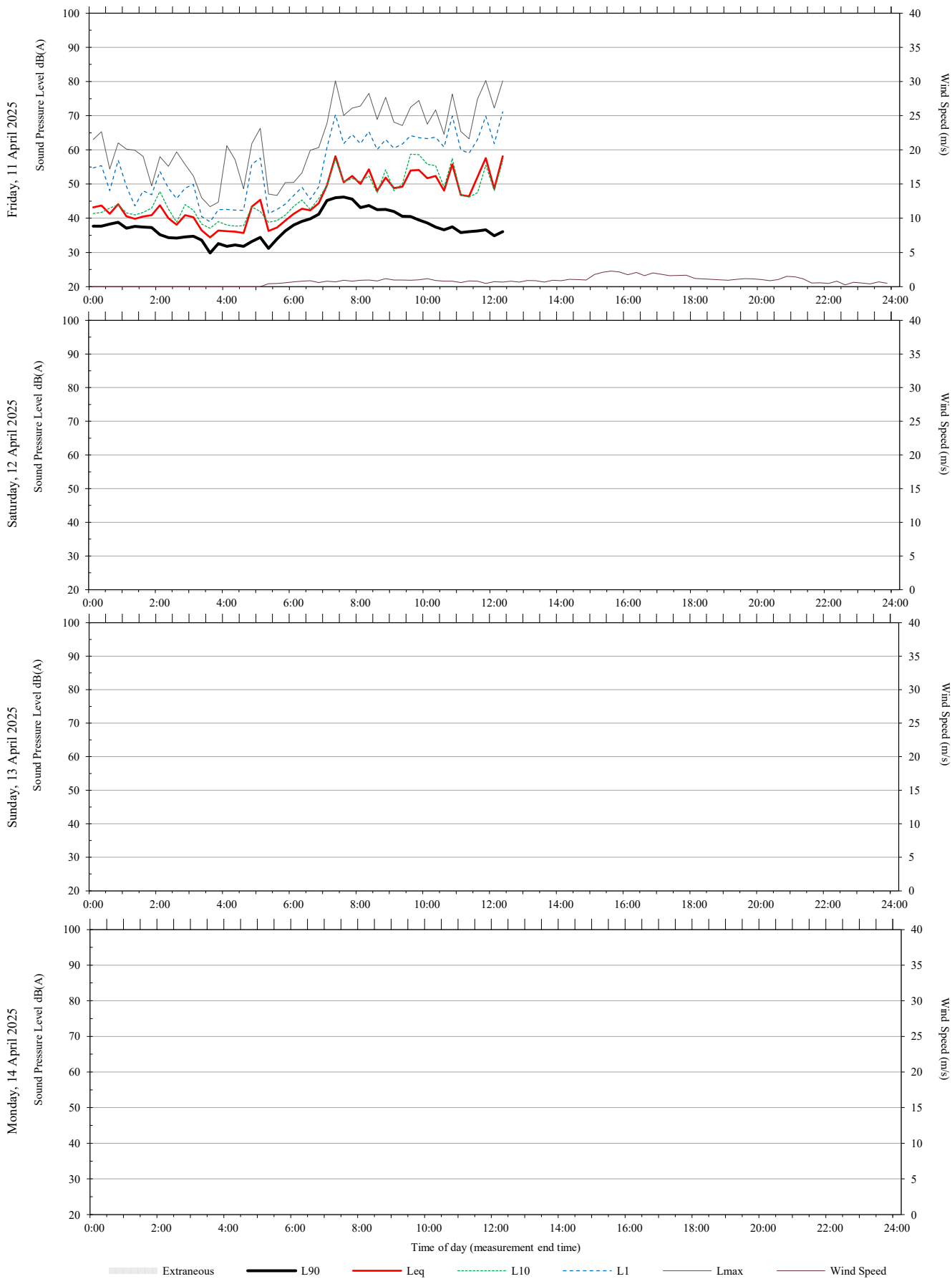


Sunday, 6 April 2025



Extraneous L90 Leq L10 L1 Lmax Wind Speed





Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L _{A90} Background noise levels ⁴			L _{Aeq} Ambient noise levels		
	Day ¹	Evening ²	Night ³	Day ¹	Evening ²	Night ³
Thursday-03-April-2025		45	37		55	47
Friday-04-April-2025	44	43	37	53	55	45
Saturday-05-April-2025	45	43	36	53	52	48
Sunday-06-April-2025	43	43	36	53	54	44
Monday-07-April-2025	45	43	36	52	54	45
Tuesday-08-April-2025	46	43		54	54	
Wednesday-09-April-2025	46	43	36	61	52	44
Thursday-10-April-2025	45	44	36	52	52	44
Friday-11-April-2025						
Representative Weekday⁵	45	43	36	56	54	45
Representative Weekend⁵	44	43	36	53	53	47
Representative Week⁵	45	43	36	56	53	46

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times

2. Evening is 6:00pm to 10:00pm

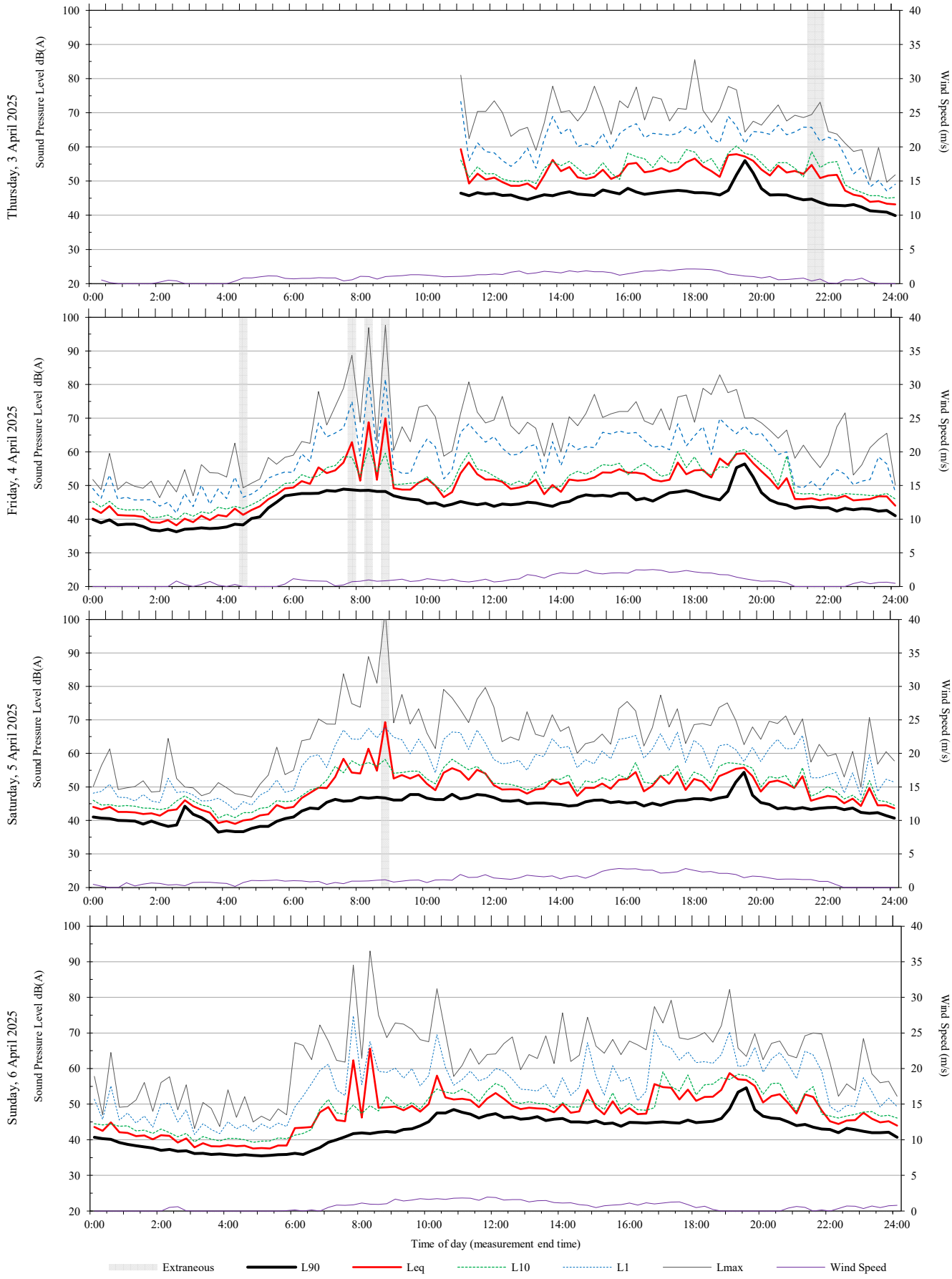
3. Night is the remaining periods

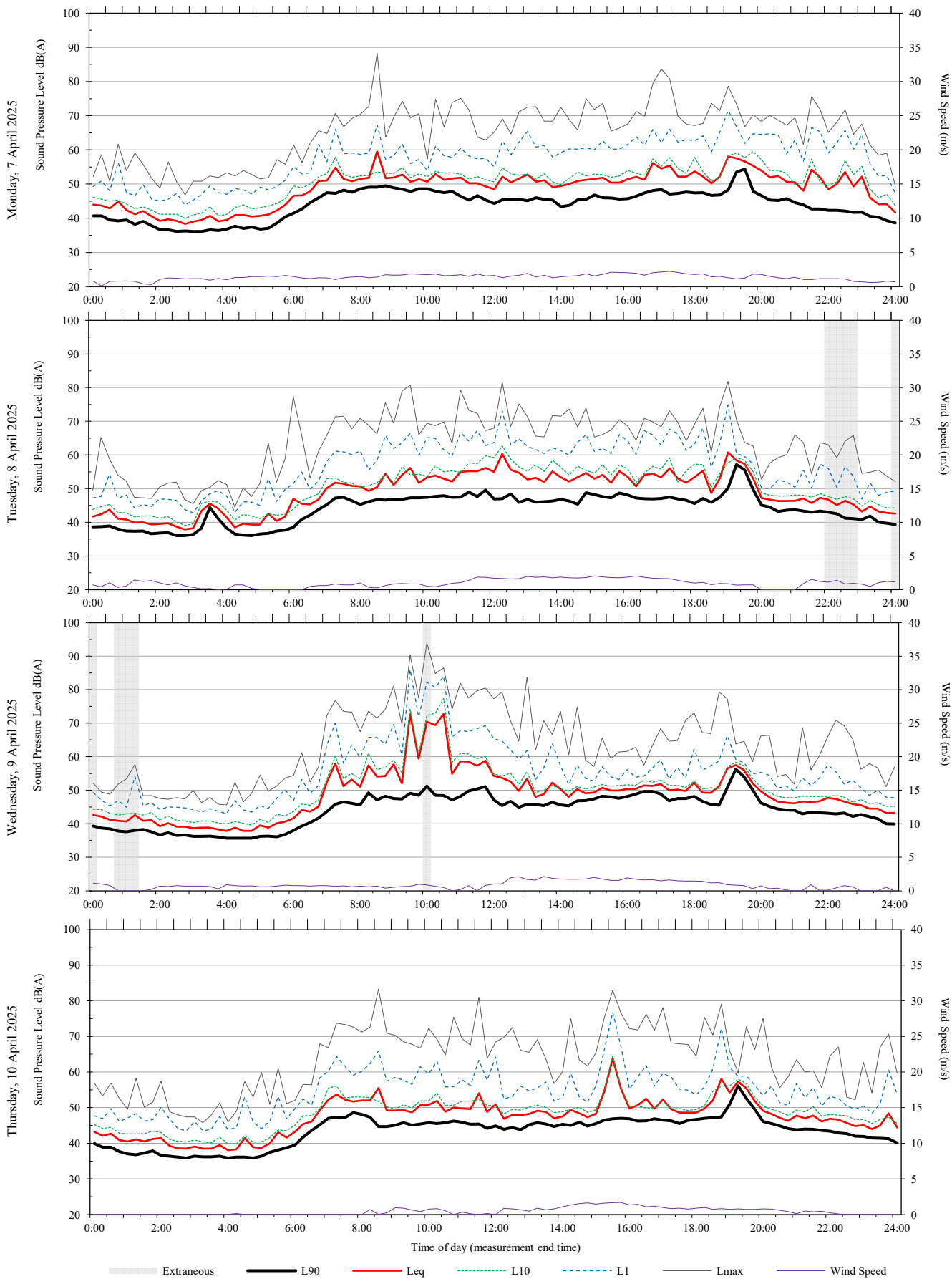
4. Assessment Background Level (ABL) for individual days

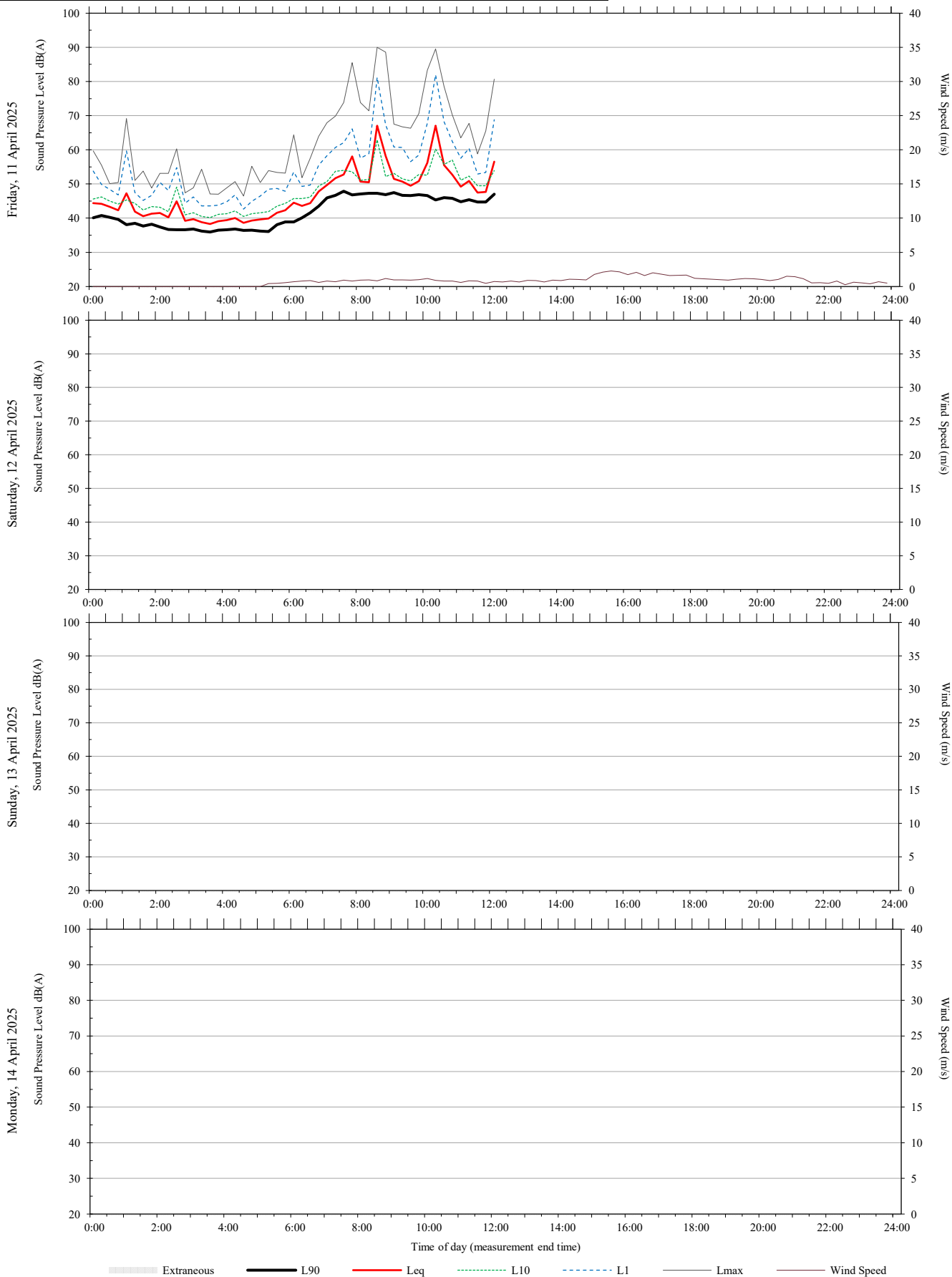
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L _{Aeq} Noise levels		L _{Aeq 1hr} Noise levels (upper 10th percentile)	
	Day ¹	Night ²	Day	Night
Thursday-03-April-2025	54	47	56	53
Friday-04-April-2025	53	45	56	49
Saturday-05-April-2025	53	43	56	47







Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L _{A90} Background noise levels ⁴			L _{Aeq} Ambient noise levels		
	Day ¹	Evening ²	Night ³	Day ¹	Evening ²	Night ³
Thursday-03-April-2025		37	29		62	47
Friday-04-April-2025	35	34	29	55	61	42
Saturday-05-April-2025	39	35	24	55	58	45
Sunday-06-April-2025	35	34	28	59	59	42
Monday-07-April-2025	38	36	27	53	54	47
Tuesday-08-April-2025	38	34		59	60	
Wednesday-09-April-2025	37	35	28	55	60	42
Thursday-10-April-2025	35	34		54	58	
Friday-11-April-2025						
Representative Weekday⁵	37	35	28	56	60	45
Representative Weekend⁵	37	34	26	58	58	43
Representative Week⁵	37	35	28	56	59	44

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times

2. Evening is 6:00pm to 10:00pm

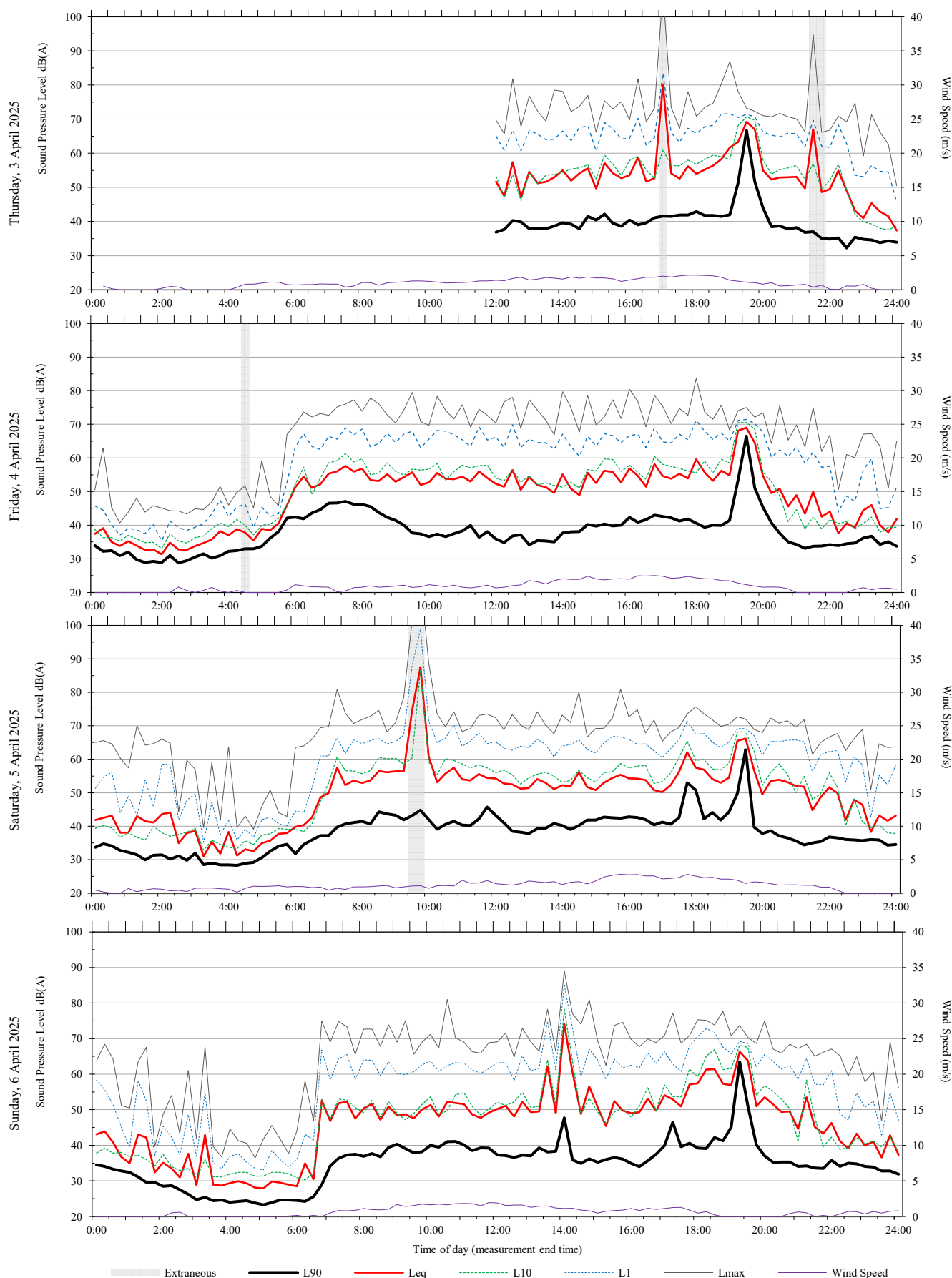
3. Night is the remaining periods

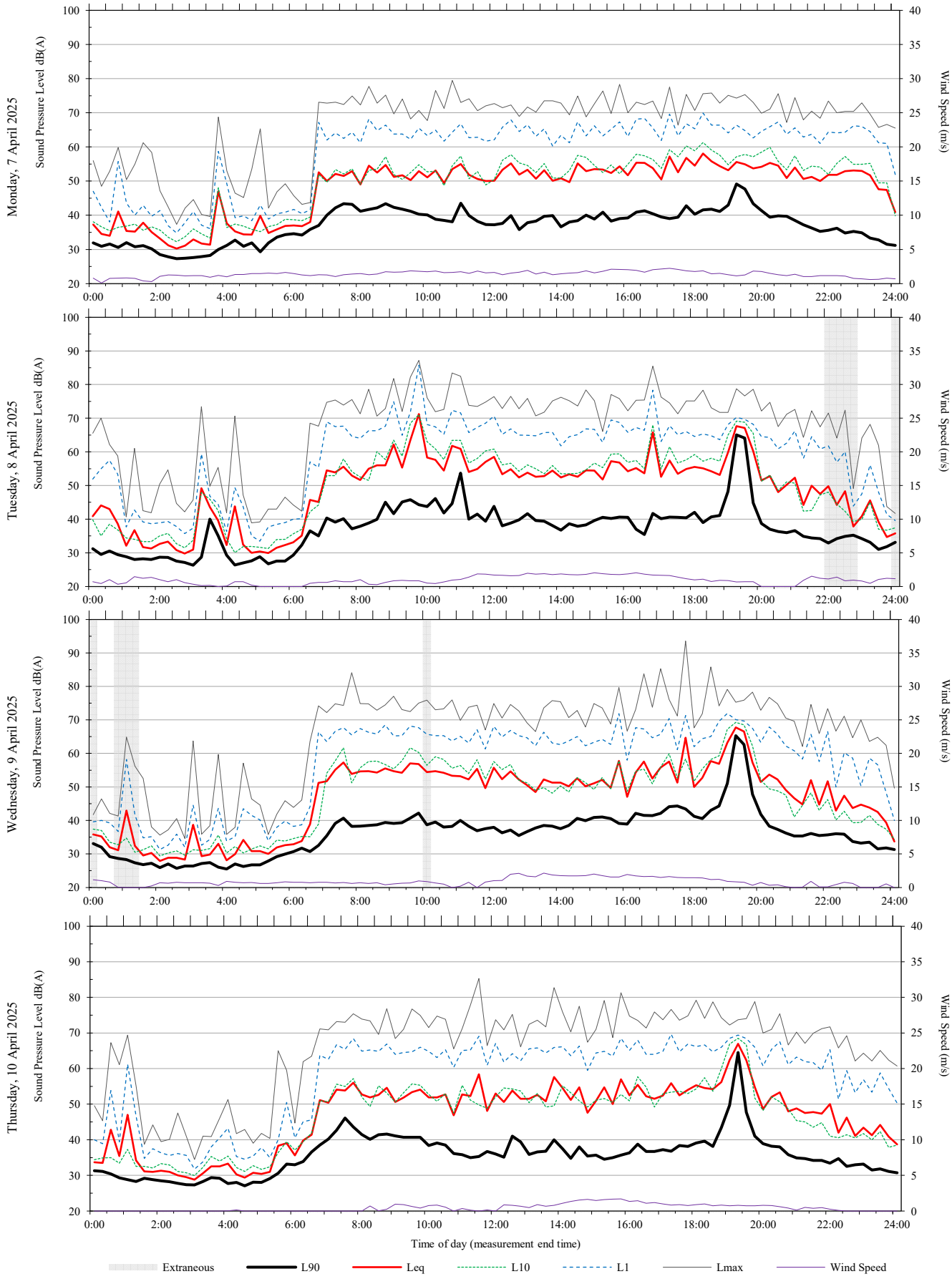
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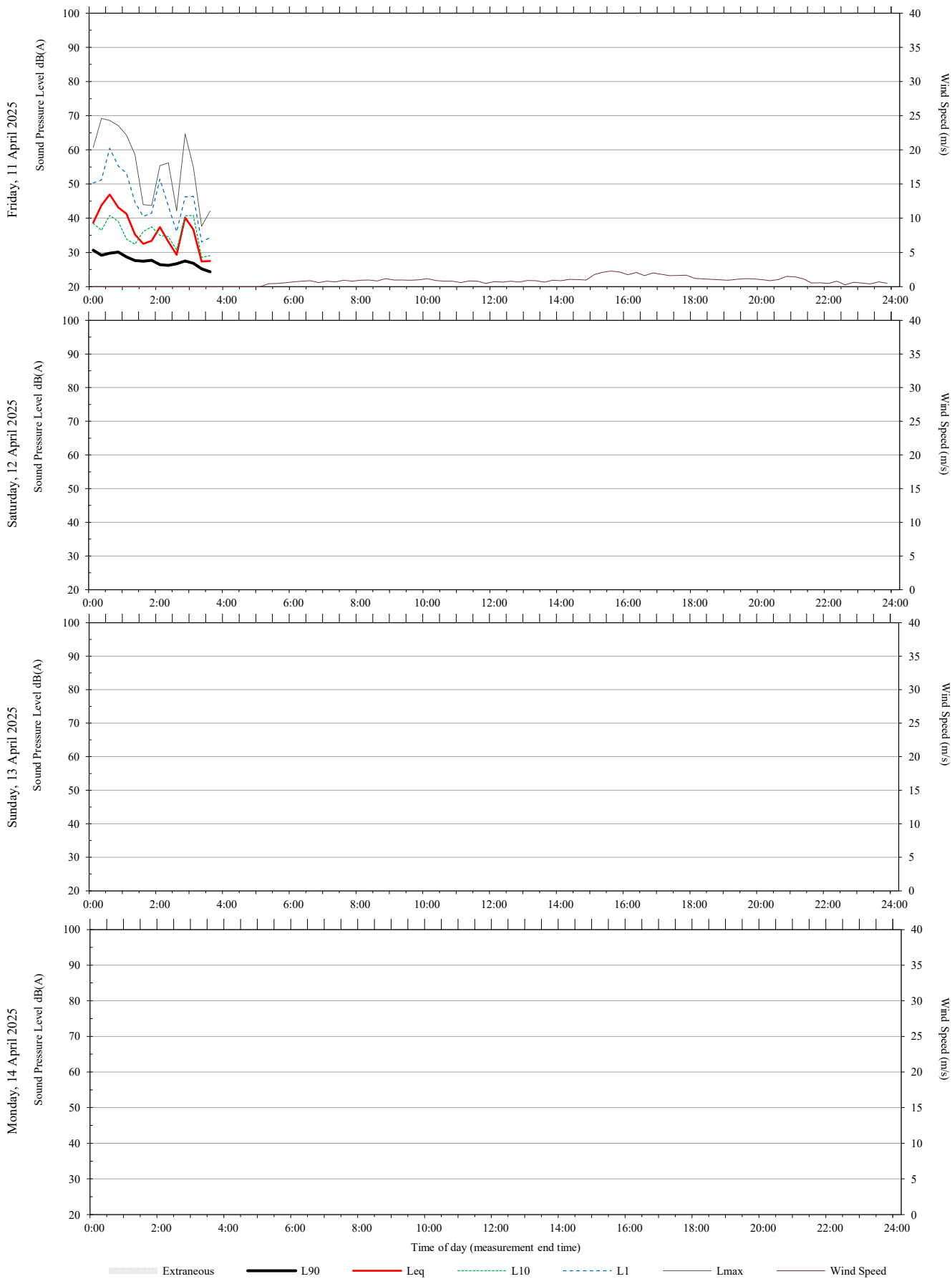
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L _{Aeq} Noise levels		L _{Aeq 1hr} Noise levels (upper 10th percentile)	
	Day ¹	Night ²	Day	Night
Thursday-03-April-2025	58	47	59	54
Friday-04-April-2025	57	42	57	47
Saturday-05-April-2025	56	43	59	48







Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L _{A90} Background noise levels ⁴			L _{Aeq} Ambient noise levels		
	Day ¹	Evening ²	Night ³	Day ¹	Evening ²	Night ³
Thursday-03-April-2025		37	28		53	43
Friday-04-April-2025	34	38	30	52	53	37
Saturday-05-April-2025	37	33	25	52	51	43
Sunday-06-April-2025	35	35	32	50	50	39
Monday-07-April-2025	36	37	28	52	51	44
Tuesday-08-April-2025	37	38		53	50	
Wednesday-09-April-2025	37	39	29	52	48	38
Thursday-10-April-2025	34	39	29	51	49	39
Friday-11-April-2025						
Representative Weekday⁵	36	38	29	52	51	41
Representative Weekend⁵	36	34	29	51	51	41
Representative Week⁵	36	37	29	52	51	41

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times

2. Evening is 6:00pm to 10:00pm

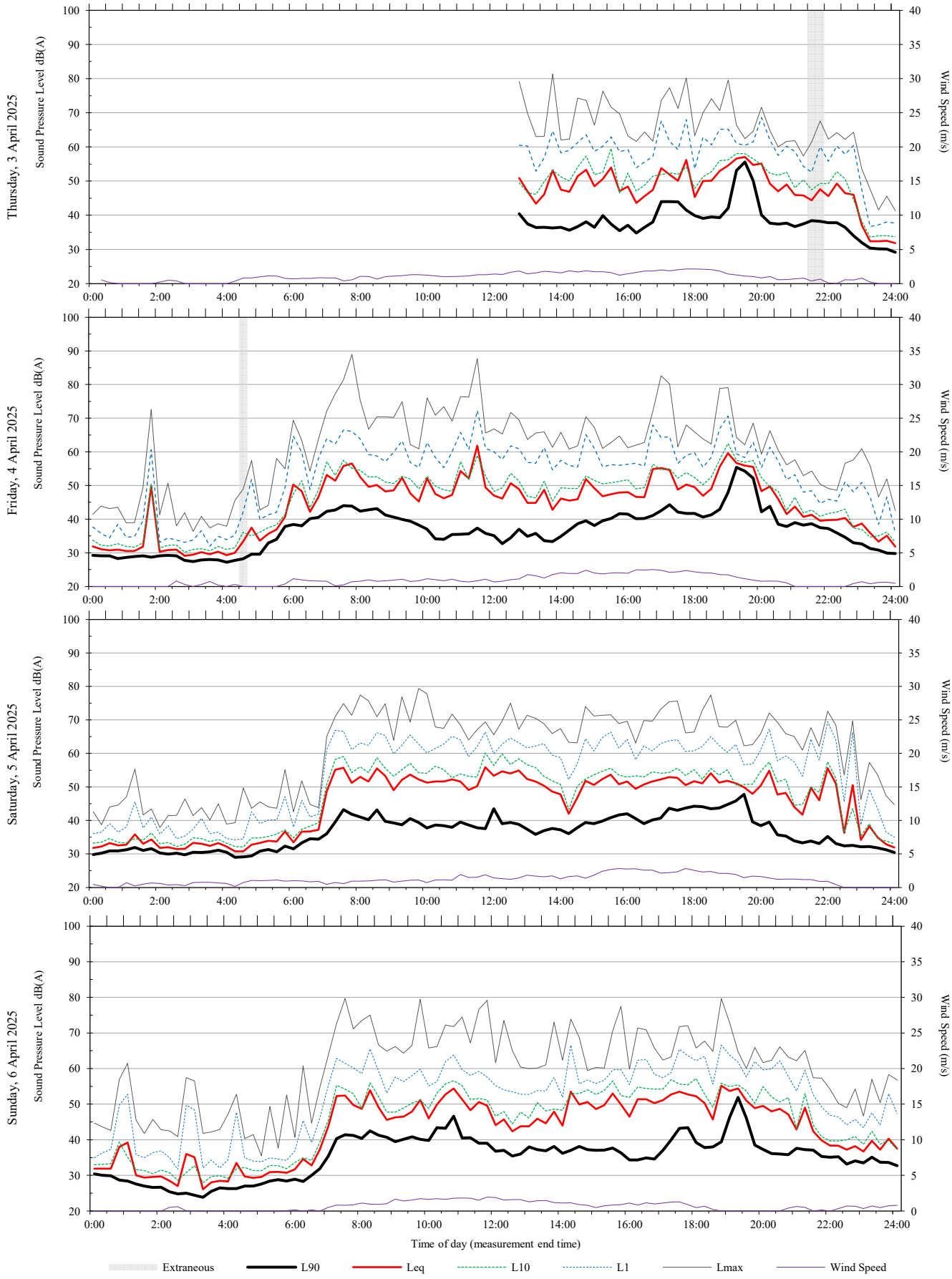
3. Night is the remaining periods

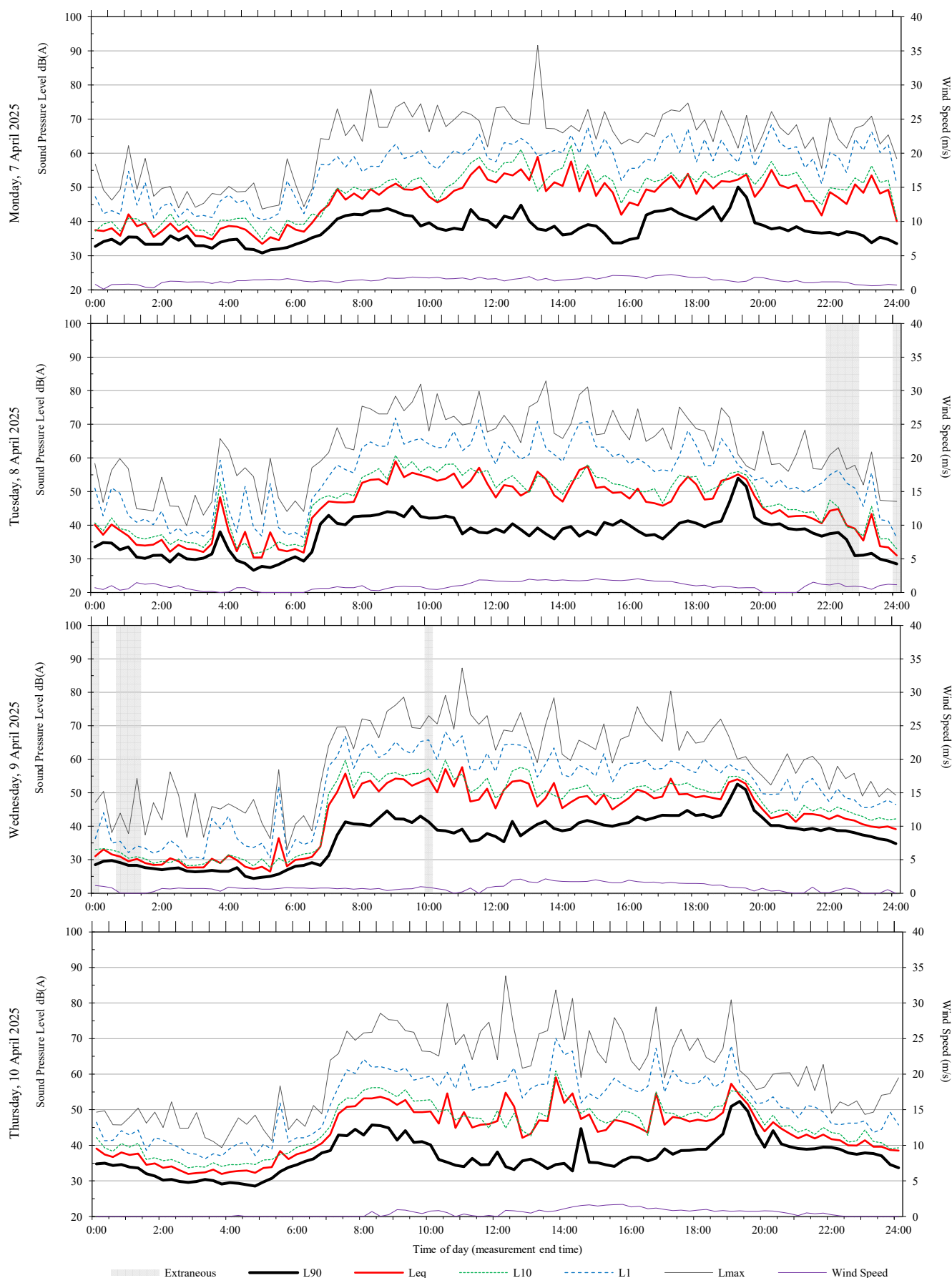
4. Assessment Background Level (ABL) for individual days

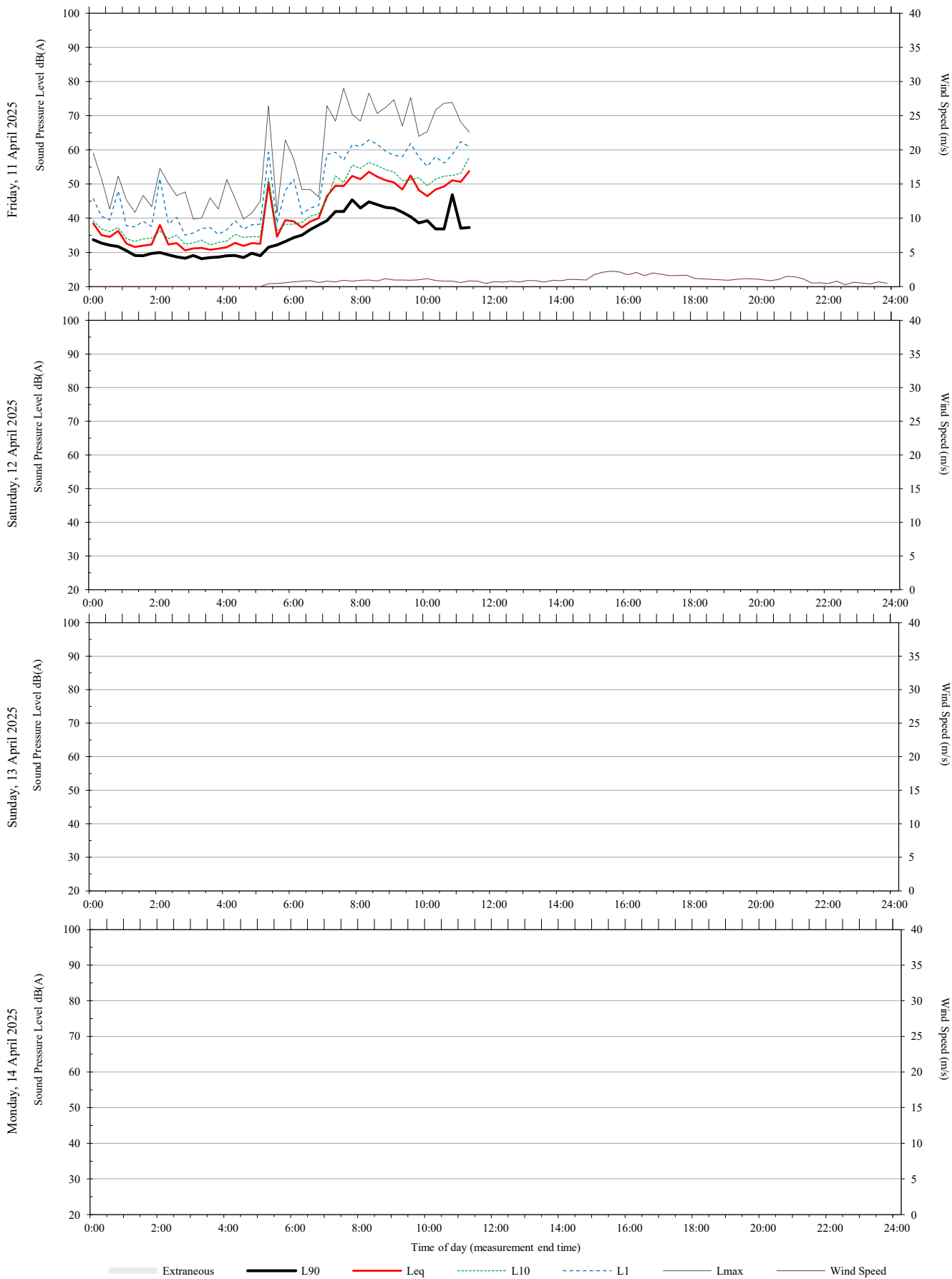
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L _{Aeq} Noise levels		L _{Aeq 1hr} Noise levels (upper 10th percentile)	
	Day ¹	Night ²	Day	Night
Thursday-03-April-2025	52	43	54	49
Friday-04-April-2025	52	37	56	44
Saturday-05-April-2025	52	40	54	48







Appendix C

Construction noise criteria

To establish residential criteria, the background noise is typically to be measured, while for all other receiver types, the criteria is fixed.

The ICNG [1] provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction management noise levels above which all ‘feasible and reasonable’ work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a ‘screening’ criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all ‘feasible and reasonable’ work practices to reduce noise levels.

The ICNG sets out management levels for noise at sensitive receivers and how they are to be applied. For residential receivers, the RBL is used when determining the management level. The management level for residential is reproduced in Table 20. For other sensitive land uses, the management levels are based on a fixed criteria independent of ambient noise levels. Those management levels are reproduced in Table 21.

Table 20: Construction noise management levels at residential receivers

Time of day	Management level ¹ dBL _{Aeq} (15 min)	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm 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. Where the predicted or measured L _{Aeq} (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Notes:

- 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.

Table 21: Construction noise management levels at other noise sensitive land uses

Land use	Where objective applies	Management level, dBL _{Aeq} (15 min) ¹
Commercial premises	External noise level	70
Educational premises	Internal noise level	45
	External noise level	55 ²
Places of worship	Internal noise level	45
	External noise level	55 ²
Childcare ³	Internal noise level	45
	External noise level	55 ²
Community Centre ⁴	Internal noise level	45
	External noise level	55 ²
Industrial	External noise level	75
Active recreation	External noise level	65
Passive recreation	External noise level	60

Notes:

1. Noise management levels apply when properties are in use
2. Assuming a 10dB addition to internal criteria for windows open
3. Internal noise level based on AS2107 [31] max design level for Teaching Spaces/Single Classroom – Primary Schools
4. Internal noise level based on AS2107 [31] max design level for Municipal building – function area

Appendix D

Vibration criteria

D.1 Disturbance to building occupant

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW DEC *Assessing Vibration; a technical guideline* [2]. The criteria outlined in the guideline is based on the British Standard BS 6472-1992 *Evaluation of human exposure to vibration in buildings (1-80Hz)* [10]. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 22.

Table 22: Types of vibration - Definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day and/or night)	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.

Table 23 reproduces the 'Preferred' and 'Maximum' values for continuous and impulsive vibration from Table 2.2 of the Guideline.

Table 23: Preferred and maximum vibration acceleration levels for human comfort, m/s²

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

Note 1 - Day is 7:00am to 10:00pm and night is 10:00pm to 7:00am

Table 24 reproduces the 'Preferred' and 'Maximum' values for intermittent vibration from Table 2.4 of the Guideline. The VDV is dependent upon the level and duration of the vibration episode and the number of vibration episodes occurring during the assessment period; a higher vibration level is permitted if the total duration of the vibration event(s) is small.

Table 24: Acceptable vibration dose values (VDV) for intermittent vibration ($m/s^{1.75}$)

Location	Day ¹		Night ¹	
	Preferred value	Maximum value	Preferred value	Maximum value
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

Note:

1_ Day is 7:00am to 10:00pm and night is 10:00pm to 7:00am

D.2 Impact on building contents – sensitive equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

Where vibration sensitive scientific and/or medical instruments are in use within an identified vibration sensitive receiver, objectives for the satisfactory operation of the instrument should be sourced from manufacturer's data. Where manufacturer's data is not available, generic vibration criterion (VC) curves as published by the Society of Photo-Optical Instrumentation Engineers [25] or the ASHRAE Chapter 49 [26] may be adopted, as presented in Table 17. Baseline vibration levels could also be measured to inform the establishment of appropriate criteria.

Table 25: Application and interpretation of the generic Vibration Criterion (VC) curves (as defined in the CNVG)

Criterion Curve	Max Level ($\mu m/sec, rms$) ¹	Detail size (micron) ²	Description of use
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.

Note 1: As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz

Note 2: The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given consider the observation that the vibration requirements of many items depend upon the detail size of the process.

D.3 Impact on structures and services

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [11] and/or German Standard DIN4150-3 [12]. Additional information is also provided in the CNVG [5].

D.3.1 Standard structures

British Standard 7385 Part 1: 1993, defines different levels of structural damage as:

- *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.*

Table 1 and Section 7.4.2 of BS7385-2 sets limits for the protection against the different levels of structural damage and those levels are reproduced in Table 26 below.

Table 26: BS 7385-2 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s ¹		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor ²	100		
		Major ²	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor ²	30 to 40	40 to 100	100
		Major ²	60 to 80	80 to 200	200

Notes:

1_ Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

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

3_ All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

The guide values in Table 26 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 26 may need to be reduced by up to 50%.

Activities considered to have the potential to cause dynamic loading in some structures (e.g. residences) include rock breaking/hammering and sheet piling activities. On the basis that the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range) a conservative vibration damage screening level per receiver type is given below:

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

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

D.3.2 Sensitive structures

German Standard *DIN 4150 – Part 3 ‘Structural vibration in buildings – Effects on Structure’* [12] is generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings.

Heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound and should otherwise be assessed in accordance with BS7385-2. If a heritage building or structure is found to be structurally unsound (following inspection) DIN 4150-3, line 3 as outlined in Table 27, provides a conservative cosmetic damage objective that should be adopted unless alternative limits are justified by a dilapidation or structural survey. The sensitivity of heritage buildings and other potentially at-risk structures are subject to confirmation by the contractor prior to start of any works.

Table 27: DIN 4150-3 structural damage guideline values

Line	Type of structure	Peak component particle velocity (PCPV), mm/s				
		Vibration at the foundation at a frequency of			At horizontal plane of highest floor	In the vertical direction, at floor slabs
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz ¹	All frequencies	All frequencies
3	Structures that because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under a preservation order) ³	3	3 to 8	8 to 10	8	20 ²

Notes:

1_ At frequencies above 100 Hz, the values given in this column may be used as minimum values.

2_ Guideline value might have to be lowered to prevent minor damage

3_ Line 1 refer to buildings used for commercial purposes, industrial buildings and buildings of similar design, while Line 2 refers to residential buildings and buildings of similar design and/or occupancy

Note that no sensitive structures have been identified near the site.

D.3.3 Buried services

It is not expected that the proposed works will impact upon buried services, however the following is nonetheless provided for guidance.

DIN 4150-2:2016 sets out guideline values for vibration effects on buried pipework (see Table 28).

Table 28: Guideline values for short-term vibration impacts on buried pipework

Line	Pipe material	Peak component particle velocity (PCPV) measured on pipe, mm/s
1	Steel, welded	100
2	Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50
-	High pressure gas pipelines*	75 Monitoring required if predicted above 50. No piling within 15 m of pipeline without detailed assessment.

Notes:

- For gas and water supply pipes within 2 m of buildings, the levels given in DIN4150-3 [12] should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

- For Rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50%.

* Based on UK National Grid's specification [32]

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

D.3.4 Vibration limits – Sydney Water assets

Sydney Water specifies vibration limits for Sydney Water assets based on the asset type as presented in Table 29 (as per the Sydney Water Specialist Engineering Assessment [29]). The susceptibility of Sydney Water assets to vibration damage depends on a range of factors including the nature of the ground, the

geometry, materials and condition of the structure, the nature of the vibrations and their proximity to the structure and whether they are long acting or intermittent.

Table 29: Threshold vibration limits [29]

Line	Asset Type	Threshold values for velocity (PPV) measured on the asset in mm/s
1	Brittle Pipe assets – RC, VC/ EW, CICL	Maximum PPV for intermittent vibrations: 10mm/s Maximum PPV for continuous vibrations: 5mm/s
2	Ductile Pipe assets – SCL, DI, PVC, PE, PP, GRP	Maximum PPV for intermittent vibrations: 20mm/s Maximum PPV for continuous vibrations: 10mm/s
3	Masonry	3mm/s
4	Unreinforced concrete	3mm/s

Note:

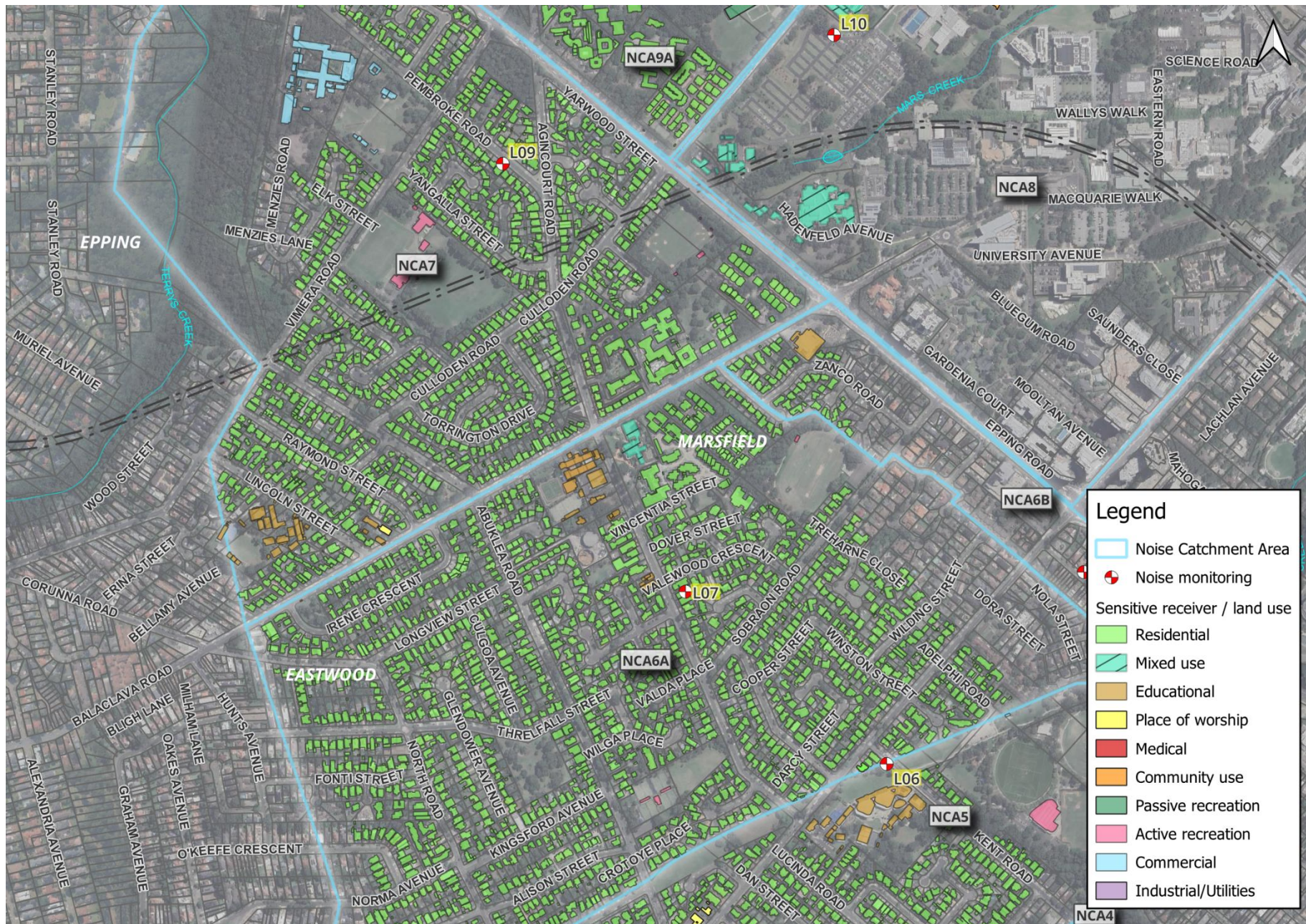
This table is applicable for buried assets, in sound condition, and laid in a typical soil trench in stable ground. Alternative criteria shall be developed for other asset types, above ground assets, concrete encased pipes, pipes on piled/ special supports and pipes in tunnels or of other unusual construction or ground conditions.

Appendix E

Sensitive receivers, land uses, NCAs and noise monitoring locations

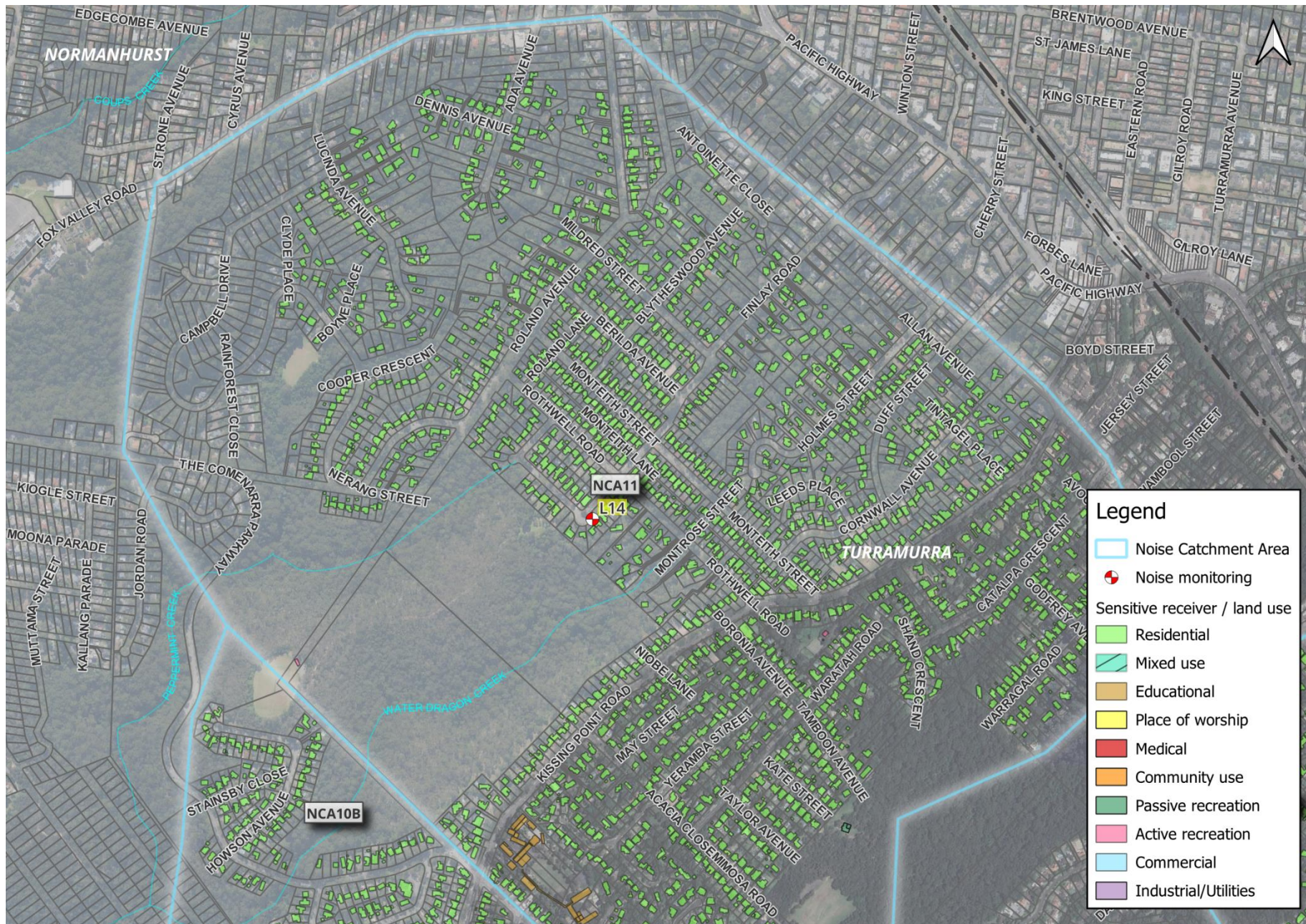


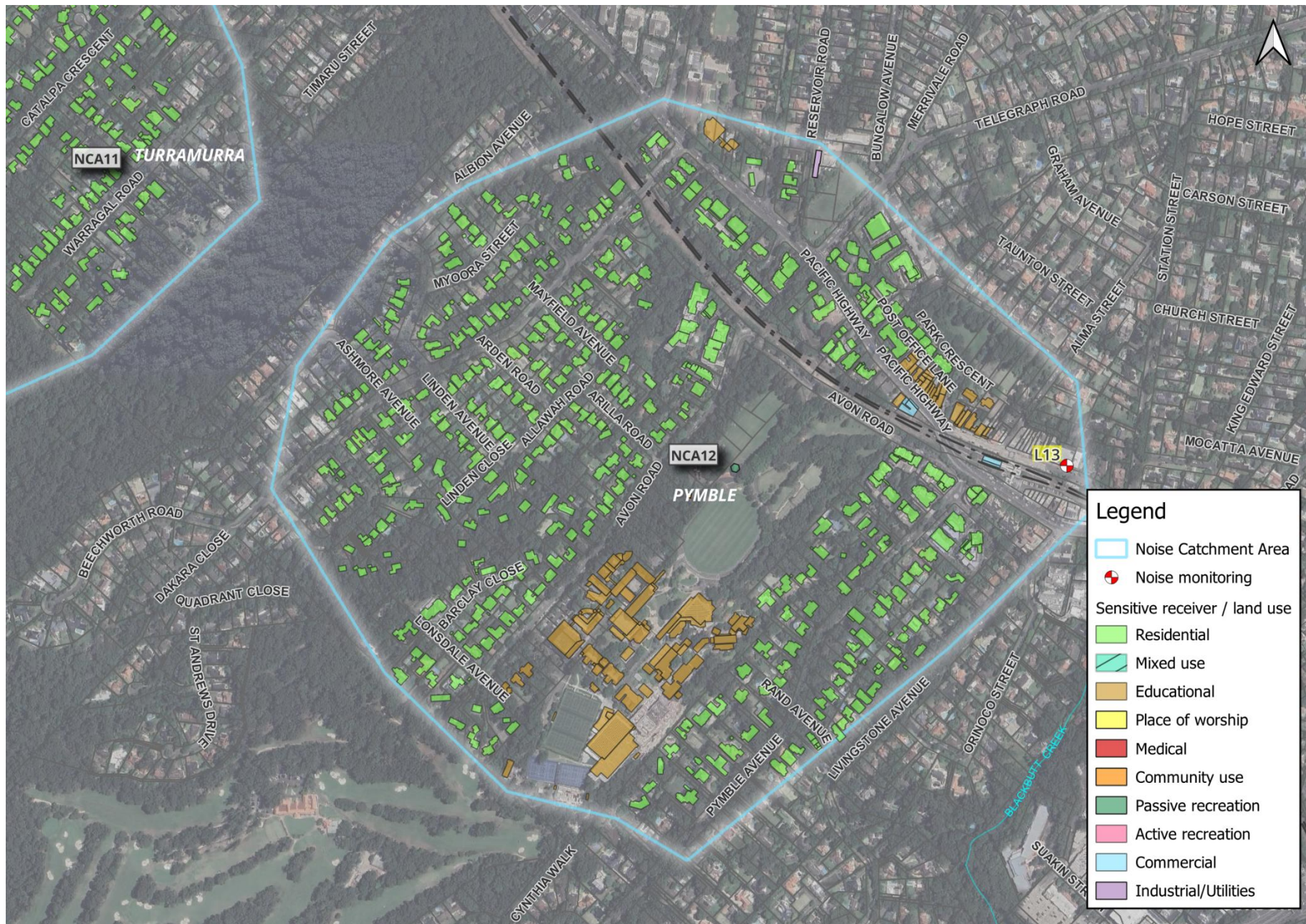


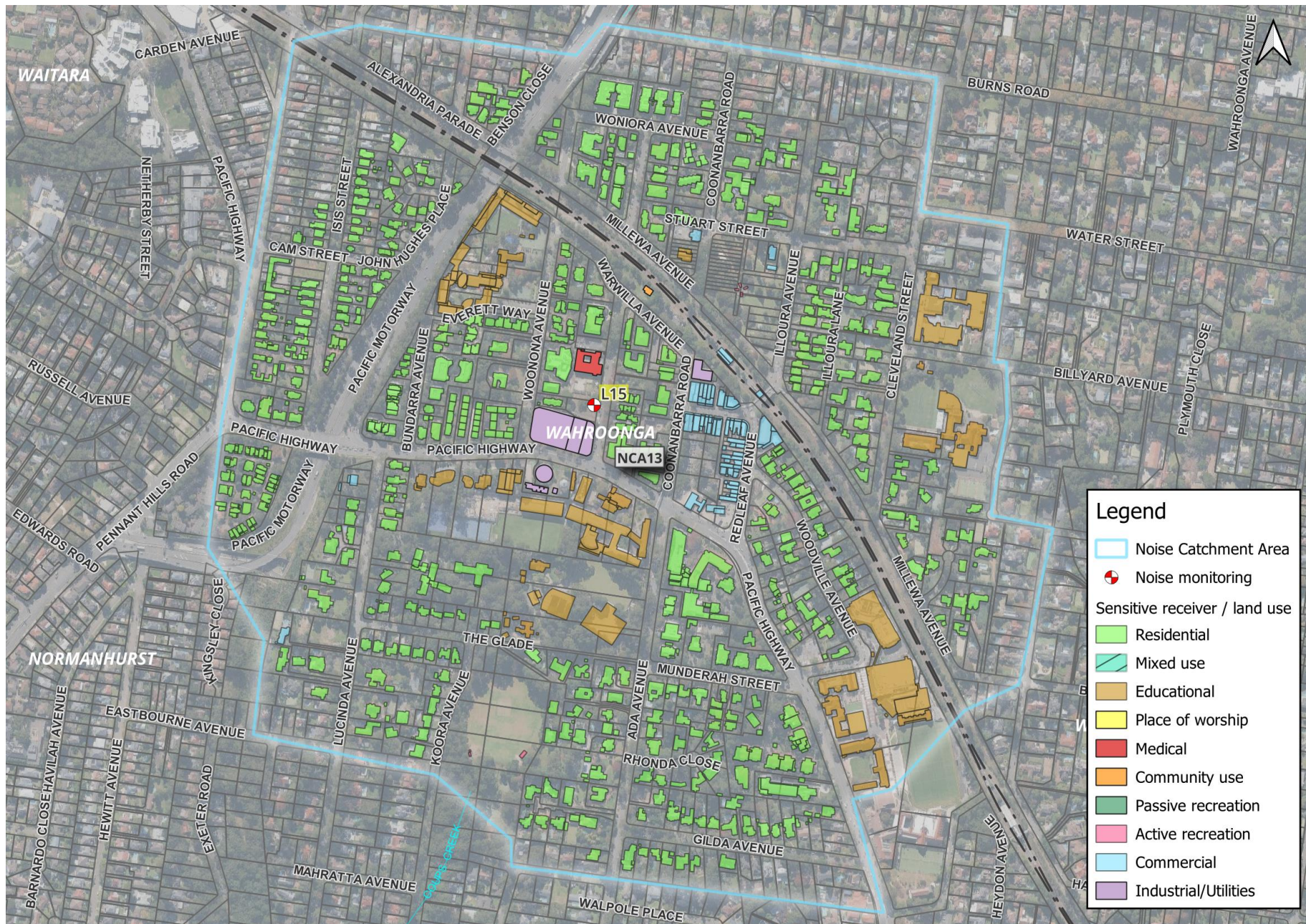


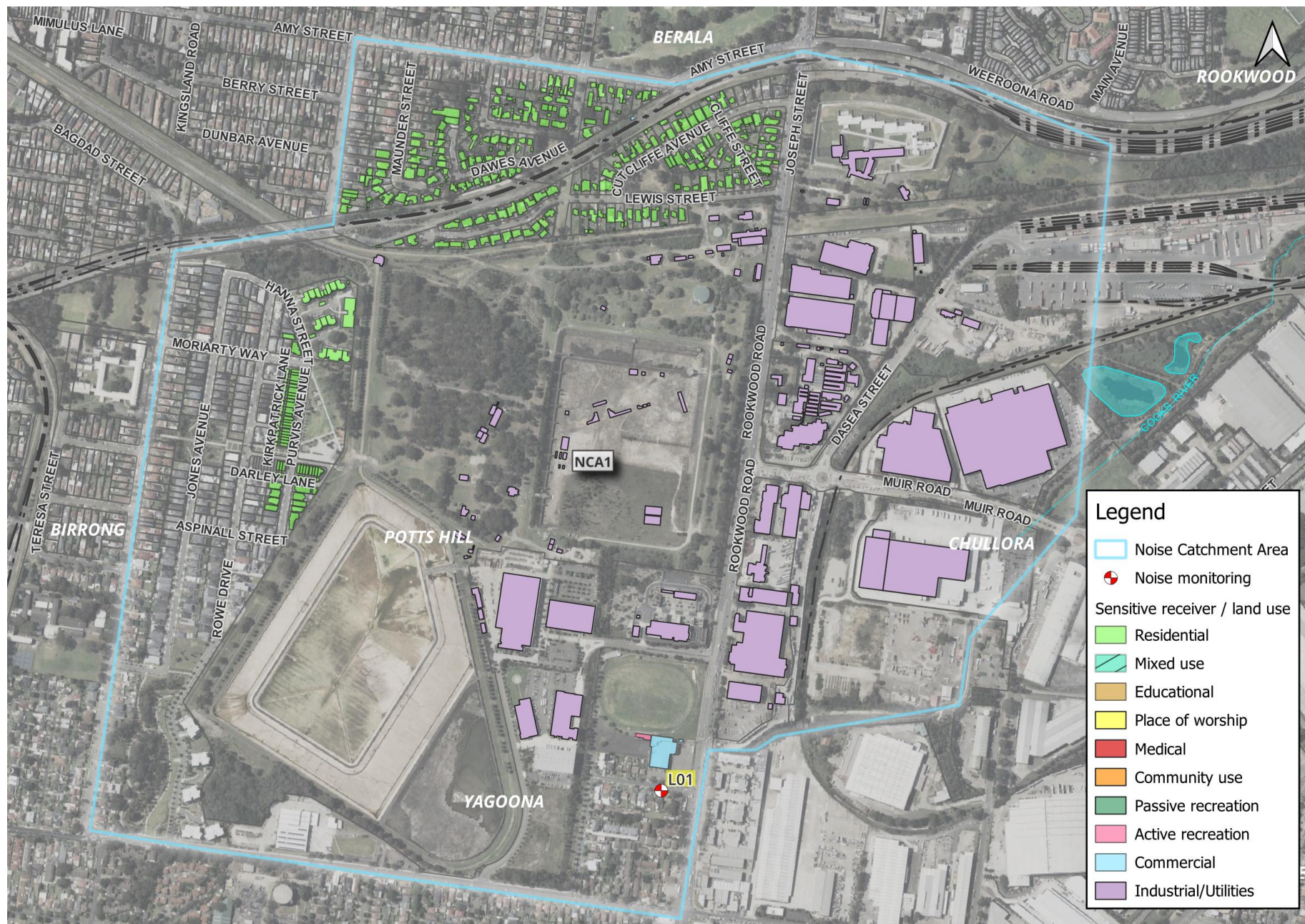








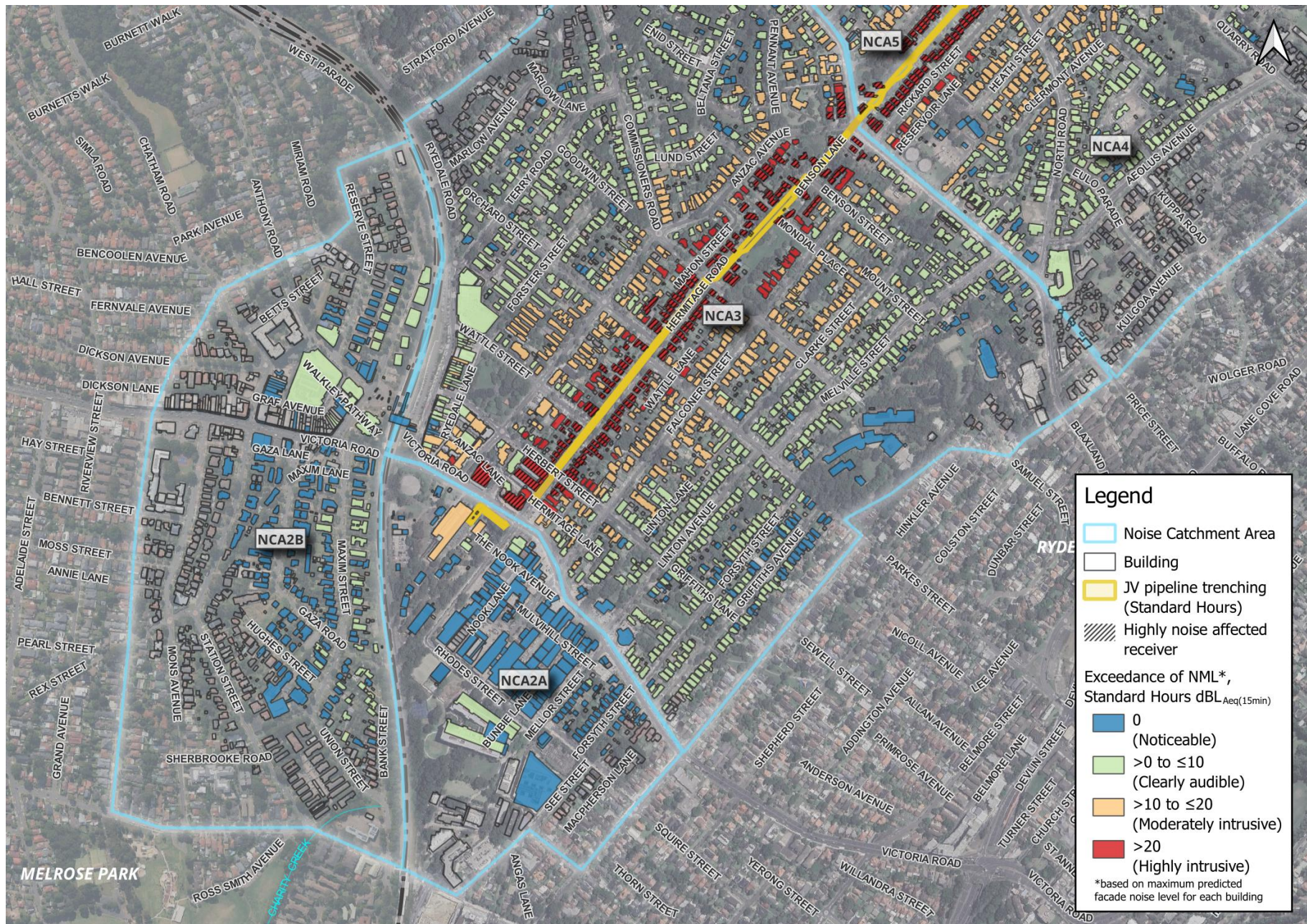




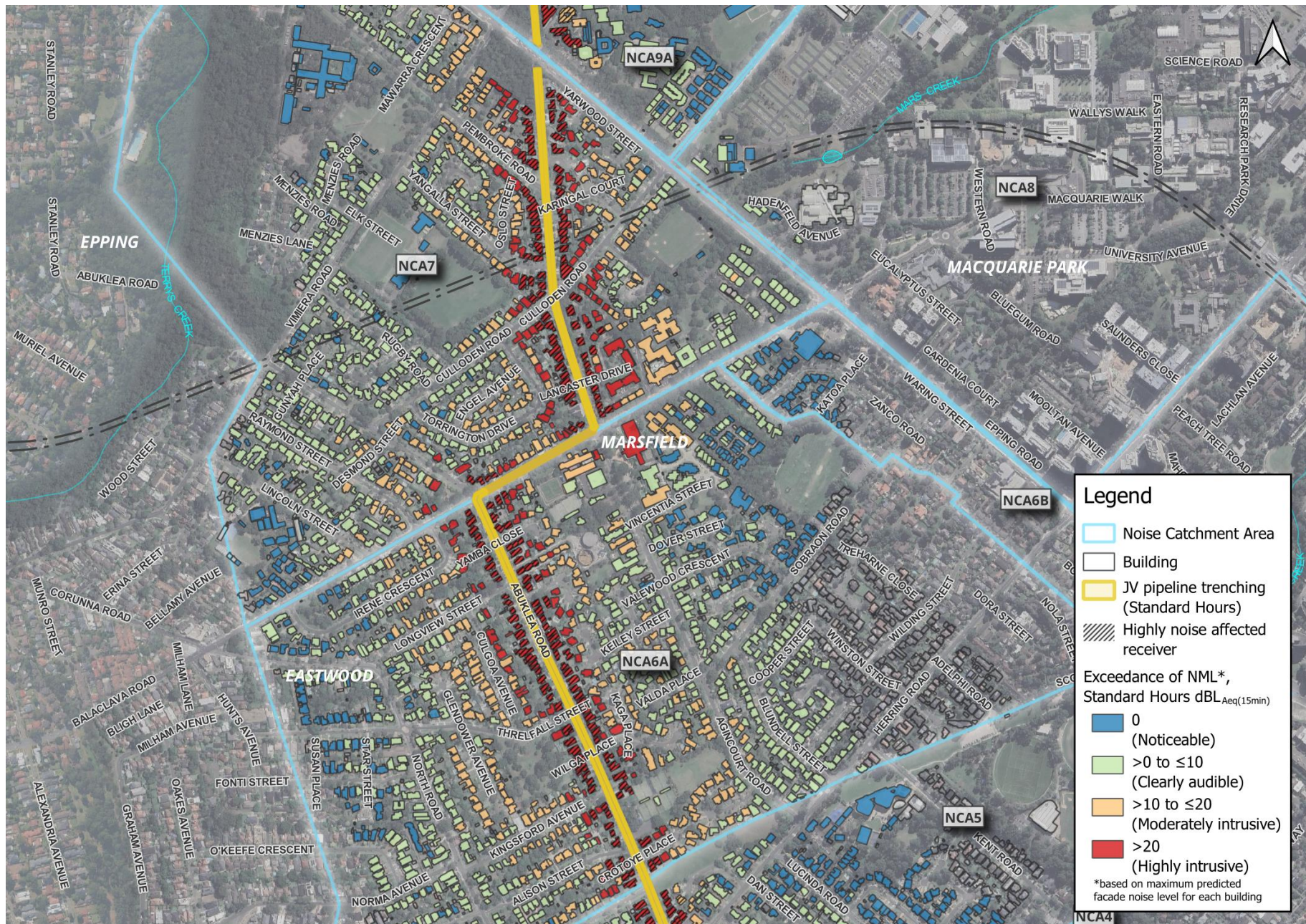
Appendix F

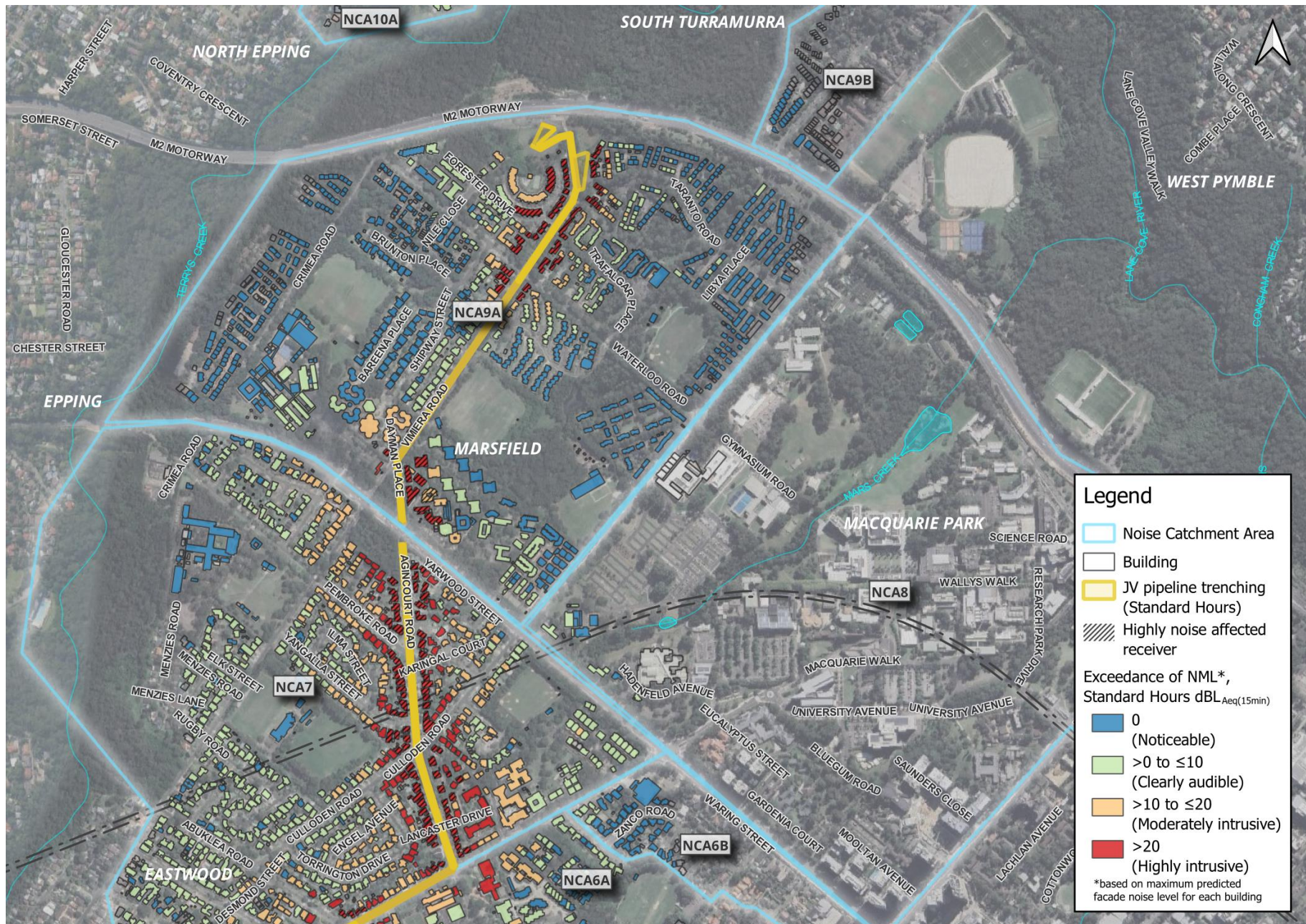
Noise exceedance maps

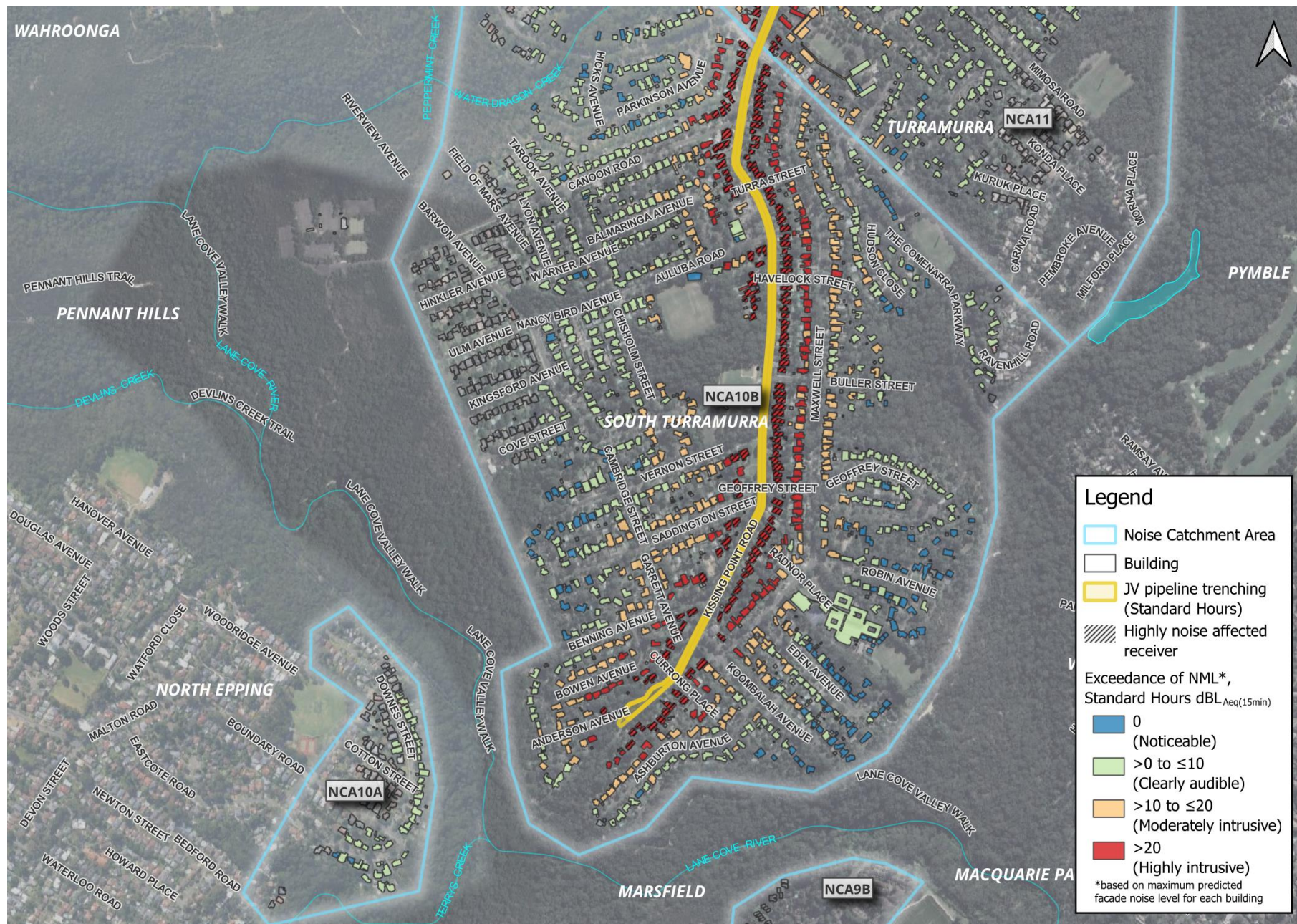
F.1 JV pipeline alignment trenching works – Standard Hours

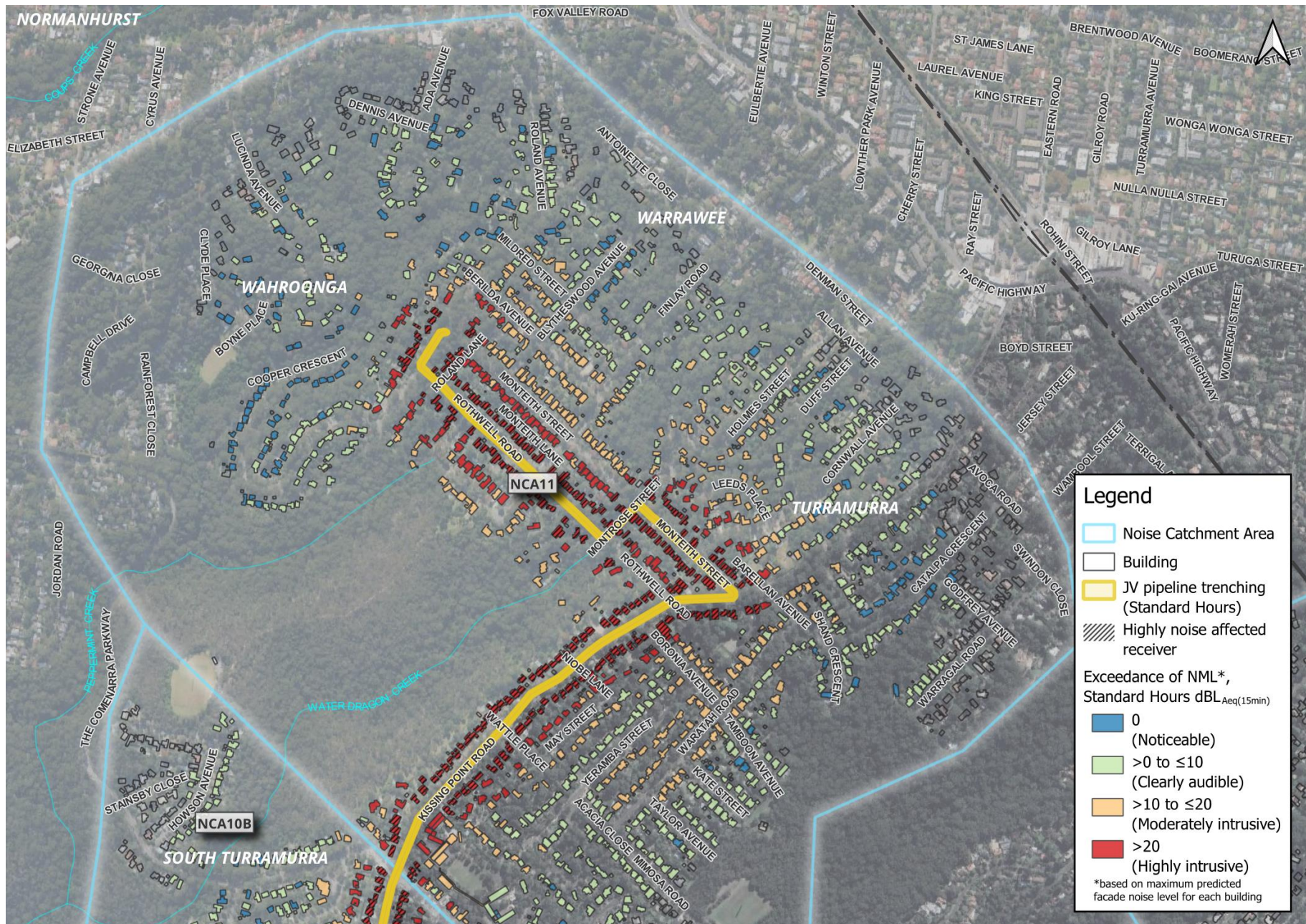


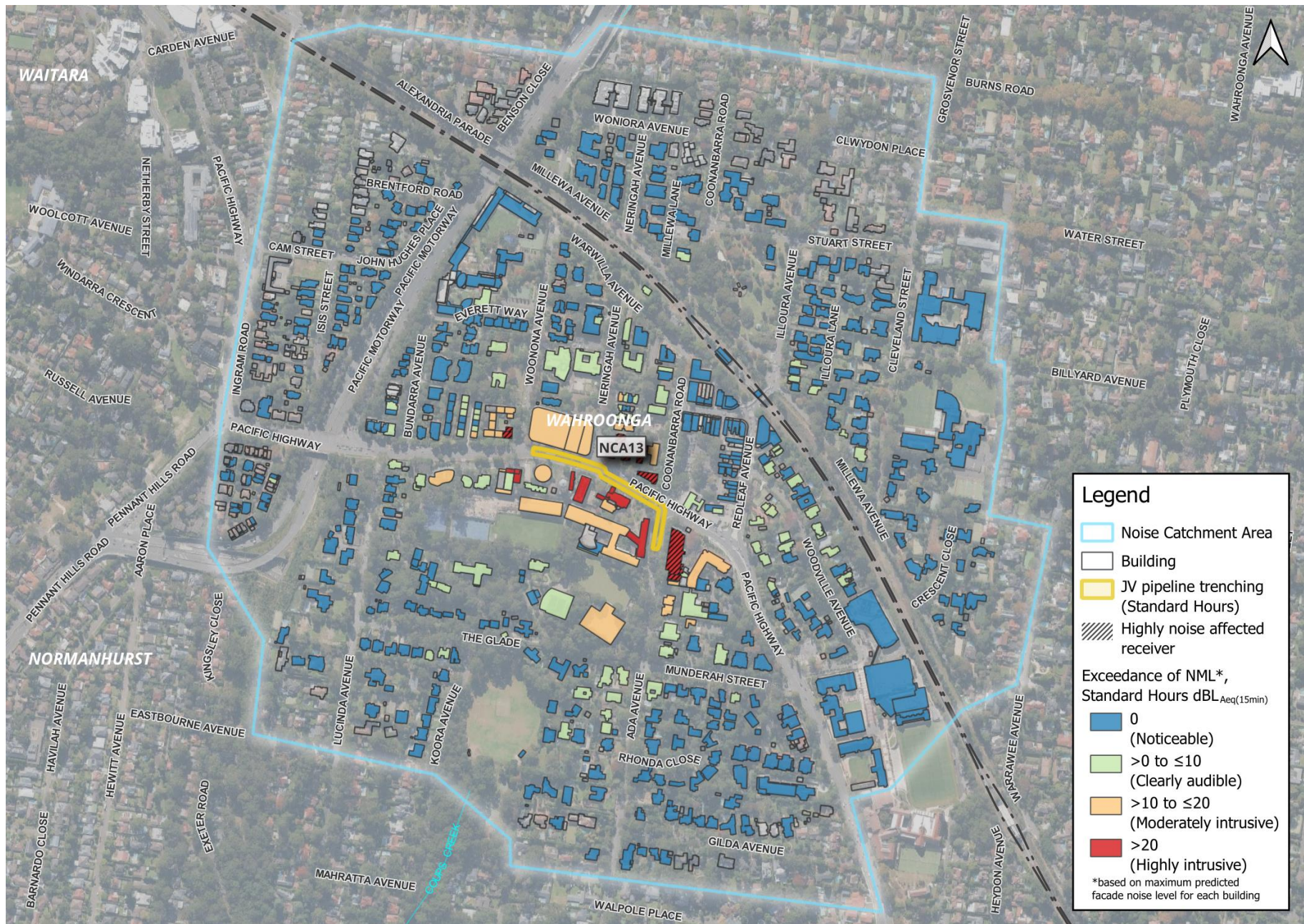




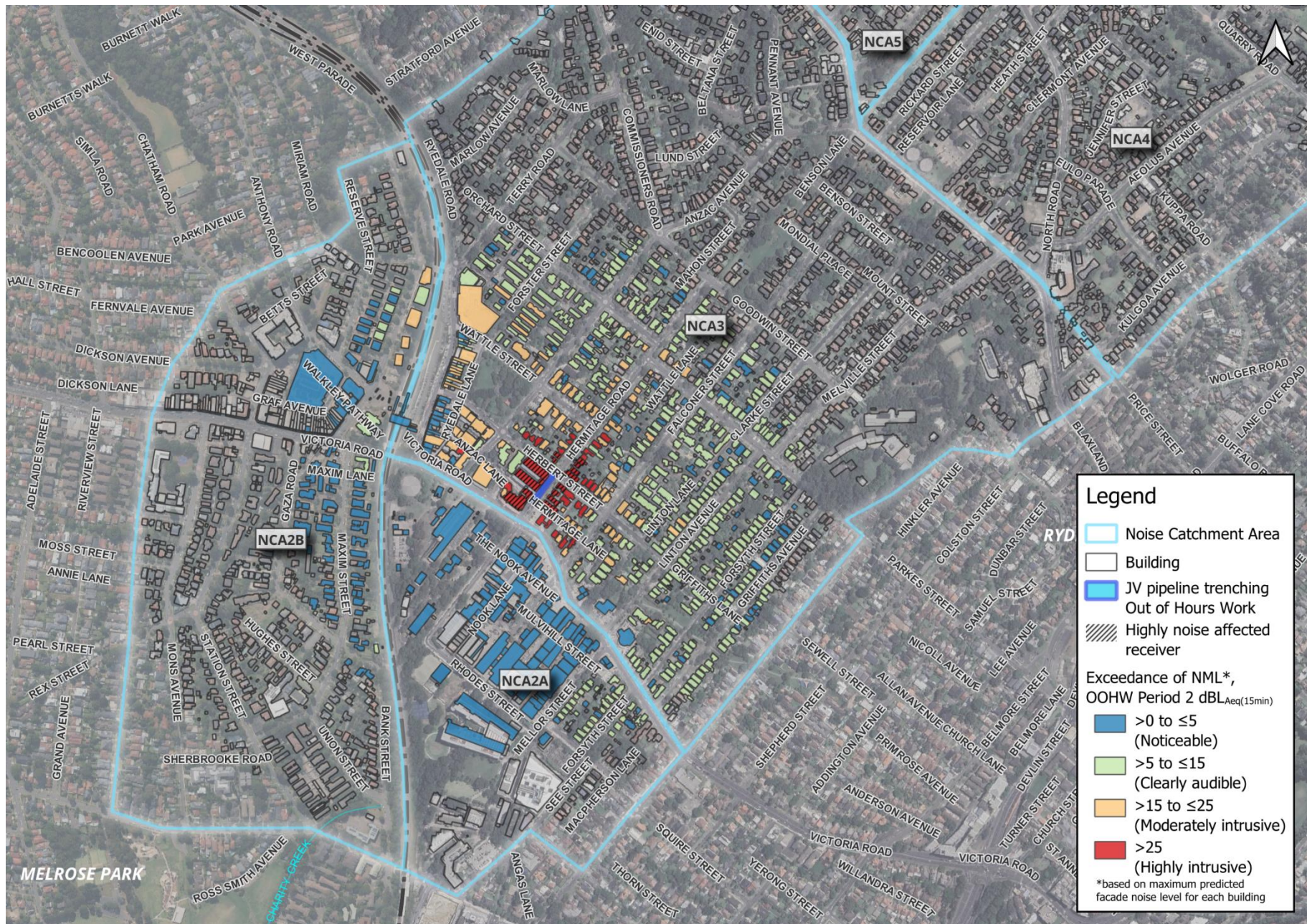




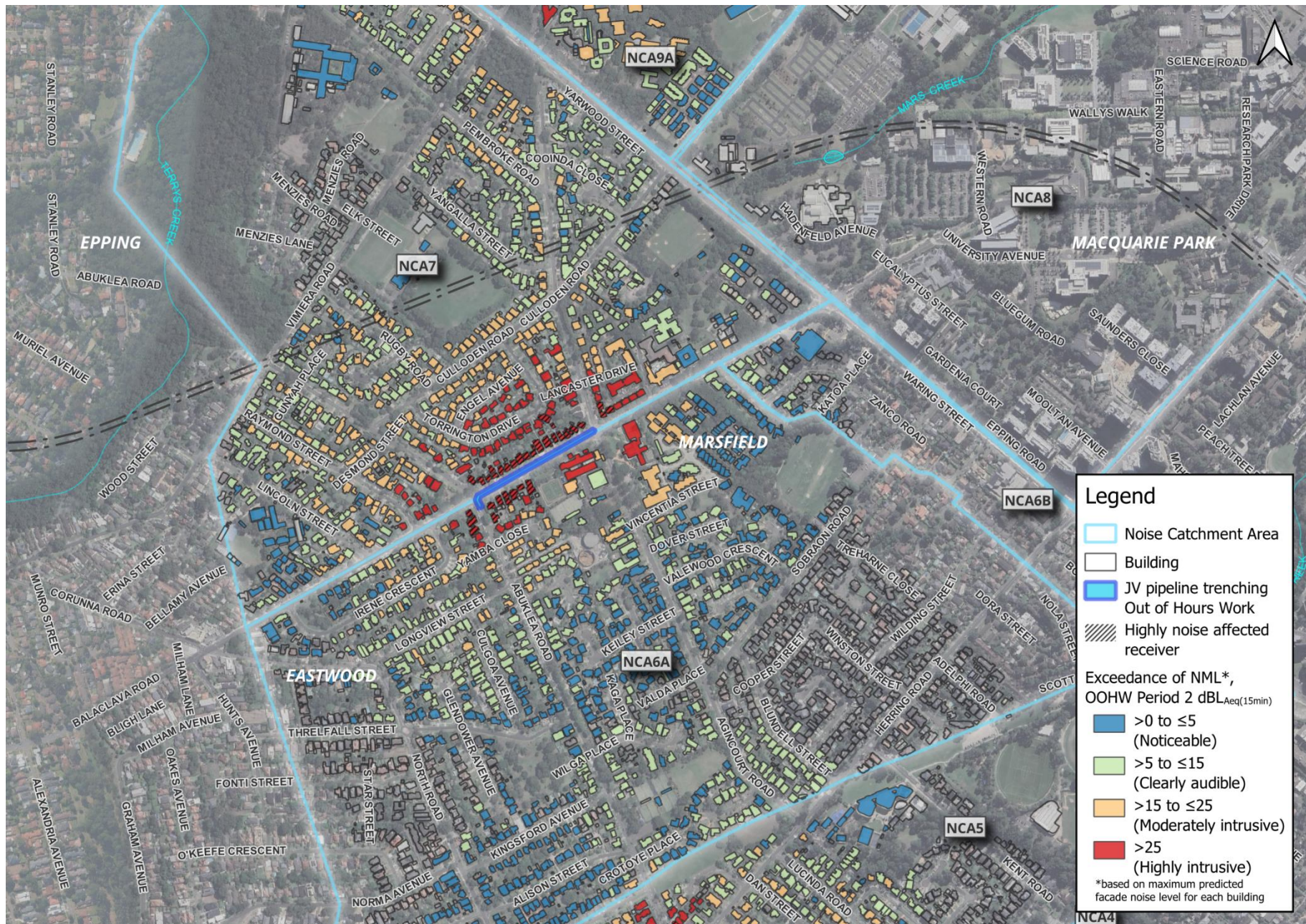


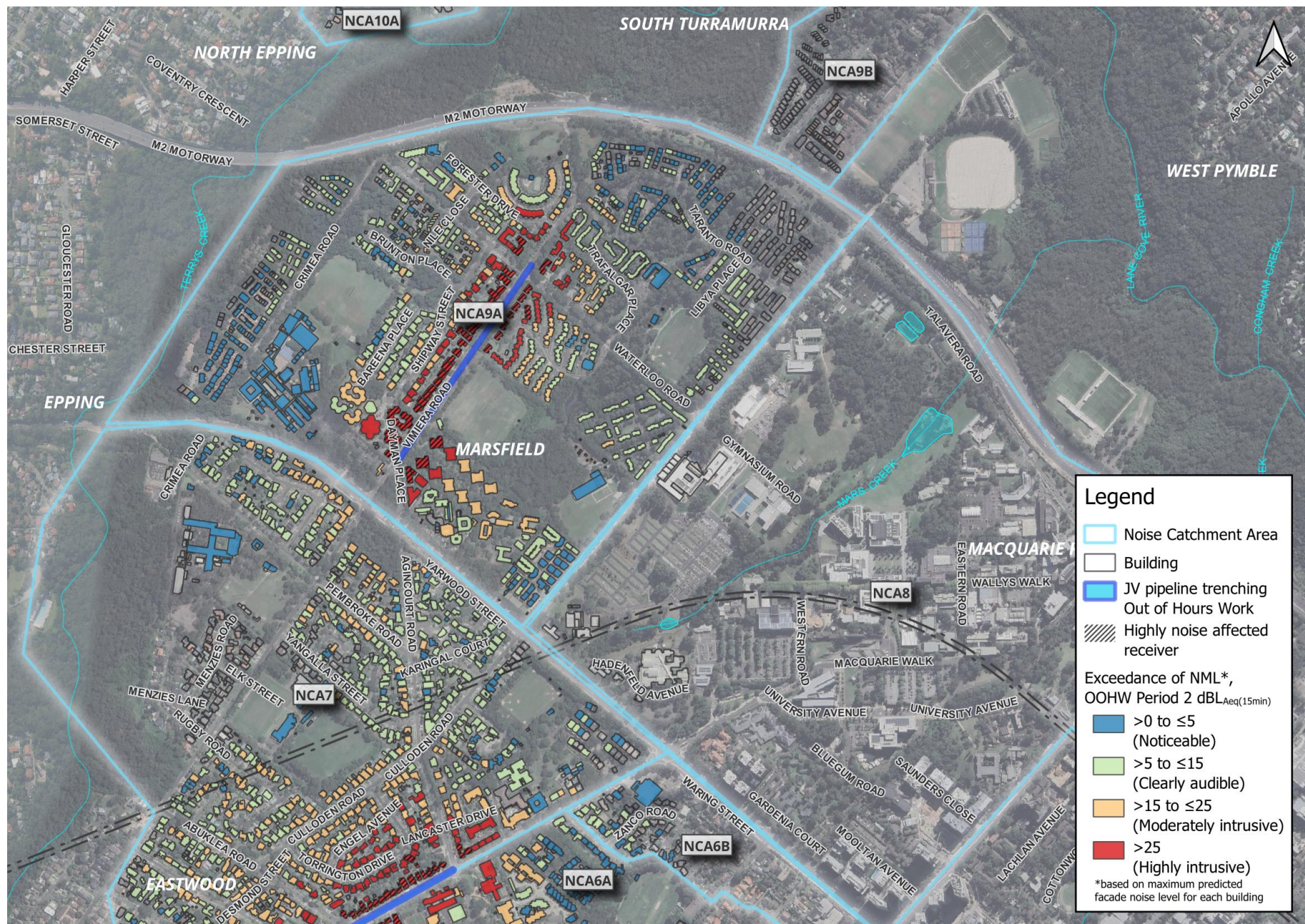


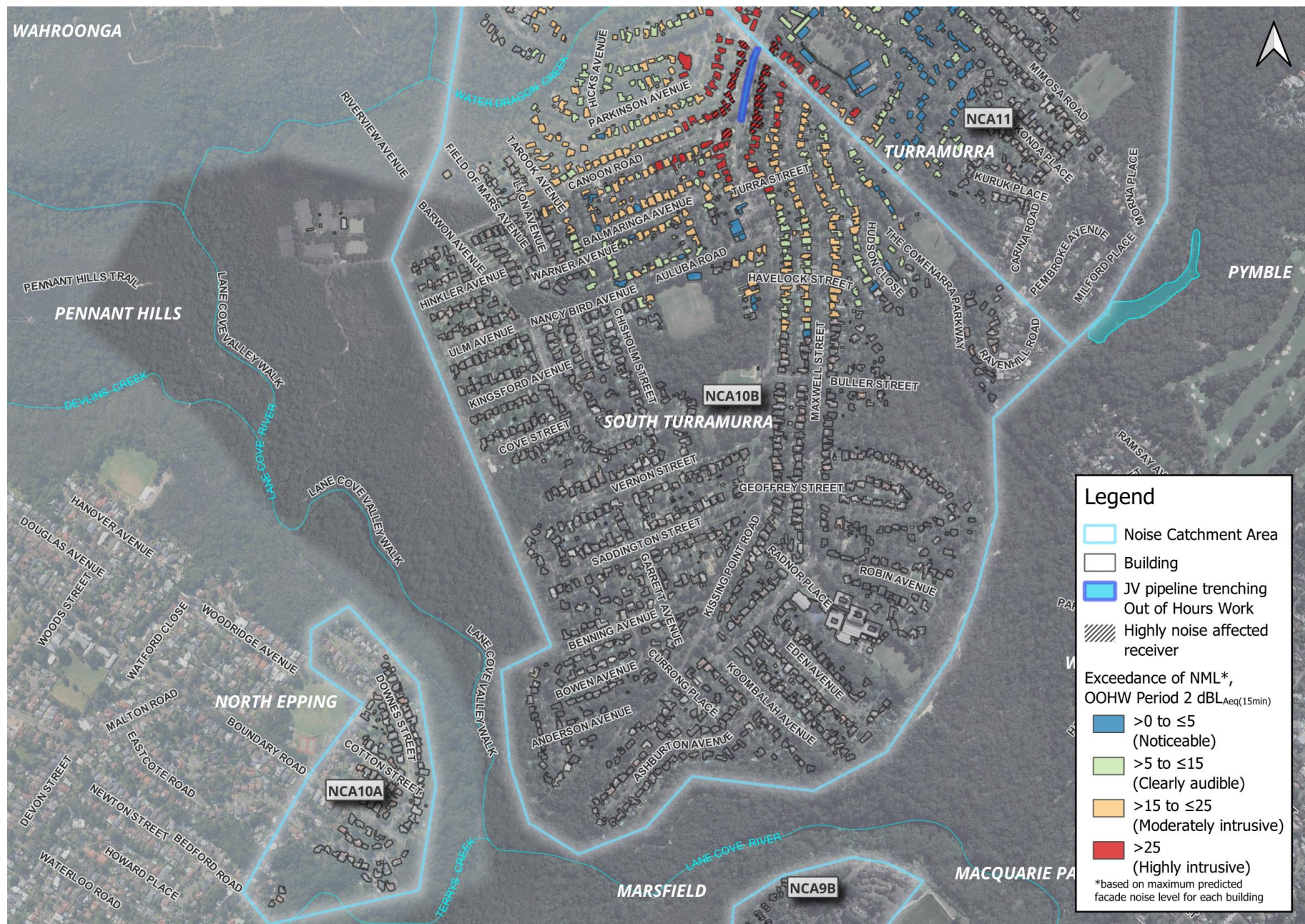
F.2 JV pipeline alignment trenching works – OOHW Period 2

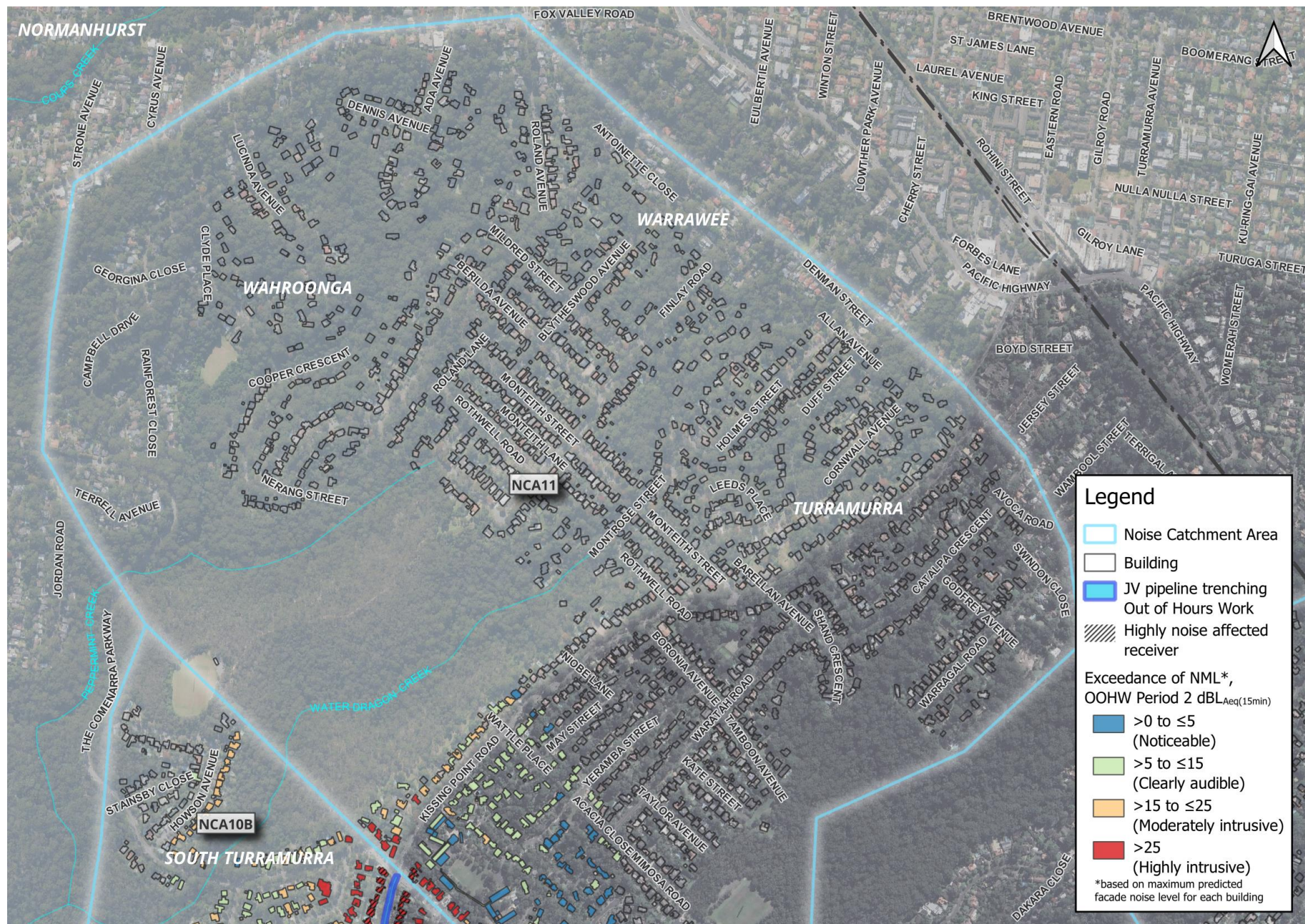


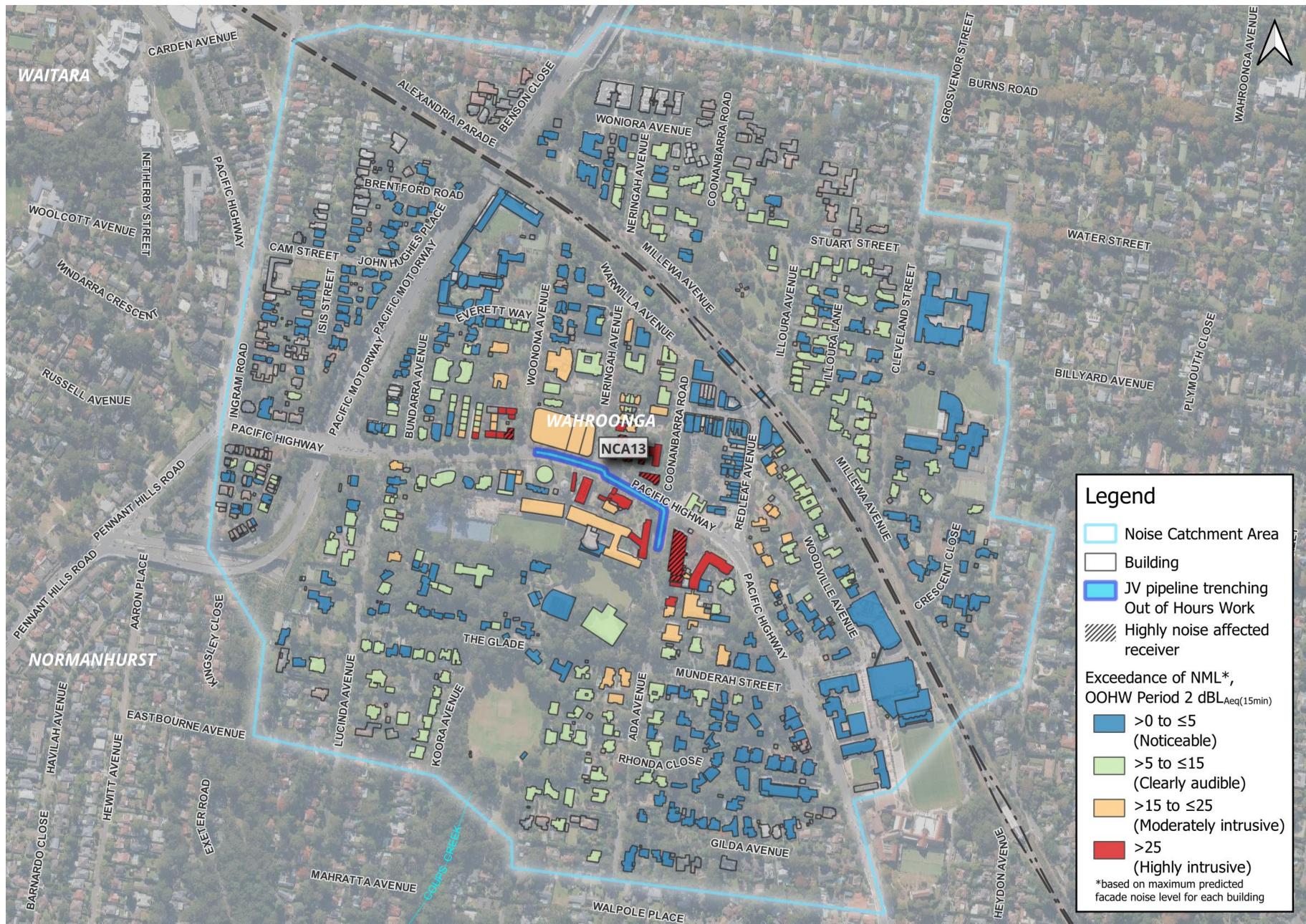




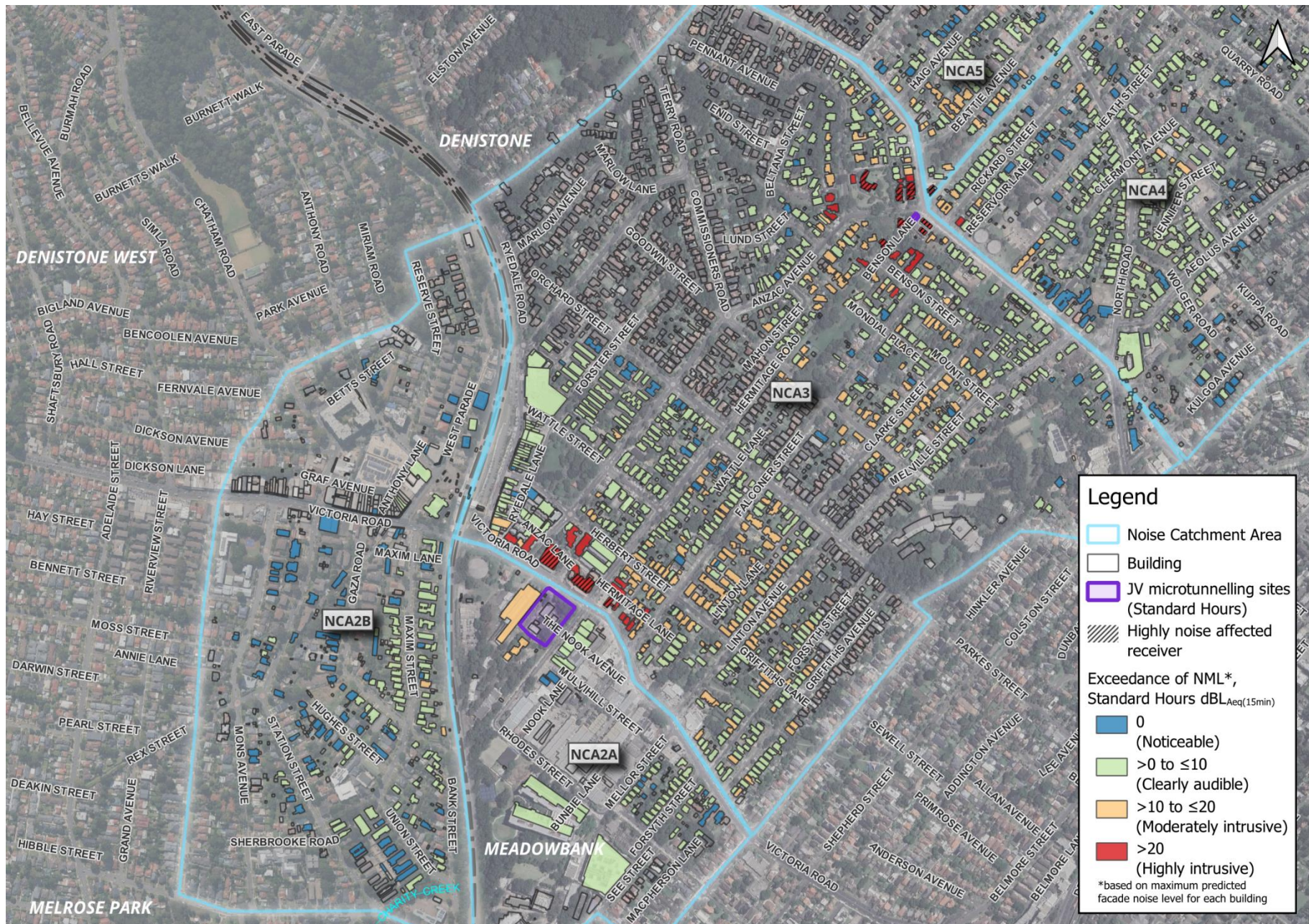






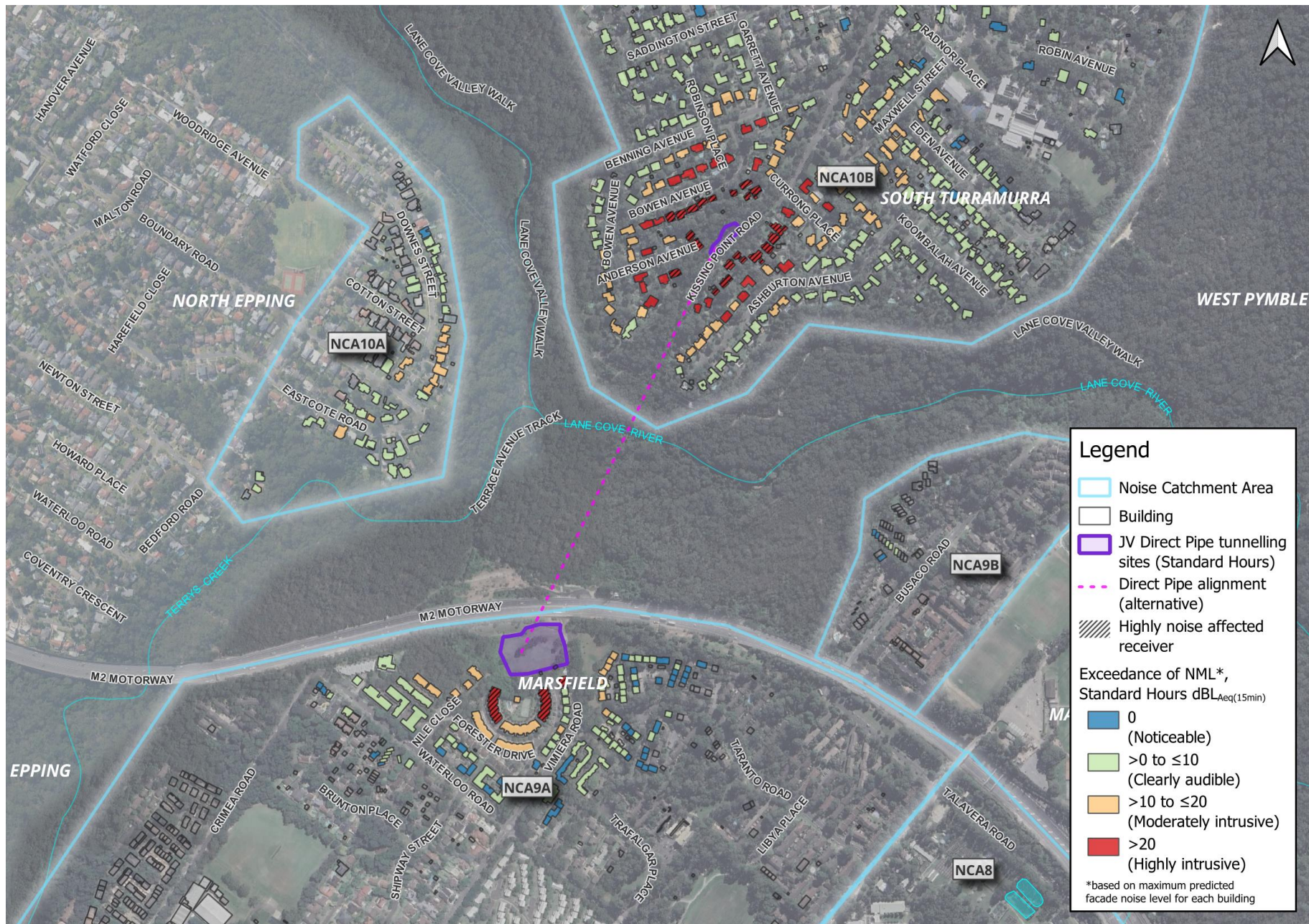


F.3 JV microtunnelling sites – Standard Hours

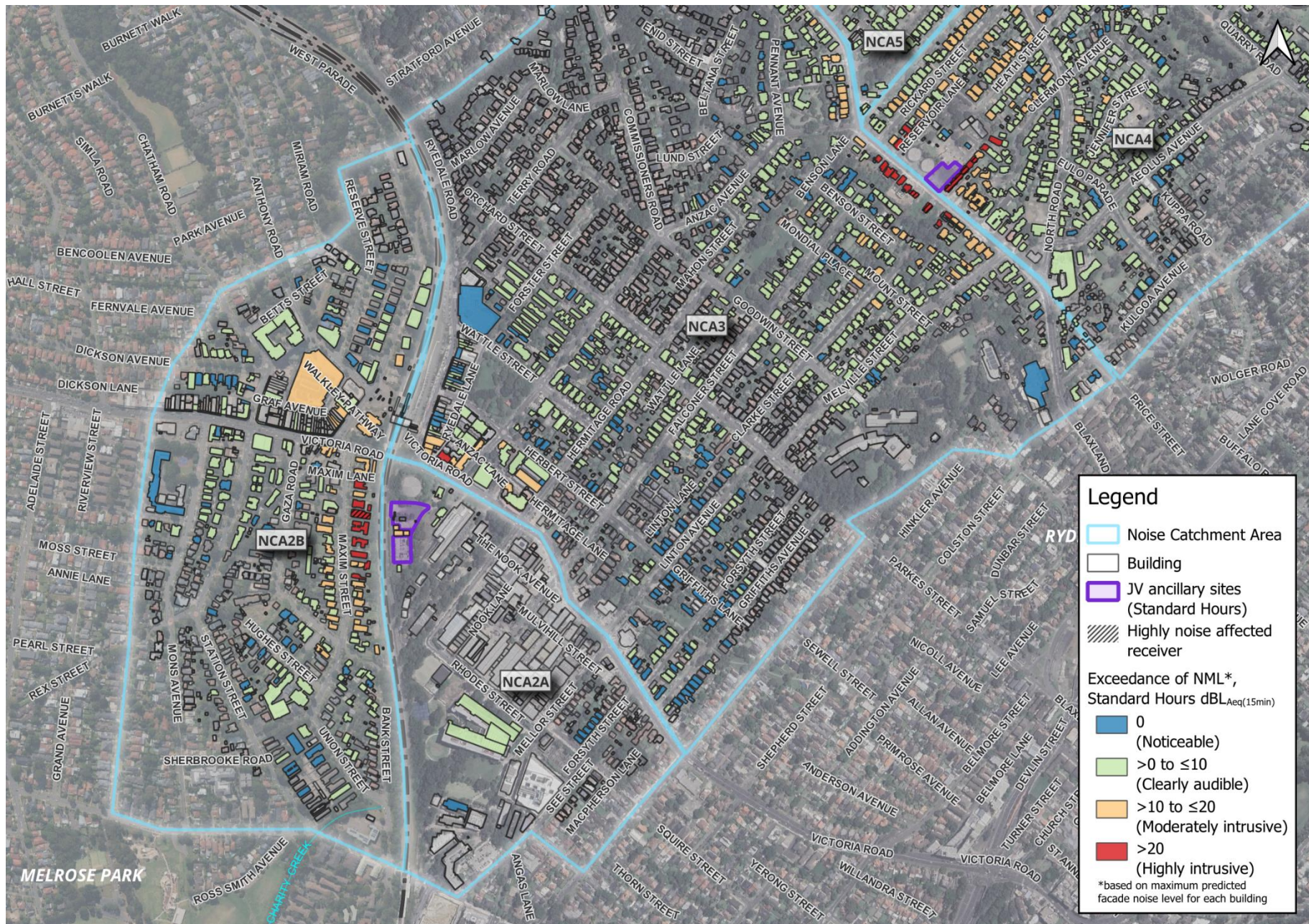


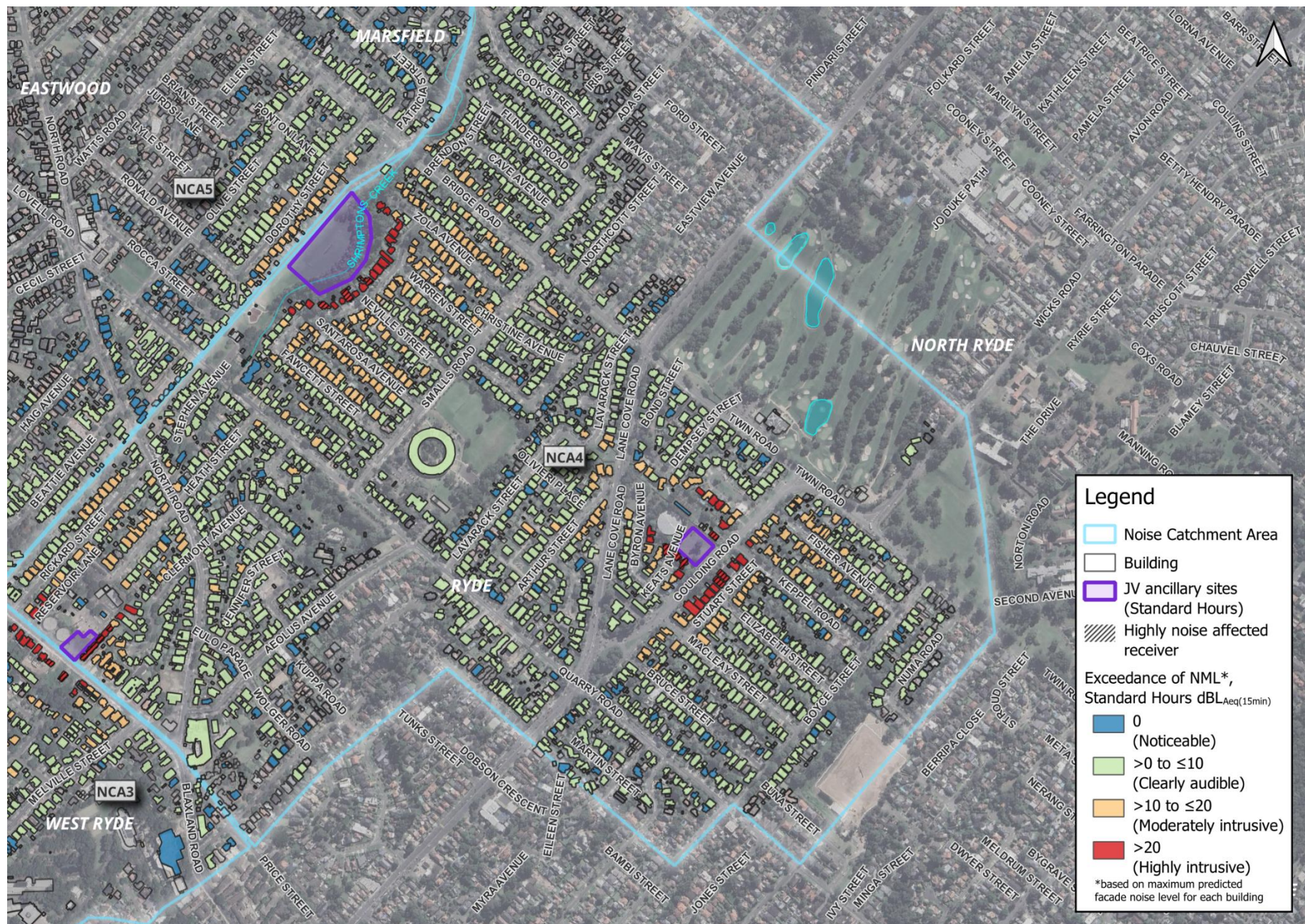


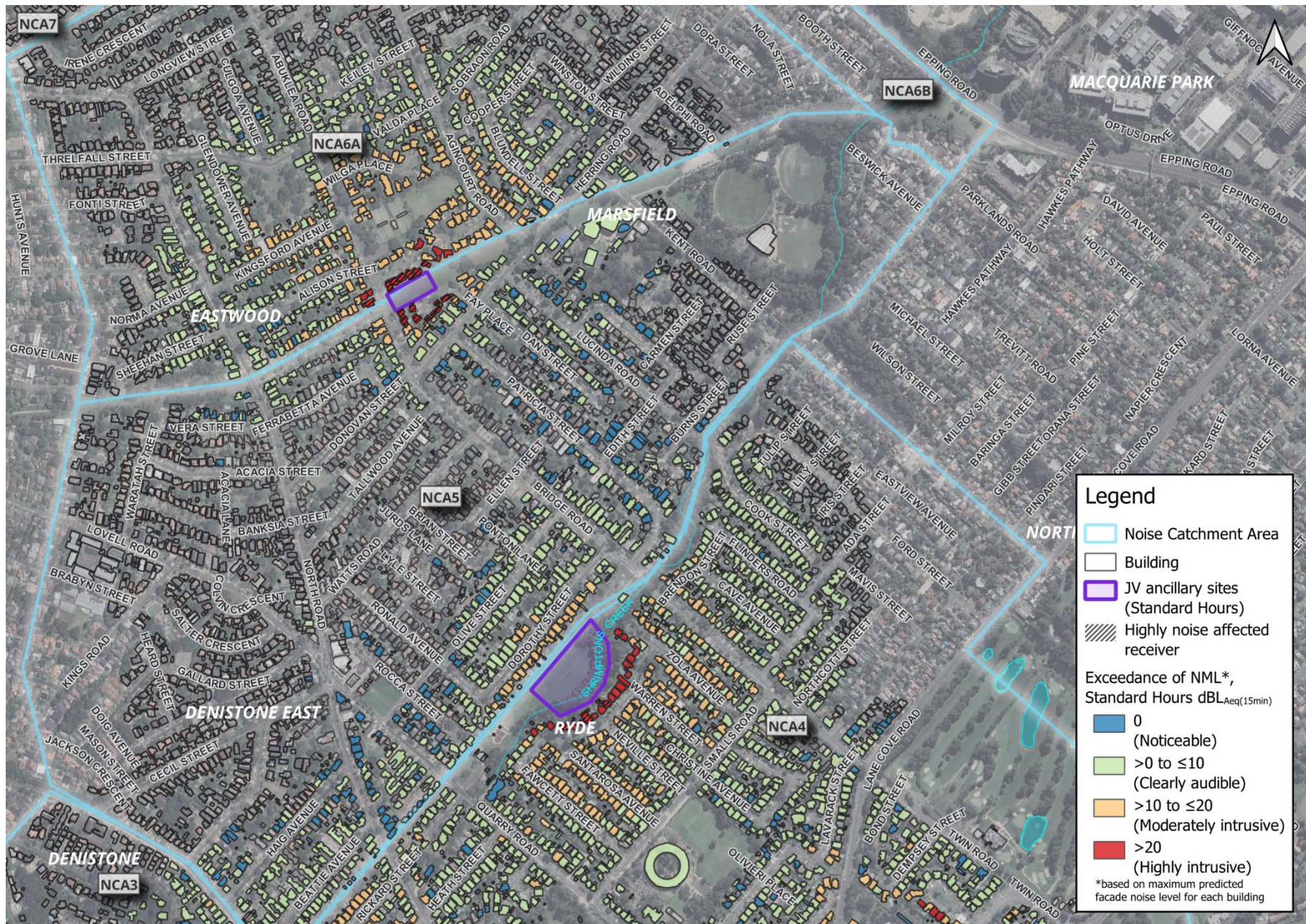
F.4 JV Direct Pipe tunnelling sites – Standard Hours

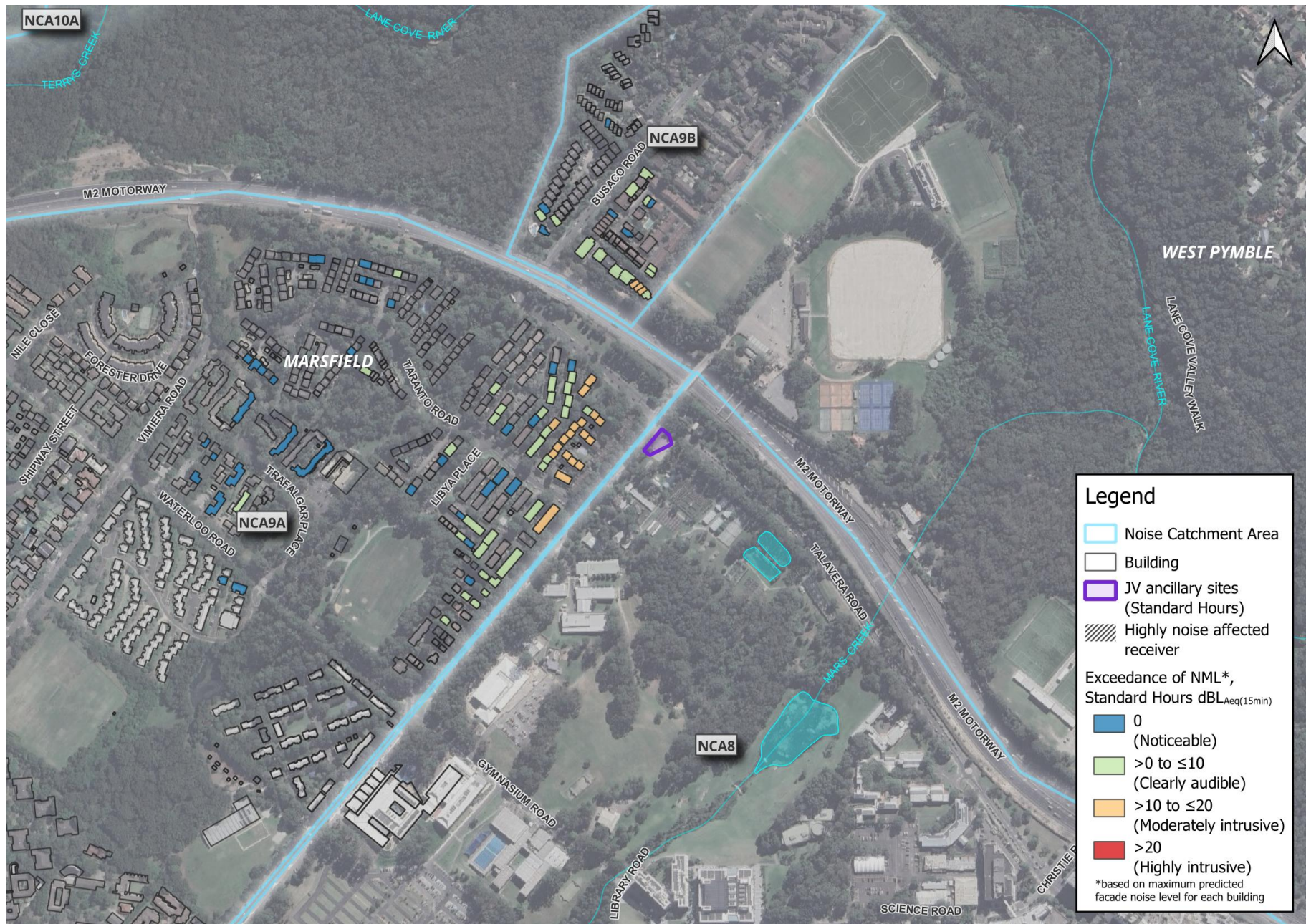


F.5 JV ancillary sites / compound sites – Standard Hours

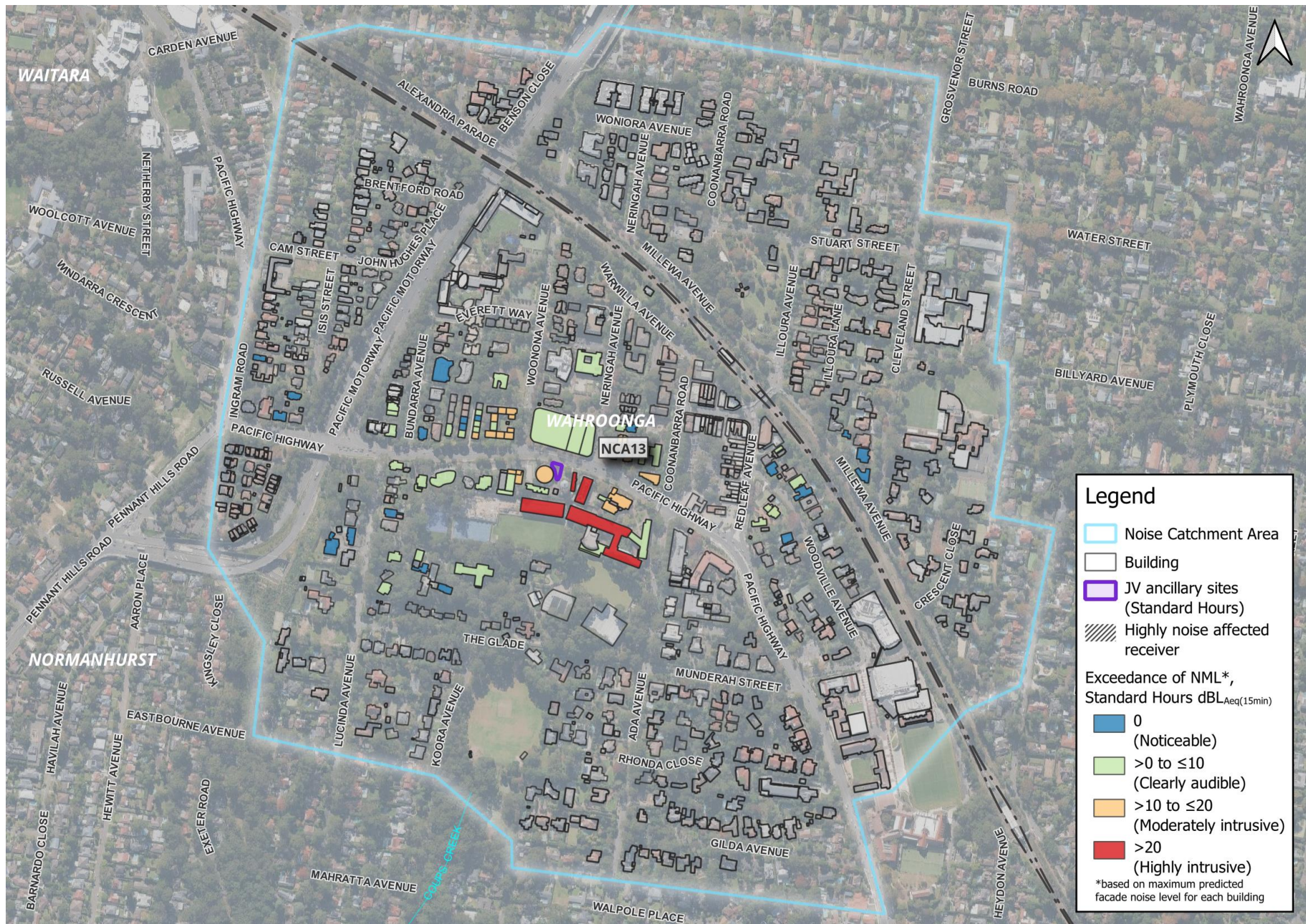


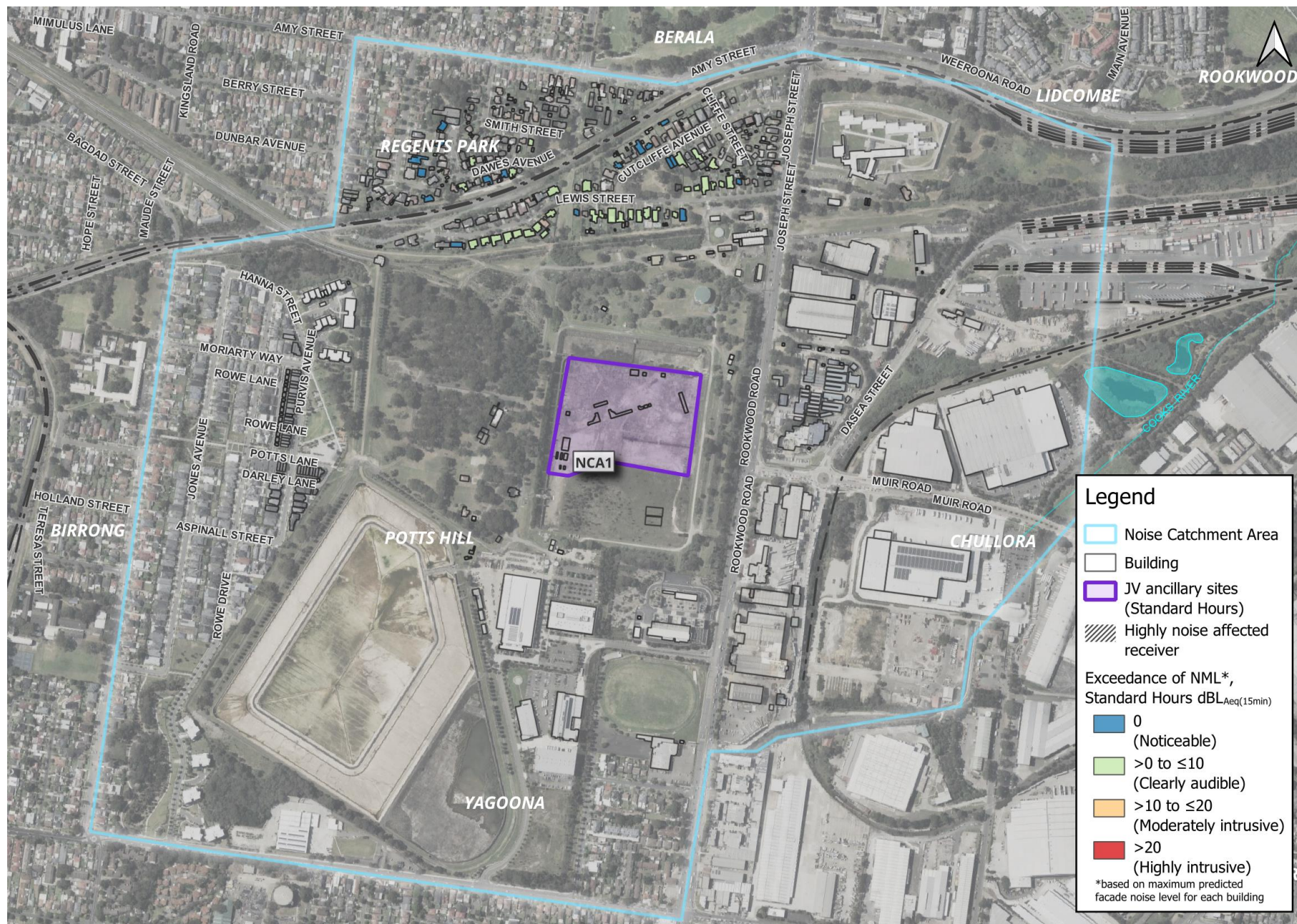




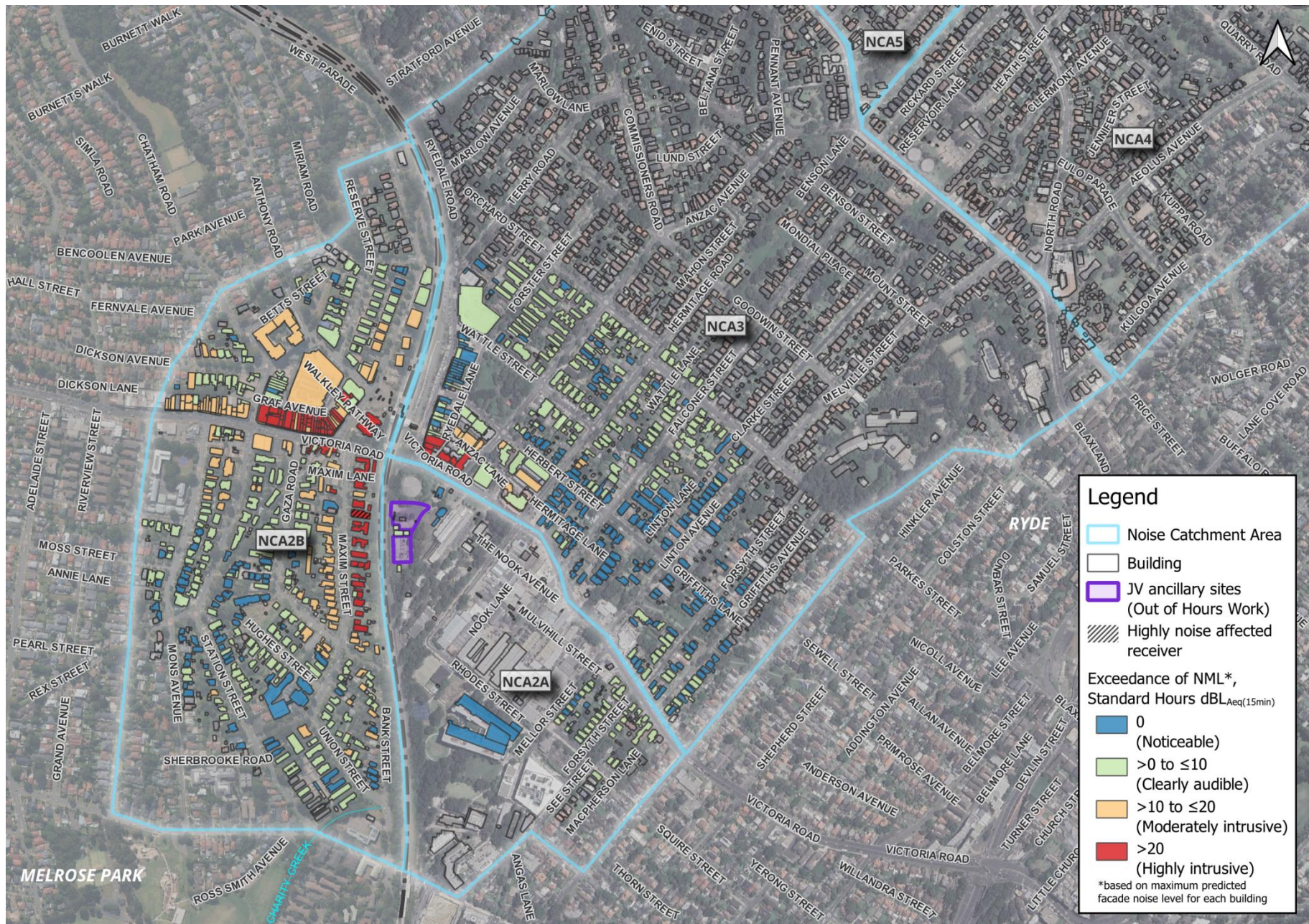


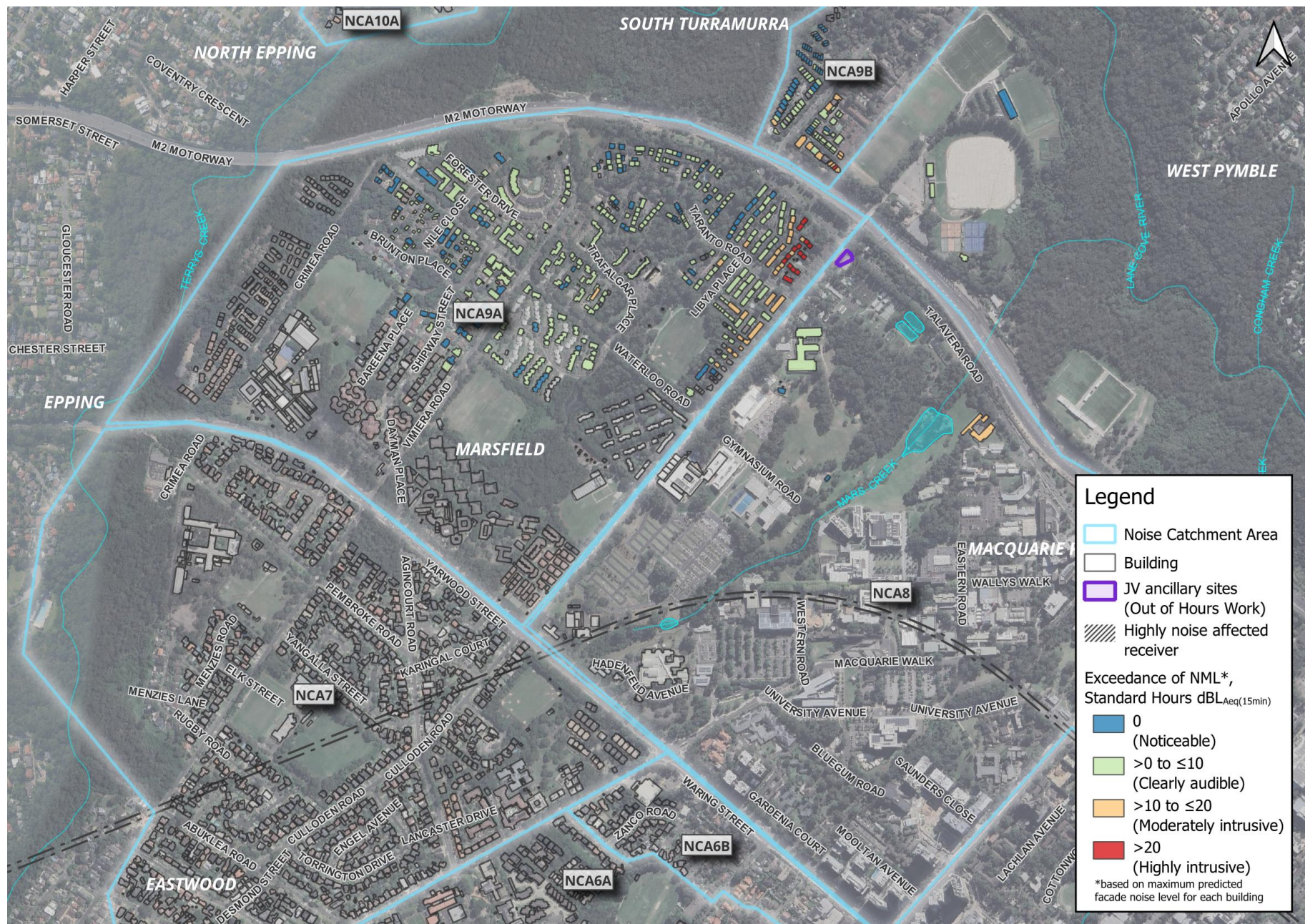


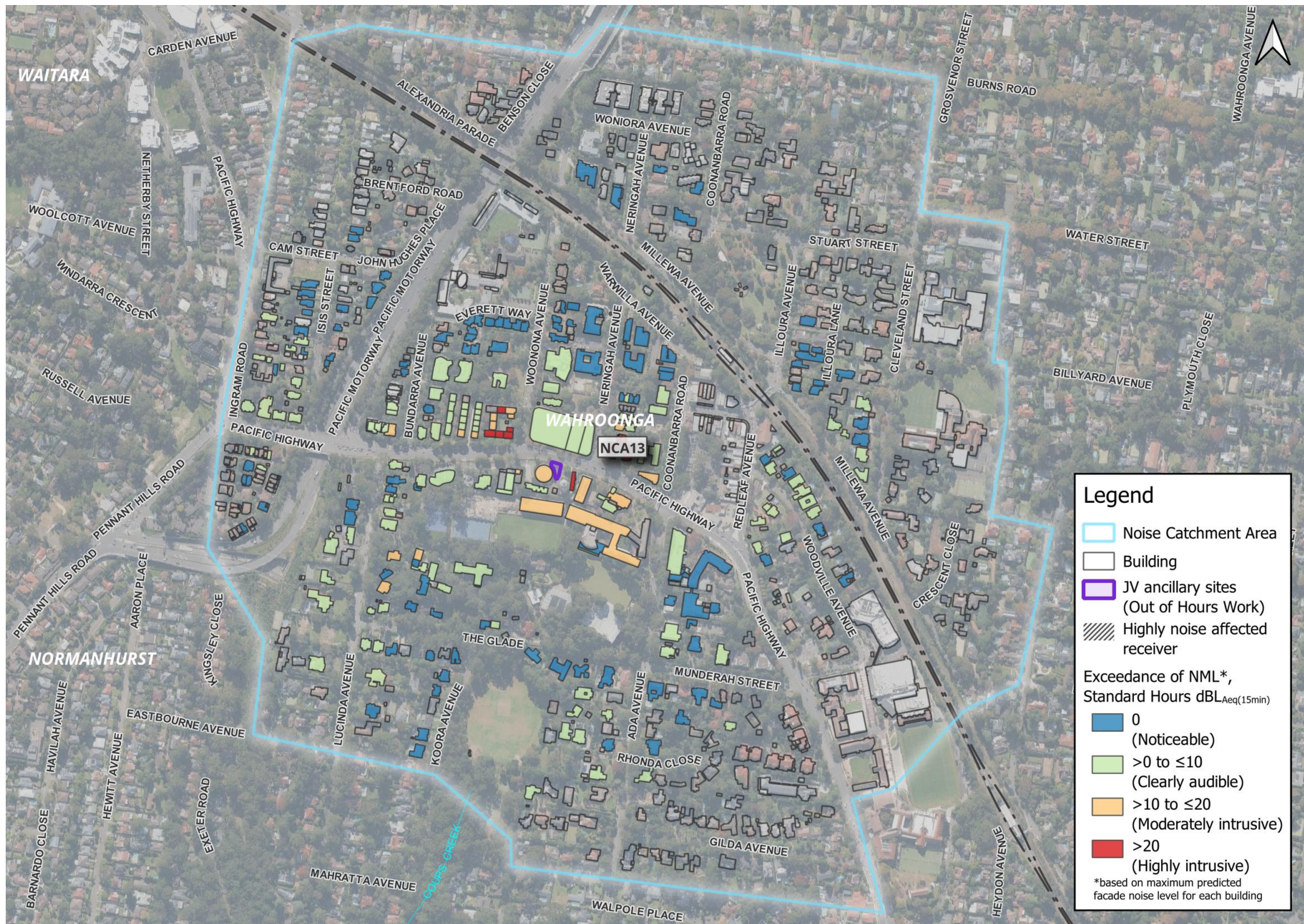




F.6 JV ancillary sites / compound sites – OOHW Period 2



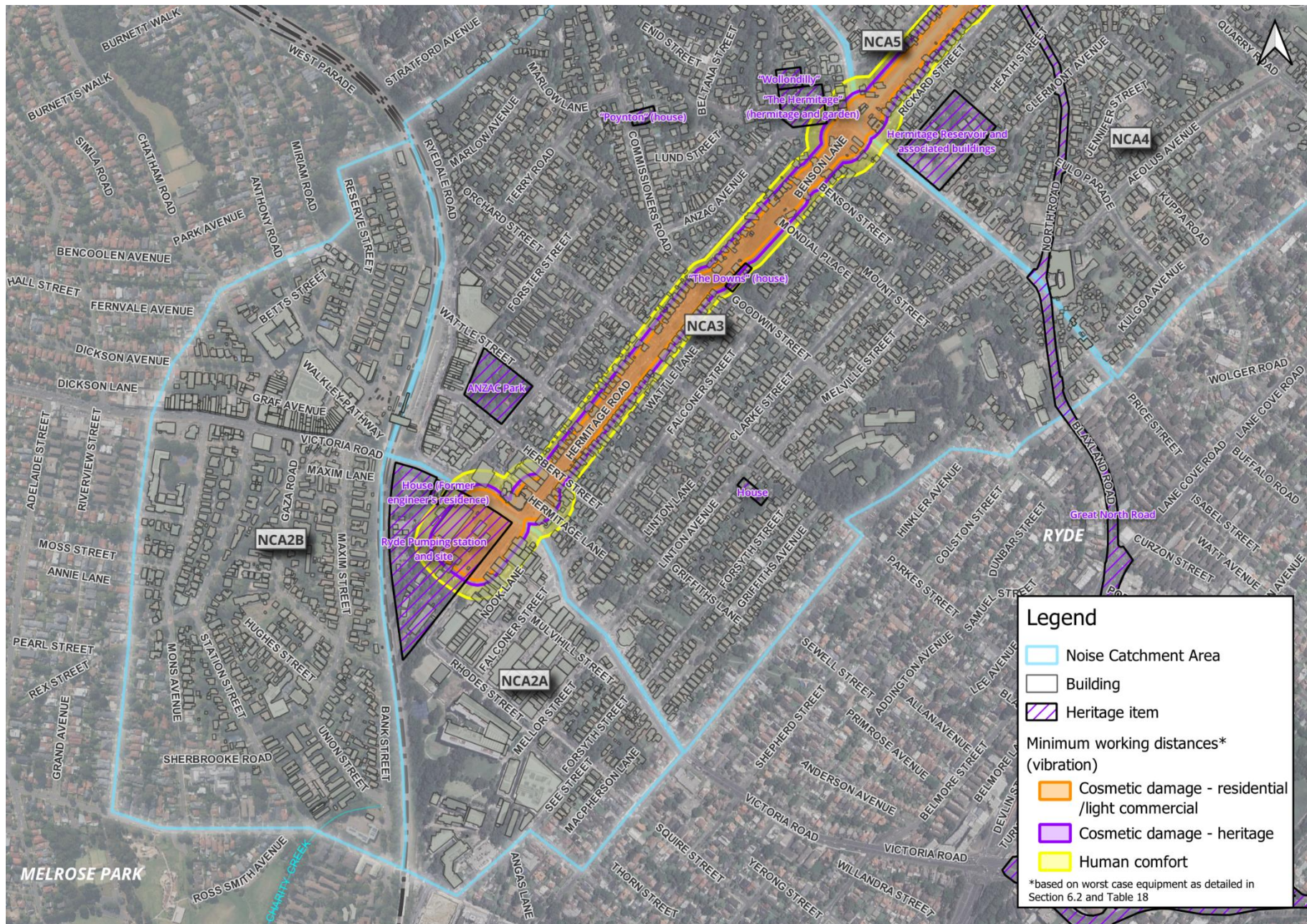


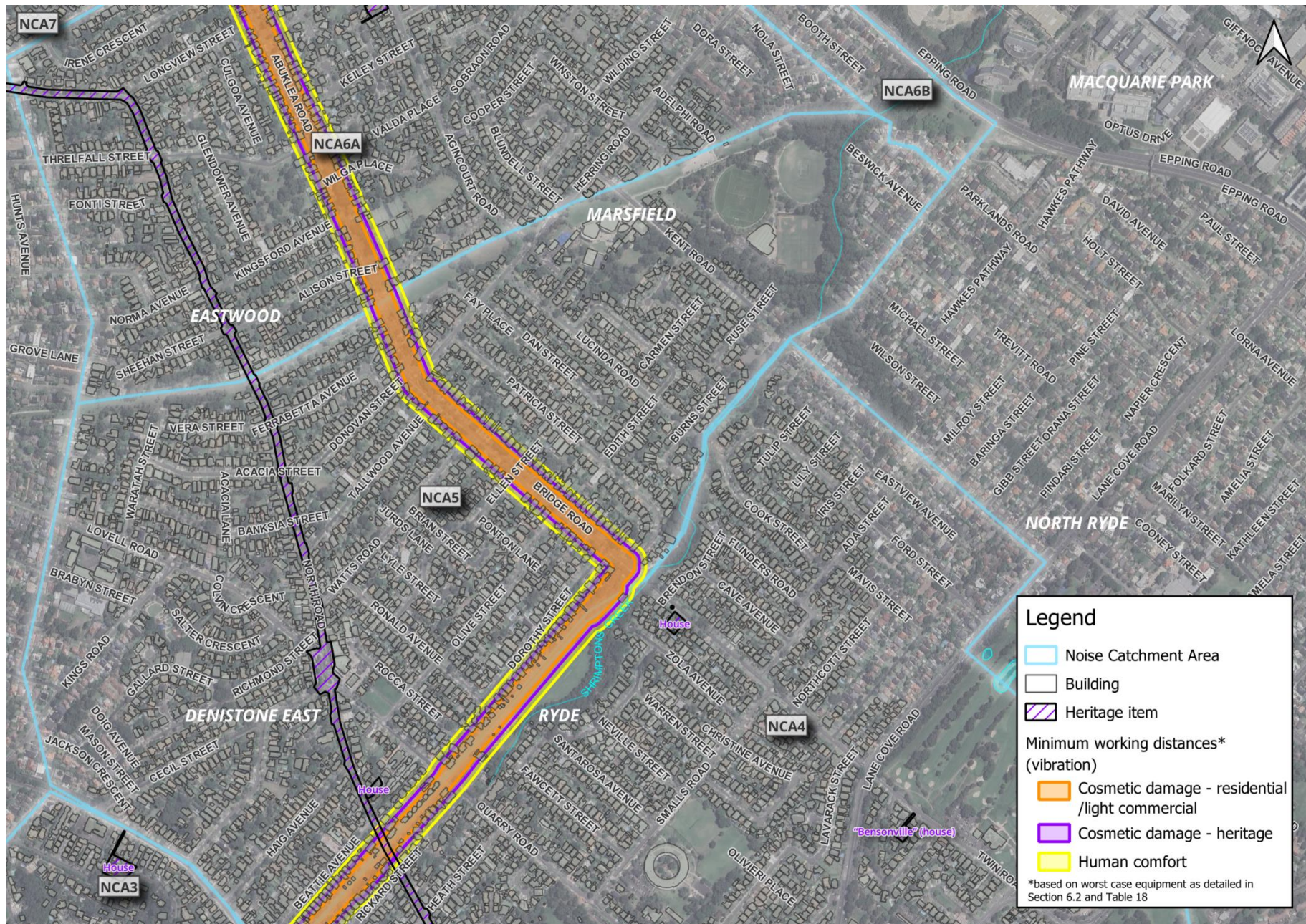


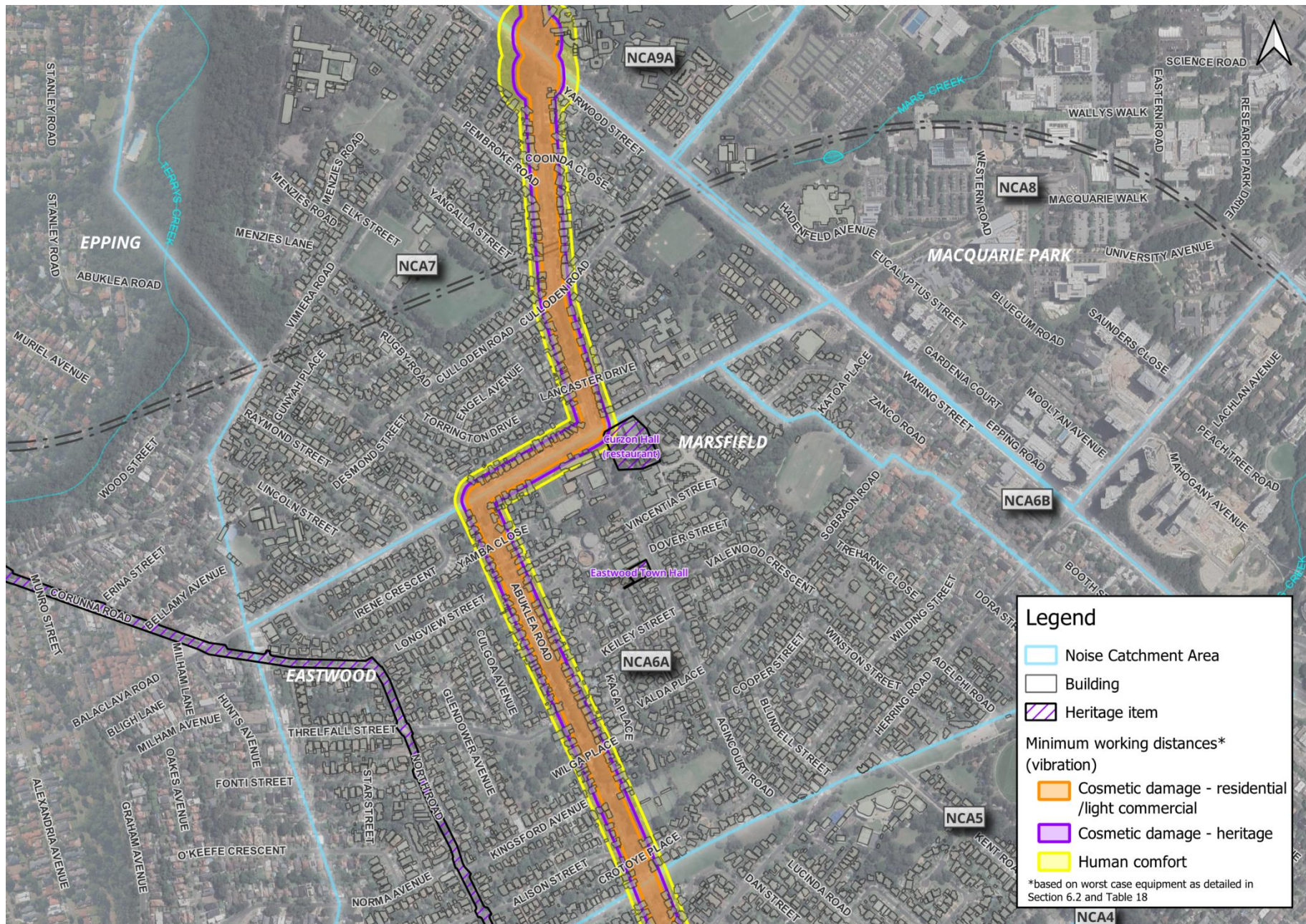
Appendix G

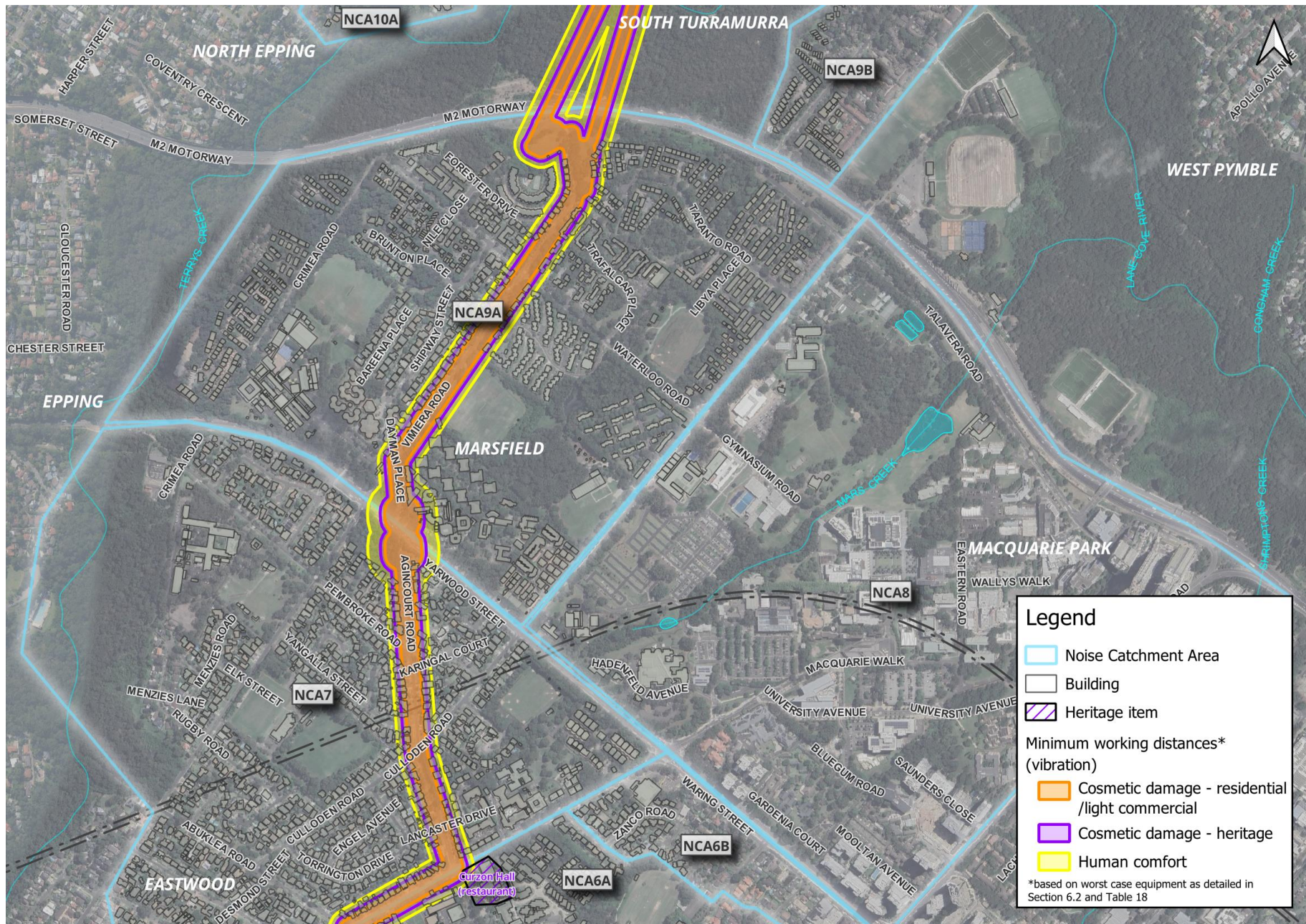
Vibration screening assessment

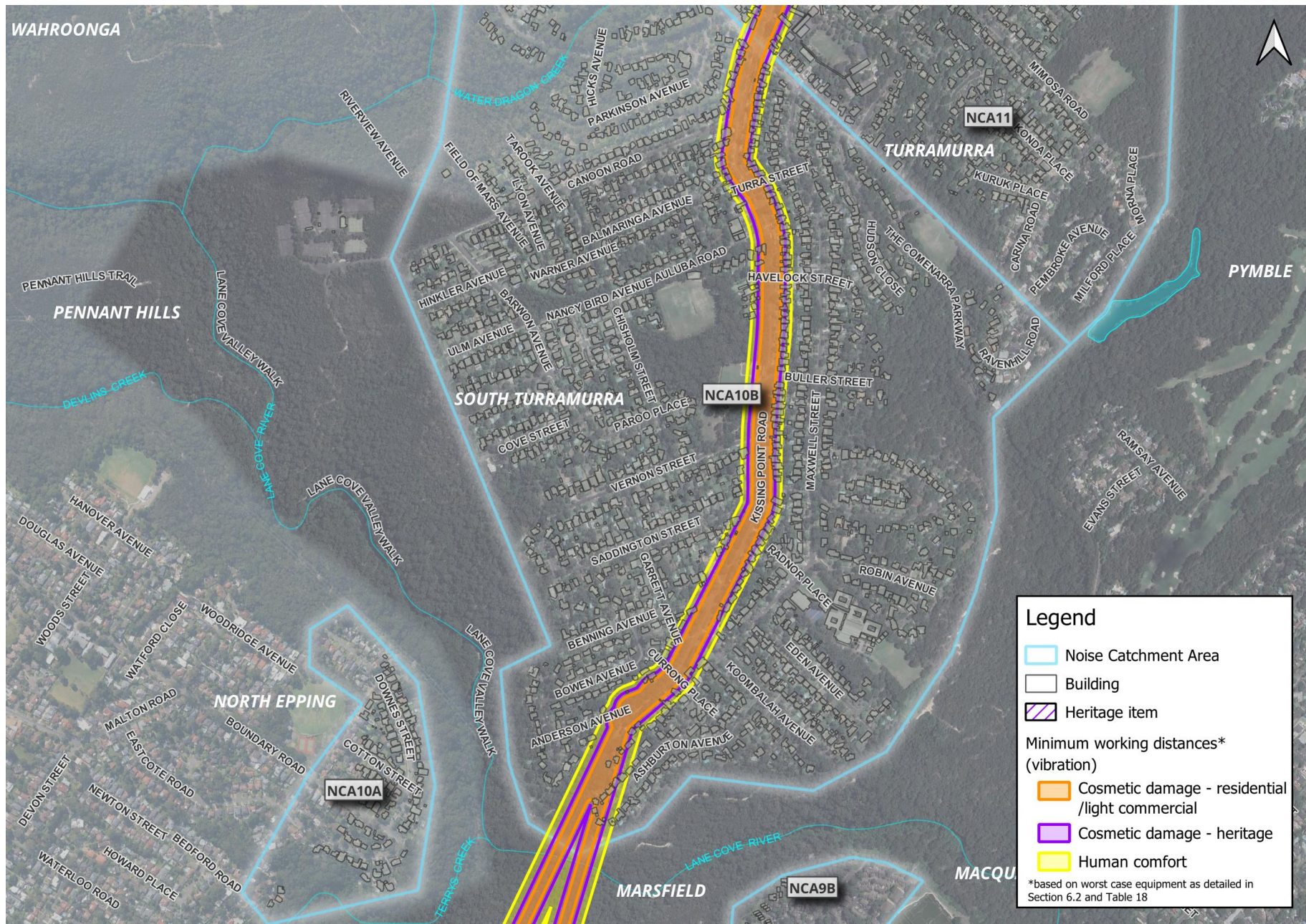
G.1 JV proposed construction works – vibration screening assessment

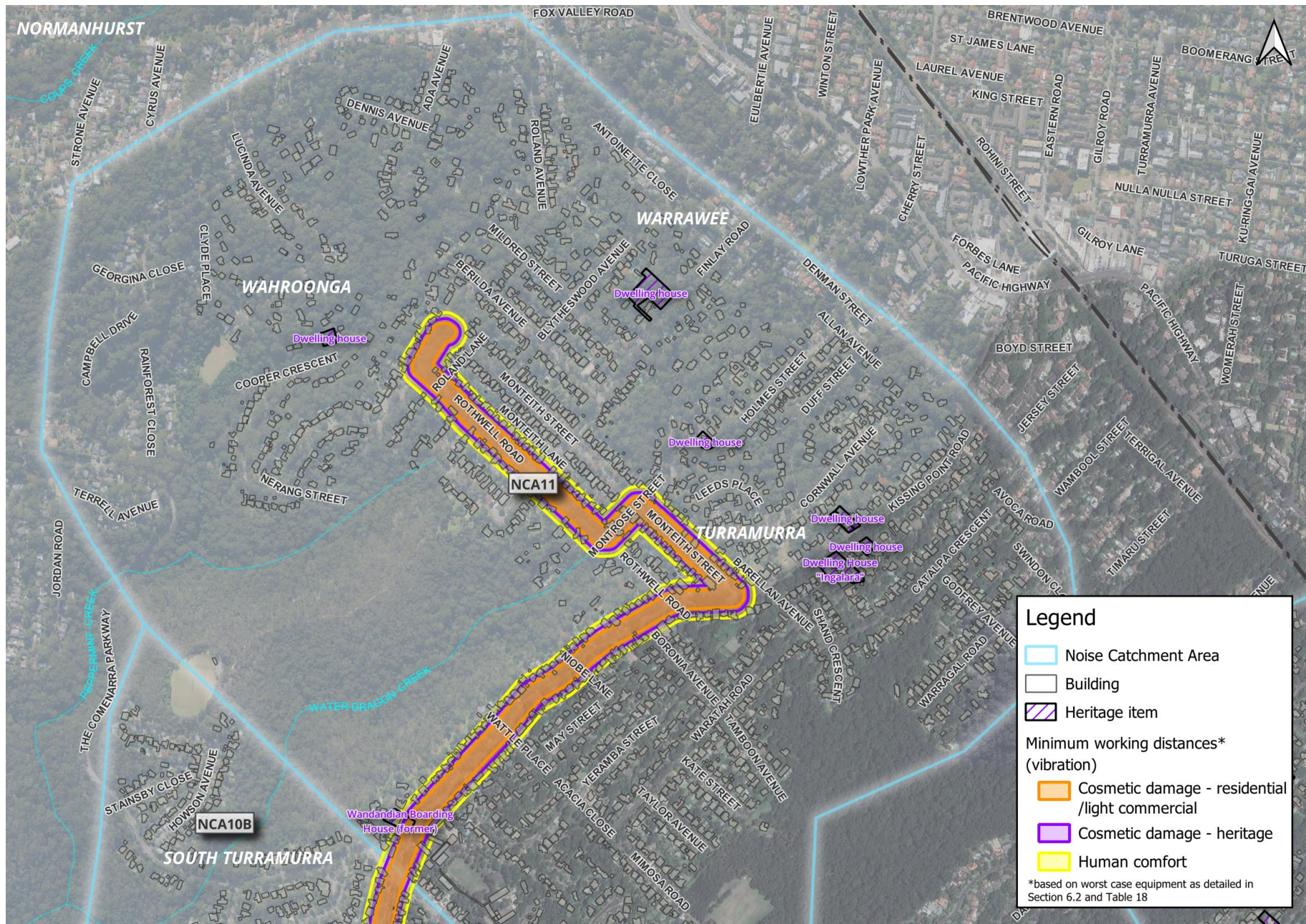


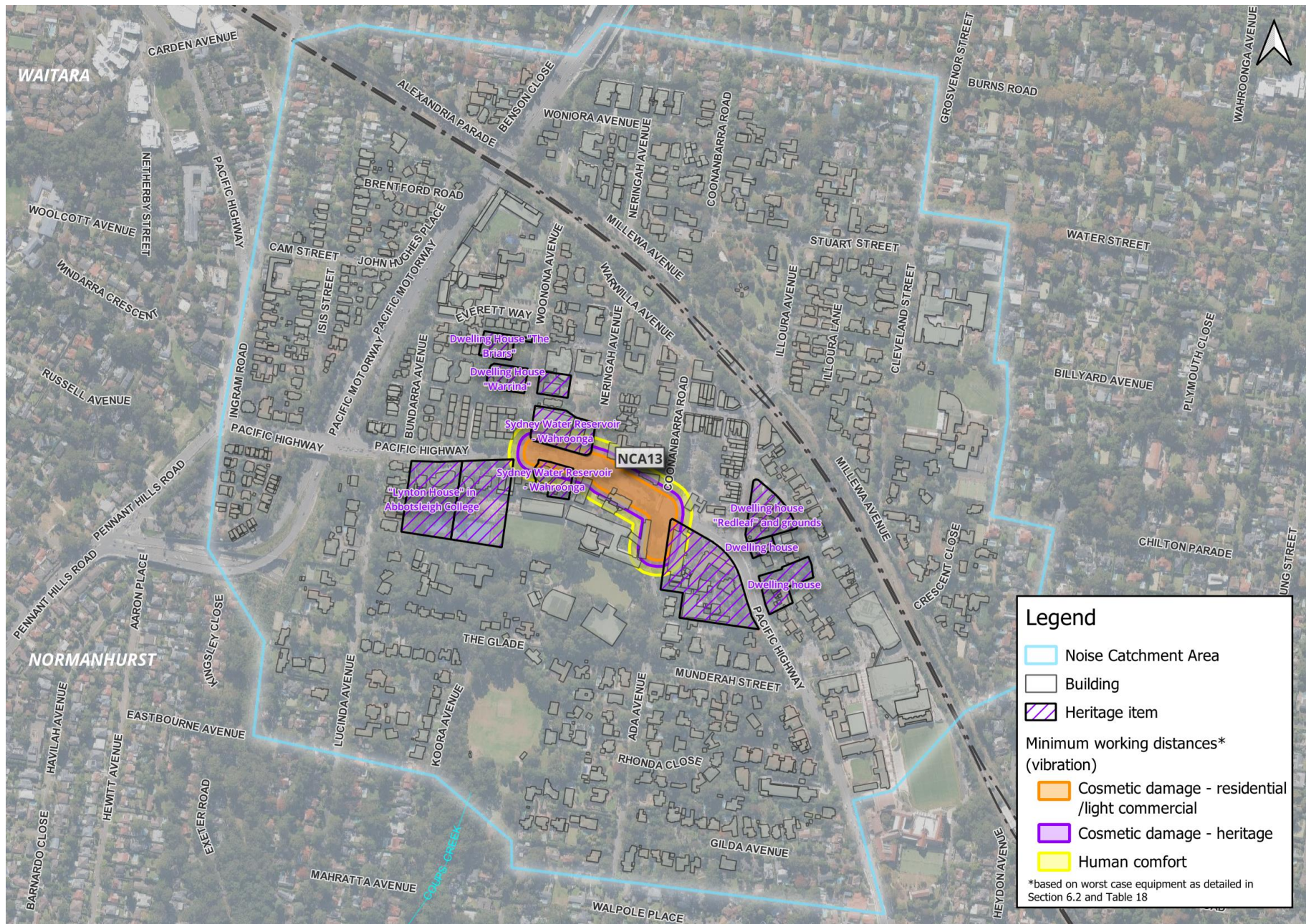












Appendix H

Noise and vibration complaint management procedure

