

Noise and Vibration Impact Assessment

Sutherland to Cronulla Active Transport Link
Sydney, NSW

Prepared for: Hills Environmental
November 2021
MAC211332-01RP1



Document Information

Noise and Vibration Impact Assessment

Sutherland to Cronulla Active Transport Link

Sydney, NSW

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DOCUMENT ID	STATUS	DATE	PREPARED	SIGNED	REVIEWED	SIGNED
MAC211332-01RP1	Final	12 November 2021	Dale Redwood		Oliver Muller	

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Hills Environmental Pty Ltd (Hills Environmental) to prepare a Noise and Vibration Impact Assessment (NVIA) on behalf of Transport for NSW (TfNSW) to quantify emissions from the construction of Stage 2 of the Sutherland to Cronulla Active Transport Link (the 'proposal') in the Sutherland Shire, Sydney, NSW.

1.1 Scope of the Assessment

The NVIA scope of work included:

- identifying the potentially most affected receivers within the area of influence to the proposal;
- determining the representative noise environment for each of the noise catchments in accordance with the TfNSW Construction and Maintenance Noise Estimator tool, and establish the construction noise management levels (NMLs) for the proposal site;
- undertaking a quantitative assessment of noise and vibration from proposed construction activities;
- undertaking a semi quantitative assessment of operational noise levels associated with pedestrian use of the shared pathway;
- providing recommendations (to be implemented by TfNSW to manage impacts) for feasible and reasonable noise and vibration mitigation and management measures, and monitoring options, where NMLs or vibration objectives may be exceeded; and
- preparing a NVIA summarising the findings and recommendations of the assessment.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Project Description

2.1 Proposal Area

The proposal area is located within the Sutherland Shire Local Government Area (LGA) in the south district of Greater Sydney, NSW. The proposal runs in a general west to east alignment from Kirrawee in the west to Woolooware in the east. The study area for the proposal and general arrangement of the alignment is presented in **Figure 1**.

2.2 Proposal Background

The Sutherland to Cronulla Active Transport Link (SCATL) is a proposed pedestrian and bicycle facility that provides a strategic connection between Sutherland and Cronulla Stations and the five urban centres in between (Kirrawee, Gymea, Miranda, Caringbah and Woolooware). Once complete, SCATL is intended to make walking and cycling more attractive for short distance trips within the Sutherland Shire and facilitate a mode shift away from private vehicles.

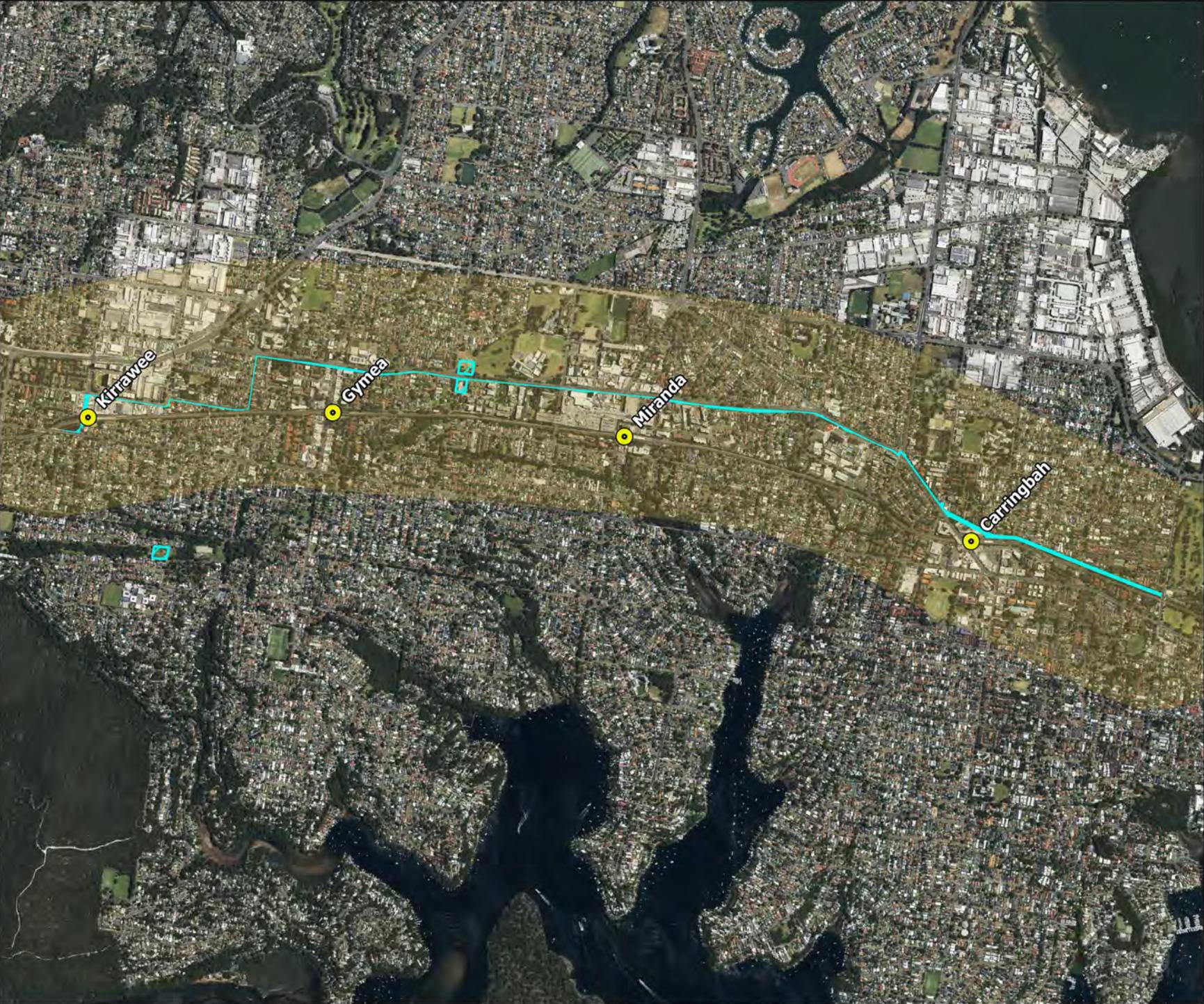
The construction of the SCATL will involve the utilisation of existing footpaths outside the rail corridor that will be upgraded to a shared path and separated bike path where possible. The alignment allows surrounding networks to connect to the proposed active transport link, allowing ease of access to surrounding attractions and facilities from Sutherland to Cronulla.

The objectives of this project are to:

- Provide connection and movement between town centres, active and passive recreation space, and health facilities;
- Provide adequate separation between cycling between pedestrians, cyclists, and vehicles; and
- Provide a safe environment and accessibility for people using the SCATL.

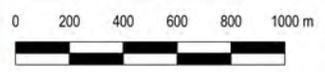
Construction is expected to take up to 21 months, with the main construction constraints arising from working close to the live traffic environment, the retention of trees and the potential for land acquisition. The work would be carried out sequentially, with discrete sections of existing footpaths closed at any one time, thereby retaining access to most of the thoroughfare and minimising sustained noise exposure to nearby receivers.

FIGURE 1
LOCALITY PLAN
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site
-  Train Station



2.3 Proposal Details

MAC understands that the SCATL project is to be completed in three stages. Stage 1, the Sutherland to Kirrawee section, known as Horizon 1, was opened in 2020. Stage 2 is the Kirrawee to Woolooware section, which is currently under planning and is the subject of this study. The final stage of the SCATL project will be the Woolooware to Cronulla section, which will be undertaken under a separate scope of works.

Stage 2 works from Kirrawee to Woolooware will be undertaken sequentially within the following four sections:

- Section 2: Kirrawee to Gymea;
- Section 3: Gymea to Miranda;
- Section 4: Miranda to Carringbah; and
- Section 5: Carringbah to Woolooware.

Typical construction activities with the potential to generate noise impacts on nearby receivers include:

- Establishment of the compound / ancillary sites;
- Earthworks including excavation and preparation of alignment;
- Pavement formation and concrete laying;
- Kerb realignment including concrete sawing; and
- Line marking and furniture installation.

It is anticipated that the proposal would typically be undertaken during standard construction hours. It is noted however, that out of hours (OOH) work may be required for activities that are undertaken close to busy roads, including kerb realignment works.

Transport for NSW propose the establishment of up to three potential temporary compound sites for the duration of the proposal. The primary compound sites would be located on both sides of Kingsway at the intersection with Sylvania Road, Miranda. The compound site on the northern side of Kingsway would be established on a vacant parcel of land and would be accessed opposite Marion Street. The compound site of the southern side of Kingsway is an existing TfNSW compound site and would be accessed via Pinnacle Street. The third compound site would be located on a vacant parcel of land off Hunter Street at Kirrawee. The locations of the compound sites are presented on **Figure 1**.

2.4 Identification of Sensitive Receivers

A review of potentially affected receivers identifies that the proposal area generally comprises a mixture of residential and commercial premises. There are four main commercial centres located in Kirrawee, Gymea, Miranda and Carringbah, with isolated commercial premises located along the proposal alignment.

In addition to the residential and commercial receivers, a number of other non-residential receivers were identified, including:

- Hospitals including Kareena Private Hospital and the Sutherland Hospital in Carringbah;
- Education institutions including Port Hacking High School, Miranda Public School, Our Lady Star of the Sea Catholic School, Gymea TAFE, Kirrawee Public School, and Kirrawee High School;
- Places of worship including St Marys, St Bakhomios and St Shenouda Coptic Orthodox Church, St Stylianos Parish, Our Lady Star of the Sea Catholic Church and St Lukes Anglican Church;
- Active recreation areas including Gymea Bowling Club, Miranda Park, Jenola Hockey Fields and Woollooware Golf Club; and
- Passive recreation areas including Hazlehurst Regional Gallery and Arts Centre.

A locality plan showing the position of non-residential receivers with respect to the proposal site is provided in **Figure 2** for the western extent of the works and **Figure 3** for the eastern extent of the works. It is noted that receivers adjacent to the proposal site, not identified on the figures below, were determined to be residential receivers.

FIGURE 2
Non Residential Receivers
Western Extent
MAC211332-01
SCATL Project



KEY

- Proposal Site
- Compound Site

Non-Residential Receivers

- Educational Institution
- Place of Worship
- Hospital Ward
- Passive Recreation
- Active Recreation
- Commercial

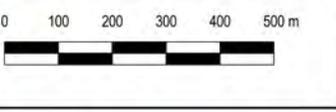


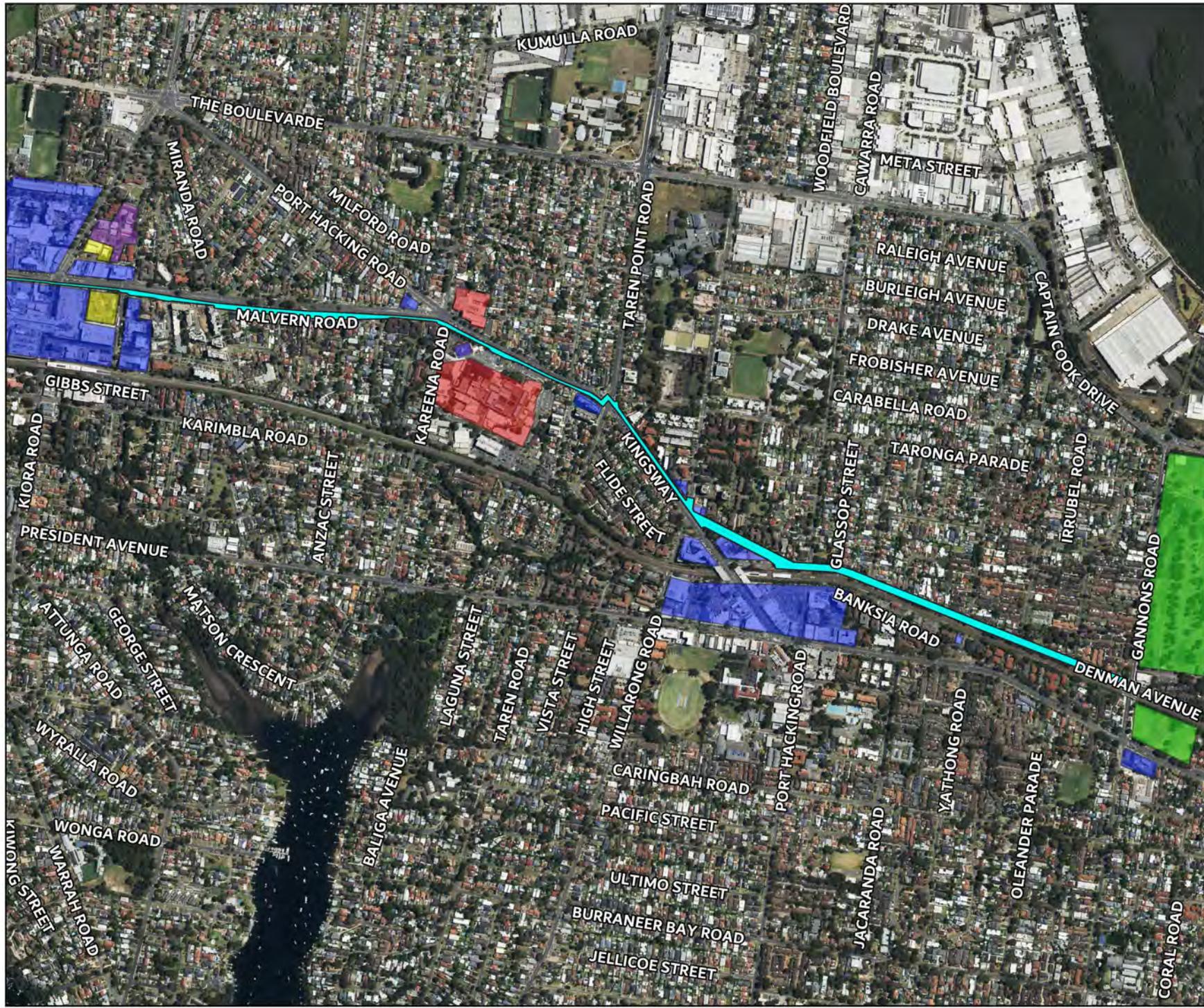
FIGURE 3

Non Residential Receivers

Eastern Extent

MAC211332-01

SCATL Project

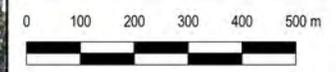


KEY

- Proposal Site
- Compound Site

Non-Residential Receivers

- Educational Institution
- Place of Worship
- Hospital Ward
- Passive Recreation
- Active Recreation
- Commercial



3 Existing Environment

3.1 Background Noise Environment

Due to the COVID-19 travel and social distancing restrictions, background noise monitoring was unable to be undertaken at the proposal site. In lieu of site-specific data, the 'representative noise environment' for each noise catchment area (NCA) was determined in accordance with the TfNSW Maintenance and Construction Noise Estimator (MCNE) tool.

Two NCAs were identified in the area surrounding the proposal site. NCA 1 was identified as the area immediately surrounding the Kirrawee compound site. The location is described as a residential neighbourhood with the noise environment dominated by traffic noise from the local road network and distant traffic from Kingsway and Princes Highway, general urban hum and environmental noise. The representative noise environment was classified as R2.

The area immediately surrounding the proposal alignment (NCA 2) was classified as representative noise environment R3. The area is described as predominantly residential and commercial with the noise environment dominated by Kingsway, which carries a traffic volume greater than 20,000 vehicles daily.

The representative rating background levels (RBLs) for each of the NCAs is provided in **Table 1**.

Table 1 Adopted Background Noise Levels				
Noise Catchment Area	Representative Noise Environment	Adopted Background Noise Level (LA90) dB		
		Day	Evening	Night
NCA 1	R2	45	40	35
NCA 2	R3	50	45	40

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

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4 Construction Noise Impact Assessment

The assessment and management of noise from construction work is completed with reference to the Construction Noise and Vibration Guideline (CNVG). This guideline outlines the approach Transport for NSW takes when assessing and mitigating construction noise. The guideline provides the detail required to identify feasible and reasonable noise mitigation measures for construction, minor work and maintenance projects and needs to be considered for all Transport for NSW managed projects.

Construction noise impacts and mitigation measures need to be evaluated at various stages of a project to inform the concept design, environmental impact assessment, detail design and construction process.

The guideline describes the principles to be applied when reviewing and assessing construction noise, vibration and construction traffic. It also describes procedures to assist in reviewing noise and vibration mitigation.

The intention in all situations is to meet the following principles:

1. Good engagement with the community will be maintained to facilitate effective project delivery with balanced community impact.
2. Construction noise and vibration levels at sensitive receivers will be minimised where feasible and reasonable.
3. Feasible and reasonable mitigation will reflect the time of day, and/or the degree and duration of the impact.
4. The community will be informed of the dates for the intended work, sequencing and timing of noisy events. Where possible this will include an indicative schedule over a 24 hour period.
5. Minimising construction noise and vibration will be viewed as a continuous improvement exercise that is inclusive of stakeholders where no idea is too small to be considered.
6. Staff and community will be informed of the effort and methods undertaken to reduce noise and vibration for the work.
7. Any operational noise and vibration improvements resulting from the work will be promoted to the community.

4.1 Policies and Guidelines

4.1.1 Construction Noise and Vibration Guideline – Construction Hours

Table 2 summaries the CNVG recommended standard and out of hours periods for construction. Note, although not mandatory, strong justification is required to work outside of normal construction hours.

Table 2 Recommended Hours for Construction																								
Hour Commencing	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM
Monday	OOH Period 2						Standard Hours											OOH Period 1					OOH Period 2	
Tuesday	OOH Period 2						Standard Hours											OOH Period 1					OOH Period 2	
Wednesday	OOH Period 2						Standard Hours											OOH Period 1					OOH Period 2	
Thursday	OOH Period 2						Standard Hours											OOH Period 1					OOH Period 2	
Friday	OOH Period 2						Standard Hours											OOH Period 1					OOH Period 2	
Saturday	OOH Period 2						OOH Period 1											OOH Period 1					OOH Period 2	
Sunday	OOH Period 2						OOH Period 1											OOH Period 1					OOH Period 2	
Public Holiday	OOH Period 2						OOH Period 1											OOH Period 1					OOH Period 2	

Out of Hours (OOH) periods are divided into two categories generally representing evening and night periods and cover the hours listed below:

- **OOH Period 1 (evening/low risk period):** Monday to Friday – 6pm to 10pm, Saturdays – 7am to 8am & 1pm to 6pm, Sundays/Public Holidays – 8am to 6pm.
- **OOH Period 2 (night/medium to high-risk period):** Monday to Friday – 10pm to 7am, Saturdays/Sundays/Public Holidays – 6pm to 7am (8am on Sunday mornings and Public Holidays).

4.1.2 Interim Construction Noise Guideline

In accordance with the CNVG, construction noise management levels are established with reference to the NSW Interim Construction Noise Guideline (ICNG). The ICNG is specifically aimed at managing noise from construction work regulated by the EPA and is used to help in setting statutory conditions in licences or other regulatory instruments. The types of construction regulated by the Environment Protection Authority (EPA) under the Protection of the Environment Operations Act 1997 (POEO Act), include construction, maintenance and renewal activities carried out by a public authority, such as road upgrades as described in Schedule 1 of the POEO Act.

The ICNG sets out procedures to identify and address the impact of construction noise on residences and other sensitive land uses. This section provides a summary of noise objectives that are applicable to the assessment. The ICNG provides two methodologies for the assessment of construction noise emissions:

- Quantitative, which is suited to major construction proposals with typical durations of more than three weeks
- Qualitative, which is suited to short term infrastructure maintenance (for proposals with a typical duration of less than three weeks).

The methodology for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the relevant assessment locations, whilst the qualitative assessment methodology is a more simplified approach that relies more on noise management strategies.

This report has adopted a quantitative assessment approach. The assessment includes identification of potentially affected assessment locations, description of activities involved in the proposal, derivation of the construction noise criteria for standard and out of hours (OOH) periods, quantification of potential noise impacts at receivers and, provides management and mitigation recommendations.

Table 3 reproduces the ICNG management levels for residential receivers. The construction Noise Management Level (NML) is the sum of the management level and relevant Rating Background Level (RBL) for each specific assessment period. **Table 4** reproduces the ICNG management levels for other receiver types.

Table 3 ICNG Residential Management Levels

Time of Day	Management Level LAeq(15min) ¹	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 LAeq(15min) 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 75dBA.	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: <ul style="list-style-type: none"> 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 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction NML for noise assessment purposes and is the median of the ABL's.

Table 4 Noise Management Levels for Other Noise Sensitive Receivers

Land use	Where objective applies	Management Level
		L _{Aeq} (15min) ¹
Classrooms at schools and other educational institutions	Internal noise level	45dB
Hospital wards and operating theatres	Internal noise level	45dB
Places of worship	Internal noise level	45dB
Active recreation areas	External noise level	65dB
Passive recreation areas	External noise level	60dB
Commercial premises	External noise level	70dB
Industrial premises	External noise level	75dB

Note 1: Noise management levels apply when receiver areas are in use only.

Where the predicted or measured L_{Aeq}(15min) noise level is greater than the NML, the proponent should apply all feasible and reasonable work practices to meet the relevant NML. Following the implementation of standard mitigation measures, where residual noise impacts occur, additional mitigation measures (AMMs) should be implemented.

4.1.3 Construction Noise Management Levels (Criteria)

Construction NMLs for residential receivers are established from the representative noise environment for each of the NCAs. The NMLs for standard and out of hours work periods are summarised in **Table 5** for residential receivers and **Table 6** for applicable non-residential receivers.

Table 5 Construction NMLs – Residential Receivers

Location	Assessment Period	RBL, dBA	NML	Highly noise affected NML ¹
			dB L _{Aeq} (15min)	dB L _{Aeq} (15min)
NCA 1	Day (Standard Hours)	45	55 (RBL+10dBA)	75 Standard Hours
	Evening (OOH Period 1)	40	45 (RBL+5dBA)	75 Outside Recommended Hours
	Night (OOH Period 2)	35	40 (RBL+5dBA)	75 Outside Recommended Hours
	Day (Standard Hours)	50	60 (RBL+10dBA)	75 Standard Hours
NCA 2	Evening (OOH Period 1)	45	50 (RBL+5dBA)	75 Outside Recommended Hours
	Night (OOH Period 2)	40	45 (RBL+5dBA)	75 Outside Recommended Hours
	Day (Standard Hours)	50	60 (RBL+10dBA)	75 Standard Hours

Note 1: The highly noise affected NML is a hypothetical level that is adopted to ensure the avoidance of strong community reaction. Should this level be exceeded the construction methodology is to be reviewed to reduce the impact on surrounding sensitive receivers.

Table 6 Construction NMLs – Non-Residential Receivers

Location	Assessment Period	Where NML Applies	NML dB LAeq(15min)
Educational institutions	When in use	Internal noise level	45
		External noise level ¹	70
Hospital wards and operating theatres	When in use	Internal noise level	45
		External noise level ¹	70
Places of Worship	When in use	Internal noise level	45
		External noise level ¹	70
Passive Recreation	When in use	External noise level	60
Active Recreation	When in use	External noise level	65
Commercial Receivers	When in use	External noise level	70

Note 1: External noise level assumes a 25dB transmission loss for a masonry building with single glazing (windows closed) as per the ENMM (RTA, 2001).

4.2 Maximum Noise Level Assessment

The maximum noise level assessment (sleep disturbance) criterion of 65dB LA_{max} is referred to in Section 3.1.5 of the Environmental Impact Assessment Procedure: Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report (Roads and Maritime, 2016) and Appendix E of the Construction Noise and Vibration Guideline (Roads and Maritime, 2016).

The maximum noise level assessment criterion has been adopted as the relevant assessment criterion for the assessment of sleep disturbance effects.

4.3 Noise Assessment Methodology

A conservative computer model was developed to quantify project noise emissions to neighbouring receivers using DGMR (iNoise, Version 2021) noise modelling software. iNoise is an intuitive and quality assured software package for industrial noise calculations in the environment. 3D noise modelling is considered industry best practice for assessing noise emissions from projects.

The model incorporated a three-dimensional digital terrain map giving all relevant topographic information used in the modelling process. Additionally, the model uses relevant noise source data, ground type, attenuation from barrier or buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers. It is noted that affected receivers are those that would potentially experience noise levels above the relevant NMLs. Where relevant, modifying factors in accordance with Fact Sheet C of the Noise Policy for Industry (NPI) (EPA, 2017) have been applied to calculations.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation' including corrections for meteorological conditions using CONCAWE¹. The ISO 9613 standard from 1996 is the most used noise prediction method worldwide. Many countries refer to ISO 9613 in their noise legislation. However, the ISO 9613 standard does not contain guidelines for quality assured software implementation, which leads to differences between applications in calculated results. In 2015 this changed with the release of ISO/TR 17534-3. This quality standard gives clear recommendations for interpreting the ISO 9613 method. iNoise fully supports these recommendations. The models and results for the 19 test cases are included in the software.

¹ Report no. 4/18, "the propagation of noise from petroleum and petrochemical complexes to neighbouring communities", Prepared by C.J. Manning, M.Sc., M.I.O.A. Acoustic Technology Limited (Ref.AT 931), CONCAWE, Den Haag May 1981

4.4 Proposed Works and Construction Scenarios

The construction scenarios included in this assessment are described in **Table 7** and the typical plant and equipment, along with the fleet sound power level (SWL) for each of the construction activities are provided in **Table 8**. It is noted that where available, SWLs for items of equipment were sourced from the TfNSW Construction and Maintenance Noise Estimator (CMNE). For items of equipment not listed in the CMNE, SWLs were sourced from MAC's noise emission database.

It is noted that the precise locations and types of equipment used to construct the proposal is not known in detail at this stage. Additionally, it is unlikely that all plant and equipment would operate simultaneously but may be used sequentially across each part of the construction area. On that basis, the assessment provides a broad representation of the likely worst-case impacts from each component of the construction works.

Table 7 Construction Scenarios

Scenario	Description
Scenario 1 – Site establishment	Survey set out, establishment of environmental controls and establishment of compound sites.
Scenario 2 – Alignment formation	Excavation or importation of fill to form alignment. Sub-base layers placed and compacted.
Scenario 3 – Pavement formation	Installation of formwork, concrete pouring and finishing.
Scenario 4 – Kerb realignment	Concrete sawing and kerb removal.
Scenario 5 – Line marking and furniture installation	Line marking and installation of signage and facilities.

Table 8 Acoustically Significant Sources - Sound Power Levels (dBA re 10⁻¹² Watts)

Item	Sound Power Levels dB LAeq(15min)	Construction Scenario				
		Sc 1	Sc 2	Sc 3	Sc 4	Sc 5
Road Truck	103	✓	✓			
Truck with Lifting Boom	103	✓				
Light Vehicles	103	✓	✓	✓	✓	✓
Positrack	101	✓				
Generator	99	✓				
Mini Tracked Excavator (x2)	96		✓			
Smooth Drum Roller (3t)	101		✓			
Handheld Power Tools	97			✓	✓	✓
Concrete Truck	109			✓		
Concrete Path Layer	104			✓		
Concrete Saw	118				✓	
Line Marking Truck	99					✓
Total Fleet SWL		109	108	110	118	105

4.5 Construction Noise Results

Construction noise levels have been predicted for sensitive receiver locations for each of the construction scenarios described in **Section 4.4**. It is noted that the affected distances displayed for each scenario below represent the maximum distance from the proposal site where receivers may experience noise levels above the relevant NMLs.

4.5.1 Scenario 1 – Compound Site Establishment

As shown in **Table 9**, LAeq(15min) noise emissions are predicted to be above the relevant NMLs for nearby residential receivers and active recreation areas immediately adjacent to the proposal site during compound establishment works. Noise emissions are not predicted to exceed the highly noise affected (HNA) NML of 75dB LAeq(15min) at any receiver locations. It is noted that the compound establishment is anticipated to occur during standard construction hours only, however, in the event that works are undertaken during OOH work periods, results are displayed for OOH P1 and OOH P2 also.

Table 9 Affected Distances – Scenario 1 – Compound Site Establishment

Receiver Type	Assessment Period	NML dB LAeq(15min)	Affected Distance (m)	Affected Receivers
Residential (NCA 1)	Standard Hours	60	~30m	Yes
	OOH P1	50	~105m	Yes
	OOH P2	45	~195m	Yes
	HNA	75	~10m	No
Residential (NCA 2)	Standard Hours	60	~30m	Yes
	OOH P1	50	~130m	Yes
	OOH P2	45	~205m	Yes
	HNA	75	~10m	No
Education Institutions	When in use	45 (internal) 70 (external)	~15m	No
Hospital Wards	When in use	45 (internal) 70 (external)	~15m	No
Places of Worship	When in use	45 (internal) 70 (external)	~15	No
Passive Recreation	When in use	60	~30m	No
Active Recreation	When in use	65	~20m	Yes
Commercial	When in use	70	~15m	No

Noise contour plots identifying the affected areas are provided in **Figure 4** for receivers surrounding the Kirrawee compound site, and **Figure 5** for receivers surrounding the Miranda compound sites.



FIGURE 4
 Noise Contour Plot
 Sc1-Compound Establishment
 Kirrawee Compound Site
 MAC211332-01
 SCATL Project

KEY

-  Compound Site
- LAeq(15min) Noise Contour**
-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

0 20 40 60 80 100 m





FIGURE 5
 Noise Contour Plot
 Sc1-Compound Establishment
 Miranda Compound Sites
 MAC211332-01
 SCATL Project

KEY

- Proposal Site
- Compound Site

LAeq(15min) Noise Contour

- Standard Hours NML
- OOH P1 NML
- OOH P2 NML
- Highly Noise Affected NML

0 20 40 60 80 100 m

4.5.2 Scenario 2 – Earthworks and Alignment Formation

As shown in **Table 10**, LAeq(15min) noise emissions are predicted to be above the relevant NMLs for nearby residential receivers up to two rows of houses back from the proposal site, as well as places of worship, passive and active recreation areas and commercial receivers immediately adjacent to the proposal site. Furthermore, given the close proximity of adjacent buildings to the proposal site, noise emissions are anticipated to exceed the highly noise affected NML of 75dB LAeq(15min) for receivers within approximately 12m of the proposal site. It is noted that earthworks and formation of the proposal alignment are anticipated to occur during standard construction hours only, however, in the event that works are undertaken during OOH work periods, results are displayed for OOH P1 and OOH P2 also.

Noise contour plots identifying the affected areas are provided in **Figure 6** to **Figure 9**. The contour plots show sections of the alignment moving from Kirrawee in the west to Woollooware in the east.

Table 10 Affected Distances – Scenario 2 – Earthworks and Alignment Formation

Receiver Type	Assessment Period	NML dB LAeq(15min)	Affected Distance (m)	Affected Receivers
Residential (NCA 2)	Standard Hours	60	~65m	Yes
	OOH P1	50	~190m	Yes
	OOH P2	45	~330m	Yes
	Highly Noise Affected	75	~12m	Yes
Education Institutions	When in use	45 (internal) 70 (external)	~20m	No
Hospital Wards	When in use	45 (internal) 70 (external)	~20m	No
Places of Worship	When in use	45 (internal) 70 (external)	~20m	Yes
Passive Recreation	When in use	60	~65m	Yes
Active Recreation	When in use	65	~45m	Yes
Commercial	When in use	70	~20m	Yes

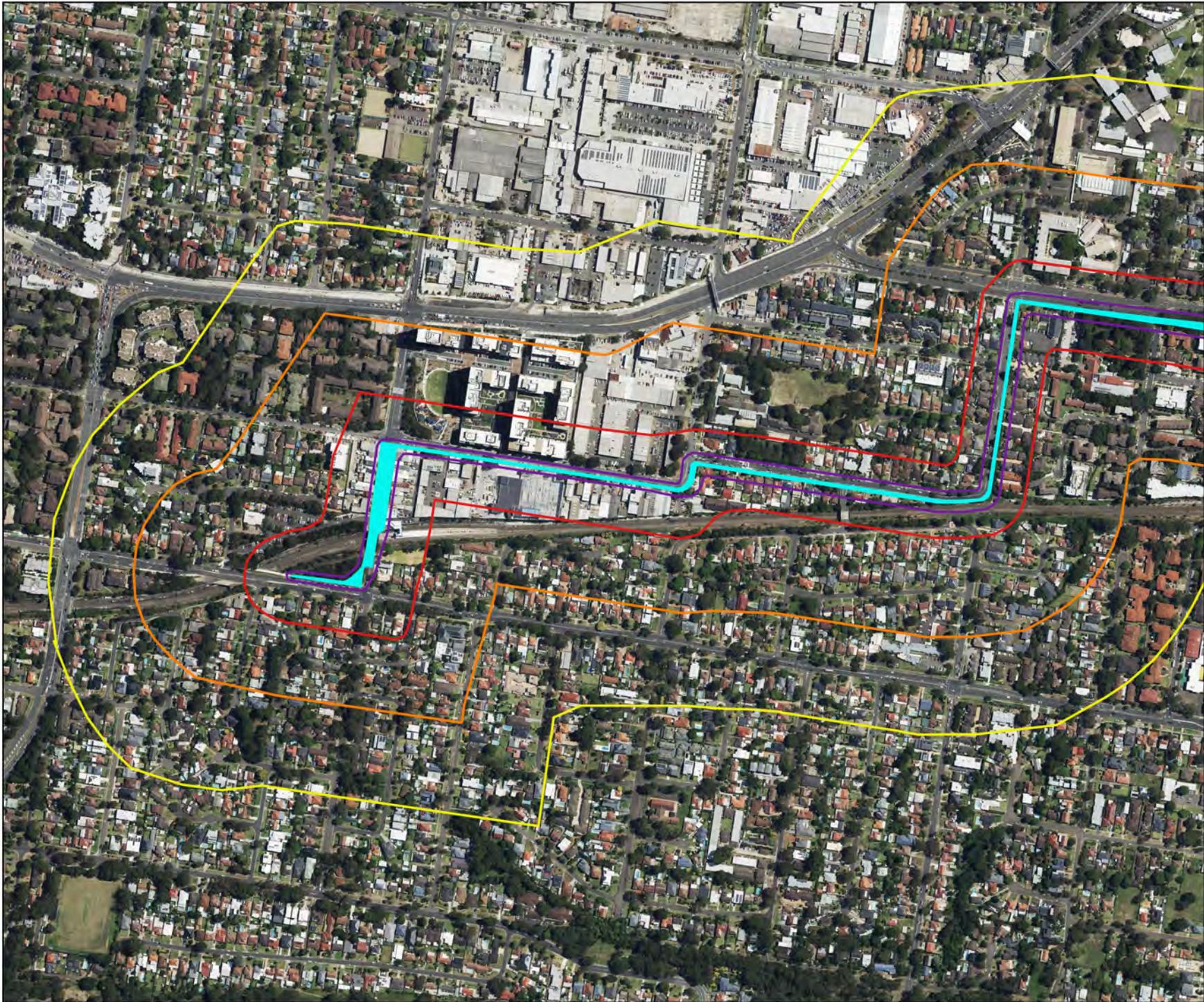


FIGURE 6
Noise Contour Plot
Sc2-Earthworks
MAC211332-01
SCATL Project

KEY

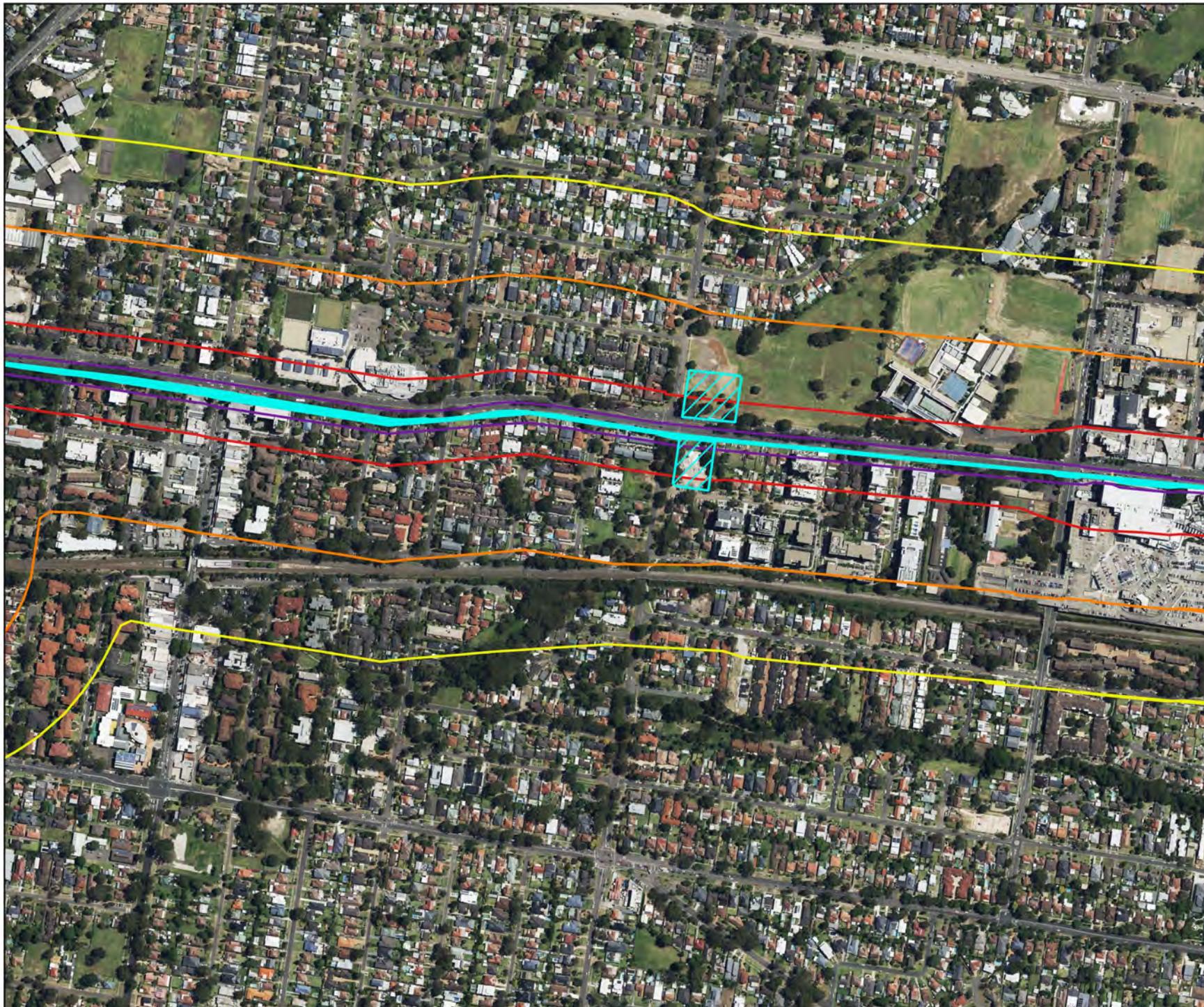
- Proposal Site
- Compound Site

LAeq(15min) Noise Contour

- Standard Hours NML
- OOH P1 NML
- OOH P2 NML
- Highly Noise Affected NML



FIGURE 7
Noise Contour Plot
Sc2-Earthworks
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

LAeq(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML



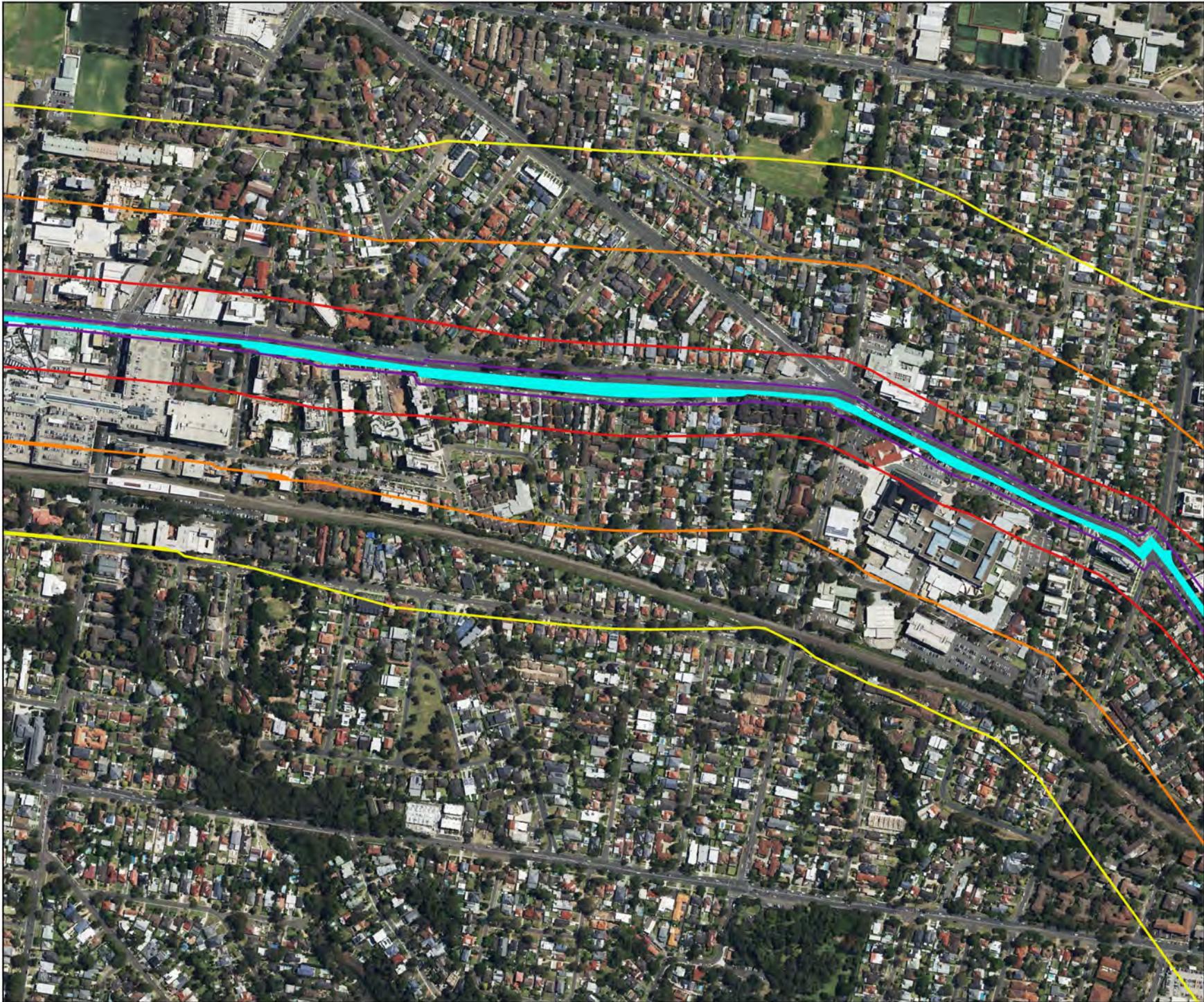


FIGURE 8
Noise Contour Plot
Sc2-Earthworks
MAC211332-01
SCATL Project

KEY

-  Proposal Site
-  Compound Site

L_{Aeq}(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

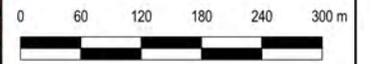


FIGURE 9
Noise Contour Plot
Sc2-Earthworks
MAC211332-01
SCATL Project

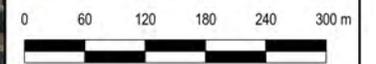


KEY

-  Proposal Site
-  Compound Site

LAeq(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML



4.5.3 Scenario 3 – Pavement Formation Works

As shown in **Table 11**, LAeq(15min) noise emissions are predicted to be above the relevant NMLs for nearby residential receivers up to two rows of houses back from the proposal site, as well as The Sutherland Hospital, places of worship, passive and active recreation areas and commercial receivers immediately adjacent to the proposal site. Furthermore, given the close proximity of adjacent buildings to the proposal site, noise emissions are anticipated to exceed the highly noise affected NML of 75dB LAeq(15min) for receivers within approximately 15m of the proposal site. It is noted that pavement formation works are anticipated to occur during standard construction hours only, however, in the event that works are undertaken during OOH work periods, results are displayed for OOH P1 and OOH P2 also.

Noise contour plots identifying the affected areas are provided in **Figure 10** to **Figure 13**. The contour plots show sections of the alignment moving from Kirrawee in the west to Woollooware in the east.

Table 11 Affected Distances – Scenario 3 – Pavement Formation Works

Receiver Type	Assessment Period	NML dB LAeq(15min)	Affected Distance (m)	Affected Receivers
Residential (NCA 2)	Standard Hours	60	~90m	Yes
	OOH P1	50	~270m	Yes
	OOH P2	45	~440m	Yes
	Highly Noise Affected	75	~15m	Yes
Education Institutions	When in use	45 (internal) 70 (external)	~23m	No
Hospital Wards	When in use	45 (internal) 70 (external)	~23m	Yes
Places of Worship	When in use	45 (internal) 70 (external)	~23m	Yes
Passive Recreation	When in use	60	~90m	Yes
Active Recreation	When in use	65	~35m	Yes
Commercial	When in use	70	~23m	Yes

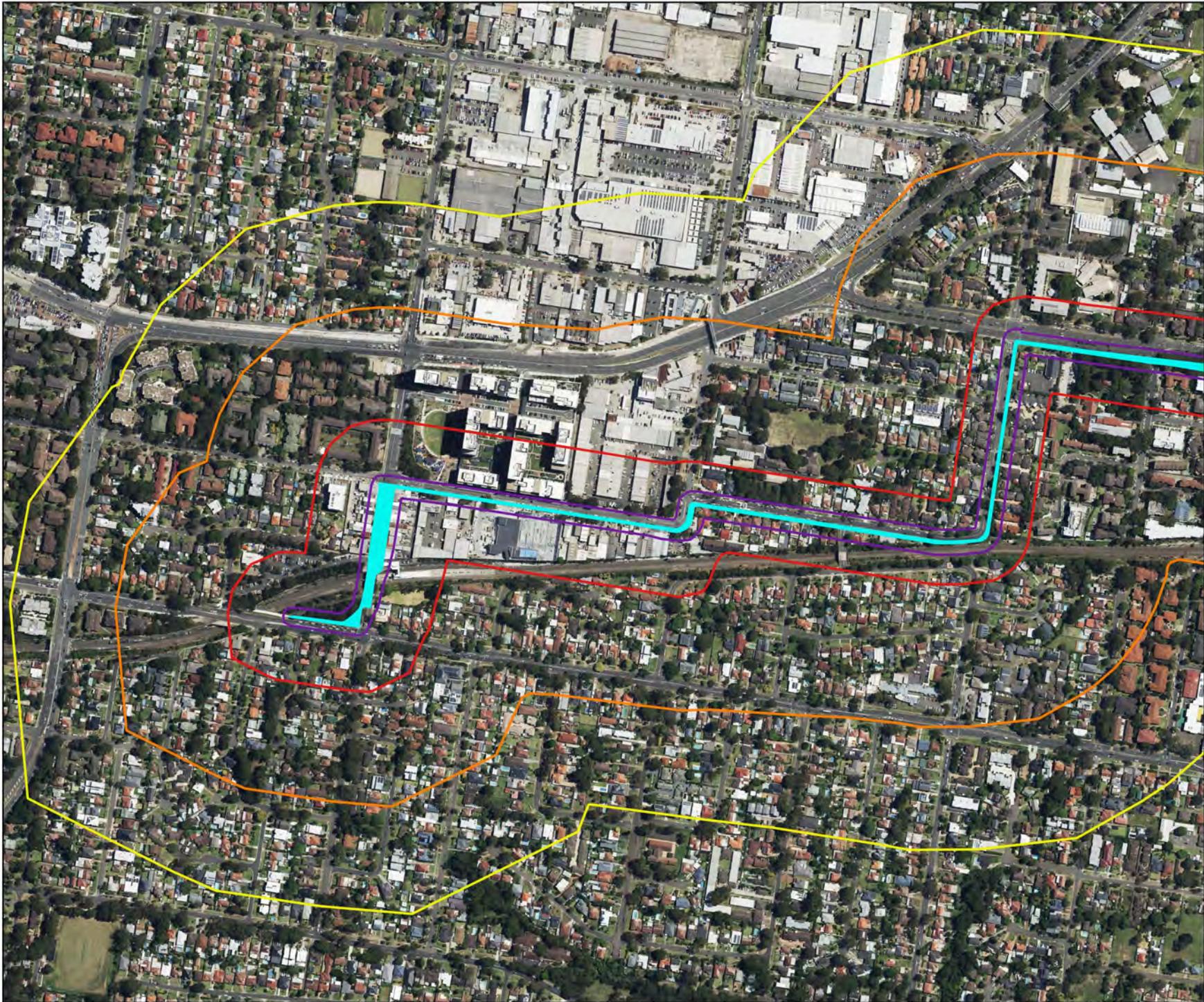


FIGURE 10
Noise Contour Plot
Sc3-Pavement Works
MAC211332-01
SCATL Project

KEY

-  Proposal Site
-  Compound Site

L_{Aeq}(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

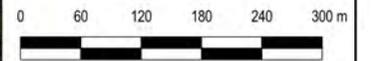
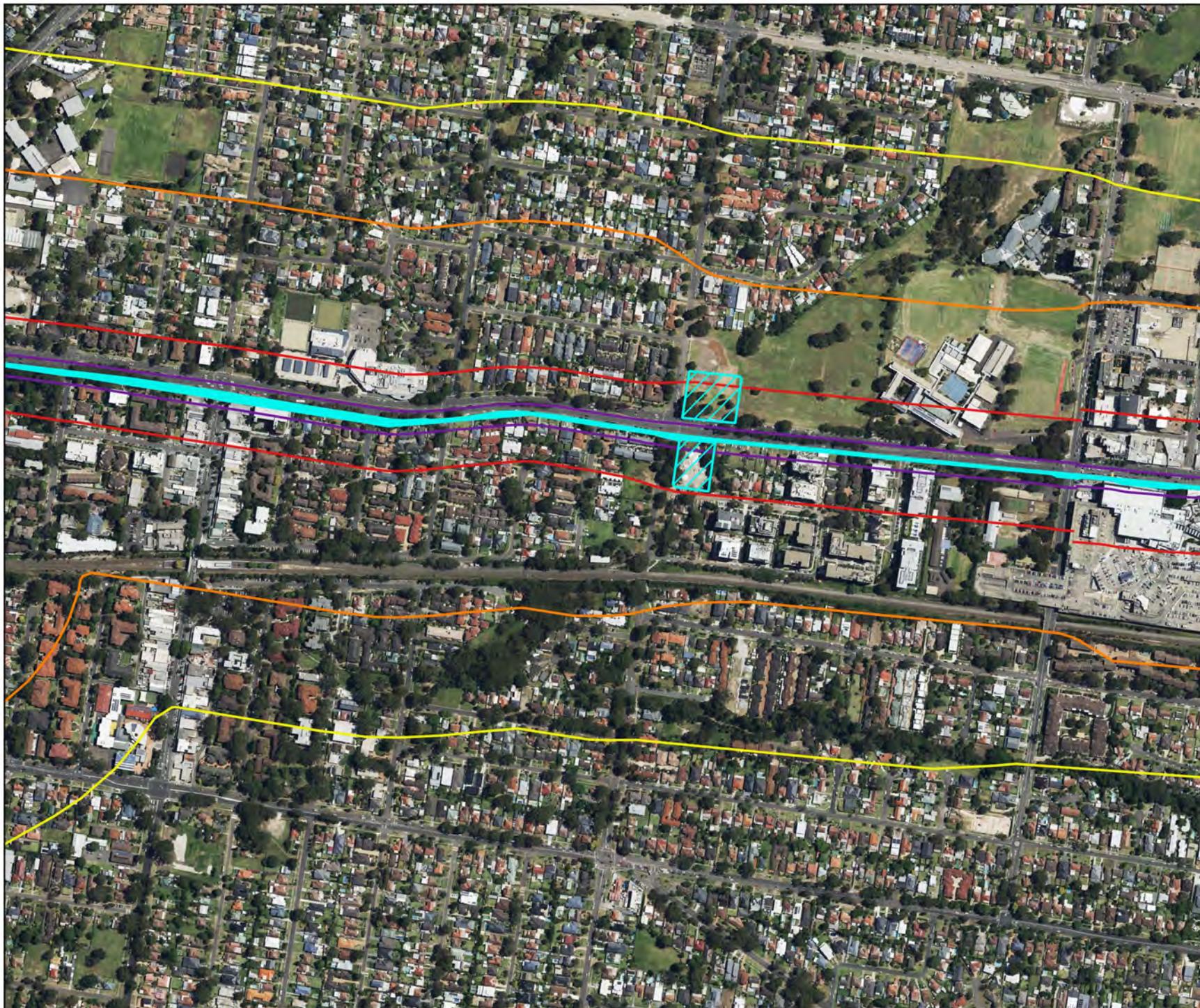


FIGURE 11
Noise Contour Plot
Sc3-Pavement Works
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

LAeq(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

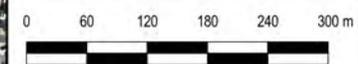
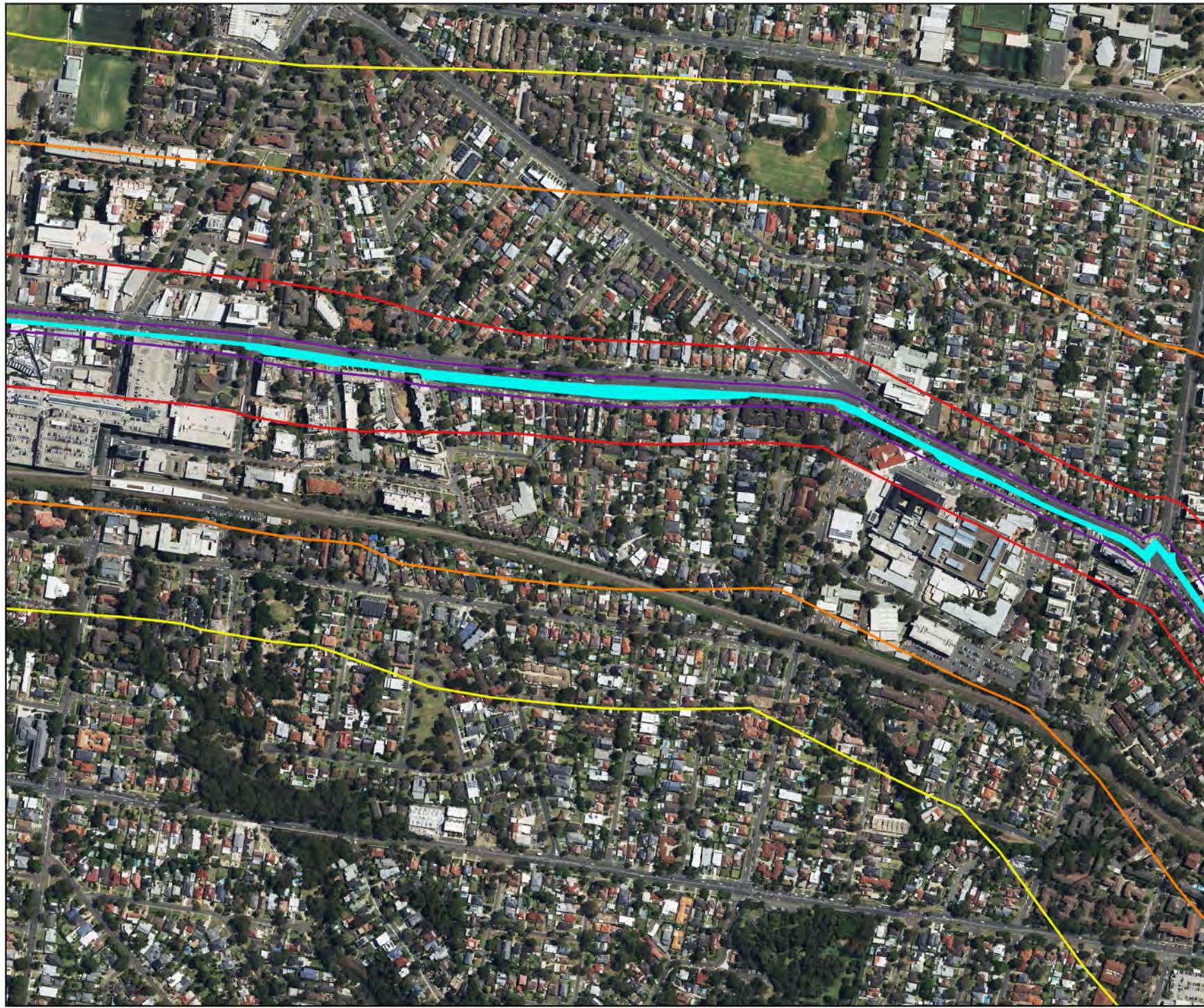


FIGURE 12
Noise Contour Plot
Sc3-pavement Works
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site
- LAeq(15min) Noise Contour**
-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

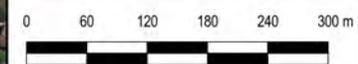


FIGURE 13
Noise Contour Plot
Sc3-Pavement Works
MAC211332-01
SCATL Project

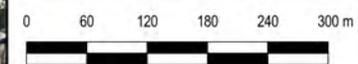


KEY

-  Proposal Site
-  Compound Site

L_{Aeq}(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML



4.5.4 Scenario 4 – Kerb Realignment including Concrete Sawing

It is understood that kerb realignment works, including concrete sawing would be undertaken in discrete locations only. As the location of the works is unknown at this stage of the proposal planning, noise emissions from concrete sawing have been predicted along the length of the alignment. It is also understood that to prevent traffic impacts, kerb realignment works may be undertaken during OOH work periods.

As shown in **Table 12**, LAeq(15min) noise emissions would potentially be above the relevant NMLs for all receiver types. The predictive modelling indicates that during OOH P2, residential receivers up to 1.1km from the proposal site may experience noise levels above the NMLs. Additionally, receivers within approximately 45m would potentially be exposed to noise levels above the highly noise affected NML of 75dB LAeq(15min).

Noise contour plots identifying the affected areas are provided in **Figure 14** to **Figure 16**. The contour plots show sections of the alignment moving from Kirrawee in the west to Woolooware in the east.

Table 12 Affected Distances – Scenario 4 – Kerb Realignment Works				
Receiver Type	Assessment Period	NML dB LAeq(15min)	Affected Distance (m)	Affected Receivers
Residential (NCA 2)	Standard Hours	60	~220m	Yes
	OOH P1	50	~570m	Yes
	OOH P2	45	~1,100m	Yes
	Highly Noise Affected	75	~45m	Yes
Education Institutions	When in use	45 (internal) 70 (external)	~70m	No
Hospital Wards	When in use	45 (internal) 70 (external)	~70m	Yes
Places of Worship	When in use	45 (internal) 70 (external)	~70m	Yes
Passive Recreation	When in use	60	~200m	Yes
Active Recreation	When in use	65	~135m	Yes
Commercial	When in use	70	~70m	Yes

FIGURE 14
Noise Contour Plot
Sc4-Kerb Realignment
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

LAeq(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

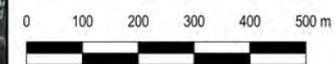
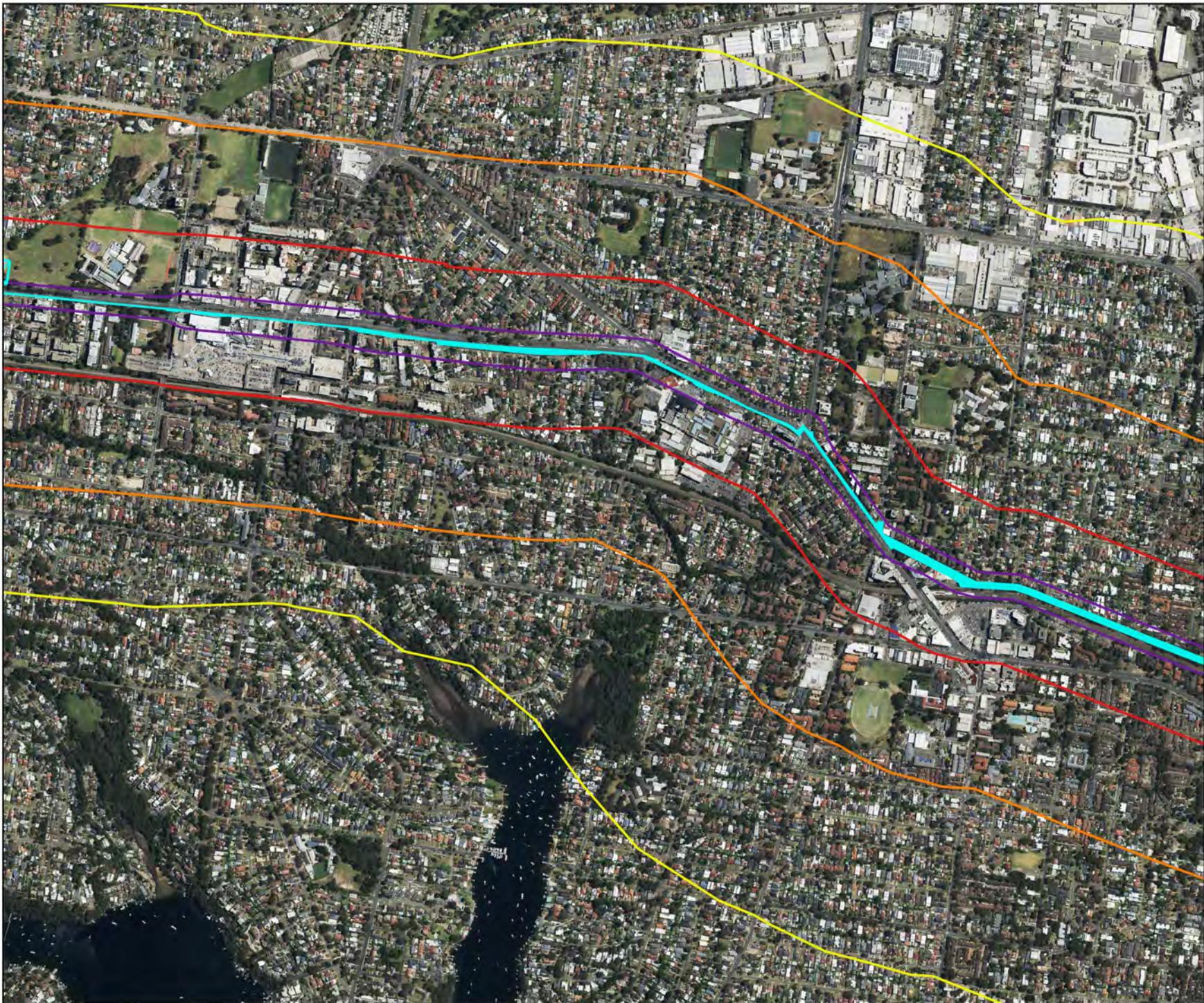


FIGURE 15
Noise Contour Plot
Sc4-Kerb Realignment
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

L_{Aeq}(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

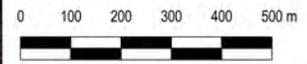
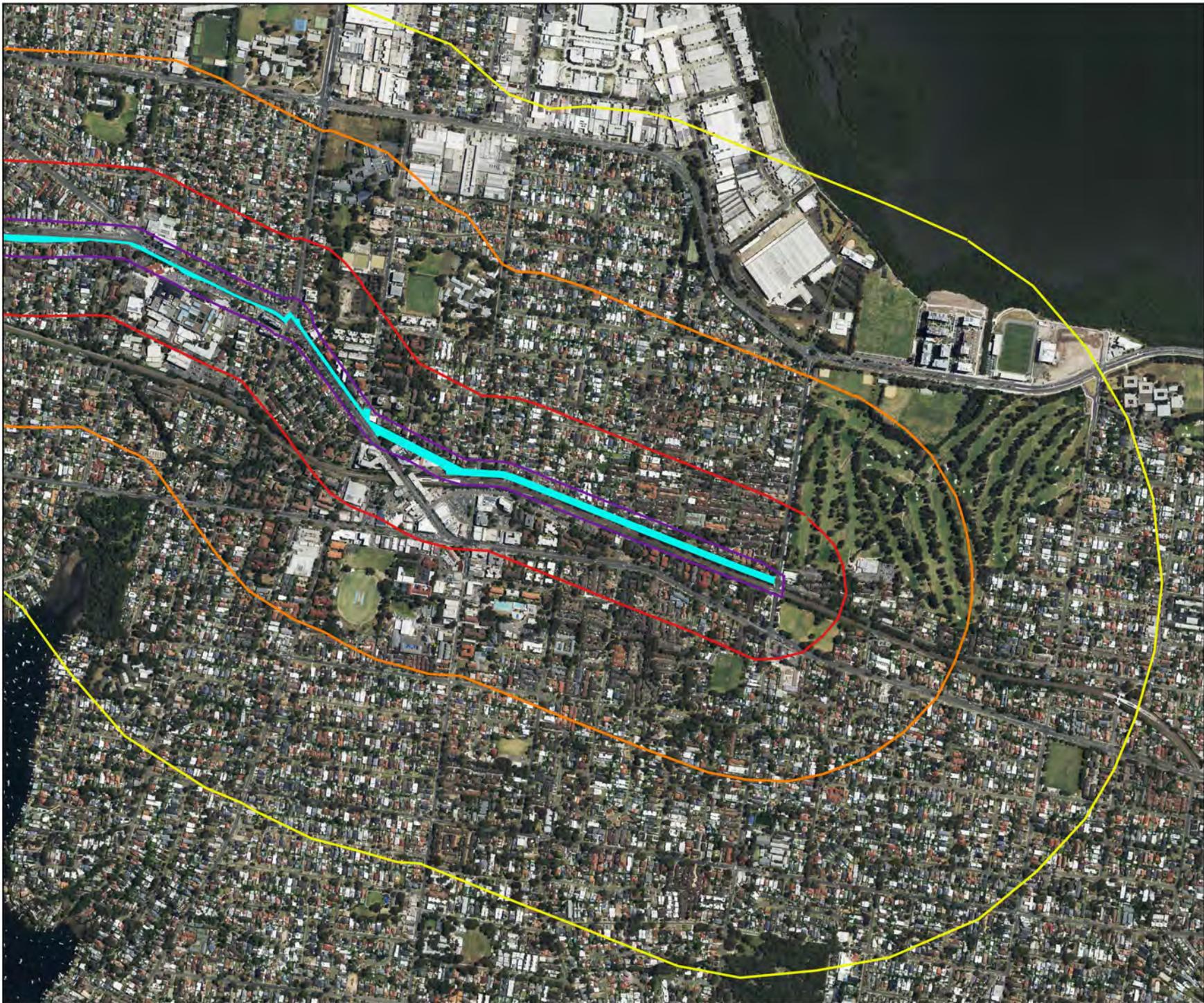
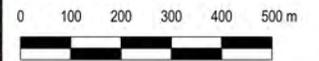


FIGURE 16
Noise Contour Plot
Sc4-Kerb Realignment
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site
- LAeq(15min) Noise Contour**
 -  Standard Hours NML
 -  OOH P1 NML
 -  OOH P2 NML
 -  Highly Noise Affected NML



4.5.5 Scenario 5 – Line Marking and Furniture Installation

As shown in **Table 13**, LAeq(15min) noise emissions are predicted to be above the relevant NMLs for nearby residential receivers directly adjacent to the proposal site. Additionally, places of worship (St Stylianos Greek Orthodox Parish), passive and active recreation areas, and commercial receivers immediately adjacent to the proposal site may also experience noise levels above the relevant NMLs.

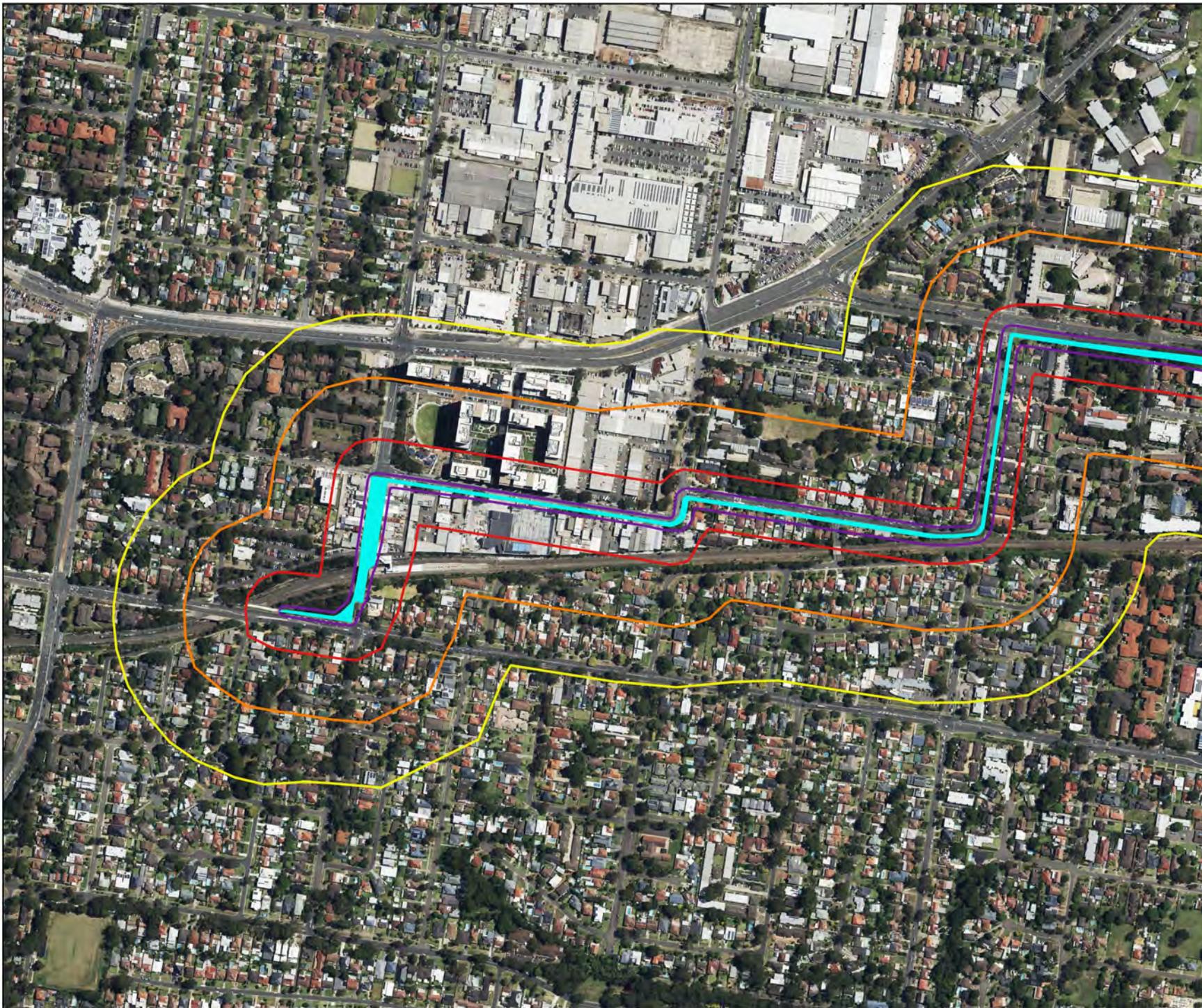
Furthermore, given the close proximity of adjacent buildings to the proposal site, noise emissions are anticipated to exceed the highly noise affected NML of 75dB LAeq(15min) for receivers within approximately 15m of the proposal site. It is noted that line marking and furniture installation works are anticipated to occur during standard construction hours only, however, in the event that works are undertaken during OOH work periods, results are displayed for OOH P1 and OOH P2 also.

Noise contour plots identifying the affected areas are provided in **Figure 17** to **Figure 20**. The contour plots show sections of the alignment moving from Kirrawee in the west to Woolooware in the east.

Table 13 Affected Distances – Scenario 5 – Line Marking and Furniture Installation

Receiver Type	Assessment Period	NML dB LAeq(15min)	Affected Distance (m)	Affected Receivers
Residential (NCA 2)	Standard Hours	60	~50m	Yes
	OOH P1	50	~145m	Yes
	OOH P2	45	~240m	Yes
	Highly Noise Affected	75	<10m	Yes
Education Institutions	When in use	45 (internal) 70 (external)	~20m	No
Hospital Wards	When in use	45 (internal) 70 (external)	~20m	No
Places of Worship	When in use	45 (internal) 70 (external)	~20m	Yes
Passive Recreation	When in use	60	~50m	Yes
Active Recreation	When in use	65	~40m	Yes
Commercial	When in use	70	~20m	Yes

FIGURE 17
Noise Contour Plot
Sc5-Line Marking
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

LAeq(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

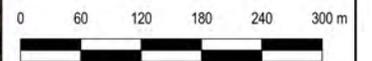
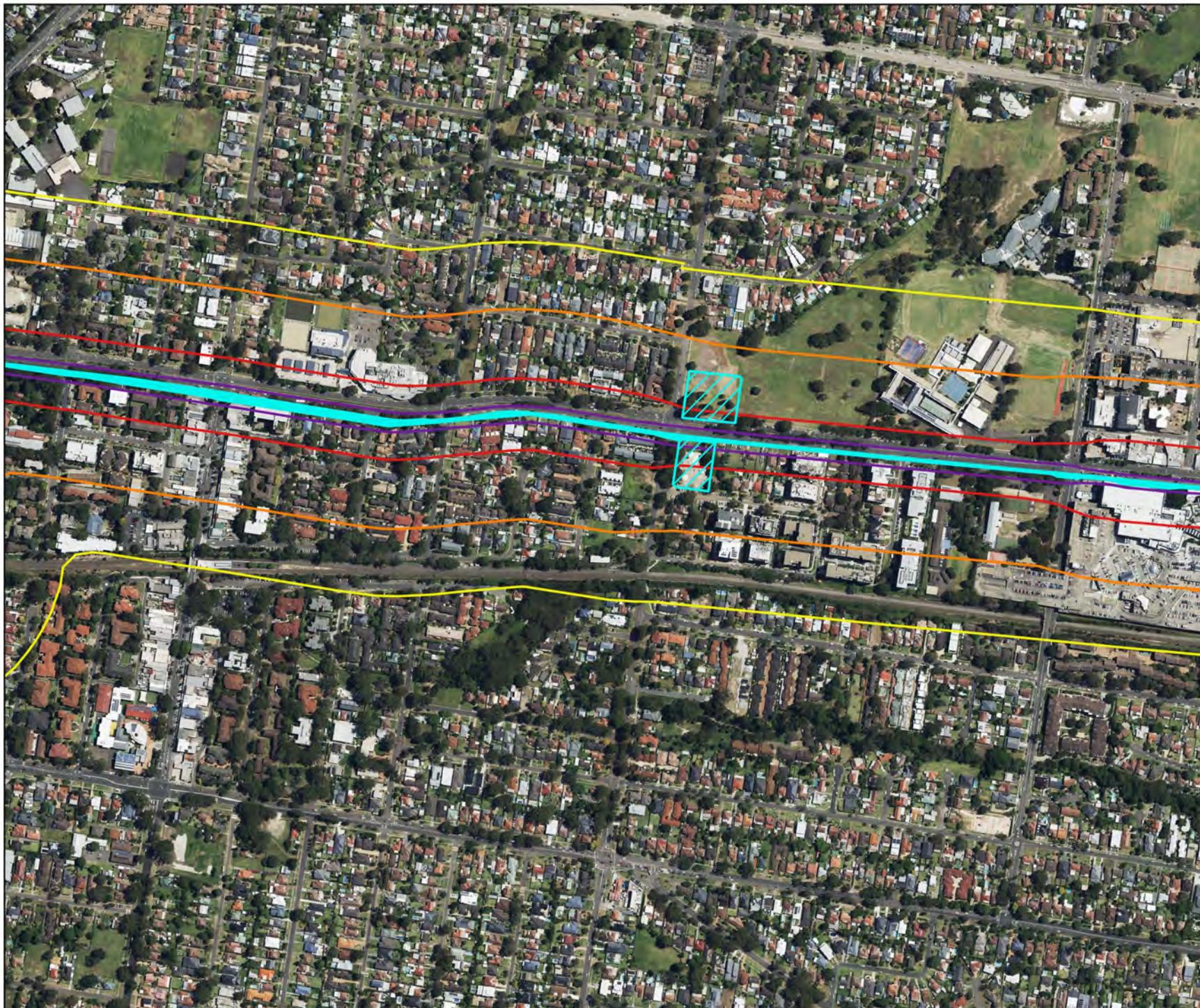


FIGURE 18
Noise Contour Plot
Sc5-Line Marking
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

L_{Aeq}(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

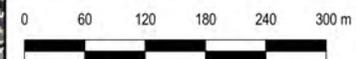
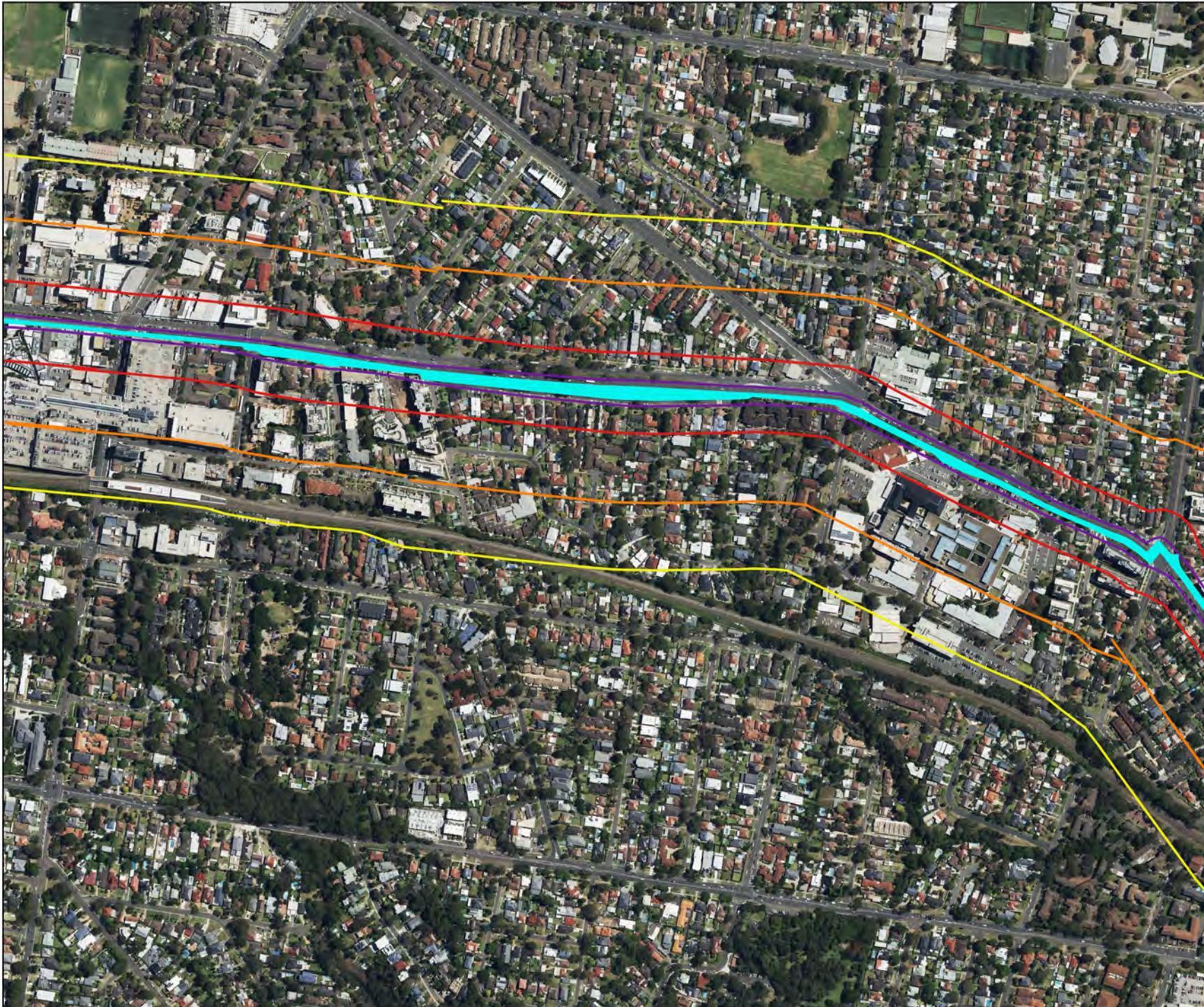


FIGURE 19
Noise Contour Plot
Sc5-Line Marking
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

LAeq(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML

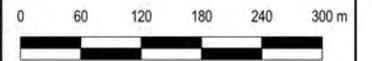


FIGURE 20
Noise Contour Plot
Sc5-Line Marking
MAC211332-01
SCATL Project



KEY

-  Proposal Site
-  Compound Site

LAeq(15min) Noise Contour

-  Standard Hours NML
-  OOH P1 NML
-  OOH P2 NML
-  Highly Noise Affected NML



4.5.8 Maximum Noise Trigger Level Assessment (Sleep Disturbance) Results

Out of hours construction activities occurring during the night-time have the potential to generate noise emissions that may cause sleep disturbance at receivers in proximity to the proposal site.

Noise modelling quantified the levels from maximum night-time events occurring during OOH work periods to nearby receiver locations. Modelling adopted a sound power level of 118dB LAmax for concrete sawing works.

Modelling identified that noise emissions have the potential to be above the maximum noise trigger level at residential receivers located within approximately 70m of the proposal site. It is understood that concrete sawing works, would be undertaken at discrete locations along the proposal alignment. Prior to undertaking concrete sawing activities during OOH P2, a review of all receivers within 70m of the activity location should be undertaken. Where receivers are likely to be impacted, it is recommended that the proposal proactively manages night-time noise emissions and implement reasonable and feasible noise control strategies to minimise the occurrence of sleep disturbance within the surrounding locality. It is also recommended that particularly noisy activities, such as concrete sawing should be avoided during OOH work were possible.

5 Construction Mitigation Measures

5.1 Standard Mitigation Measures

The TfNSW CNVG outlines noise management and mitigation measures to minimise the noise and vibration impacts from construction activities on nearby sensitive receivers. Adopting the standard mitigation measures may result in an attenuation of up to 10dBA where space requirements place limitations on the attenuation options, and up to 20dBA in situations where noise source noise mitigation measures (silencers, mufflers etc) can be combined with noise barriers and other management techniques. The standard mitigation measures from the CNVG, with project specific amendments are provided in **Table 14**.

Table 14 Standard Mitigation Measures	
Action Required	Details
Management Measures	
Implementation of any project specific mitigation measures required	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures	<p>Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone number.</p> <p>Notification should be a minimum of 7 calendar days prior to the start of works. More advanced consultation or notification may be required, including the following in accordance with the Communication and Stakeholder Engagement Plan.</p> <ul style="list-style-type: none"> ▪ Website (If required) ▪ Contact telephone number for community ▪ Email distribution list (if required) ▪ Community drop in session (if required by approval conditions).
Site inductions	<p>All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include:</p> <ul style="list-style-type: none"> ▪ All relevant project specific and standard noise and vibration mitigation measures ▪ Relevant licence and approval conditions ▪ Permissible hours of work ▪ Any limitations on noise generating activities ▪ Location of nearest sensitive receivers ▪ Construction employee parking areas ▪ Designated loading/unloading areas and procedures ▪ Site opening/closing times (including deliveries)

Table 14 Standard Mitigation Measures

Action Required	Details
	<ul style="list-style-type: none"> Environmental incident procedures.
Behavioural practices	<p>No swearing or unnecessary shouting or loud stereos/radios on site.</p> <p>No dropping of materials from height, throwing of metal items and slamming of doors.</p>
Verification	Where specified under Appendix C a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plan	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage.
Source Controls	
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating noise with special audible characteristics and/or vibration levels should be scheduled during less sensitive time periods
Construction respite period	<p>Please refer to Appendix C of the CNVG for more details on the following respite measures:</p> <ul style="list-style-type: none"> Respite Offers (RO) Respite Period 1 (R1) Respite Period 2 (R2) Duration Respite (DR)
Equipment selection	<p>Use quieter and less vibration emitting construction methods where feasible and reasonable.</p> <p>Ensure plant including the silencer is well maintained.</p>
Plant noise levels	<p>The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of the CNVG.</p> <p>Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of the CNVG.</p>
Rental plant and equipment	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 of the CNVG.
Use and siting of plant	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised.

Table 14 Standard Mitigation Measures

Action Required	Details
	<p>Plant used intermittently to be throttled down or shut down.</p> <p>Noise-emitting plant to be directed away from sensitive receivers.</p> <p>Only have necessary equipment on site.</p>
Plan worksites and activities to minimise noise and vibration.	<p>Locate compounds away from sensitive receivers and discourage access from local roads.</p> <p>Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.</p> <p>Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm, where possible.</p> <p>Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters.</p> <p>If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.</p>
Reduce equipment power	Use only the necessary size and power.
Non-tonal reversing alarms	<p>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.</p> <p>Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.</p>
Minimise disturbance arising from delivery of goods to construction sites	<p>Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers.</p> <p>Select site access points and roads as far as possible away from sensitive receivers.</p> <p>Dedicated loading/unloading areas to be shielded if close to sensitive receivers.</p> <p>Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.</p> <p>Avoid or minimise these out of hours movements where possible.</p>
Engine compression brakes	<p>Limit the use of engine compression brakes at night and in residential areas.</p> <p>Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.</p>

Table 14 Standard Mitigation Measures	
Action Required	Details
Path Controls	
Shield stationary noise sources such as pumps, compressors, fans etc	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS2436:2010 lists materials suitable for shielding
Shield sensitive receivers from noise activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor Controls	
Structural surveys and vibration monitoring	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See Appendix C of the CNVG for additional measures	In some instances additional mitigation measures may be required.

5.2 Additional Mitigation Measures

Standard noise mitigation and management measures in accordance with the ICNG would be implemented for the proposal where practicable.

The CNVG (Roads and Maritime, 2015) outlines a range of mitigation measures which are recommended in order to manage the potential impact. The CNVG additional measures reproduced in **Table 15** will be considered by Transport for NSW or the construction contractor following incorporation of feasible and reasonable mitigation measures for the proposal. **Appendix C** provides a definition of each additional mitigation measure listed below.

Table 15 CNVG Triggers for Additional Mitigation Measures – Airborne Noise				
Perception	Predicted airborne LAeq(15min) noise level at receiver		Additional mitigation measures Type	Mitigation Levels
	dB(A) above RBL	dB(A) above NML		
All hours				
	75dBA or greater		N, V, PC, RO	HA
Standard Hours: Mon – Fri (7am – 6pm), Sat (8am – 1pm), Sun/Pub Holidays (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly Audible	10 to 20	< 10	-	NML
Moderately intrusive	20 to 30	10 to 20	N, V	NML+10
Highly intrusive	> 30	> 20	N, V	NML+20
OOH Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Hol (8am – 6pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly Audible	10 to 20	5 to 15	N, R1, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, N, R1, DR	NML+15
Highly intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML+25
OOH Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Pub Holidays (6pm – 7am)				
Noticeable	5 to 10	< 5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML+15
Highly intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML+25

Notes: AA = Alternative accommodation, R1 = Respite Period 1, V = Validation of predicted noise levels (not required for projects less than 3 weeks), PC = Phone calls, IB = Individual briefings (not required for projects less than 3 weeks), SN = Specific notifications, N = Notification, R2 = Respite Period 2, DR = Duration Respite, Perception = relates to level above RBL, NML = Noise Management Level (see Appendix C), HA = Highly Affected (> 75 dB(A) – applies to residences only).

It is understood that the proposed construction activities would generally be undertaken during standard work periods, however, to reduce traffic impacts, kerb realignment works including concrete sawing, may be undertaken during OOH work periods. The assessment of Additional Mitigation Measures (AMM) affected distances is provided for kerb realignment works, which are anticipated to have the highest potential for noise impacts on surrounding receivers.

The affected distances for each AMM category are presented in **Table 16**. It is noted that the derivation of affected distances has allowed for a conservative 5dB reduction to account for noise attenuation from the implementation of standard mitigation measures as per **Section 5.1**.

AMM affected areas are provided in **Figure 21** to **Figure 24** for standard construction hours, **Figure 25** to **Figure 28** for OOH P1, and **Figure 29** to **Figure 32** for OOH P2.

Table 16 Additional Mitigation Measures – Affected Distances				
Assessment Period	Affected Distance (m)			
	Noticeable	Clearly Audible	Moderately Intrusive	Highly Intrusive
Standard Hours	n/a	n/a	25	10
OOH P1	n/a	115	70	5
OOH P2	350	275	125	5

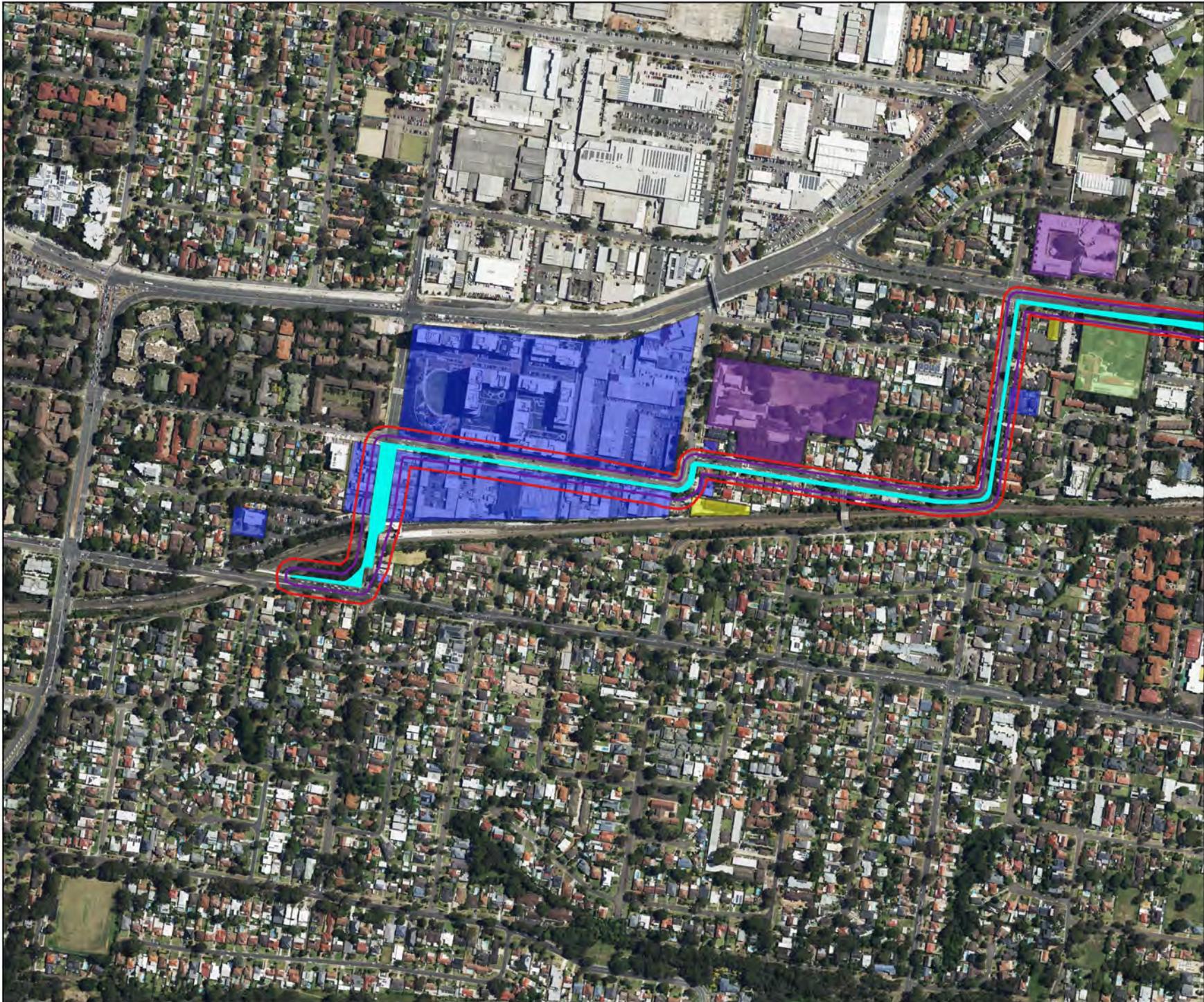


FIGURE 21
 AMM Affected Area
 Sc3-Concrete Saw
 Standard Hours
 MAC211332-01
 SCATL Project

KEY

- Proposal Site
- AMM Category**
- Moderately Intrusive
- Highly Intrusive
- Non-Residential Receivers**
- Educational Institution
- Place of Worship
- Hospital Ward
- Passive Recreation
- Active Recreation
- Commercial

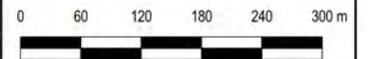




FIGURE 22
 AMM Affected Area
 Sc3-Concrete Saw
 Standard Hours
 MAC211332-01
 SCATL Project

KEY

- Proposal Site

- AMM Category**
- Moderately Intrusive
- Highly Intrusive

- Non-Residential Receivers**
- Educational Institution
- Place of Worship
- Hospital Ward
- Passive Recreation
- Active Recreation
- Commercial

- 0 60 120 180 240 300 m



FIGURE 23
AMM Affected Area
Sc3-Concrete Saw
Standard Hours
MAC211332-01
SCATL Project



KEY

-  Proposal Site
- AMM Category**
-  Moderately Intrusive
-  Highly Intrusive

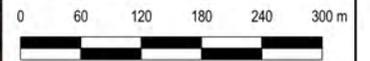
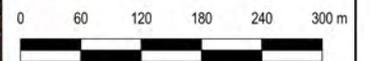


FIGURE 24
AMM Affected Area
Sc3-Concrete Saw
Standard Hours
MAC211332-01
SCATL Project



KEY

-  Proposal Site
- AMM Category**
 -  Moderately Intrusive
 -  Highly Intrusive
- Non-Residential Receivers**
 -  Educational Institution
 -  Place of Worship
 -  Hospital Ward
 -  Passive Recreation
 -  Active Recreation
 -  Commercial



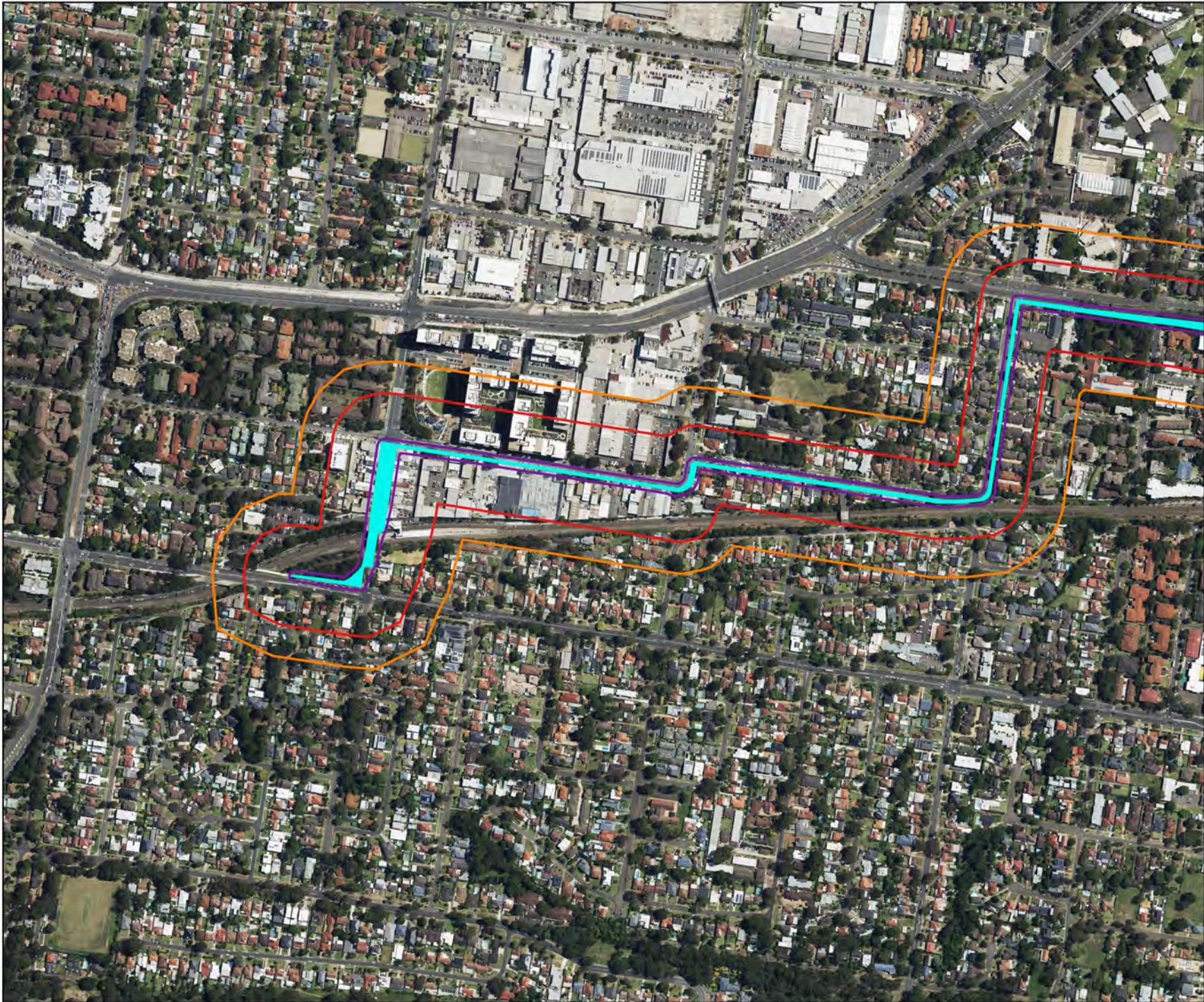
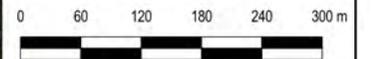


FIGURE 25
AMM Affected Area
Sc3-Concrete Saw
OOH P1
MAC211332-01
SCATL Project

KEY

-  Proposal Site
- AMM Category**
-  Clearly Audible
-  Moderately Intrusive
-  Highly Intrusive



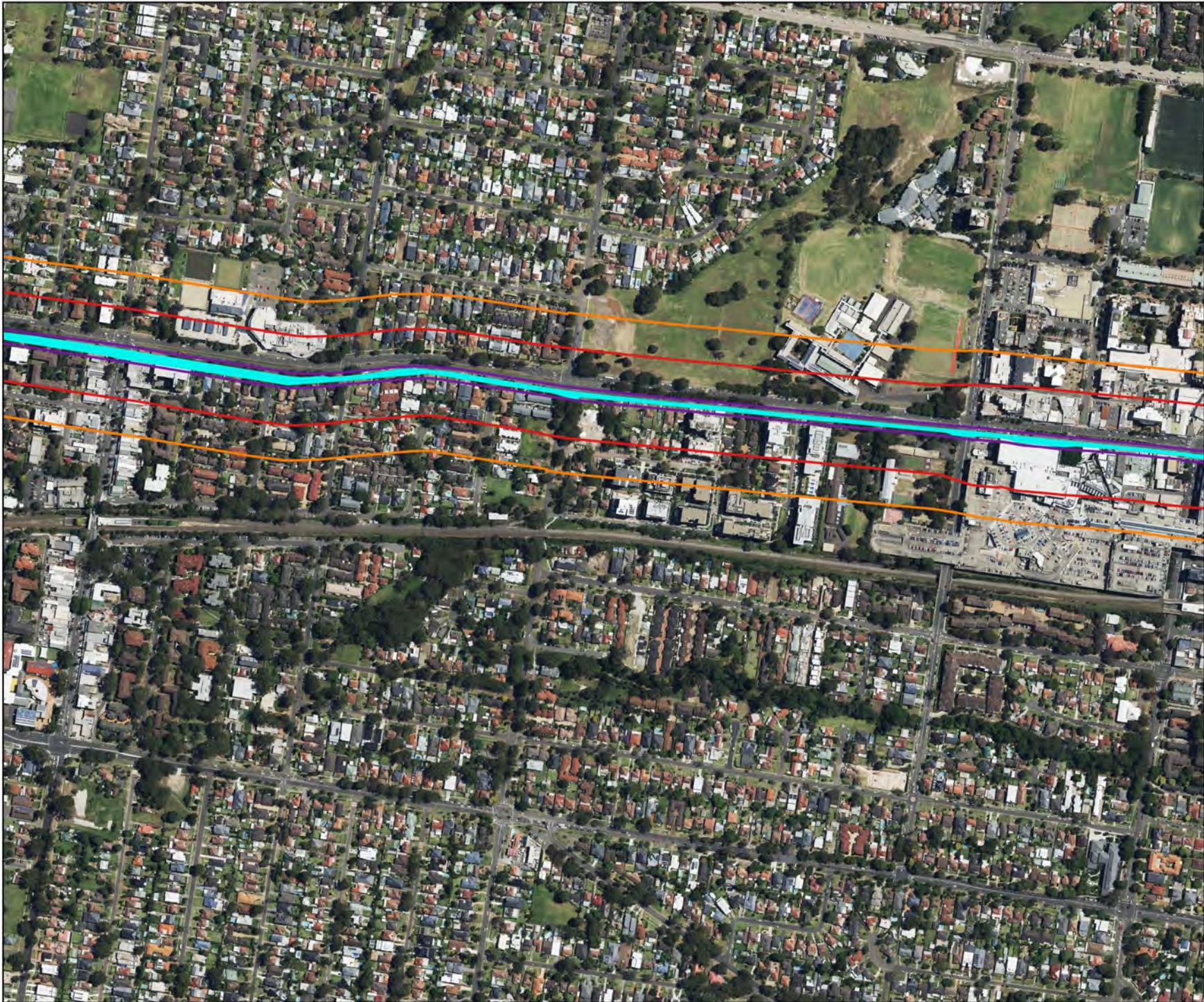


FIGURE 26
AMM Affected Area
Sc3-Concrete Saw
OOH P1
MAC211332-01
SCATL Project

KEY

-  Proposal Site
- AMM Category**
-  Clearly Audible
-  Moderately Intrusive
-  Highly Intrusive

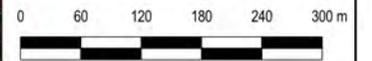


FIGURE 27
AMM Affected Area
Sc3-Concrete Saw
OOH P1
MAC211332-01
SCATL Project



KEY

-  Proposal Site
 - AMM Category**
 -  Clearly Audible
 -  Moderately Intrusive
 -  Highly Intrusive
- 0 60 120 180 240 300 m
- 



FIGURE 28
AMM Affected Area
Sc3-Concrete Saw
OOH P1
MAC211332-01
SCATL Project



KEY

-  Proposal Site
- AMM Category**
-  Clearly Audible
-  Moderately Intrusive
-  Highly Intrusive

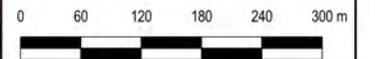
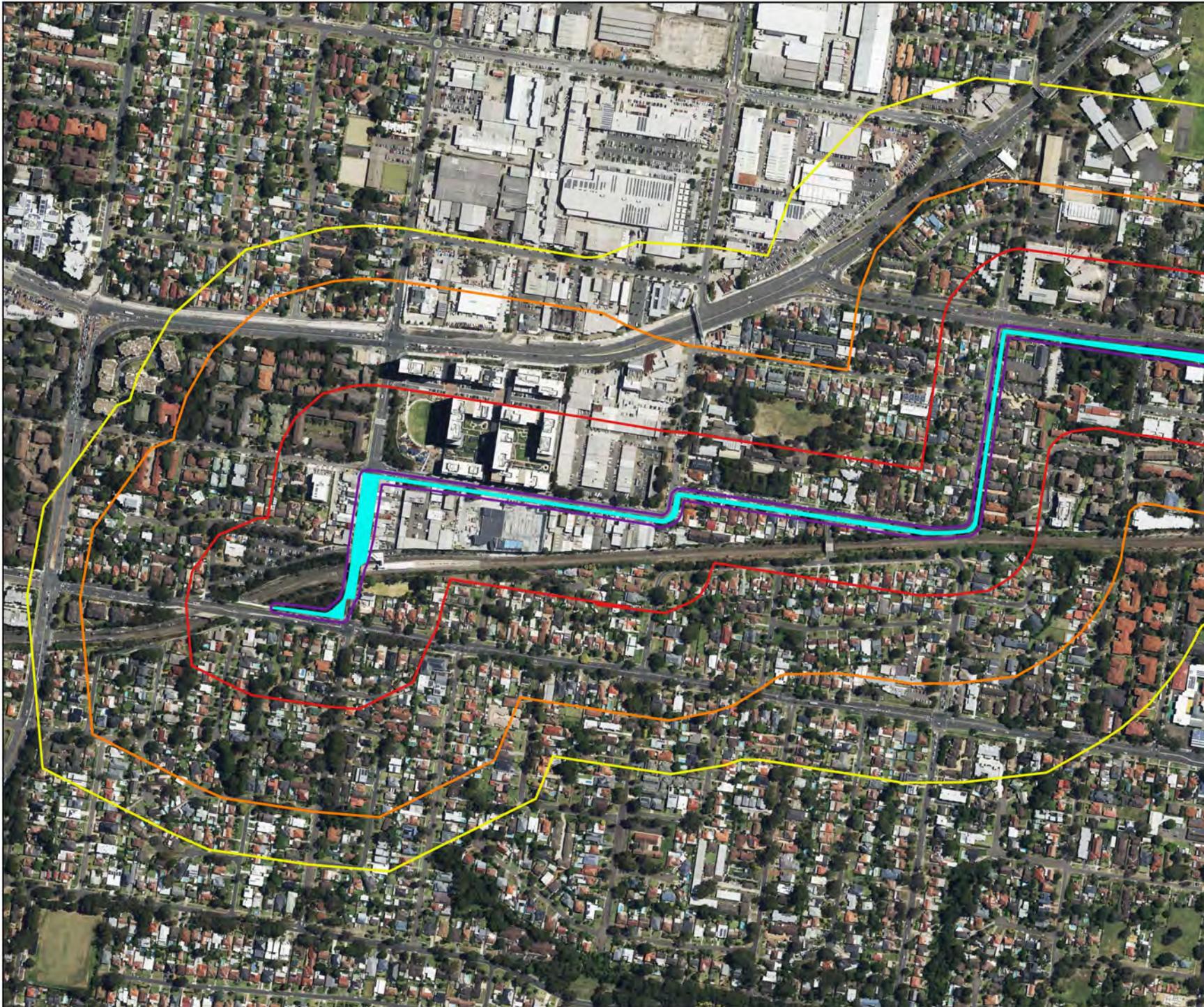


FIGURE 29
AMM Affected Area
Sc3-Concrete Saw
OOH P2
MAC211332-01
SCATL Project

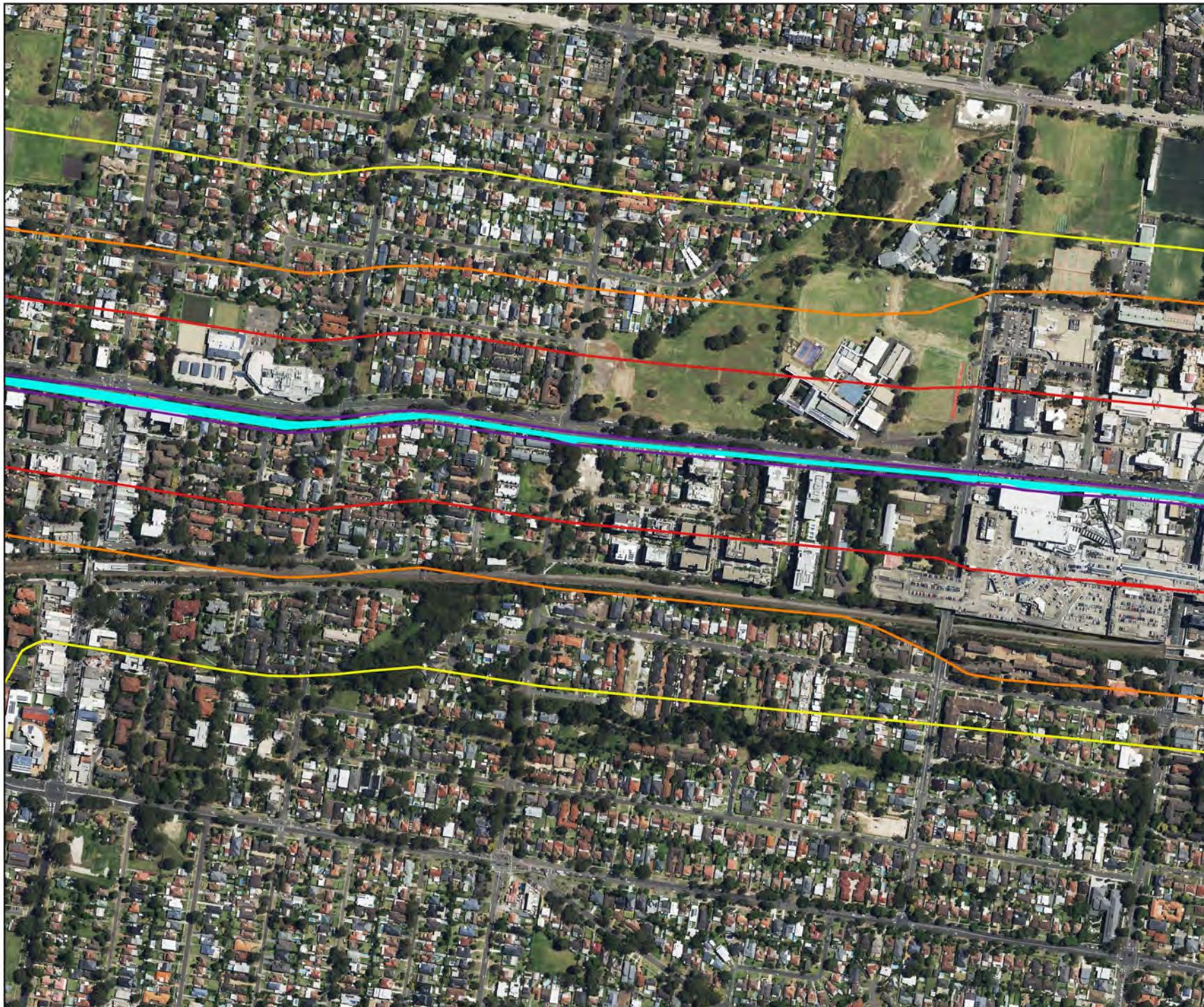


KEY

-  Proposal Site
 - AMM Category**
 -  Noticeable
 -  Clearly Audible
 -  Moderately Intrusive
 -  Highly Intrusive
- 0 60 120 180 240 300 m
- 



FIGURE 30
AMM Affected Area
Sc3-Concrete Saw
OOH P2
MAC211332-01
SCATL Project

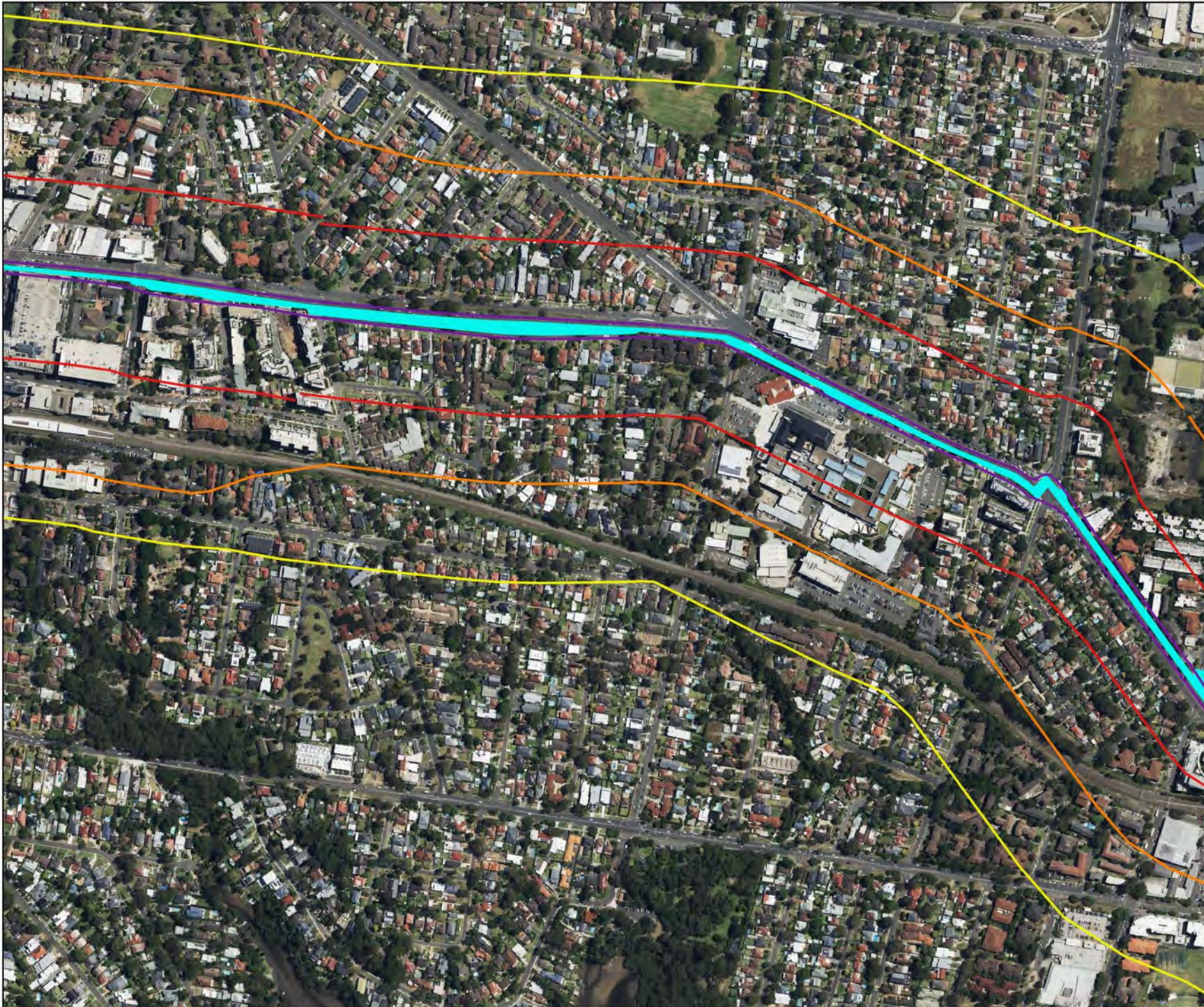


KEY

-  Proposal Site
 - AMM Category**
 -  Noticeable
 -  Clearly Audible
 -  Moderately Intrusive
 -  Highly Intrusive
- 0 60 120 180 240 300 m
- 



FIGURE 31
AMM Affected Area
Sc3-Concrete Saw
OOH P2
MAC211332-01
SCATL Project

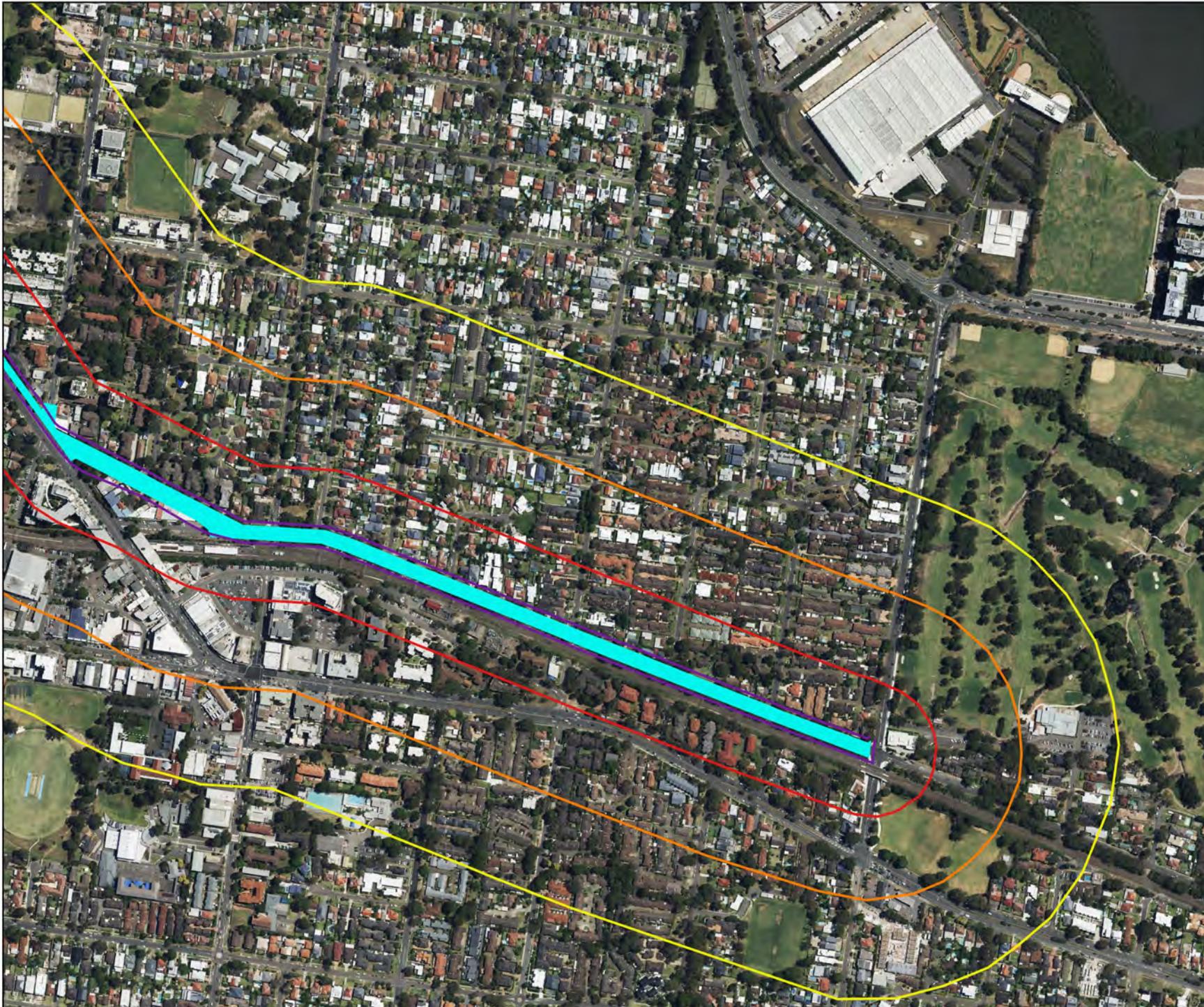


KEY

-  Proposal Site
- AMM Category**
-  Noticeable
-  Clearly Audible
-  Moderately Intrusive
-  Highly Intrusive



FIGURE 32
AMM Affected Area
Sc3-Concrete Saw
OOH P2
MAC211332-01
SCATL Project



KEY

-  Proposal Site
 - AMM Category**
 -  Noticeable
 -  Clearly Audible
 -  Moderately Intrusive
 -  Highly Intrusive
- 0 60 120 180 240 300 m
- 



6 Construction Vibration Assessment

It is understood that the proposal would not require the use of vibration intensive items of equipment. However, where items of equipment such as excavators with a hydraulic hammer attachment or vibratory rollers are used, **Table 17** (reproduced from the CNVG) should be used as a guide to the minimum working distances to minimise cosmetic damage to adjacent buildings and human annoyance to residents.

Table 17 Minimum Working Distances for Vibratory Plant

Plant item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Vibratory Roller	< 50 kN (Typically 1 to 2t)	5m	15m to 20m
	< 100 kN (Typically 2 to 4t)	6m	20m
	< 200 kN (Typically 4 to 6t)	12m	40m
	< 300 kN (Typically 7 to 13t)	15m	100m
	> 300 kN (Typically 13 to 18t)	20m	100m
	> 300 kN (> 18t)	25m	100m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Pile Boring	≤ 800 mm	2m (nominal)	N/A
Piling Rig - Hammer	12t down force	15m	50m
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

Note: Source, CNVG (Roads and Maritime, 2016).

Note: More stringent conditions may apply to heritage or other sensitive structures.

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7 Operational Noise Impact Assessment

Operational noise from the proposal would typically be associated with pedestrians using the shared pathway. Raised voices or loud conversations may occur, however, it is considered that these noise events would be sporadic and would have a negligible effect on the $L_{Aeq}(15min)$ noise levels at receiver locations adjacent to the proposal.

It is important to note that the proposal alignment generally runs immediately adjacent to the busy Kingsway, with the noise environment dominated by road traffic noise. It is anticipated that operational noise from the proposal would be significantly masked by existing road traffic noise. Notwithstanding, a semi quantitative Maximum Noise Level Assessment has been completed to assess potential sleep disturbance effects from pedestrians using the shared pathway.

The sound power levels for the operational assessment were derived from the Proceedings of Acoustics 2011 paper *Prediction of Noise from Small to Medium Sized Crowds*. This Paper provides equivalent A-weighted sound pressure levels of speech for different vocal efforts at 1m. A conservative sound power level of 92dBA for a pedestrian shouting was adopted for maximum noise level (L_{Amax}) events during the night period.

The results of the assessment indicated that residential receivers within approximately 8m of the proposal alignment may experience noise levels above the Maximum Noise Level Assessment criterion of 65dB L_{Amax} due to pedestrians shouting.

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8 Conclusion

A Noise and Vibration Impact Assessment has been prepared in accordance with Transport for NSW requirements to quantify potential noise and vibration impacts from Stage 2 of the Sutherland to Cronulla Active Transport Link project within the Sutherland Shire, Sydney, NSW.

The construction noise and vibration assessment demonstrates that noise from the construction works are anticipated to exceed the noise management levels at nearby residential and non-residential receivers for each construction activity. It is noted that each of the construction activities, except for kerb realignment / concrete sawing, is anticipated to occur during standard construction hours only. The affected distances for works undertaken during standard construction hours extends to approximately 90m during paving works.

During kerb realignment / concrete sawing works, which may be carried out outside of standard construction hours, it is predicted that the maximum distance from the proposal site that residential receivers may experience noise levels above the relevant noise management levels is approximately 1.1km. Therefore proactive management of noise emissions is recommended. It is noted that the assessment considered all equipment operating simultaneously and at maximum capacity for the duration of the assessment. Furthermore, while the predictive modelling considered topography and the influence of buildings, other features that affect the propagation of noise, including solid boundary fences and sheds were not accounted for. Therefore, the results of the predictive modelling are highly conservative and representative of the highest potential noise emissions from the proposed construction activities.

Following implementation of standard mitigation measures, it is predicted that receivers up to 350m from the proposal alignment would experience noticeable noise levels from concrete sawing activities during out of hours period 2, while receivers within approximately 5m would experience noise levels above the highly intrusive noise level.

Predictive noise modelling identifies that the sleep disturbance trigger level has the potential to be exceeded for residential receivers located up to 70m from the proposal site during concrete sawing. To minimise the potential for sleep disturbance, it is recommended that particularly noisy activities including concrete sawing should not be undertaken during OOH P2. With the implementation of reasonable and feasible mitigation measures, it is anticipated that the received noise levels would be significantly reduced.

It is understood that the proposal would not require the use of vibration intensive plant. However, where items of plant such as vibratory rollers or hydraulic hammers are used during any construction activities, a review of safe working distances should be undertaken. Where receivers are located within the potential area of affectation, alternative items of plant should be selected, or additional mitigation measures should be implemented.

The results of the operational noise assessment demonstrates that noise levels from pedestrians using the shared pathway would have a negligible impact on the noise environment surrounding the proposal site. In circumstances where pedestrians are talking loudly or shouting, noise levels are predicted to exceed the maximum noise trigger level at distances of up to 8m from the alignment. However, based on the proximity of the proposal alignment to busy roads such as the Kingsway and offset distances to the nearest residential receivers, maximum noise levels are likely to remain lower than those experienced from the passage of vehicles.

Appendix A – Glossary of Terms

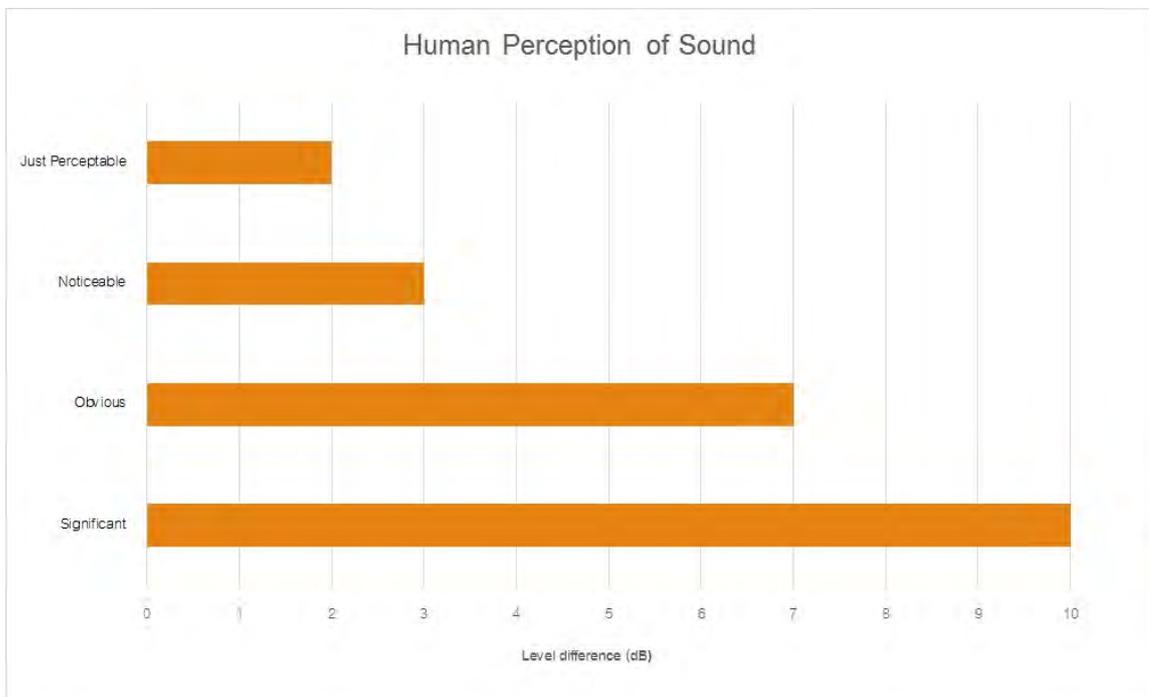
A number of technical terms have been used in this report and are explained in **Table A1**.

Table A1 Glossary of Acoustical Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The total noise associated with a given environment. Typically, a composite of sounds from all sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to sound.
Background Noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is usually represented by the LA90 descriptor
dba	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Z-weighted or decibels Linear (unweighted).
Extraneous Noise	Sound resulting from activities that are not typical of the area.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A sound level which is exceeded 10% of the time.
LA90	Commonly referred to as the background noise, this is the level exceeded 90% of the time.
LAeq	Represents the average noise energy or equivalent sound pressure level over a given period.
LAmx	The maximum sound pressure level received at the microphone during a measuring interval.
Masking	The phenomenon of one sound interfering with the perception of another sound. For example, the interference of traffic noise with use of a public telephone on a busy street.
RBL	The Rating Background Level (RBL) as defined in the NPI, is an overall single figure representing the background level for each assessment period over the whole monitoring period. The RBL, as defined is the median of ABL values over the whole monitoring period.
Sound power level (Lw or SWL)	This is a measure of the total power radiated by a source in the form of sound and is given by $10 \cdot \log_{10} (W/W_0)$. Where W is the sound power in watts to the reference level of 10^{-12} watts.
Sound pressure level (Lp or SPL)	the level of sound pressure; as measured at a distance by a standard sound level meter. This differs from Lw in that it is the sound level at a receiver position as opposed to the sound 'intensity' of the source.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Pressure Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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