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Department of Planning, Industry & Environment

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Ingleside Precinct

Noise and Vibration Impact Assessment

Ingleside Precinct

Noise and Vibration Impact Assessment

Client: Department of Planning, Industry & Environment

ABN: 38 755 709 681

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Quality Information

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A	02-Dec-2020	Draft for review	Gayle Greer Technical Director	GG
B	03-Dec-2020	For issue	Gayle Greer Technical Director	GG
C	03-Mar-2021	Address Council comments	Gayle Greer Technical Director	GG
D	23-Mar-2021	Updated Figure 2	Gayle Greer Technical Director	Gayle Greer

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Executive Summary

Over the next 20 years, Sydney's population is forecast to grow by 1.6 million people, requiring an additional 664,000 homes. The Northern Beaches is also expected to change dramatically during this time. In recent years, a number of locations have been identified by the NSW Government and local Councils across Sydney as potential sites for new precincts/communities to be developed in response to these demands.

AECOM Australia Pty Ltd (AECOM) has been commissioned to conduct a noise and vibration impact assessment which will inform the rezoning of the Ingleside Land Release Area (Ingleside Precinct).

This study presents the assessment of the potential noise and vibration emissions associated with the existing and future urban development within the Precinct, including:

- Additional traffic noise generated by the increased capacity on nearby public roads; and
- Noise emission from all noise generating premises within and adjacent to the precinct.

Potential future sources of noise and vibration within the Precinct include retail premises and recreational spaces, as well as existing noise sources including light industrial premises, churches and horse riding trail areas.

The purpose of the study is to consider and assess environmental noise impacts, including the proposed Mona Vale Road Upgrade, on the existing and future residents of Ingleside.

Environmental noise monitoring

Unattended and attended noise monitoring was conducted along the main road sources within and in vicinity of the precinct. Noise logging was completed at six locations in order to facilitate calibration of the road traffic noise model. Attended noise monitoring was conducted to qualify noise sources and verify unattended monitoring results.

The background noise environment was controlled by traffic travelling along the main roads, including Mona Vale Road, Powderworks Road and Lane Cove Road, within the Precinct, with noise from natural surrounds also present, namely cicadas.

Road traffic noise levels

Road traffic noise levels in 2036 were predicted and road traffic noise contours presented. The road traffic noise model took into account the proposed Mona Vale Road upgrade. The road traffic noise contours were overlaid on the Structure Plan. It was noted that road traffic noise levels are likely to exceed the criteria presented in the State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) by up to 10 dB(A), where houses are proposed in close proximity to Mona Vale Road and to a lesser extent Powderworks Roads. Indicative recommendations were provided which may be required to achieve the criteria.

South Ingleside Sub-Precinct

Houses are proposed to the south of Mona Vale Road. Appendix E shows how road traffic noise levels are likely to exceed the Infrastructure SEPP criteria within approximately 150 m from Mona Vale Road by up to 10 dB(A). Rural properties are also proposed to the south of Mona Vale Road within the eastern portion of the precinct. Generally this is located further from Mona Vale Road than the house development. However noise mitigation measures would need to be considered as road traffic noise levels are likely to exceed the Infrastructure SEPP criteria. Residential development is also proposed on both sides of Powderworks Road. Noise levels are likely to exceed criteria by up to 5 dB(A), therefore noise mitigation measures will need to be considered during the design of the individual buildings. Low rise and townhouses are proposed to the southern extent of the Precinct however road traffic noise levels are not expected to exceed the Infrastructure SEPP criteria due to the distances from major roads.

Other noise sources

Noise from both existing sources on proposed residential developments, and noise from proposed community facilities, shops, and recreational areas on existing residences have been discussed, with

planning considerations and indicative mitigation measures provided. These may include standard acoustic treatment to external building services, noise barriers and buffer zones.

Construction noise and vibration

Although construction details are not available at this early stage of the project, construction noise management levels have been established based on measured Rating Background Levels (RBLs). Indicative construction scenarios have been proposed in order to demonstrate typical noise impacts from works that may take place during the Precincts urban development. Generic mitigation measures have been provided to minimise adverse noise and vibration impacts.

Recommendations

The Study has found that it is likely that mitigation measures will be required for the proposed houses and rural developments to reduce noise levels to the appropriate noise criteria. Areas within the Precinct where treatment may be necessary have been identified for consideration in the preparation of the development control plan for the Ingleside Precinct however, it is also likely that more prescriptive treatment design will need to be assessed at the development application stage. This study presents conceptual noise control measures and management strategies which are likely to be required to minimise adverse impacts on existing and future residential receivers.

Where land subdivision development application assessments deem noise mitigation measures necessary for proposed residential developments, they shall be implemented according to the following hierarchy:

- Treatment of noise at source; such as integrated design measures such as road design and traffic management, as well as road surface treatment
- Treatment of noise path; such as in-corridor barriers
- Treatment at receivers; such as at-property treatments and receiver building layouts

This process is detailed in Section 6.5.

It is noted that detailed noise and vibration impact assessments will be required during the development application stage for noise sensitive receivers where they are proposed to be located close to existing/future noisy land uses.

1.0 Introduction

1.1 Background

The NSW Government's "A Plan for Growing Sydney" (December, 2014) reaffirmed the pressures being faced by the metropolitan area in terms of population growth and associated demands for the economy and employment, housing, transport, environment and resources, parks and public places.

Over the next 20 years, Sydney's population is forecast to grow by 1.6 million people, requiring an additional 664,000 homes. The Northern Beaches is also expected to change dramatically during this time. In recent years, a number of locations have been identified by the NSW Government and local Councils across Sydney as potential sites for new precincts/communities to be developed in response to these demands.

The Ingleside Land Release Area (Ingleside Precinct) is located approximately 3.2 km from the Mona Vale Town Centre, south of Mona Vale Road (a 20 km arterial road corridor running east-west between the Pacific Highway to the west and Pittwater Road to the east), which Transport for NSW (Transport) is widening to two lanes in each direction between McCarrs Creek Road and Foley Street.

The Ingleside Indicative Layout Plan and Precinct Plan were informed by a number of studies over the years to determine an appropriate land use and density. These studies included a Noise and Vibration Impact Assessment completed in October 2017. Following an extensive review of the bushfire risk in the Ingleside Precinct, the 2016 Draft Structure Plan and been significantly revised and the revised Rezoning Investigation Area is now focused on the area south of Mona Vale Road, with the area north of Mona Vale Road excluded from the investigation area. An updated Noise and Vibration Impact Assessment is therefore required to assist in the preparation, lodgement and gazettal for the rezoning of the Investigation Area.

1.2 Study objective

This study presents the assessment of the potential noise and vibration emissions associated with the existing and future urban development within the Precinct, including:

- Additional traffic noise generated by the increased capacity on nearby public roads; and
- Noise emission from all noise generating premises within and adjacent to the precinct.

Potential future sources of noise and vibration within the Precinct include retail premises and recreational spaces, as well as existing noise sources including light industrial premises, churches and horse riding facilities.

The purpose of the study is to consider and assess environmental noise impacts on the existing and future residents of Ingleside. It is noted that detailed noise and vibration impact assessments will be required during the development application stage for noise sensitive receivers where they are proposed to be located close to existing/future noisy land uses.

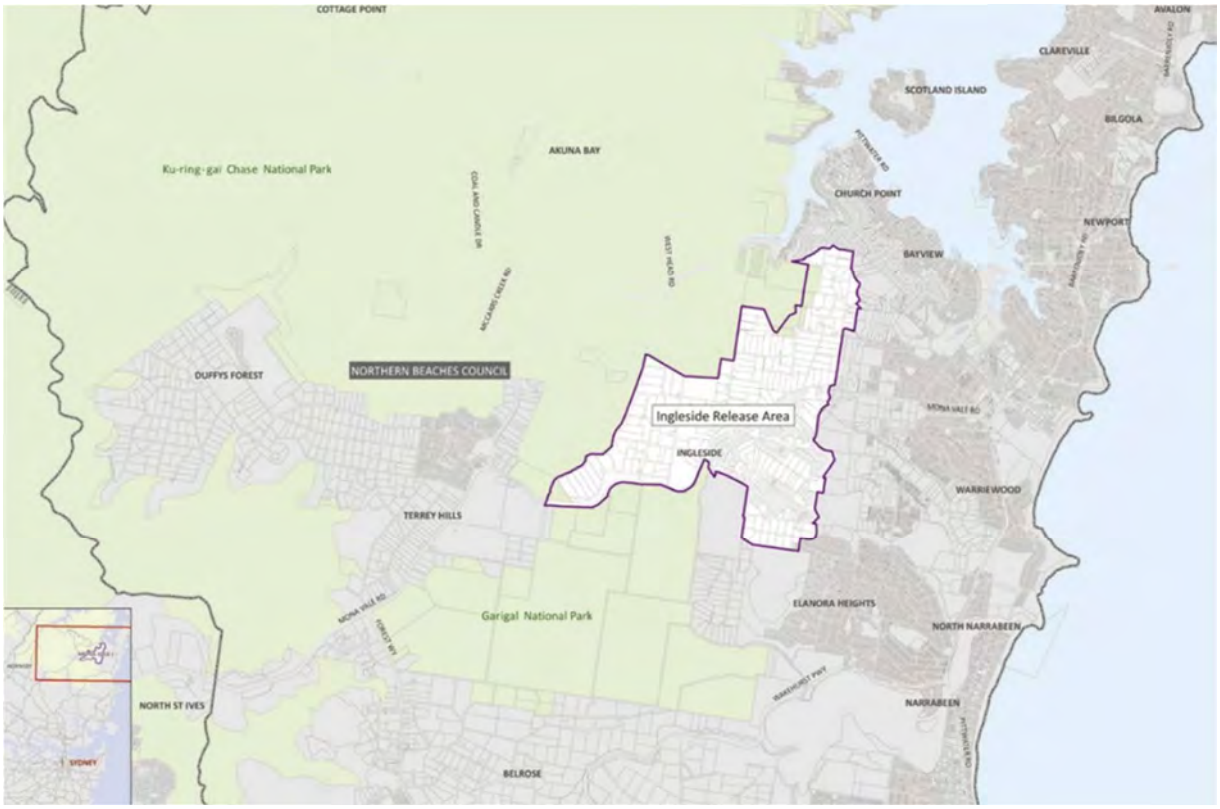
The study also presents conceptual noise control measures and management strategies which are likely to be required to minimise adverse impacts on existing and future residential receivers.

1.3 Site description

The Ingleside Precinct is located in the Northern Beaches Local Government Area (LGA), approximately 30 kilometres north of the Sydney CBD by road. The precinct comprises 153 hectares and lies between Terrey Hills and Mona Vale, off Mona Vale Road, the main road linking Mona Vale to western Sydney.

The Precinct and regional context is shown in Figure 1.

Figure 1 Regional context of the Ingleside Precinct



Source: NSW Department of Planning and Environment, 2016

The Precinct currently is zoned RU2 – Rural Landscape under Pittwater Local Environment Plan (LEP) 2014, and a mix of public and private land ownership exists in the Precinct. It is proposed for the Precinct to be rezoned as shown in Figure 2.

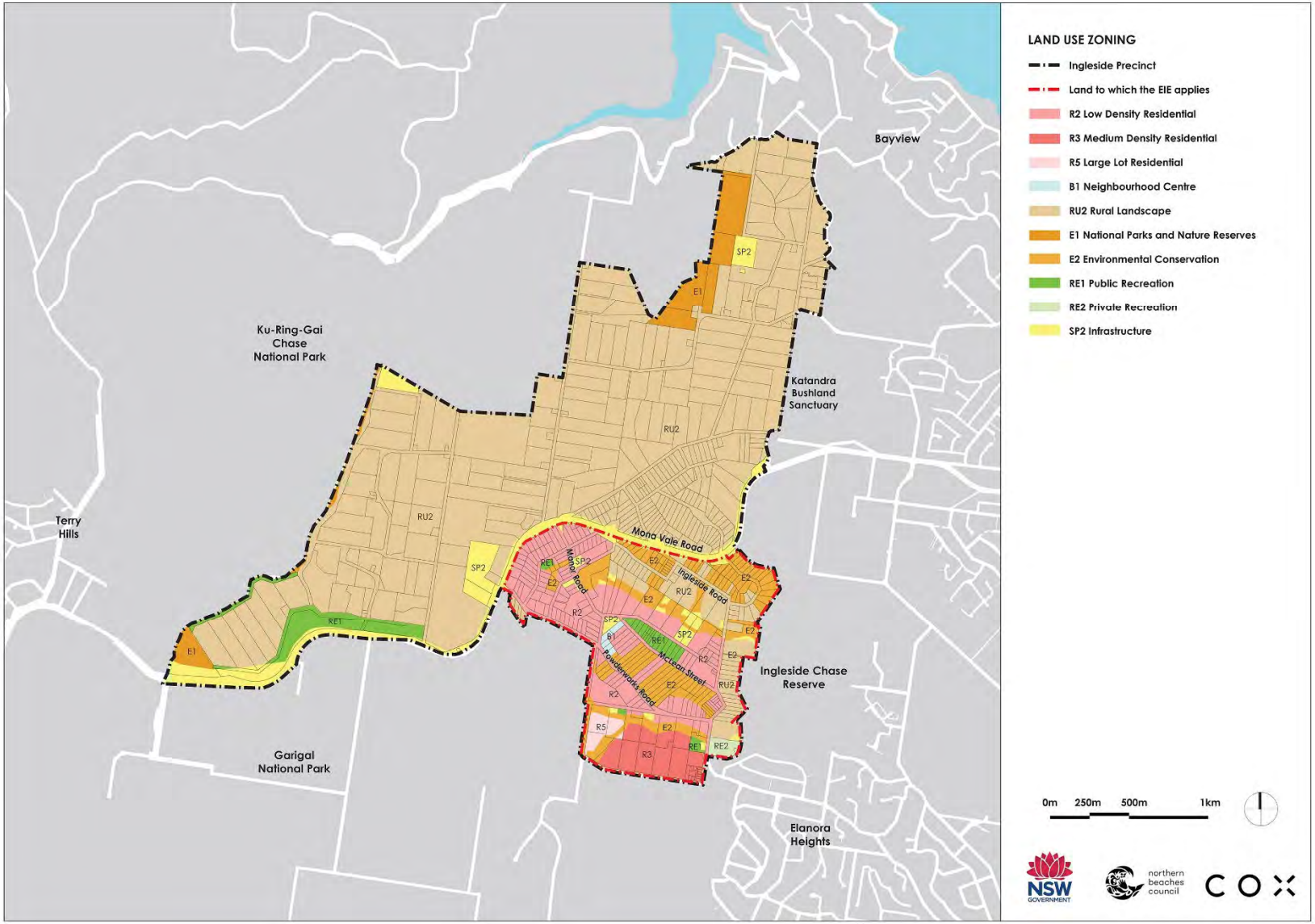


Figure 2 Proposed Land Use Zoning

1.4 Mona Vale Road upgrade

The NSW Government has approved upgrades to Mona Vale Road from two lanes to four lanes between McCarrs Creek Road at Terrey Hills and Powderworks Road at Ingleside. The upgrades are being constructed in stages and are aimed at improving safety and traffic efficiency. The stages are as follows:

- Stage 1 – Intersection improvement of Mona Vale Road and Ponderosa Parade – This work was completed in early 2015.
- Stage 2 – Mona Vale Road East upgrade – Upgrade of 3.2 km of Mona Vale Road from two lanes to four lanes between Manor Road, Ingleside and Foley Street, Mona Vale. Transport prepared a Review of Environmental Factors (REF). A noise and vibration assessment report has been prepared as part of the REF. The report provides detailed information on the proposed concept road design, environmental impacts and mitigation measures to minimise the impacts. Transport has now appointed a Contractor to construct the road upgrade.
- Stage 3 – Mona Vale Road West upgrade – Upgrade of 3.4 km of Mona Vale Road from two lanes to four lanes between McCarrs Creek Road, Terrey Hills and Powderworks Road, Ingleside. Transport has prepared an REF and a noise and vibration assessment report has been prepared as part of the REF. The report provides detailed information on the proposed concept road design, environmental impacts and mitigation measures to minimise the impacts.

It should be noted that the section of Mona Vale Road between Powderworks Road, Ingleside and Manor road, Ingleside has been upgraded previously and currently comprises four lanes.

This study has been completed based on the year 2036, when the precinct is likely to be fully developed. The road traffic noise modelling has included Mona Vale Road as a four lane road.

It should be noted that operational and construction noise and vibration impact assessments have been completed for the three stages of the Mona Vale Road upgrade. These impact assessments considered all existing noise sensitive receivers and those which have Development Application approval.

The REF for Mona Vale Road upgrade Stage 2 recommended the use of Stone Mastic Asphalt along the entire alignment. In addition architectural treatments were recommended for some existing residential buildings. As these recommendations are subject to change during the detailed design phase the use of Stone Mastic Asphalt has not been included in this assessment to present a conservative approach. The REF for mona Vale Road upgrade Stage 3 did not recommend the use of Stone Mastic Asphalt.

The criteria applicable to road projects are detailed in the NSW *Road Noise Policy*, whilst criteria for land use developments affected by road traffic noise are detailed in the State Environment Planning Policy (Infrastructure) 2007. Feasible and reasonable noise mitigation measures for road projects generally include ‘quiet’ road surfaces, noise barriers and architectural treatments whilst feasible and reasonable noise mitigation measures for land use developments generally include noise barriers, buffer zones, architectural layouts and architectural treatments.

2.0 Structure Plan

2.1 Introduction

Structure and precinct plans are a proven approach for the delivery of greenfield residential developments. The intention being to achieve high quality outcomes, including easy access to jobs and major town centres, streets and suburbs so that people can walk/cycle to shops (or for other short distance journeys), and frequent bus services that link to the rail network for longer journeys.

The Ingleside Precinct comprises four sub-precincts, North Ingleside, South Ingleside, Bayview and Wirreanda Valley. Bayview is the rural area at the north of the Precinct and Wirreanda Valley is the rural area at the west of the Precinct. The remainder of the Precinct comprises North and South Ingleside with North Ingleside lying to the north of Mona Vale Road and South Ingleside lying to the South of Mona Vale Road. All of the proposed development was to occur in North and South Ingleside.

2.2 Draft Plan

A Draft Plan was developed through an iterative process over a period of time, involving multiple stakeholders across a range of technical disciplines providing inputs and guidance as to the precinct development opportunities and constraints. All of the proposed development was to occur in North and South Ingleside.

2.3 Structure Plan

Following an extensive review of the bushfire risk in the Ingleside Precinct, the 2016 Draft Structure Plan has been significantly revised and development is now proposed for only the South Ingleside sub-precinct. The Structure Plan for Ingleside is shown in Figure 3.

2.3.1 Residential land uses

The proposed development is predominantly low and medium density residential dwellings,(houses and low rise apartments/townhouses respectively) with a neighbourhood retail centre to serve local residents. Current projections estimate that approximately 1,110 dwellings will be provided as part of the proposed development, in addition to the 130 existing dwellings.

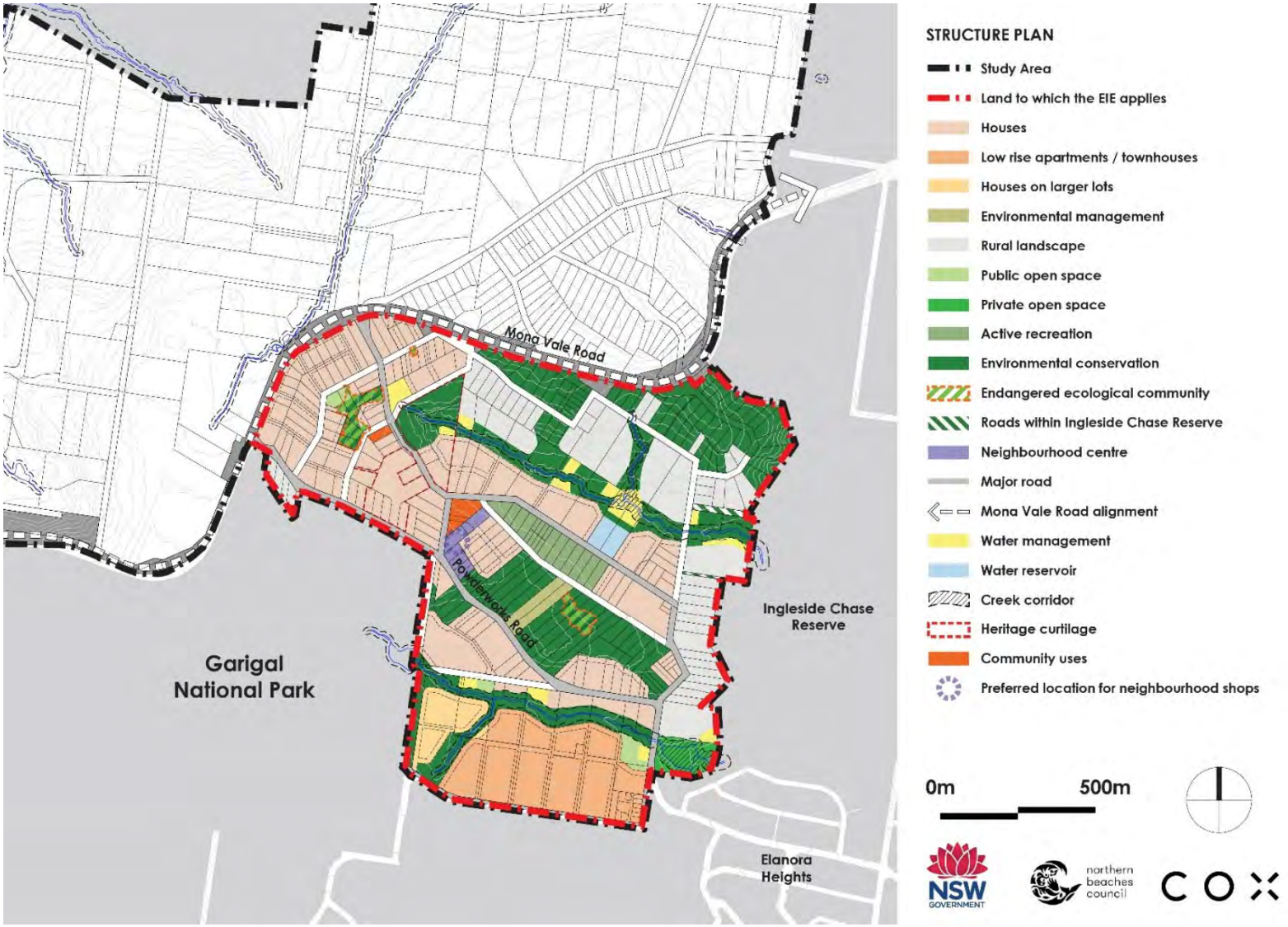


Figure 3: Structure Plan for Ingleside

Source: Department of Planning, Industry and Environment, February 2021

2.3.2 Neighbourhood Centre

Given the physical constraints of the precinct, access to the Mona Vale Town Centre and the small village centre at Elanora Heights may be difficult for residents seeking to travel by non-car modes. As such, one neighbourhood centre and two community areas are proposed within the precinct. The proposed neighbourhood centre will be located, at the intersection of Powderworks Road/Wattle Road adjacent to the southern side of the central Community area. It is proposed that this neighbourhood centre would include retail uses. The proposed northern community area is to be located south of the intersection of Manor Road/King Street.

2.3.3 Community uses and open space

Under the currently proposed Structure Plan there is opportunity to provide public space and active recreation areas. These will be accessible by public transport, walking and cycling routes. There is also an opportunity to locate leisure cycling and walking routes along riparian corridors (subject to feasibility).

2.4 Noise and vibration implications

As detailed above, a number of future developments have been proposed for the Precinct. A summary is provided in Table 1. Pertinent to noise, the developments listed in may act as noise sources, sensitive receivers, or both.

Table 1 Proposed development sources and receivers

Development	Location	Noise source or sensitive receiver
Neighbourhood centre/Community area	Intersection of Powderworks Road and Wattle Road.	Both
Community area	Intersection of Manor Road and King Road.	Both
Active recreation areas – may host 1,000s of attendees	Wattle Road	Source

In addition, the proposed Mona Vale Road upgrade will result in the widening of the road corridor to two lanes in each direction for the entirety of its length (4-lane divided road). The proposed upgrade pertains to two sections of Mona Vale Road that are currently 1 lane in each direction, from McCarrs Creek Road to Powderworks Road (west) and Lane Cove Road/Manor Road to Foley Street (east).

Although at this stage of development details of future works are unknown, provisions have been made to control noise and vibration from a planning perspective. It is noted that planning controls do not deal with construction noise sources as these are of a temporary nature.

3.0 Existing ambient noise environment

The South Ingleside sub-precinct is semi-rural in nature and includes a mix of existing land uses comprising predominantly lifestyle blocks, recreational land uses, plant nurseries, the equine industry and small scale commercial agriculture. Other land uses include places of worship, and a conference facility.

3.1 Sources

The existing noise environment at the proposed South Ingleside sub-precinct is controlled largely by noise from traffic along Mona Vale Road, Powderworks Road and Lane Cove Road. Noise from natural surrounds is present from bushlands surrounding these roads.

A number of locations within the Precinct have also been identified to be associated with potentially noisy activities. The significant noise sources within the Precinct are listed in Table 2.

Table 2 Existing noise sources potentially affecting South Ingleside

Source type	Address
Horse riding area/trail for educational/recreational use	22-24 McLean Street
Places of worship	5 Wilson Avenue, 2 Wattle Road, 280 Powderworks Road
Sydney Conference and Training Centre	30 Ingleside Road
Heavy vehicles and construction equipment	Rural lots within Wirreanda Valley

South Ingleside is surrounded by bushland to the east, Mona Vale Road lies on the northern/north-western boundary. Country clubs are located to the west and south and an existing residential area lies to the south east of the site. No existing noise sources which could significantly impact the noise environment within the Precinct were identified adjacent to the precinct. These include such sources as airports, industrial sites, ports or terminals, etc.

3.2 Receivers

South Ingleside currently consists largely of suburban residential properties surrounded by bushland. Residential receivers have been grouped into Noise Catchment Areas (NCAs). The NCAs are shown in Figure 4. The noise environment at each of the residential receivers within an NCA is considered to have a similar noise environment to the unattended monitoring location within that NCA.

In addition, existing non-residential noise sensitive receivers located within the Precinct are listed in Table 3.

Table 3 Non-residential sensitive receivers

Receiver	Address	Receiver type
Monash Country Club	Powderworks Road, Ingleside	Recreation area
Kingdom Hall of Jehovah's Witnesses	2A Wattle Road, Ingleside	Place of Worship
Serbian Orthodox Church St Sava	5 Wilson Ave, Ingleside	Place of Worship
Church on the Hill	280 Powderworks Road, Ingleside	Place of Worship

3.3 Ambient noise monitoring

Unattended and attended noise monitoring was conducted at the following six locations within and in vicinity of the Precinct in December 2013:

NL1 - 1 Wirreanda Road, Ingleside

NL2 – Baha'i Temple Way, Ingleside

NL3 - 240 Powderworks Road, Ingleside

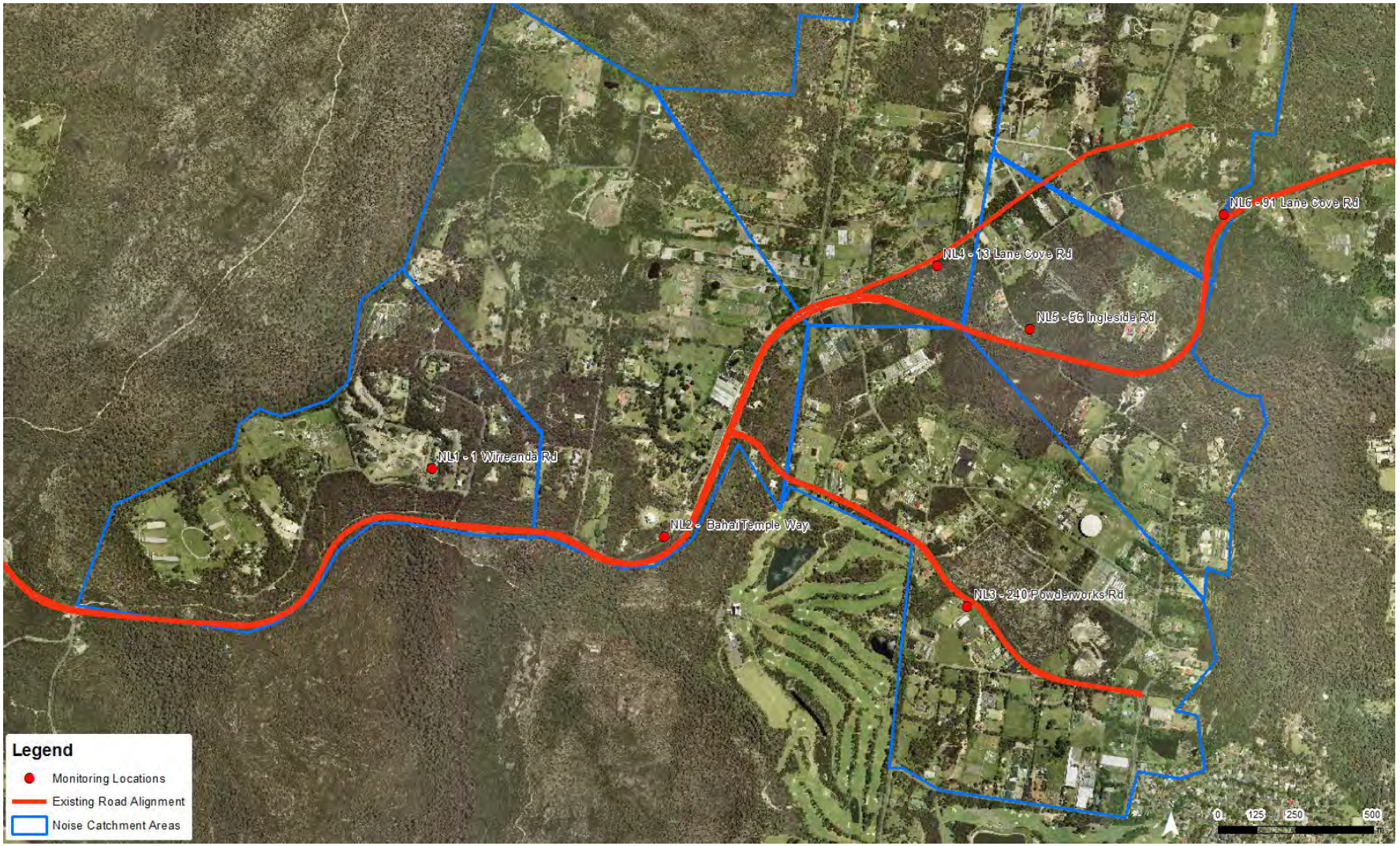
NL4 - 13 Lane Cove Road, Ingleside

NL5 - 56 Ingleside Road, Ingleside

NL6 - 91 Lane Cove Road, Ingleside

These locations were considered to provide good representations of typical background noise levels of the most affected receivers within the Precinct and also facilitate calibration of the operational road traffic noise model. It should be noted that the noise measurements were not intended to determine existing industrial noise levels throughout the Precinct. The logging locations are presented in Figure 4.

Figure 4 Noise monitoring locations and NCAs



3.3.1 Instrumentation

Attended noise measurements were undertaken at the site using a Brüel & Kjær Type 2270 (Serial No. 3000860) integrating sound level meter. This meter complies with Australian Standard 1259.2:1990 “Acoustics - Sound Level Meters – Part 2: Integrating - averaging” and is designated as a Type 1 instrument having accuracies suitable for field and laboratory use.

Long-term unattended noise logging was conducted using the following instrumentation:

- Infobyte Noise Monitors Serial No. 104, 109, 110 & 112
- ARL 315 Serial No. 15-299-444
- Rion NL-21 Serial No. 409169

All instrumentation used was designated as either Type 1 or Type 2 appropriate for field measurements. The noise loggers and the sound level meter were calibrated before and after the measurements with no drift in calibration exceeding ±0.5 dB.

All equipment used for this assessment has current calibration certificates.

3.3.2 Background noise monitoring results

Unattended noise monitoring was conducted over a seven day period from 3 December to 10 December 2013.

The loggers measured noise levels over the sample period and then determined L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The $L_{A1,}$ L_{A10} and L_{A90} noise levels are the levels exceeded for 1%, 10% and 90% of the measurement period respectively. The L_{A90} is taken as the background level. The L_{A1} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the *Noise Policy for Industry* for each monitoring location. The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. Table 4 presents individual ABLs for each day’s assessment periods. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring period.

Periods which were affected by noise from wind and rain were omitted from results as noise from the wind blowing through trees, falling rain and increased tyre noise from wet roads may affect results.

A summary of the noise monitoring results is presented in Table 4.

A graphical representation of unattended monitoring results is presented in Appendix B.

Table 4 Background noise monitoring results

Noise logging location	Rating Background Level, L_{A90} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
NL1	46	41	33
NL2	47[1]	47	28[2]
NL3	49	41	30
NL4	39[1]	39	31
NL5	-[3]	-[3]	-[3]
NL6	44[1]	44	34

Notes:

1. *Daytime data was adversely affected by insect noise, daytime RBL has been conservatively set at the evening RBL*
2. *Where the rating background noise level is found to be less than 30 dB(A) for the evening and night periods, then it is set to 30 dB(A) in accordance with the Noise Policy for Industry ;*
3. *Results unavailable due to logger failure*

3.3.3 Operational road traffic noise monitoring results

Provided in Table 5 are the average noise levels measured at each noise monitoring location.

Table 5 Operational road noise monitoring results

Noise logging location	Ambient road traffic noise level, L_{Aeq} dB(A)	
	Day (7 am to 10 pm)	Night (10 pm to 7 am)
NL1	57	51
NL2	64	58
NL3	62	56
NL4	59	51
NL5	-[1]	-[1]
NL6	65	60

Notes:

1. *Results unavailable due to logger failure*

3.3.4 Attended monitoring

Attended noise monitoring was also conducted at the six unattended monitoring locations. Monitoring was conducted over a 15 minute period in order to identify noise sources on site.

Road traffic noise was present at all locations; however cicada noise was dominant at some locations. No industrial noise was noticeable at any measurement locations.

Table 6 Attended monitoring results

Noise logging location	Monitoring location	Date/time	Description	Noise levels dB(A)	
				$L_{eq(15min)}$	$L_{90(15min)}$
NL1	1 Wirreanda Road	11/12/2013 12:01	Traffic along Mona Vale Road dominant. Cicadas, trucks and some nearby construction work also noted.	63	58
NL2	Baha'i Temple Way	11/12/2013 9:18	Noise from traffic along Mona Vale Road dominant. Cicadas, kookaburras and distant trucks also noted.	77	75
NL3	240 Powderworks Road	11/12/2013 9:44	Noise from traffic along Powderworks Road dominant. Birds and cicadas also noted.	61	53
NL4	13 Lane Cove Road	11/12/2013 10:07	Noise from Cicadas dominant. Cars, trucks, helicopters and car horns also noted.	65	61
NL5	56 Ingleside Road	11/12/2013 11:28	Cicadas very loud. Traffic along Mona Vale Road and planes also noted.	79	75
NL6	91 Lane Cove Road	11/12/2013 10:32	Cicadas very loud. Traffic along Mona Vale Road also noted.	77	75

4.0 Operational assessment criteria

4.1 Road traffic noise intrusion criteria

The State Environment Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) requires that appropriate measures are taken to meet the following internal L_{Aeq} noise levels in residential developments that are on land in or adjacent to a road corridor with an annual average daily traffic volume (AADT) of more than 20,000 vehicles, pertinent to Mona Vale Road. In other circumstances (eg. development adjacent to a road with an annual average daily traffic volume of 10,000–20,000 vehicles) these guidelines provide best practice advice. Although AADTs for Powderworks Road and Lane Cove Road are approximately 15,000 and 7,000 vehicles respectively, these roads have been included in the assessment for the sake of thoroughness:

- In any bedroom in the building – 35 dB(A) at any time between 10pm and 7am; and
- Anywhere else in the building (other than the garage, kitchen, bathroom or hallway) – 40 dB(A) at any time.

In addition the *Development Near Rail Corridors and Busy Roads- Interim Guideline* states:

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

Assuming a 10 dB loss through a partially open window the external criteria become:

Table 7- External noise level criteria

Type of occupancy	External noise level, dB(A)	Time period
Bedroom	55	10pm – 7am
Other habitable rooms	60	Any time

Road traffic noise levels for the year 2036 have been modelled in order to reflect the ultimate development of the Precinct.

4.2 Operational noise emissions

The main acoustic requirement of Protection of the Environment Operations Act 1997 (POEO) is to ensure that "a noise is not offensive". The definition for an offensive noise is included below.

> ***offensive noise*** *is:*
>
> *(d) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*
>
> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
>
> *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
>
> *(e) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.*

To determine if a source of noise is offensive, a primary consideration is to determine whether the noise is intrusive. The EPA provides guidelines for external noise emissions from developments in the *Noise Policy for Industry*. The *Noise Policy for Industry* recommends a method which can be used to ascertain the intrusiveness of noise emissions.

EPA states that the relationship between the statutory definition of offensive noise and intrusive noise is that intrusive noise can represent offensive noise, but whether this is always true can depend on the source of the noise, noise characteristics and cumulative noise levels. Therefore to avoid the emission of an offensive noise, noise emissions should not be intrusive as defined by the EPA in the following manner:

> *"A noise source is generally considered to be intrusive if noise from the source, when measured over a 15 minute period, exceeds the background noise by more than 5 dB(A).*

Any noise generated within the precinct, including noise mechanical services or associated with site buildings would be assessed in accordance with the *Noise Policy for Industry*.

The assessment procedure for industrial noise sources has two components that must be satisfied:

- Controlling intrusive noise impacts in the short term for residences; and
- Maintaining noise level amenity for residences and other land uses.

4.2.1 Intrusive noise impacts

The *Noise Policy for Industry* states that the noise from any single noise source should not be greatly above the prevailing background noise level. Industrial noise sources are generally considered acceptable if the A-weighted equivalent continuous sound pressure level of noise from the source, measured over a 15 minute period ($L_{Aeq,15\ min}$) does not exceed the RBL by more than 5 dB(A) for the period under consideration. This is termed the Intrusiveness Criterion.

The rating background level (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the *Noise Policy for Industry*. Adjustments are to be applied to the level of noise produced if the noise at the receiver contains annoying characteristics such as tonality or low frequency components.

4.2.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from industrial noise sources should not normally exceed the acceptable noise levels specified in *Table 2.2* of the *Noise Policy for Industry*. That is, the background noise level should not exceed the level appropriate for the particular locality and land use. This is termed the Amenity criterion.

Existing and proposed receivers scattered throughout Ingleside would be classified as being in a suburban area. For residential receivers, the amenity criteria are shown in Table 8.

The project amenity level for a project is equal to the 'recommended amenity level' minus 5 dB. Therefore, relevant noise amenity level from Table 8 is assigned as the project amenity noise level. The project amenity level is then converted to a 15 minute period by adding 3 dB.

Amenity criteria for other nearby receiver types are also presented in Table 8.

Table 8- External recommended L_{Aeq} noise levels from industrial noise sources

Type of receiver	Indicative noise amenity area	Time of day	Recommended amenity noise level dB(A) $L_{Aeq(period)}$	Amenity noise level dB(A) $L_{Aeq(15min)}$
Residence	Suburban	Day	55	53
		Evening	45	43
		Night	40	38
School classroom	All	Noisiest 1 hour period	45[1]	43
Place of worship	Internal	When in use	50[1]	48
Passive recreation area	All	When in use	50	48
Active recreation area	All	When in use	55	53
Industrial premises	All	When in use	70	68
Commercial premises	All	When in use	65	63

Notes:

1. External noise levels are based upon a 10 dB reduction from outside to inside through an open window.

Provided below in Table 9 is the appropriate criteria for each of the assessment locations.

Table 9 Operational noise criteria

Location	Assessment period	RBL (L_{A90}), dB(A)	Intrusive criteria	Amenity criteria
NCA1	Day	46	51	53
	Evening	41	46	43
	Night	33	38	38
NCA2	Day	47	52	53
	Evening	47	52	43
	Night	30	35	38
NCA3	Day	49	54	53
	Evening	41	46	43
	Night	30	35	38
NCA4	Day	39	44	53
	Evening	39	44	43
	Night	31	36	38
NCA5	Day	-	52	53
	Evening	-	52	43
	Night	-	35	38
NCA6	Day	39	44	53
	Evening	39	44	43
	Night	31	36	38

Notes:

1. *RBLs at location 5 were unable to be determined due to equipment failure, therefore the RBLs at this location have been adopted from location 2 as the attended measurement at this location was closest to location 5 and more conservative than location 6.*

The criteria apply at the most-affected point on or within the residential property boundary- or, if that is more than 30 m from the residence, at the most-affected point within 30 m of the residence.

Indicative noise criteria for industrial/commercial noise sources are presented above, however it is recommended that a full assessment is completed when likely noise sources are known.

4.3 EPA Noise Guide for Local Government

The EPA's *Noise Guide for Local Government* outlines the techniques for assessing and managing common neighbourhood noise issues. It addresses noise emissions from schools and other educational facilities and outdoor sporting events involving sound amplification equipment for 200 or more people. These noise sources are to be assessed using the 'offensive noise test' outlined in the POEO. Management measures are also suggested in the form of noise control notices and prevention notices. It is noted that the use of these notices would not be a primary means of controlling noise in the Precinct. Noise mitigation measures would be integrated into the design and planning of any new developments. Noise control notices and prevention notices would only be used in the cases where breaches of Approval conditions occur.

5.0 Construction noise and vibration criteria

5.1 Construction noise

The EPA's *Interim Construction Noise Guideline* is the principal guideline for the assessment and management of construction noise in NSW. The *Interim Construction Noise Guideline* recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the EIA process'. Noise levels due to construction activities are predicted at nearby receivers using environmental noise modelling software and compared to the levels provided in Section 4 of the *Interim Construction Noise Guideline*.

Where an exceedance of the management levels is predicted the *Interim Construction Noise Guideline* advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practises to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as contact details.

Where construction noise levels reach 75 dB(A) residential receivers can be considered as 'highly noise affected' and the proponent should, in consultation with the community, consider restricting hours to provide respite periods.

The *Interim Construction Noise Guideline* defines what is considered to be feasible and reasonable as follows:

> *"Feasible*
>
> *A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*
>
> *Reasonable*
>
> *Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."*

5.1.1 Noise management levels for residential receivers

Noise management levels for residential receivers were established using the information provided in the *Interim Construction Noise Guideline* as reproduced in Table 10.

Table 10 Construction noise management levels

Time of day	Management level, $L_{Aeq\ (15min)}$[1]	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	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 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• 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 5 dB (A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 of the *Interim Construction Noise Guideline*.

Notes:

1. *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.*

5.1.2 Noise catchment areas

The study area has been divided into 6 distinct noise catchment areas (NCAs), shown in Figure 4. The noise environment at each of the sensitive receivers within a noise catchment area is considered to have a similar noise environment to the unattended monitoring location within that NCA. As such each of these sensitive receivers is assigned the same background noise level and noise management level. Table 11 provides details of the construction noise management levels for each NCA.

Table 11 Noise catchment areas and noise management levels

NCA	Representative logger	Period	Rating background level (RBL), dB(A)	Noise management levels (NML), dB(A)
NCA1	NL1	Day	46	56
		Evening	41	46
		Night	33	38
NCA2	NL2	Day	47	57
		Evening	47	52
		Night	30	35
NCA3	NL3	Day	49	59
		Evening	41	46
		Night	30	35
NCA4	NL4	Day	39	49
		Evening	39	44
		Night	31	36
NCA5	NL5	Day	-	57[1]
		Evening	-	52[1]
		Night	-	35[1]
NCA6	NL6	Day	44	54
		Evening	44	49
		Night	34	39

Notes:

1. *NMLs at location 5 were unable to be determined due to unavailable RBLs due to equipment failure, therefore NMLs at this location have been adopted from location 2 as the attended measurement at this location was closest to location 5 and more conservative than location 6.*

5.1.3 Non-residential receivers

Noise management levels recommended by the *Interim Construction Noise Guideline* for other sensitive land uses, such as schools, hospitals or places of worship are shown in Table 12. Noise management levels for commercial and industrial premises are provided in Table 13.

Table 12 Construction noise management levels – Sensitive land uses other than residential

Land use	Management level, $L_{Aeq\ (15\ min)}$ (applies when properties are in use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended "maximum" internal levels in AS2107 for specific uses.

Table 13 Construction noise management levels – Commercial and industrial land uses

Land use	Management level, $L_{Aeq\ (15min)}$ (applies when properties are in use)
Industrial premises	External noise level 75 dB(A)
Offices, retail outlets	External noise level 70 dB(A)

5.1.4 Sleep disturbance (construction)

The *Interim Construction Noise Guideline* requires a sleep disturbance analysis where construction work are planned to extend over more than two consecutive nights. The L_{A1} noise levels and number of expected L_{A1} noise events should be predicted in order to determine the likelihood of potential sleep disturbance.

The EPA recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the $L_{A1(1\ min),}$ noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

Sleep disturbance research presented in the *Road Noise Policy* concludes that *'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides approximately 10 dB in noise attenuation from outside to inside, external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 14.

Table 14 Construction noise sleep disturbance criteria

NCA	Rating background level (RBL)	Sleep disturbance screening $L_{A1(1min)}$ criteria, dB(A)	Sleep disturbance awakening reaction $L_{A1(1min)}$ criteria, dB(A)
NCA1	33	48	65
NCA2	30	45	65
NCA3	30	45	65
NCA4	31	46	65
NCA5	30	45	65
NCA6	34	49	65

Notes:

1. *RBLs at location 5 were unable to be determined due to equipment failure, therefore the RBLs at this location have been adopted from location 2 as the attended measurement at this location was closest to location 5 and more conservative than location 6.*

5.2 Construction vibration

The relevant standards/guidelines used for assessing construction vibration are summarised in Table 15.

Table 15 Standards/guidelines used for assessing construction vibration

Item	Standard/Guideline
Structural Damage	DIN4150-Part 3:1999 'Structural Vibration Part 3 – Effects of vibration on structures
Human Comfort (tactile vibration)	NSW Department of Environment and Conservation (2006) document "*Assessing Vibration: A Technical Guideline*" [1]

Notes:

1. *This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the EPA still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.*

In the absence of Australian based vibration criteria for structural damage, German Standards and British Standards have been considered. These have been referred to in the absence of any Australian or International structural damage guidelines, and are accepted as relevant criteria in Australia. *DIN4150* structural damage criteria are more conservative (i.e. more onerous) than the British Standard BS7385-Part 2:1993 'Evaluation and Measurement for Vibration in Buildings' and have been adopted for this assessment.

5.2.1 Structural damage

Structural damage ground vibration criteria are defined in terms of levels of vibration that would minimise the risk of damage to buildings and other structures.

Most commonly specified 'safe' structural vibration levels are designed to minimise the risk of threshold or cosmetic surface cracks and are set well below the levels that have the potential to cause damage to the main structure. Examples of threshold or cosmetic cracking include minor non-structural effects such as superficial cracking in cement render or plaster. Larger exceedances of structural damage criteria increase the risk of more significant damage to a building's underlying structure.

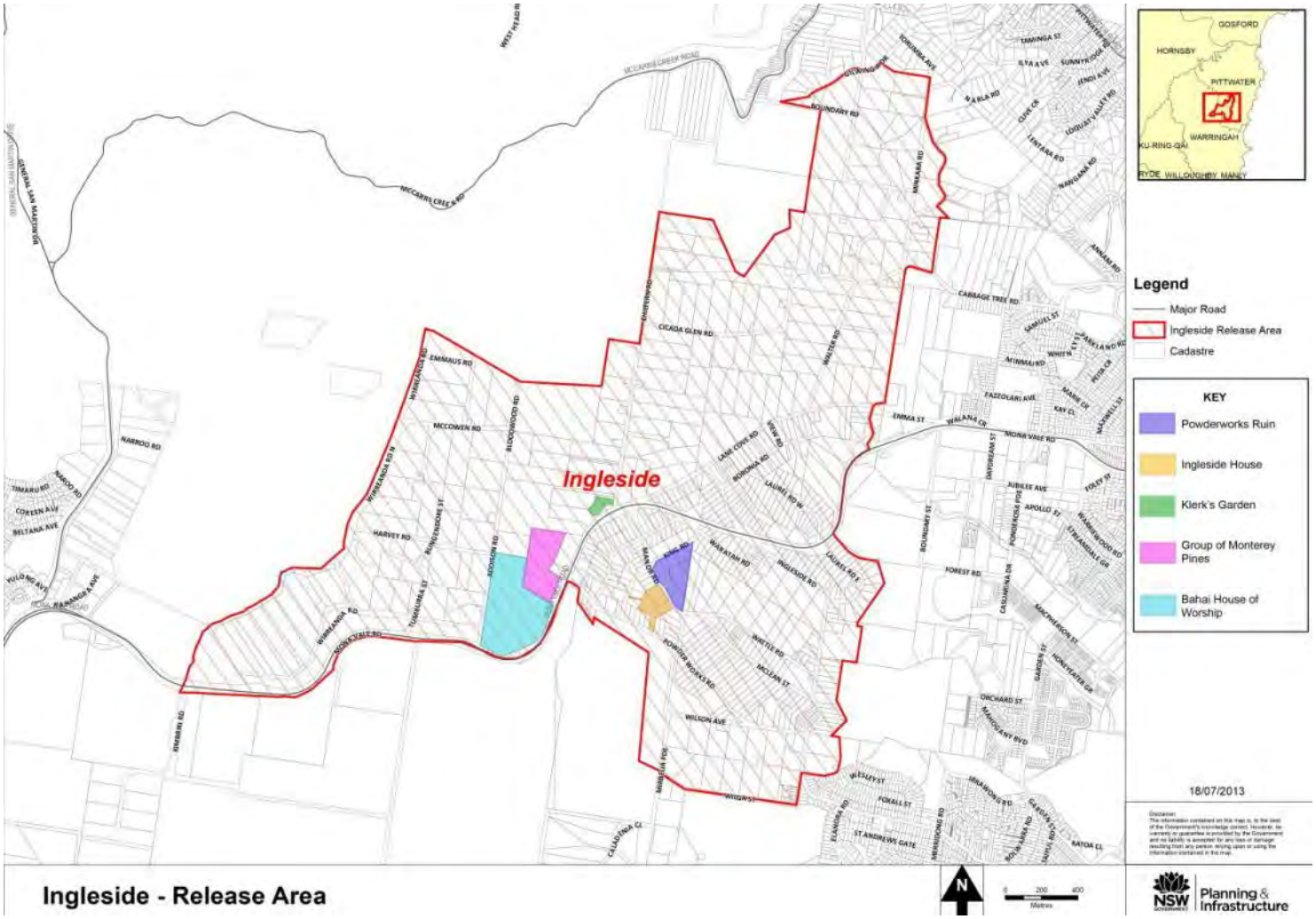
Structural damage criteria are presented in German Standard DIN 4150-Part 3 in terms of recommended maximum levels of vibration that reduce the likelihood of structural damage caused by vibration. These levels are presented in Table 16. Receivers classified as Group 1, Group 2 and Group 3 have been identified as being potentially affected by construction vibration.

Heritage buildings are listed within Ingleside Precinct and are considered as particularly sensitive to vibration impacts, and as such are classified as group 3 structures. A number of heritage items have been identified by GML Heritage in their report “Ingleside Precinct Non-Indigenous Heritage Assessment, Executive Summary” (GML Heritage, Nov 2014). These items are:

- Ingleside House
- The Powderworks Ruins

The locations of these items are shown in Figure 5.

Figure 5 Plan of non-Indigenous heritage items



Source: DPIE with GML overlay, 2015

Consideration should be given to adverse vibration impacts affecting these items when assessing construction in the vicinity.

It should be noted that the vibration criteria presented below are conservative. DIN 4150 states that:

> "*exceeding the values in table 1 does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary*".

Table 16 DIN4150 structural damage vibration criteria

Group	Type of structure	Guideline values for velocity in mm/s			
		Vibration at the foundation			Vibration at the horizontal plane of highest floor at all frequencies
		1 H to 10 Hz	10 H to 50 Hz	50 H to 100 Hz	
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20-40	40-50	40
2	Dwellings and buildings of similar design and/or use	5	5-15	15-20	15
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under Group 1 or 2 and are of great intrinsic value (e.g. listed buildings under a preservation order)	3	3-8	8-10	8

5.2.2 Human comfort

In general, human response to vibration is a complex phenomenon. There are wide variations in vibration tolerance of humans. Accordingly, acceptance goals for human comfort are hard to define and quantify. Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (e.g. workshop, office, or residence) and the character of vibration (e.g. continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual's perception.

The procedure outlined in DEC (2006)'s "*Assessing Vibration: A Technical Guideline"* has been used in this assessment. Disturbance caused by vibration will depend on its duration as well as its magnitude. This method involves the calculation of a Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of bursts of intermittent vibration. Various studies have shown that VDV assessment methods far more accurately assess the level of disturbance than methods which assess the vibration magnitude only.

The VDV is the fourth root of the integral of the fourth power of vibration with respect to time. The VDV represents an 'amount' of vibration. In assessing the VDVs, criteria detailed in BS6472:1992 'Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80Hz)' are used, however the base values and multiples are converted into VDVs assuming constant levels over a 15 hour day and a 9 hour night. The resulting VDV criteria are shown in Table 17.

Table 17 Acceptable vibration dose values for intermittent vibration (m/s$^{1.75}$)

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
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

The guideline states:

> *"There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum range may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community."*

6.0 Road traffic noise assessment

To assess the potential impacts of road traffic noise on proposed on sensitive receivers, the following steps have been completed:

- Modelling of road traffic noise levels with existing (2013) road traffic volumes, to provide a baseline for the assessment of future noise levels. This model was calibrated with noise measurements and road traffic surveys.
- Modelling of the 'Build' scenario road traffic noise levels for the year of the ultimate development of the Ingleside Precinct (2036).

6.1 Road traffic noise modelling methodology

Road traffic noise levels were calculated using SoundPLAN software, which implements the Calculation of Road Traffic Noise (CoRTN) algorithm. The UK Department of Transport devised the CoRTN algorithm and with suitable corrections, this method has been shown to give accurate predictions of road traffic noise under Australian conditions.

The modelling parameters which are included in the model are detailed in Table 18.

Table 18 Modelling noise parameters

Parameter	Comment
Traffic volumes and mix	Existing traffic volumes were obtained from traffic count data recorded at various locations along the proposed alignment. Predicted traffic volumes (2036) were sourced from traffic modelling conducted by AECOM. Traffic volumes used in the noise model are presented in Appendix C. Heavy vehicles include buses which are to be introduced in new public transport services.
Traffic speeds	Traffic speeds have been based on measured road speeds from traffic counters.
Traffic noise source heights	Road traffic noise is generally considered to comprise three source heights: Light vehicles: 0.5 metres. Truck tyres and engines: 1.5 metres. Truck exhausts: 3.6 metres. Corrections were made to the road traffic noise model to take account of the relative source contributions of the truck tyres and engines (-0.6 dB) and truck exhausts (-8.6 dB) compared with light vehicle sources.
Road surface	Dense graded asphalt (DGA) is accepted as the standard road surface with no correction applied under the CoRTN algorithm. DGA has been modelled along Mona Vale Road, Powderworks Road and Lane Cove Road.
Ground absorption	The noise calibration model verified that a ground absorption factor of 0.8 was appropriate for this project due to the high density shrub land surrounding Mona Vale Road, Powderworks Road and Lane Cove Road. A ground absorption factor of 0 would represent hard, reflective ground and a ground absorption factor of 1 would represent totally absorptive ground. High density vegetation is acoustically absorptive to an extent and a factor of 0.8 is considered appropriate.
Terrain	The model incorporates two metre terrain contours.

Parameter	Comment
Buildings	The height of all buildings within the study area was determined through site observation and map resources. Where building heights were unable to be determined buildings were assumed to be 1 storey. The difference between one and multi-storey buildings to the modelling outcomes would be insignificant since noise levels were not predicted at each receiver. One storey buildings provide a conservative estimate of impacts due to less shielding being provide to adjacent buildings, and since predicted modelled impacts do not result in the implementation of specific treatments for this assessment, the assumption that all buildings are one storey is considered appropriate here.
Road network	The Infrastructure SEPP requires that appropriate measures are taken to ensure that noise levels within new residential buildings adjacent to roads with an annual average daily traffic (AADT) volume of more than 20,000 vehicles are not above certain L_{Aeq} levels. As a conservative approach the existing major roads (Mona Vale Road, Powderworks Road and Lane Cove Road) were included in the noise model, as noise levels at sensitive receiver locations are predominantly controlled by these roads. This was verified by attended noise measurements throughout the study extents of the project. On this basis local roads have been excluded in the noise modelling.
Standard corrections	CoRTN provides L_{A10} road traffic noise levels. The industry standard correction of -3 dB was applied to convert the L_{A10} levels to L_{Aeq} road traffic noise levels to allow assessment of the results against the criteria.

6.2 Existing road traffic noise model

A road traffic noise model was developed incorporating the existing traffic flows and alignment for comparison and calibration with road traffic noise measurements. The traffic flows used in the model were provided by tube counts that were deployed concurrently with noise logging for the project. Noise logging charts are provided in Appendix B. Road traffic volumes are presented in Appendix C.

If it can be proven that the predicted road traffic noise levels are accurate at discrete locations across the extents of a project, then it is reasonable to assume that the road traffic noise levels are accurate at all modelled receivers. Furthermore, it can then be assumed that if the same road traffic noise model is updated to include the project design model parameters (eg including alignment, traffic flow etc), then the design noise model would predict to the same level of accuracy.

For a project corridor of 600 metres either side of the road, the CoRTN algorithm has a well-documented accuracy of ±2 dB(A). If the differences between measured and predicted road traffic noise levels fall within this factor, then the model is considered to have a suitable level of accuracy for that location. Provided below in Table 19 is a summary of the noise logger calibration results. Discussion on loggers that fall outside the acceptable calibration allowance of ±2 dB(A) is presented below.

Due to the bushland surroundings of the Precinct and the monitoring period falling in December, cicada noise was present at all locations and in some cases was the dominant source of noise. This was the case during the daytime at NL1, 1 Wirreanda Road, Ingleside.

During the night-time at location NL1 logger graphs showed an irregular increase in noise levels between approximately 12:00am and 5:00am, seen in Appendix B, which raised overall night-time L_{eq} levels significantly and resulted in poor calibration over the night time period. The origin of this noise was unable to be identified, however the time, level and irregularity of this noise indicates traffic was not the source.

Table 19 Noise logger calibration

Noise logger	Measured $L_{Aeq(15hr)}$	Predicted with standard correction $L_{Aeq(15hr)}$	Difference	Measured $L_{Aeq(9hr)}$	Predicted with standard correction $L_{Aeq(9hr)}$	Difference
NL1	57.1	53.6	-3.5[1]	50.5	46.7	-3.8[1]
NL2	63.6	64.8	1.2	57.9	57.9	0
NL3	61.8	62.4	0.6	55.8	55.8	0
NL4	58.7	56.7	-2	50.5	49.6	-0.9
NL5	-[4]	58.6	N/A	-[4]	52.1	N/A
NL6	64.7	65.8	1.1	60.2	59.3	-0.9

Notes:

1. *Items in Bold Red indicate the measured noise level is outside the acceptable range of ±2 dB(A), this is likely due to the presence of fauna noise during the daytime and noise of unknown origin during the night-time*
2. *Noise levels not recorded due to logger failure*

Considering all but one receiver calibrates effectively, the noise model can be considered to be operating within the acceptable accuracies.

It is noted that the road traffic noise measurements were made in 2013 and that road traffic noise levels may have increased throughout the Precinct since that time. However the road traffic model is still considered appropriate for the prediction of future road traffic noise modelling since it was validated using concurrent road traffic volumes and road traffic noise levels.

6.3 Future road traffic noise modelling

Noise impacts from traffic along Mona Vale Road, Powderworks Road and Lane Cove Road have been predicted at the worst affected façade of existing receivers for the year 2036. The results of the road traffic noise modelling are presented as noise contour maps in Appendix D. The following section provides recommendations to reduce internal noise levels at the proposed residences within the proposed subdivisions.

6.4 Road traffic noise impacts

The predicted road traffic noise levels for 2036 have been overlaid on the Structure Plan presented in Appendix E. Impacts are outlined in this Section, with mitigation measures detailed in Section 6.5.

6.4.1 South Ingleside Sub-Precinct

Houses are proposed to the south of Mona Vale Road. Appendix E shows how road traffic noise levels are likely to exceed the Infrastructure SEPP criteria within approximately 150 m from Mona Vale Road by up to 10 dB(A). Rural properties are also proposed to the south of Mona Vale Road within the eastern portion of the precinct. Generally this is located further from Mona Vale Road than the house development. However noise mitigation measures would need to be considered as road traffic noise levels are likely to exceed the Infrastructure SEPP criteria. Residential development is also proposed on both sides of Powderworks Road. Noise levels are likely to exceed criteria by up to 5 dB(A), therefore noise mitigation measures will need to be considered during the design of the individual buildings. Low rise and townhouses are proposed to the southern extent of the Precinct however road traffic noise levels are not expected to exceed the Infrastructure SEPP criteria due to the distances from major roads.

6.5 Noise mitigation measures

Noise mitigation measures should be implemented in the following hierarchy:

- Treatment of noise at source: Integrated design measures such as road design and traffic management, as well as road surface treatment
- Treatment of noise path: In-corridor barriers
- Treatment at receivers: At-property treatments and receiver building layouts.

Prioritising noise treatment in this order is the most efficient means of reducing impacts. Accordingly, noise mitigation measures that attenuate noise path and receivers will need to be considered as the Structure Plan for the Ingleside Precinct is further refined and in the preparation of the development control plan for the Ingleside Precinct.

6.5.1 Treatment of noise at source

Treatment of road traffic noise at the source includes changes to gradients, alignments, road design, administrative controls and road surface treatment. Design controls and traffic management have already been considered as part of the options study prior to the Mona Vale Road Upgrade REF assessment, and a number of road surface treatment options have been considered at the REF stage.

As noted in Section 1.4, the REF for the Mona Vale Road Upgrade Stage 2 (Mona Vale Road Upgrade East – Noise and Vibration Assessment, SMEC, 22 May 2015) recommended the use of Stone Mastic Asphalt. This would reduce road traffic noise levels by approximately 2 dB(A). This reduction has not been included in this assessment as during the Mona Vale Road Upgrade Stage 2 detailed design phase the road surface may be changed.

6.5.2 Treatment of noise path

Noise path treatment involves the attenuation of noise paths between a source and receiver. This typically involves shielding of receivers with noise barriers.

6.5.2.1 Roadside noise walls and mounds

Acoustic barriers provide immediate reductions in road traffic noise at the shielded properties.

The acoustic effectiveness of a barrier depends on its density, height, length and location. The higher the barrier (compared to the direct line-of-sight from the source to the receiver) and the closer its location to either the source or the receiver, the greater the noise attenuation provided. The barrier also needs to have a sufficient length. Roadside barriers, as distinct from barriers close to dwellings, usually have to provide shielding along an appreciable length of road to be effective.

6.5.2.2 Noise barriers close to dwellings

As noted above noise barriers are most effective when they located either close to the road or close to the affected dwelling(s) or other noise-sensitive land uses.

With the consent of owners, acoustic barriers can sometimes be located within a residential property boundary so that they provide maximum shielding of the dwelling. These barriers might also be designed to form a courtyard, providing some benefit for an outdoor area near the dwelling.

6.5.3 Treatment at receivers

Noise mitigation measures implemented at receivers include planning layouts of buildings and rooms and treatment to building facades.

6.5.3.1 Property layout

Where residential properties are located adjacent to major roads, such as Mona Vale Road, buildings should be orientated such that the buildings shield outdoor living areas such as courtyards and private open spaces.

6.5.3.2 Building layout and design

The layout of the rooms within a building is also important in determining noise levels at the façade of sensitive spaces. The less noise sensitive rooms such as garages, bathrooms and laundries should

be located closer to the noise source to provide a buffer zone to noise sensitive areas such as bedrooms and frequently used living areas.

The number of doors and windows on the exposed façade(s) of the buildings should be minimised as these represent paths of least resistance for noise ingress.

6.5.3.3 Building construction materials and methods

Windows and doors present acoustic weaknesses which control the overall sound transmission loss of the composite wall. Buildings should be constructed so that facades most exposed to the noise source have a minimum number of windows and doors to reduce the internal noise levels.

Where road traffic noise levels exceed the external noise criteria within habitable rooms fresh air must be provided to these rooms so windows can be left closed, in order to meet the Infrastructure SEPP internal noise criteria. In addition where residential buildings are located along Mona Vale Road it is likely that laminated glazing systems (such as those comprising 6.38 mm or 10.38 mm laminated glass) will be required to sufficiently attenuate road traffic noise within habitable rooms. Suitable glazing systems should be confirmed during the development application stage.

The following building construction details are also recommended:

- A brick veneer building facade
- Window detailing will have gaps between the window frames and the house frame/masonry sealed with flexible mastic
- Hinged or casement windows are preferred over sliding windows as the former two have more effective sealing mechanisms. The overall intent is to form an air-tight construction
- Acoustic insulation such as polyester or rock wool/glass wool batts placed between the wall studs of brick veneer and timber framed buildings will reduce the noise entering the building.

6.5.3.4 Principal private open space

It is recommended that properties within Ingleside Precinct include private outdoor amenity areas with noise levels less than $L_{Aeq,15hr}$ 55 dB(A), however it is noted that this is not a requirement of the Infrastructure SEPP, but rather good practice. This can be accommodated through planning of building layouts and lot divisions so that the residential buildings provide shielding from road traffic noise to the private outdoor amenity areas.

7.0 Other noise sources assessment

7.1 Existing noisy premises

Existing noise sources within the Precinct have the potential to disturb proposed residential and sensitive noise receivers. Existing noise sources include a light industrial premises, horse riding trail area, churches and heavy machinery on rural lots.

In the case that proposed residential developments encroach on existing noise sources, distances between residential premises and noise sources should be maximised. Building construction materials & methods, building layout & design and the location of principal private open spaces should be optimised to mitigate noise from these sources as prescribed in Sections 6.5.2 and 6.5.3. These should be considered in the preparation of the development control plan for the Ingleside Precinct. Additional measures may also be necessary through site specific detailed investigations as part of the development application stage.

7.2 Community centre including community hall and shops

The main sources of noise associated with community areas and shops include external building services and refrigeration plant and, in the case of a community hall, entertainment music. It is recommended that at the Development Application stage for these types of developments an environmental noise emission assessment is completed in accordance with the *Noise Policy for Industry*. Typical noise mitigation measures are likely to include standard external building services plant acoustic treatments such as attenuators, acoustic louvres and lined ductwork.

7.3 Sporting fields

Plans for an active recreation area to be located on Wattle Street in South Ingleside have been put forward. The plans indicate that the fields may have the capacity to host sporting events with seating for a large number of patrons. Existing residential receivers lie within 200 m of the proposed locations, and may be adversely affected when large events are held at the ground.

Where possible, the distance between crowd seating and noise sensitive receivers should be maximised, using parking lots, parks and back of house areas as buffer zones between the grounds and receivers where feasible. Buildings and storage facilities should also be placed between potentially noisy areas and receivers where possible.

The EPAs *Noise Guide for Local Government* presents guidelines for the assessment of such activities as sporting events, and suggests noise management procedures in the form of noise control notices and prevention notices.

7.4 Future construction works

Construction works to be undertaken in the future as part of the development of the Precinct shall require noise and vibration assessments to be undertaken prior to work commencing. Construction noise and vibration assessments shall be conducted by a qualified acoustic consultant and in accordance with the *Interim Construction Noise Guideline* and relevant vibration guidelines.

8.0 Construction noise and vibration assessment

As details of proposed works within the precinct are unavailable at this early stage of the project, typical construction activities have been modelled using spreadsheet calculations in order to provide indicative noise and vibration impacts for works likely to take place as part of the urban development. A construction noise and vibration assessment shall be conducted prior to any construction works within the precinct, including the upgrade of Mona Vale Road. In addition a Construction Noise and Vibration Management Plan (CNVMP) detailing noise feasible and reasonable mitigation measures should be prepared before any site works begin.

Noise emissions from typical construction activities have been calculated assuming a flat ground model and geometric spreading assuming no attenuation from air or ground absorption or shielding from buildings or ground effects.

A list of typical construction activities and associated plant has been assumed and are listed in Table 20.

Table 20 Typical construction activities and associated plant items.

Construction works	Equipment	SWL, dB(A)
Site clearing and demolition	Excavator with Breaker Attachment	112
	Excavator	99
	Dump Trucks	88
	Bobcat	104
	Handheld Breaker	108
	Flat Bed Truck	91
	Demolition Saw	110
	Total	**116**
Concrete works & construction	Concrete Agitator	105
	Small Mobile Crane	101
	Concrete Pump	106
	Flat Bed Truck	91
	Semi-trailers	101
	Welder	101
	Boilermaker	101
	Elevated Work Platform	97
	Generator	101
	Total	**111**
Minor road works	Bobcat	104
	Excavator with Breaker Attachment	112
	Flat Bed Truck	91
	Vibratory Roller	102
	Total	**113**

Construction works	Equipment	SWL, dB(A)
Major road works	Excavator	99
	Demolition Saw	110
	Excavator with Breaker Attachment	112
	Mini Road Planer	110
	Dump Truck	88
	Dozer	109
	Road Grader	109
	Vibratory Roller	102
	Concrete Agitator	105
	Concrete Pump	106
	Asphalt Paver	106
	Small Mobile Crane	98
	Flat Bed Truck	91
	Semi-Trailer	101
	Total	**118**

Predicted noise impacts from these typical construction works are presented in Table 21.

Table 21 Indicative predicted construction noise impacts

Construction works	Total SWL, dB(A)	Sound pressure level at distance, dB(A)			
		20m	50m	100m	500m
Site clearing and demolition	116	**82**	74	68	54
Concrete works & construction	111	**77**	70	63	50
Minor road works	113	**79**	71	65	51
Major road works	118	**84**	**76**	70	56

Notes:

1. *Items in Bold Red indicate 'highly affected' noise levels in accordance with the Interim Construction Noise Guideline, i.e. greater than 75 dB(A).*

Results show receivers closer than 50 m from clearing and demolition works, concrete works or minor road works may be 'highly affected and provisions should be made to avoid where possible. Major road works may result in 'highly affected' receivers at distances up to 100 m away, with an increased risk of disturbance due to the after-hours nature of most road works.

At 100 m, noise from all proposed construction works is predicted to exceed daytime construction NMLs at all NCAs. Predicted noise levels from some construction works (major road works and site clearing & demolition) exceed the most stringent do exceed daytime NMLs at some NCAs at 500m. A more detailed assessment would be required.

These results assume all plant items are operating simultaneously over an entire 15 minute period, and as such present a conservative worst case scenario.

8.1.1 Sleep disturbance

Due to the likely low local traffic volumes and low measured night-time RBL values throughout Ingleside Precinct, the possibility of sleep disturbance during night-time construction works is high. As no details on future construction works are currently available, a sleep disturbance assessment would be highly speculative at this stage, and has therefore not been included. Generic noise mitigation measures provided below should be implemented in the case that any night-time works are deemed necessary. It is noted that night-time works are very unlikely to be required for the construction of typical residential, community and educational buildings.

8.2 Mitigation measures

The mitigation measures for all proposed construction should be developed in a "*Construction Noise and Vibration Management Plan*" (CNVMP).

The noise emission levels from site plant and the potential annoyance to sensitive receptors would depend on the selection of plant, the type of operation, the activity duration and the time of day it is conducted. Consideration of all reasonable and feasible noise mitigation measures should be included in the construction management plan.

Generic measures to minimise the construction noise impact are detailed below, and are given to illustrate the range of techniques available:

- Construction activities to be limited to between 8 am and 5 pm Monday to Friday and 8 am to 1 pm Saturday.
- Where work is undertaken outside of the standard working hours it would be in accordance with the EPA *Interim Construction Noise Guideline* (EPA 2009) and all feasible and reasonable noise mitigation measures implemented.
- Possible restrictions to construction hours (beyond the above hours) where noise impacts are significant.
- All plant items should be properly maintained and operated according to manufacturers' recommendations in such a manner as to avoid causing excessive noise.
- All pneumatic tools should be fitted with silencers or mufflers.
- Any compressors brought on to site should be silenced or sound reduced models fitted with acoustic enclosures.
- Notification of property owners likely to be affected prior to works being carried out.
- Noise monitoring at sensitive locations as agreed with EPA for any excessive noise or noise complaints being assessed with appropriate action taken.

9.0 Construction vibration

Vibration intensive works may occur during construction activities. Minimum working distances for individual plant items that relate to cosmetic/structural damage and human comfort for the proposed works are presented in Table 22.

Table 22 Recommended safe working distances for vibration intensive plant

Plant	Rating/Description	Minimum working distance			
		Cosmetic damage (metres)			Human response (metres)
		Residential Building	Commercial Building – Non Heritage Listed	Heritage Building	
Vibratory roller	< 50 kN (Typically 1-2t)	5	-	9	15-20
	< 100 kN (Typically 2-4t)	6	-	11	20
	< 200 kN (Typically 4-6t)	12	3	22	40
	< 300 kN (Typically 7-13t)	15	6	27	100
	> 300 kN (Typically 13-18t)	20	8	36	100
	> 300 kN (> 18 t)	25	10	45	100
Small hydraulic hammer	(300 kg – 5-12t excavator)	2	-	3	7
Medium hydraulic hammer	(900 kg – 12-18t excavator)	7	3	13	23
Large hydraulic hammer	(1,600 kg – 18-34t excavator)	22	9	40	73
Pile boring	≤ 800 mm	2	-	3	N/A

An exceedance of the minimum working distances in Table 22 would not necessarily mean cosmetic damage or human discomfort would occur, however the level of risk of occurrence is such that further mitigation measures would be required. Further mitigation of vibration would not be required provided that there is adherence to the safe working distances listed in Table 22.

In the event that equipment must operate within the minimum working distances listed in , the following procedure should be considered:

- informing the community of the nature and duration of vibration activities prior to and during construction and updating potentially vibration-affected neighbours on progress;
- prior to construction, conducting dilapidation surveys on buildings located within the safe working distances as deemed required;
- at the commencement of construction:
  - Conduct attended vibration monitoring at the commencement of works;
  - Minimise the use of vibration intensive equipment where possible; and
  - Lighter construction equipment would be used where possible.

10.0 Conclusion

AECOM Australia Pty Ltd (AECOM) has been commissioned to conduct a noise and vibration impact assessment which will inform the rezoning of the Ingleside Land Release Area (Ingleside Precinct).

This study presents the assessment of the potential noise and vibration emissions associated with the existing and future urban development within the Precinct, including:

- Additional traffic noise generated by the increased capacity on nearby public roads; and
- Noise emission from all noise generating premises within and adjacent to the precinct.

Potential future sources of noise and vibration within the Precinct include retail premises, educational facilities and recreational spaces, as well as existing noise sources including light industrial premises, churches and horse riding trail areas.

The purpose of the study is to consider and assess environmental noise impacts, including the proposed Mona Vale Road Upgrade, on the existing and future residents of Ingleside.

Environmental noise monitoring
Unattended and attended noise monitoring was conducted along the main road sources within and in vicinity of the precinct. Noise logging was completed at six locations in order to facilitate calibration of the road traffic noise model. Attended noise monitoring was conducted to qualify noise sources and verify unattended monitoring results.

The background noise environment was controlled by traffic travelling along the main roads, including Mona Vale Road, Powderworks Road and Lane Cove Road, within the Precinct, with noise from natural surrounds also present, namely cicadas.

Road traffic noise levels
Road traffic noise levels in 2036 were predicted and road traffic noise contours presented. The road traffic noise model took into account the proposed Mona Vale Road upgrade. The road traffic noise contours were overlaid on the Structure Plan. It was noted that road traffic noise levels are likely to exceed the criteria presented in the State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) by up to 10 dB(A), where houses are proposed in close proximity to Mona Vale Road and to a lesser extent Powderworks Roads. Indicative recommendations were provided which may be required to achieve the criteria.

Other noise sources
Noise from both existing sources on proposed residential developments, and noise from proposed community facilities, shops and sporting fields on existing residences have been discussed, with planning considerations and indicative mitigation measures provided.

Construction noise and vibration
Although construction details are not available at this early stage of the project, construction noise management levels have been established based on measured Rating Background Levels (RBLs). Indicative construction scenarios have been proposed in order to demonstrate typical noise impacts from works that may take place during the Precincts urban development. Generic mitigation measures have been provided to minimise adverse noise and vibration impacts.

Recommendations
The Study has found that it is likely that noise mitigation measures will be required to meet the appropriate criteria. This study presents conceptual noise control measures and management strategies which are likely to be required to minimise adverse impacts on existing and future residential receivers. Residential developments where road traffic noise levels are likely to exceed Infrastructure SEPP noise limits have been identified, and mitigation measures may need to be implemented at these locations. Potential treatments have been identified in Section 6.4.1, which include noise barriers, buffer zones, building and architectural layouts and building construction materials. These may be incorporated into the Development Control Plan (DCP).

It is noted that detailed noise and vibration impact assessments will be required during the development application stage for noise sensitive receivers where they are proposed to be located close to existing/future noisy land uses.

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing
	30dB(A) A quiet country park
	40dB(A) Whisper in a library
	50dB(A) Open office space
	70dB(A) Inside a car on a freeway
	80dB(A) Outboard motor
	90dB(A) Heavy truck pass-by
	100dB(A) Jackhammer/Subway train
	110 dB(A) Rock Concert
	115dB(A) Limit of sound permitted in industry
	120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period

L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.
Impulsive noise	Noise of a short duration, characterised by a short rise time of 35 milliseconds and decay time of 1.5 seconds.
Tonal noise	Noise which is tonal in nature, characterised by a one-third octave band exceeding the level of each adjacent band by: - 5 dB(A) or more if the frequency band containing the tone is above 400 Hz - 8 dB(A) or more if the frequency band containing the tone is below 400 Hz and above 160 Hz inclusive - 15 dB(A) or more if the frequency band containing the tone is below 160 Hz

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's *Noise Policy for Industry* and the EPA's *Road Noise Policy*.

Appendix B

Logger Graphs

Noise Logger Report

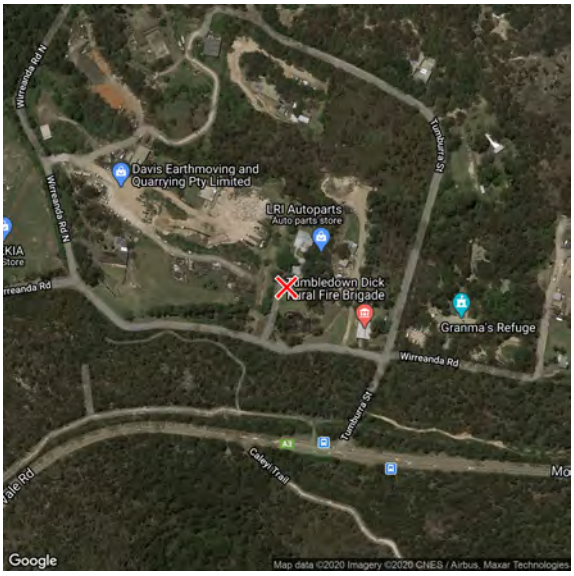
1 Wirreanda Road, Ingleside

Item	Information
Logger Type	Rion NL21
Serial number	409169
Address	1 Wirreanda Road, Ingleside
Location	Front Yard
Facade / Free Field	Free Field
Environment	Traffic along Mona Vale Road dominant. Cicadas, trucks and some nearby construction work also noted.

Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Wed Dec 4 2013	59	51	50	45	-	35	57	50
Thu Dec 5 2013	56	51	51	45	42	-	55	51
Fri Dec 6 2013	53	50	46	46	40	31	52	46
Sat Dec 7 2013	57	52	48	47	-	30	56	48
Sun Dec 8 2013	58	50	50	49	-	34	57	50
Mon Dec 9 2013	59	54	51	47	-	-	58	51
Tue Dec 10 2013	59	53	53	-	-	-	57	53
Wed Dec 11 2013	60	-	52	-	-	-	60	52
Summary	**58**	**52**	**51**	**46**	**41**	**33**	**57**	**51**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

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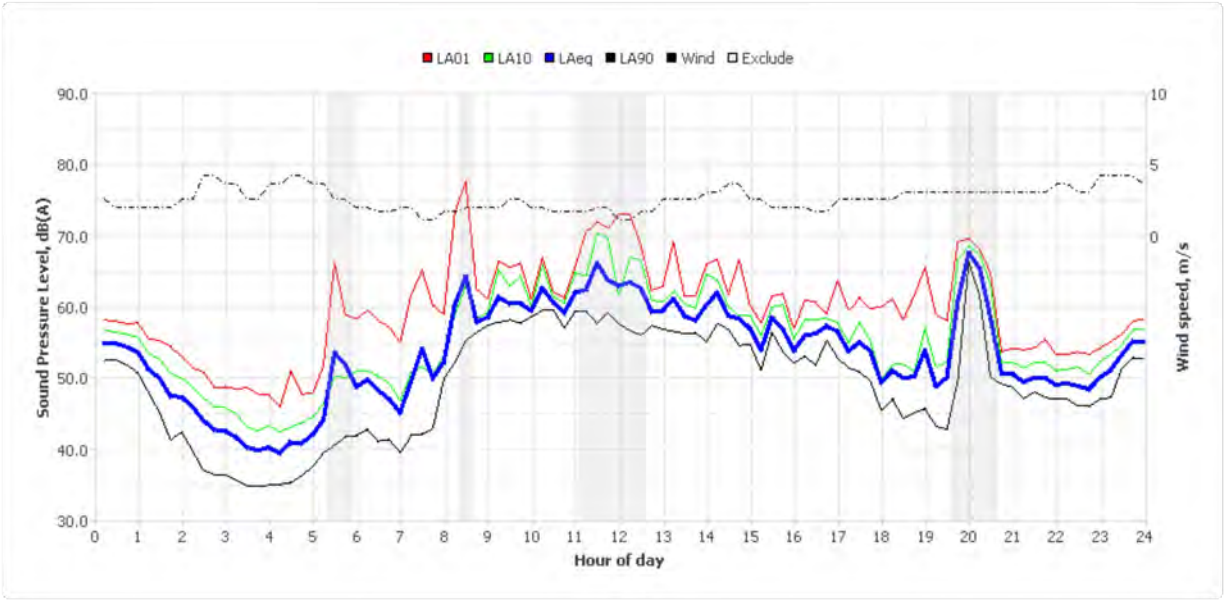

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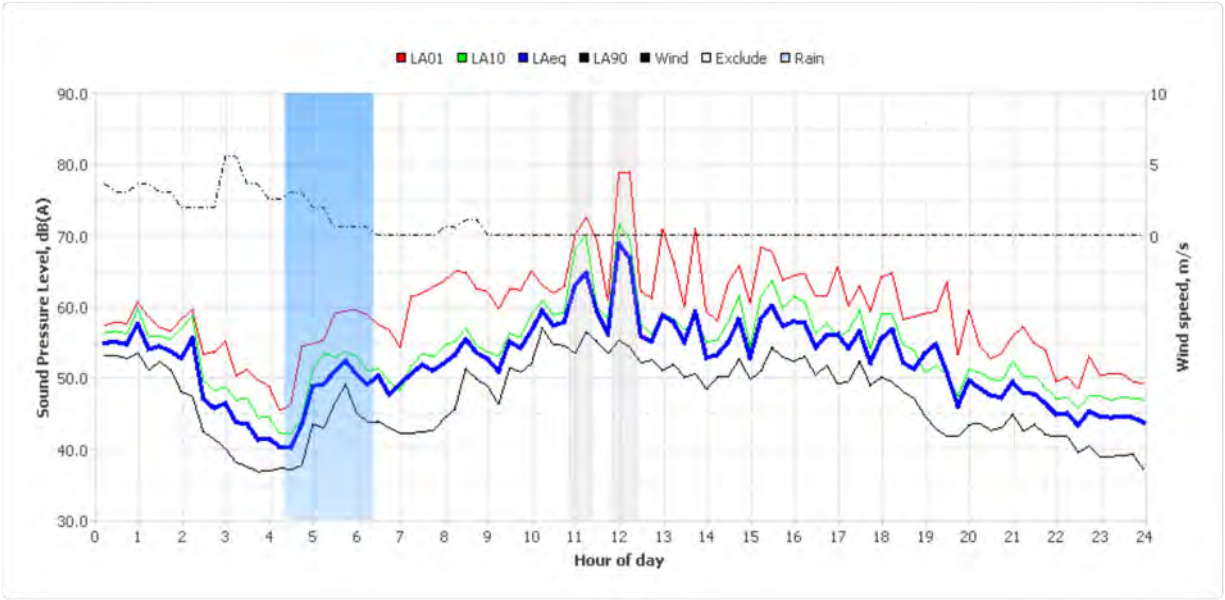

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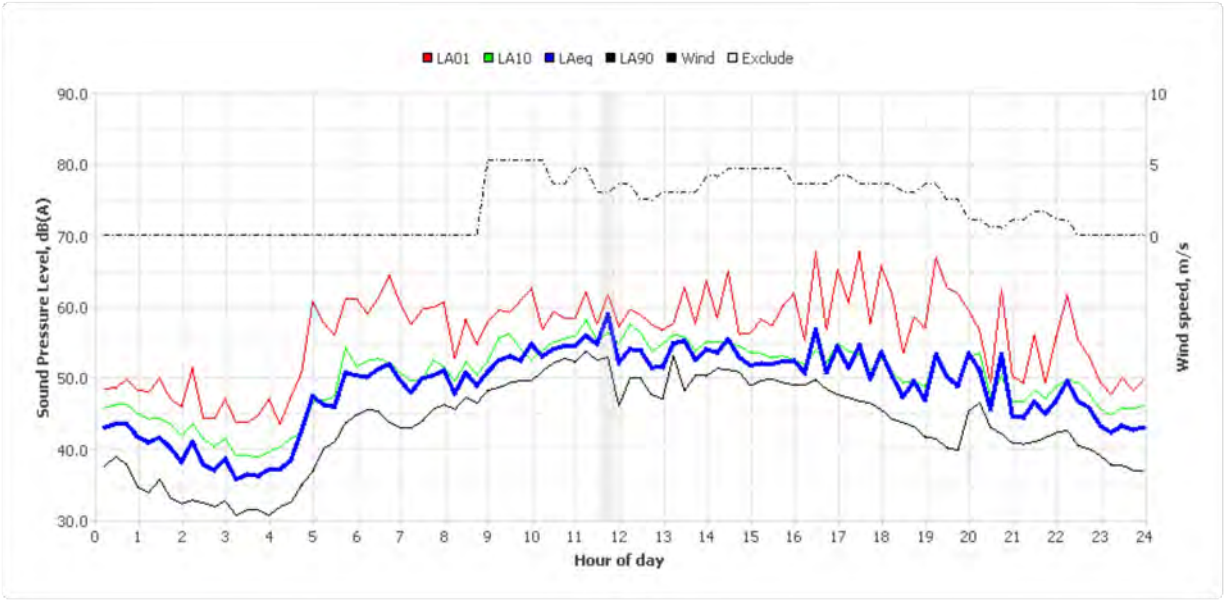

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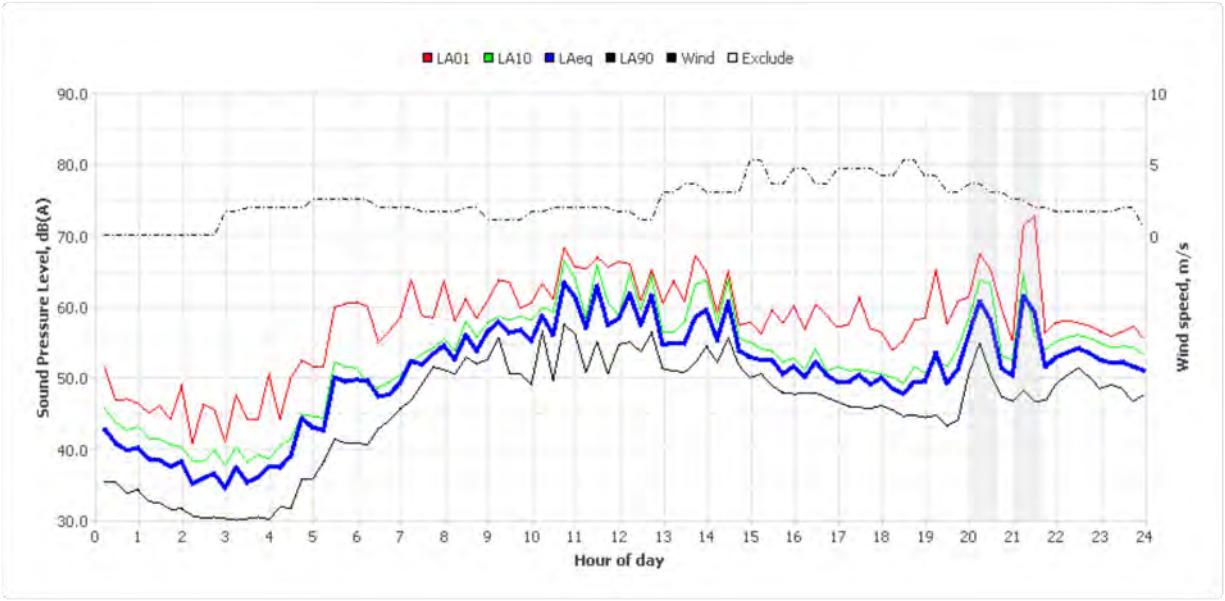

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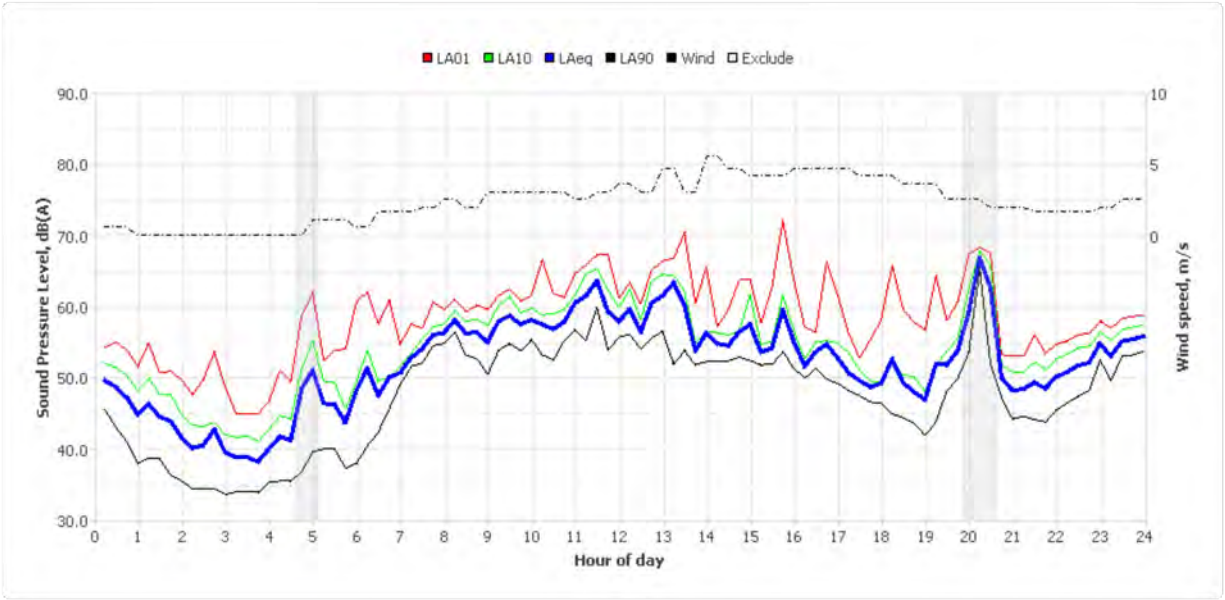

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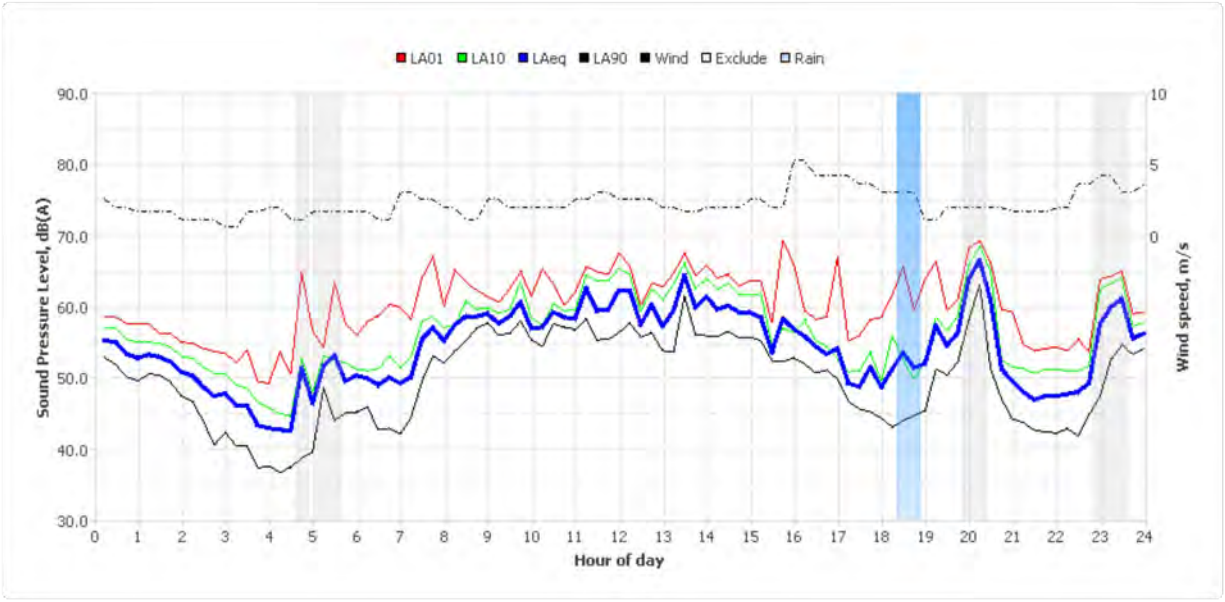

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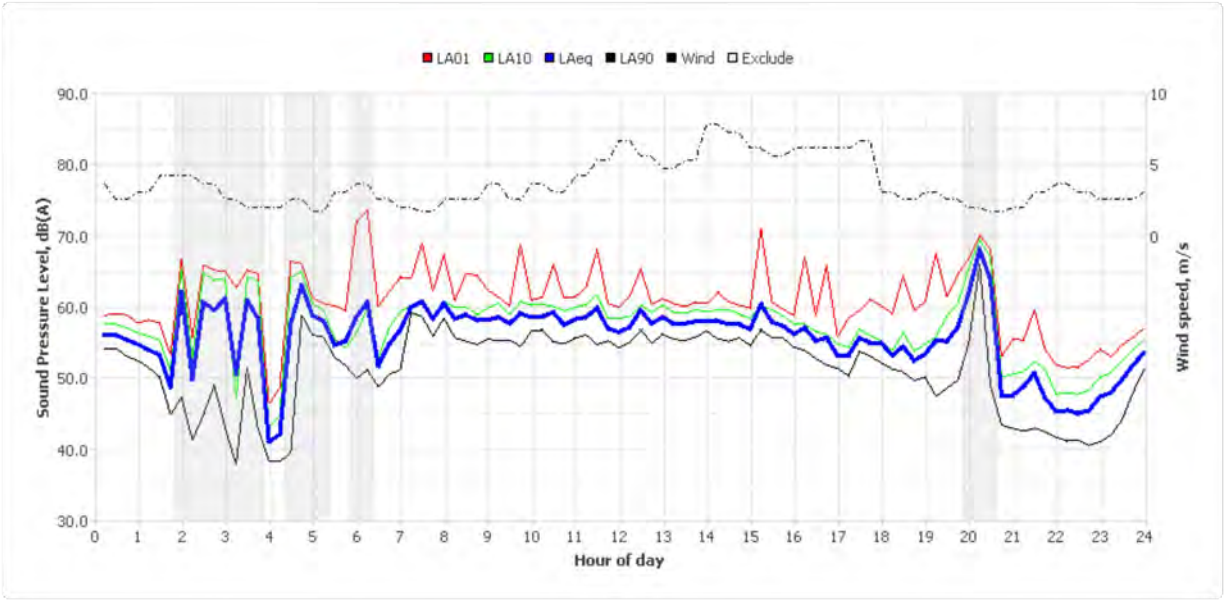

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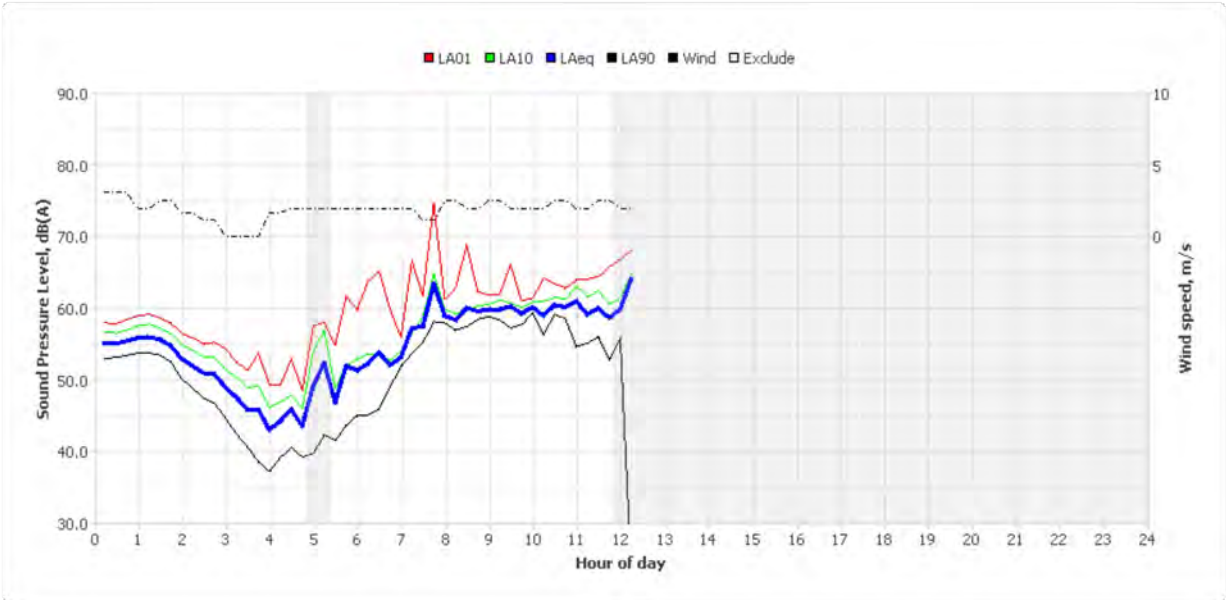

Noise Logger Report

173 Mona Vale Road, Ingleside

Item	Information
Logger Type	Infobyte
Serial number	1040166D
Address	173 Mona Vale Road, Ingleside
Location	Front Yard
Facade / Free Field	Free Field
Environment	Noise from traffic along Mona Vale Road dominant. Cicadas, kookaburras and distant trucks also noted.

Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Tue Dec 3 2013	65	60	56	-	47	-	63	56
Wed Dec 4 2013	66	63	56	-	48	33	64	56
Thu Dec 5 2013	64	60	55	-	48	-	63	55
Fri Dec 6 2013	63	59	57	-	43	36	62	57
Sat Dec 7 2013	65	59	55	-	-	26	63	55
Sun Dec 8 2013	67	59	55	-	47	28	64	55
Mon Dec 9 2013	63	61	56	-	-	28	62	56
Tue Dec 10 2013	-	62	64	-	43	-	62	64
Wed Dec 11 2013	67	-	57	-	-	-	67	57
Summary	**65**	**61**	**58**	**-**	**47**	**28**	**64**	**58**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

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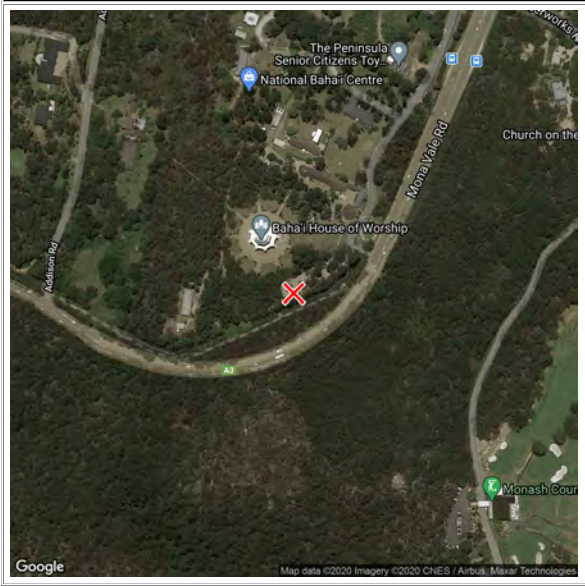	

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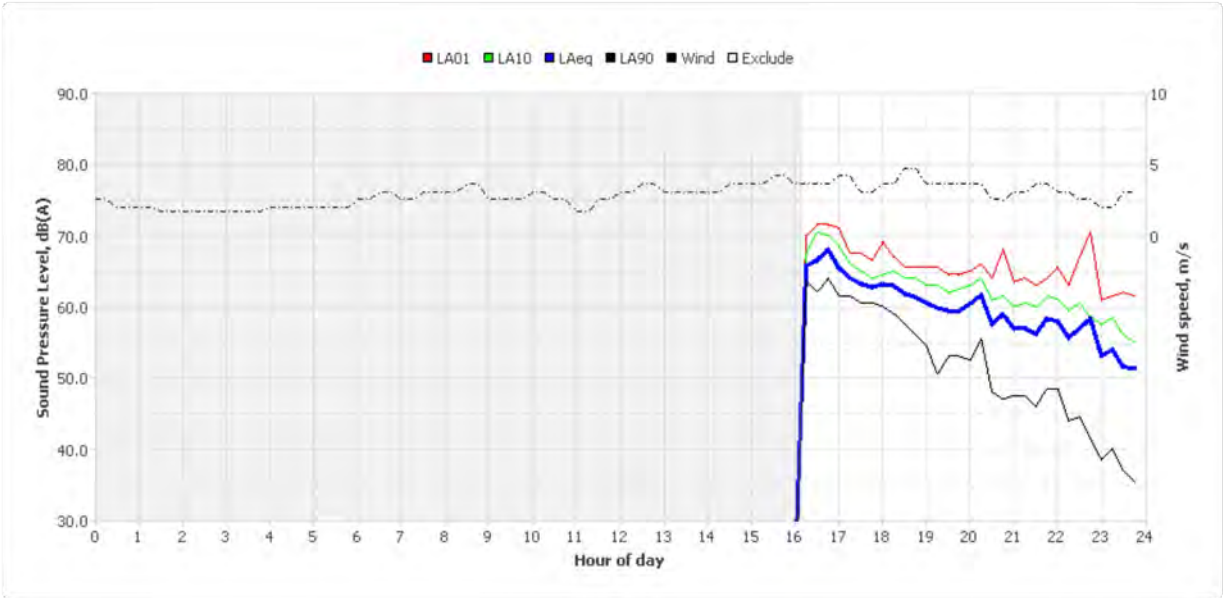

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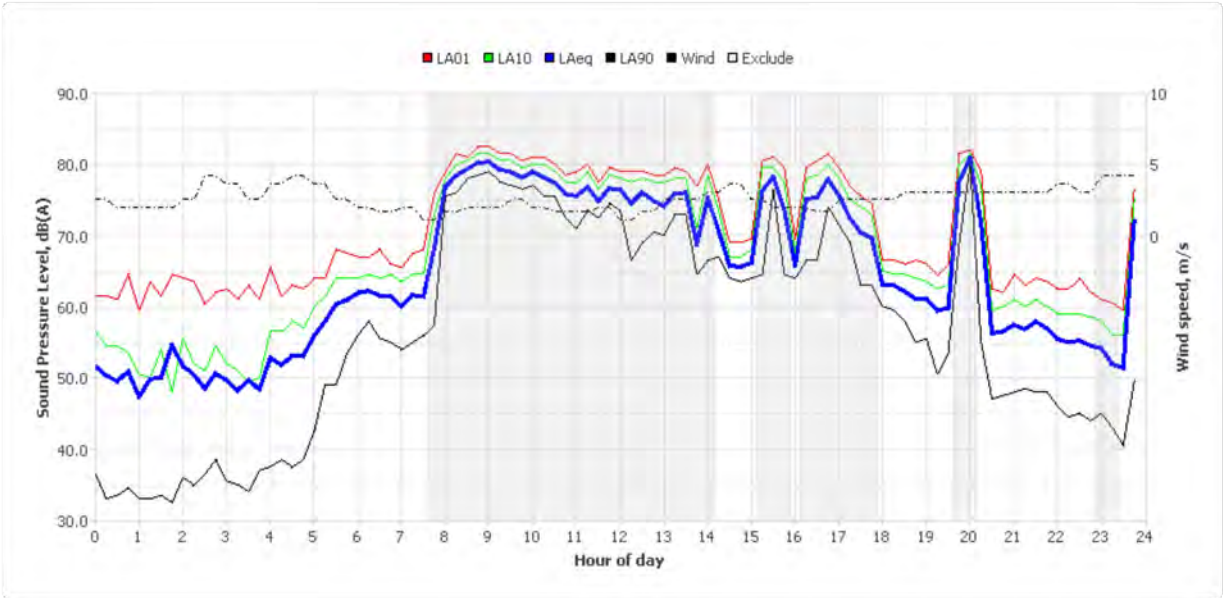

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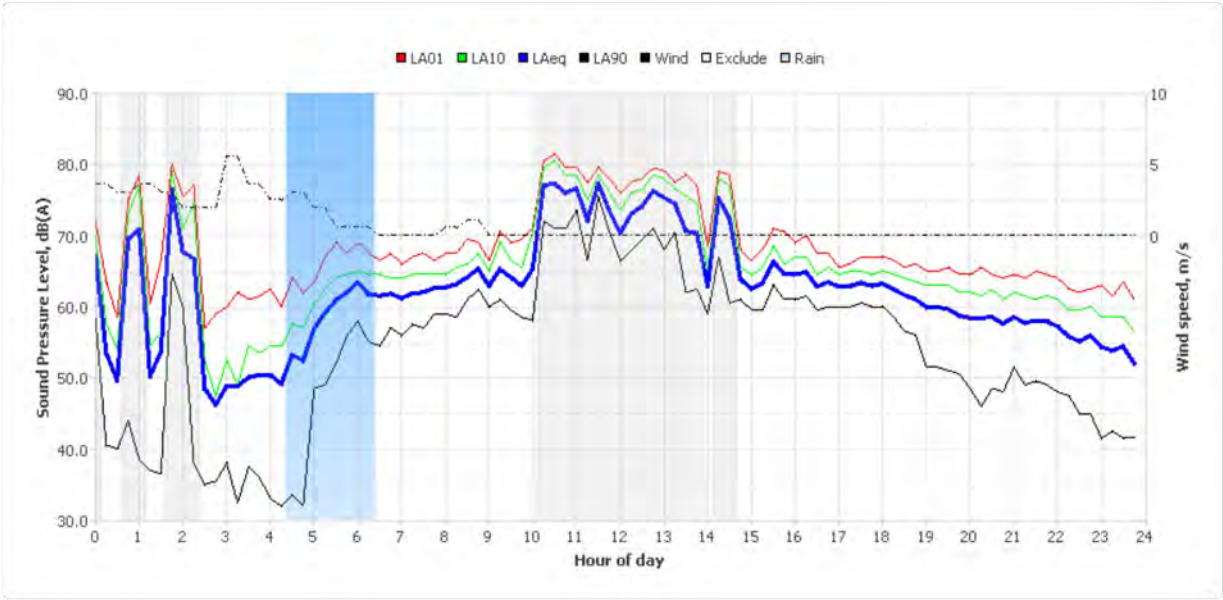

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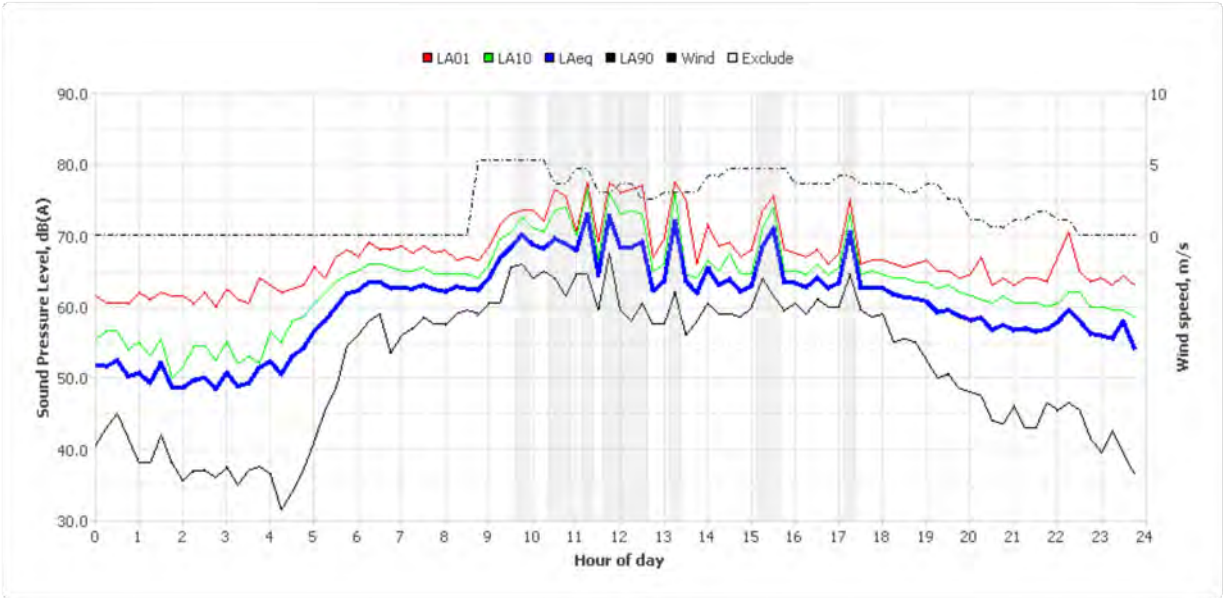

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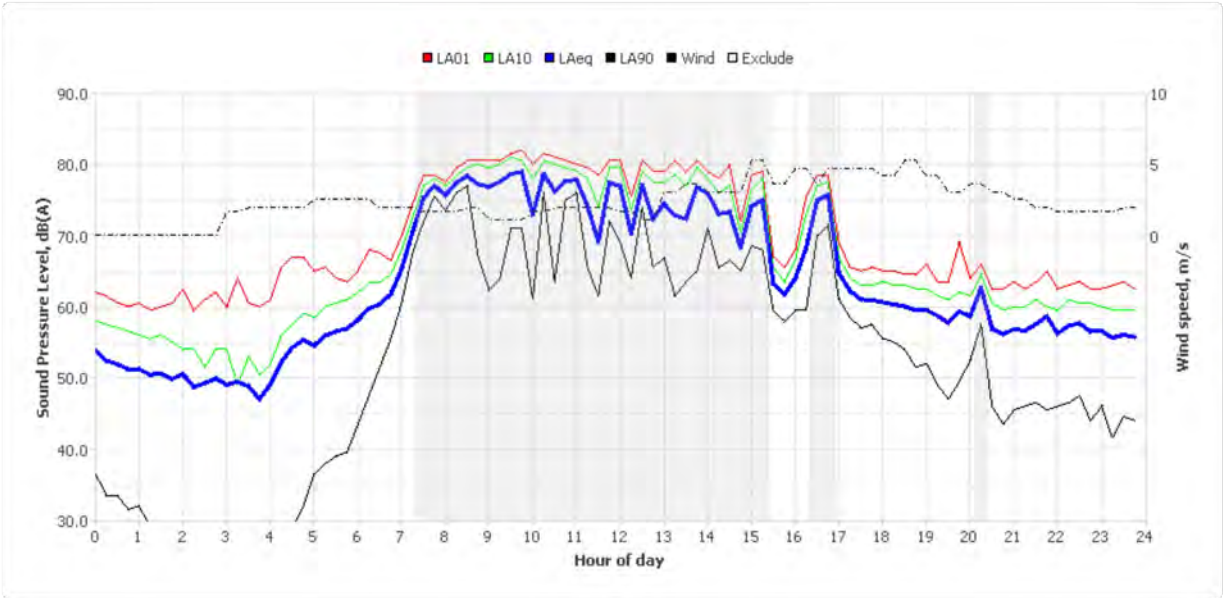

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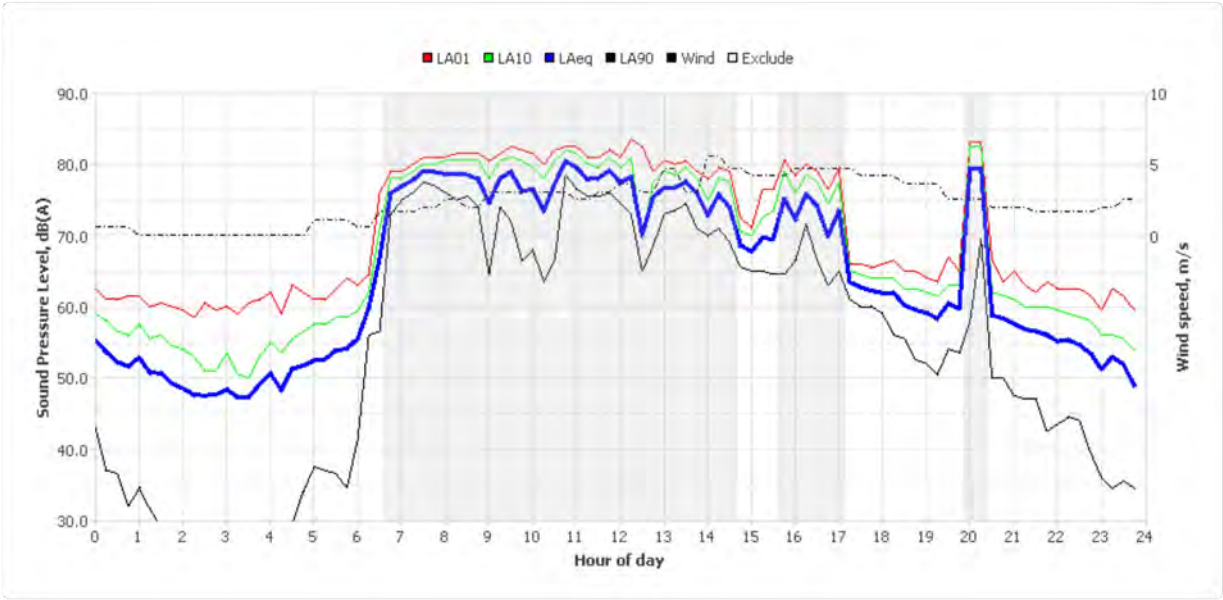

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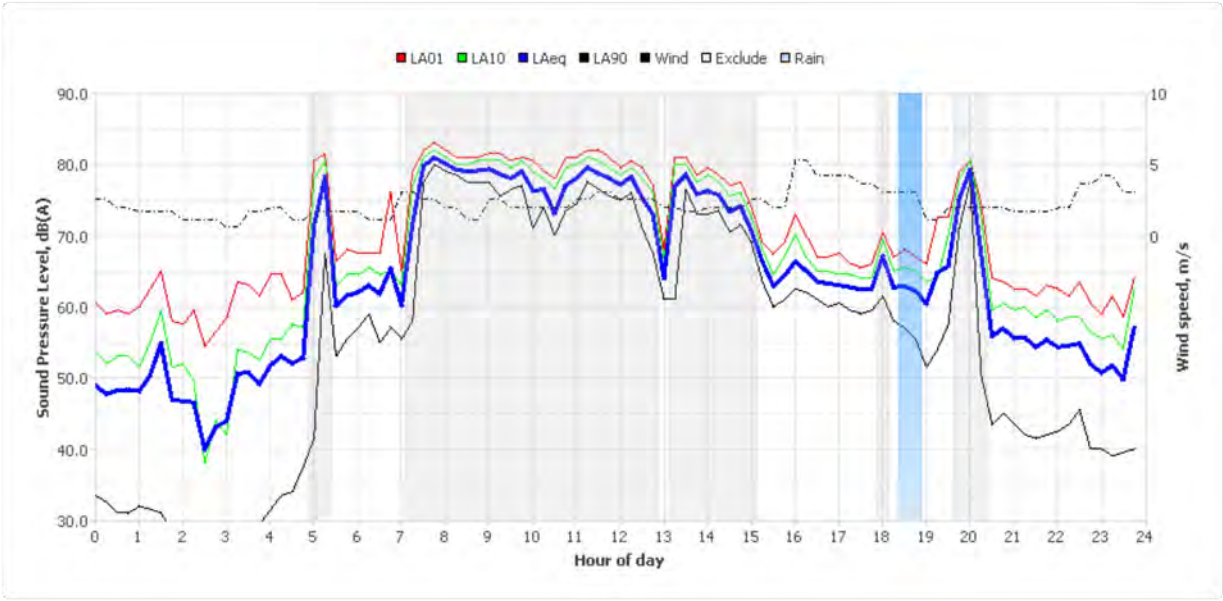

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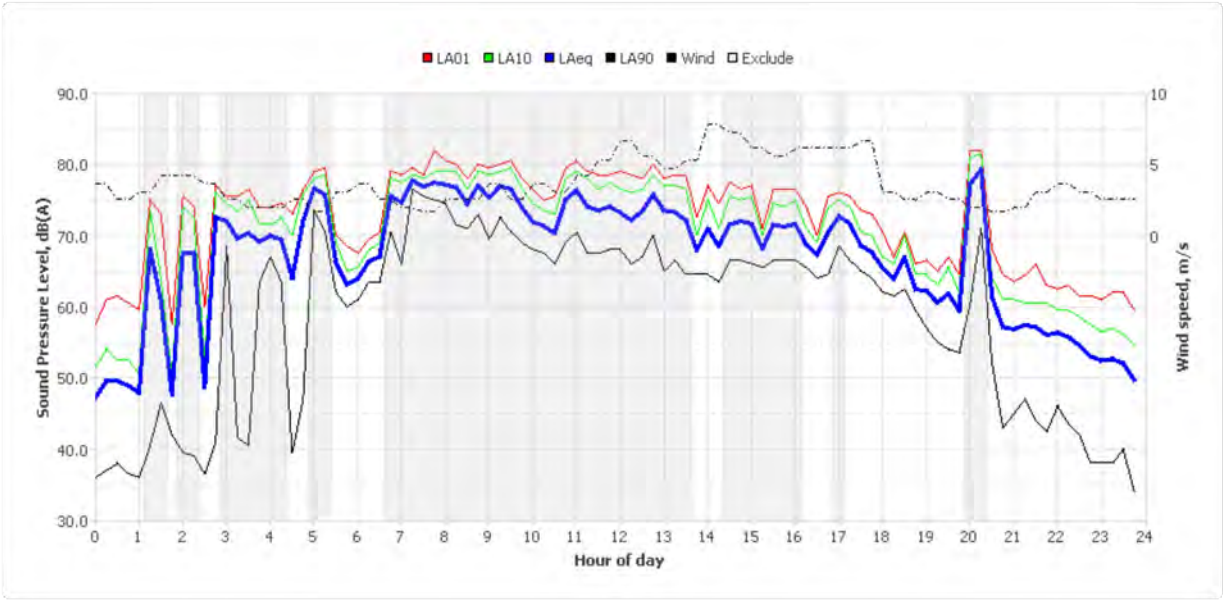

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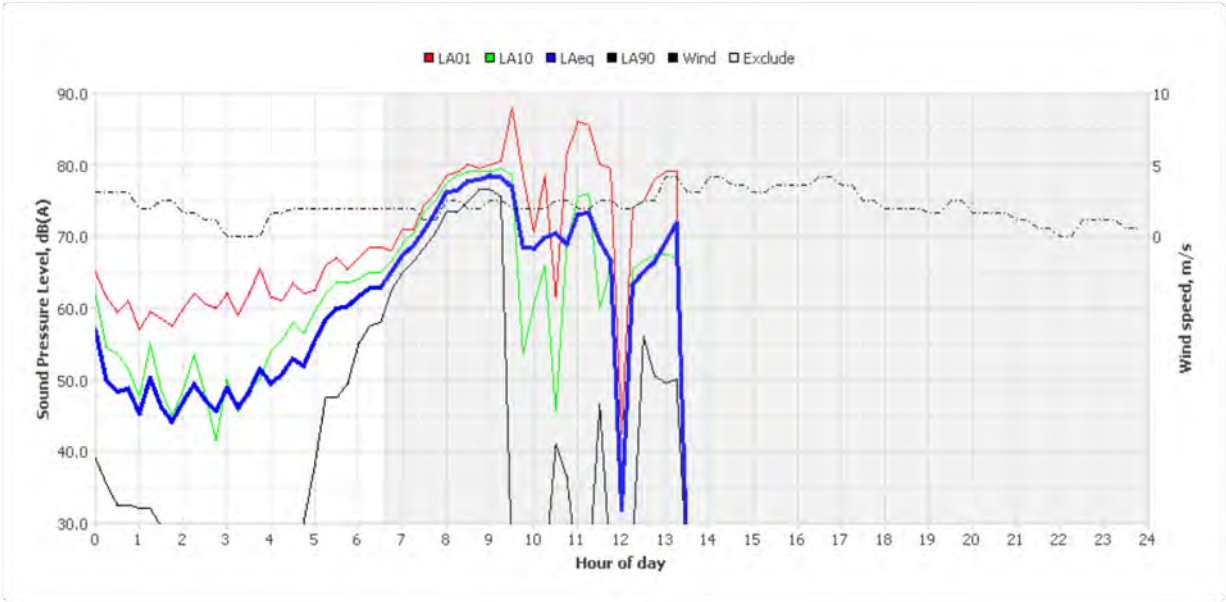

Noise Logger Report

240 Powderworks Road, Ingleside

Item	Information
Logger Type	Infobyte
Serial number	1120037D
Address	240 Powderworks Road, Ingleside
Location	Front Yard
Facade / Free Field	Free Field
Environment	Noise from traffic along Powderworks Road dominant. Birds and cicadas also noted.

Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Tue Dec 3 2013	63	60	56	-	41	-	61	56
Wed Dec 4 2013	63	60	56	49	42	32	62	56
Thu Dec 5 2013	63	60	55	50	44	-	62	55
Fri Dec 6 2013	62	59	57	47	40	30	61	57
Sat Dec 7 2013	62	59	55	47	43	25	61	55
Sun Dec 8 2013	62	59	53	49	41	30	61	53
Mon Dec 9 2013	63	58	56	49	-	29	62	56
Tue Dec 10 2013	62	-	58	-	-	-	62	58
Summary	**62**	**59**	**56**	**49**	**41**	**30**	**62**	**56**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

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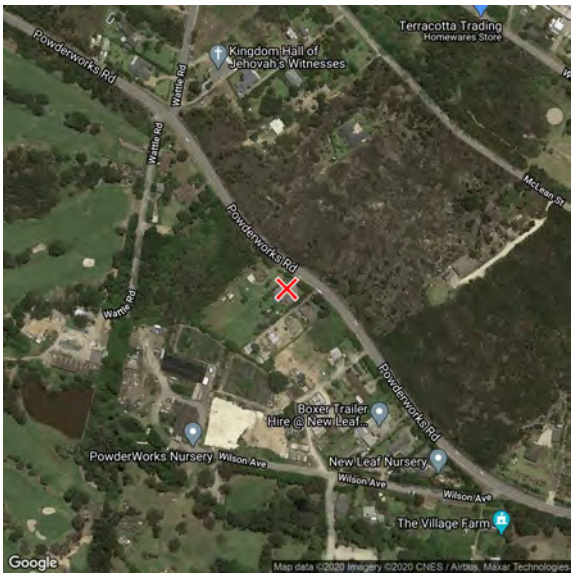	

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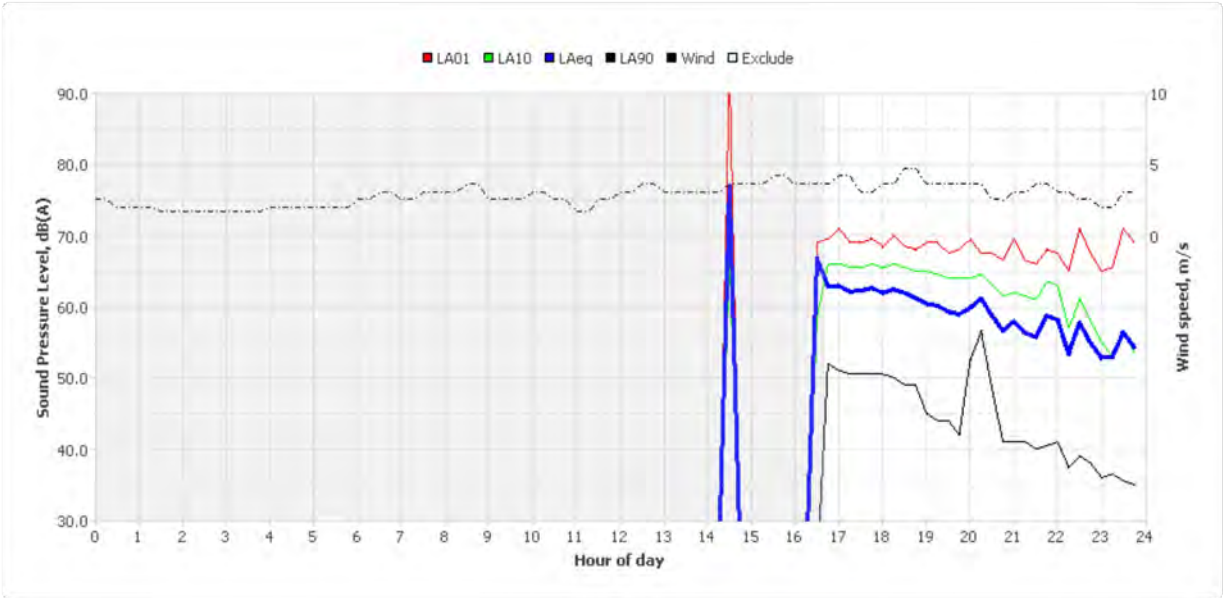

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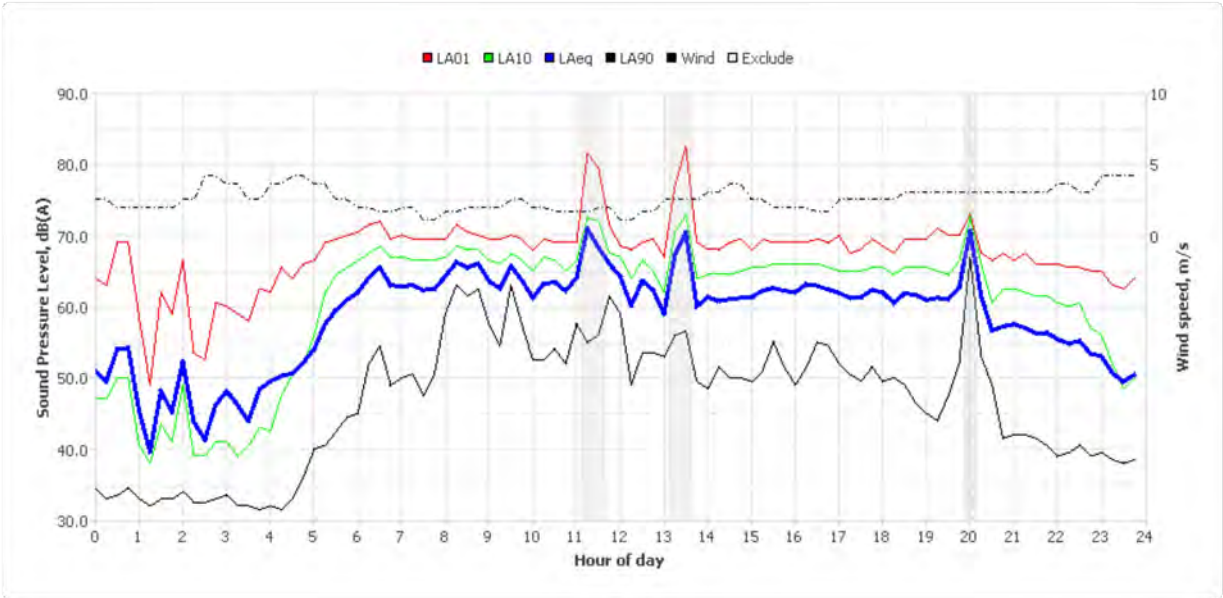

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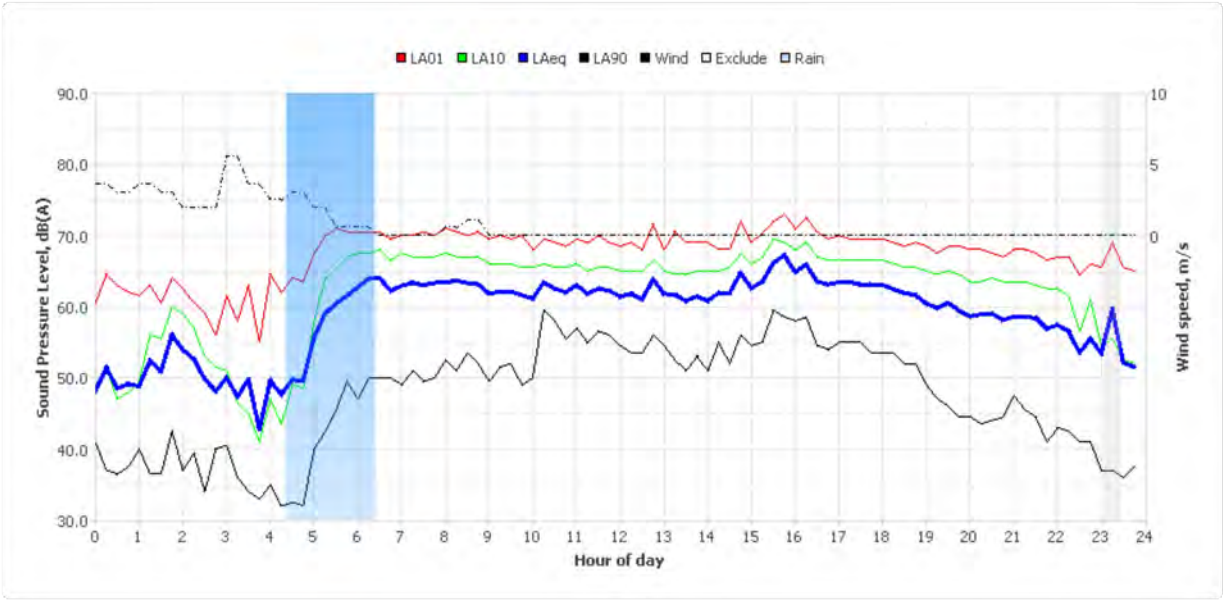
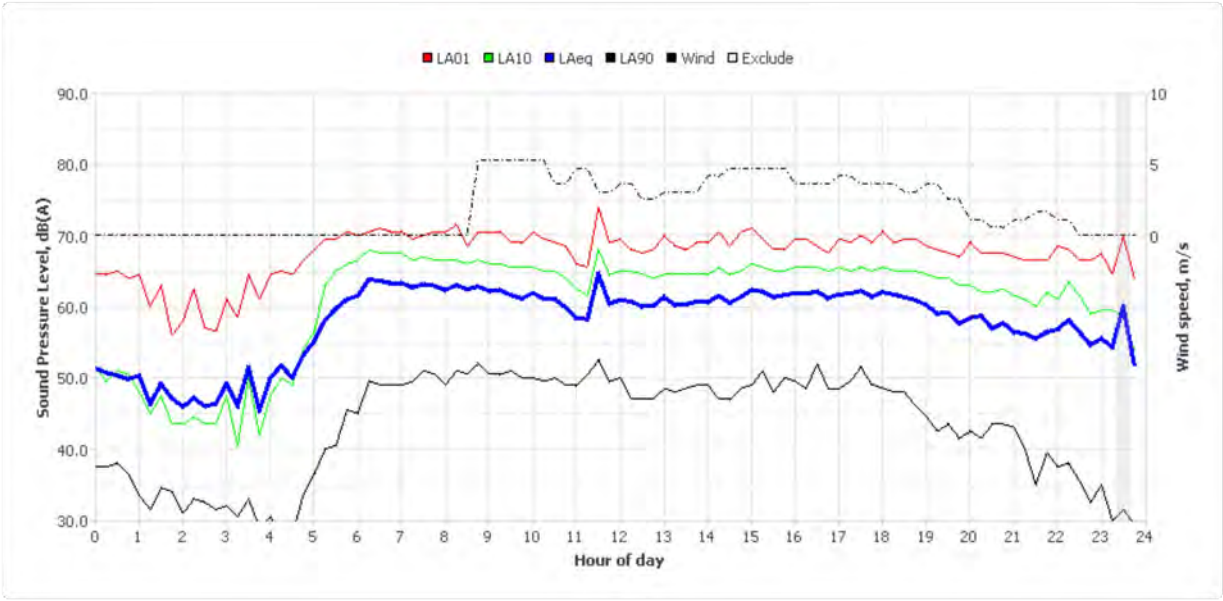
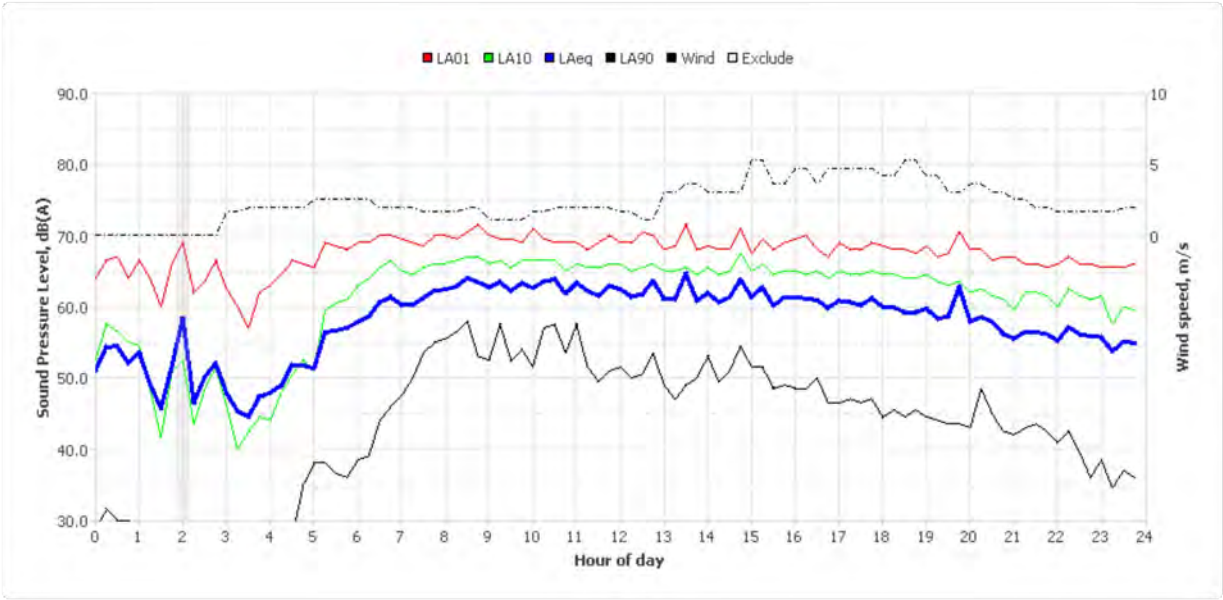


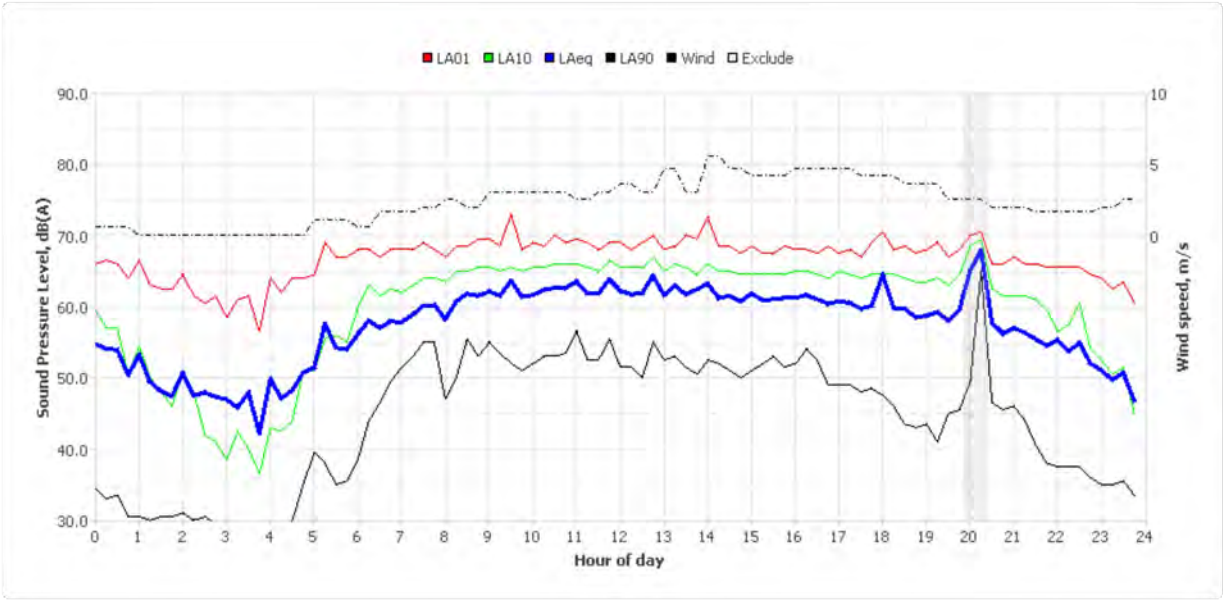
Friday, 06 Dec 2013



Saturday, 07 Dec 2013



Sunday, 08 Dec 2013



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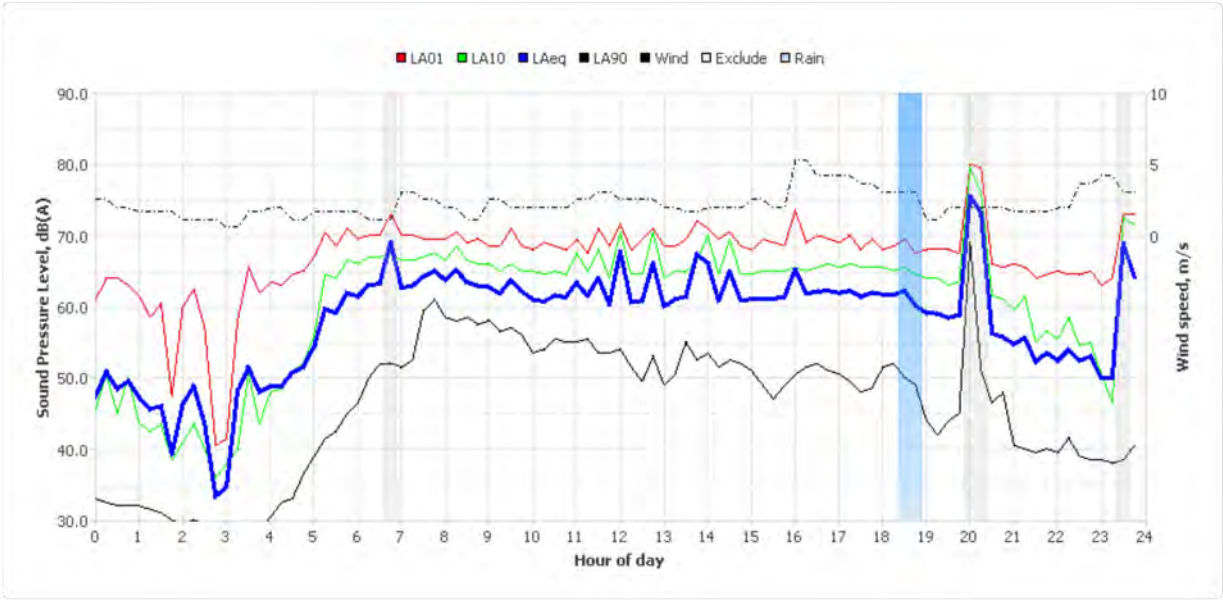

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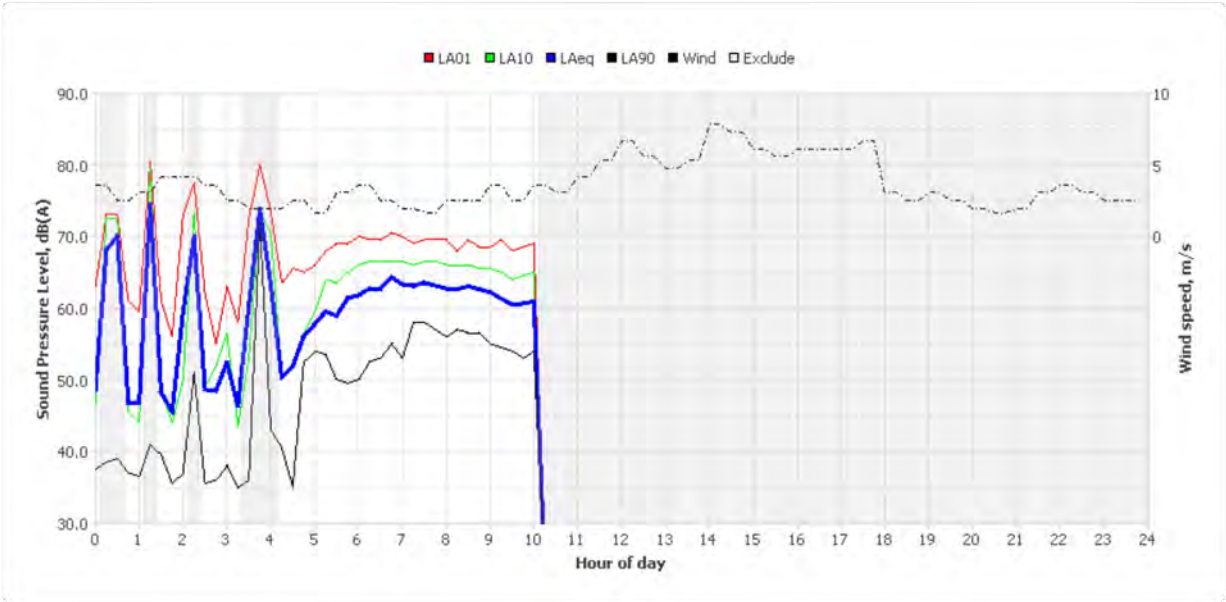


Noise Logger Report

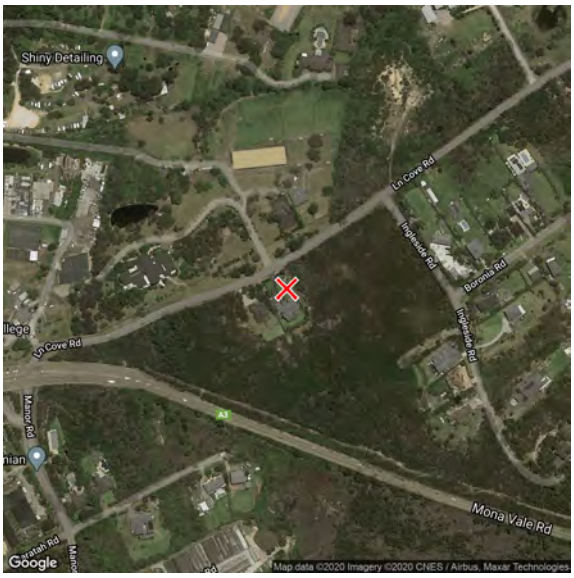
13 Lane Cove Road, Ingleside

Item	Information
Logger Type	Infobyte
Serial number	1090096D
Address	13 Lane Cove Road, Ingleside
Location	Front Yard
Facade / Free Field	Free Field
Environment	Noise from Cicadas dominant. Cars, trucks, helicopters and car horns also noted.

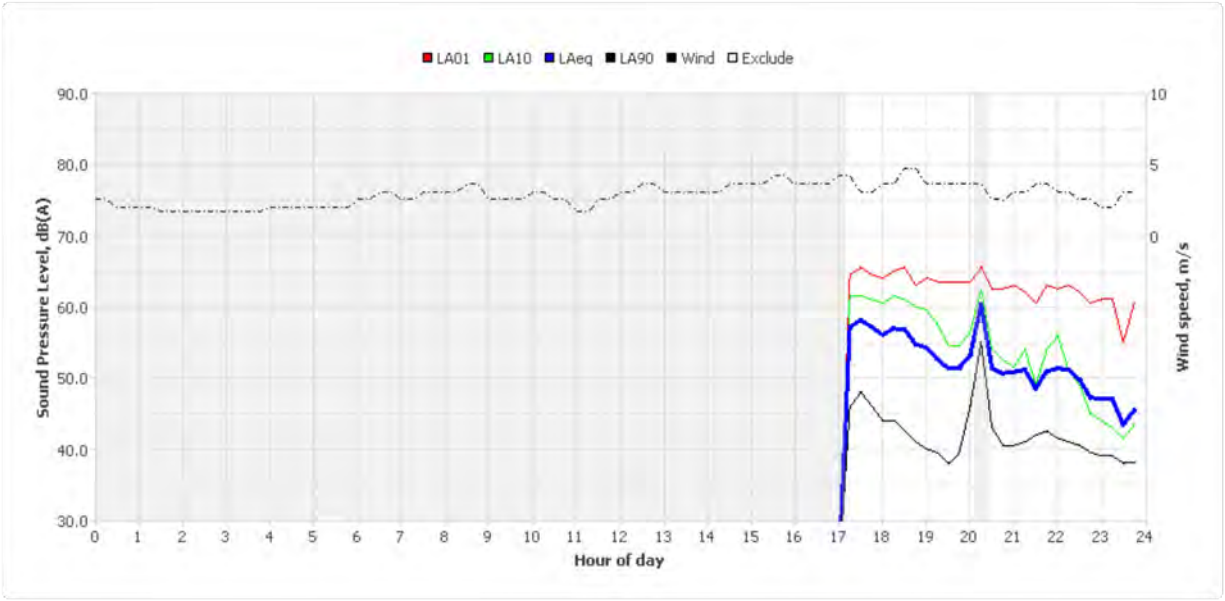
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Tue Dec 3 2013	57	53	48	-	40	-	54	48
Wed Dec 4 2013	61	58	50	-	39	34	60	50
Thu Dec 5 2013	62	58	52	-	45	-	61	52
Fri Dec 6 2013	57	53	51	-	37	31	56	51
Sat Dec 7 2013	61	52	49	-	-	26	59	49
Sun Dec 8 2013	62	54	47	-	39	30	60	47
Mon Dec 9 2013	59	55	50	-	-	32	58	50
Tue Dec 10 2013	-	57	53	-	44	-	57	53
Wed Dec 11 2013	60	-	51	-	-	-	60	51
Summary	**60**	**56**	**51**	**-**	**39**	**31**	**59**	**51**

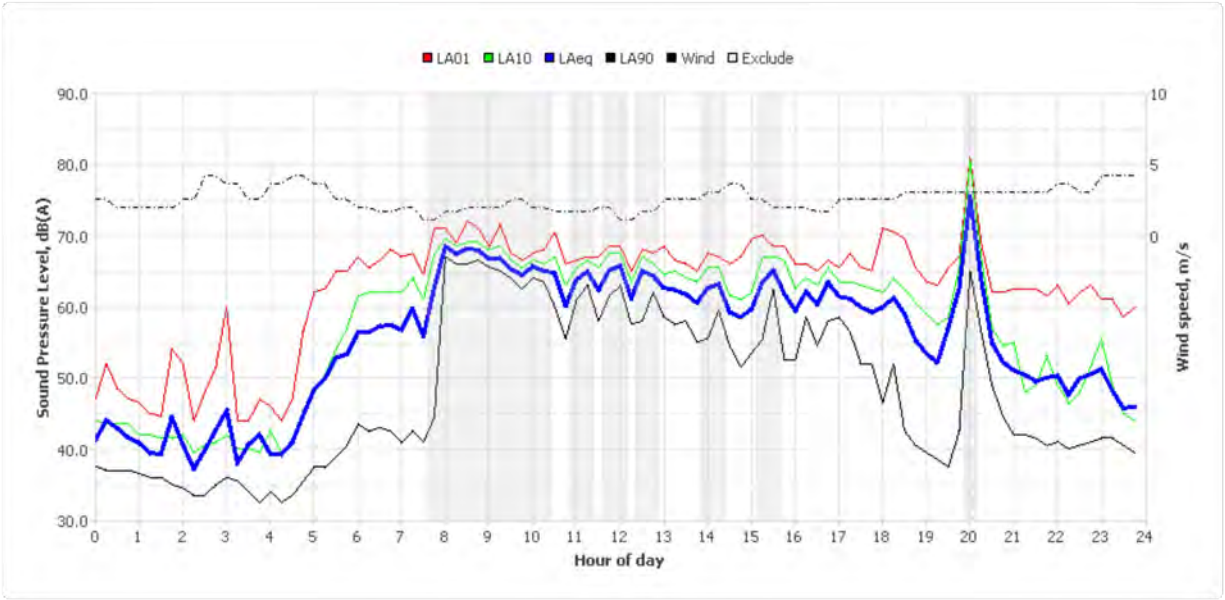
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

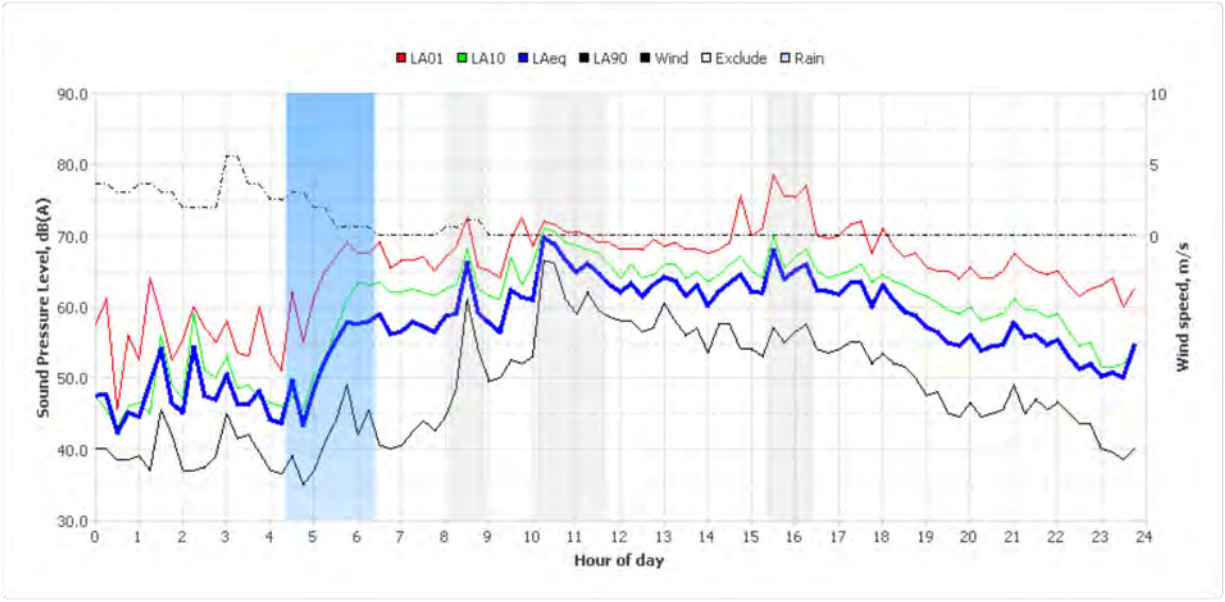
Tuesday, 03 Dec 2013



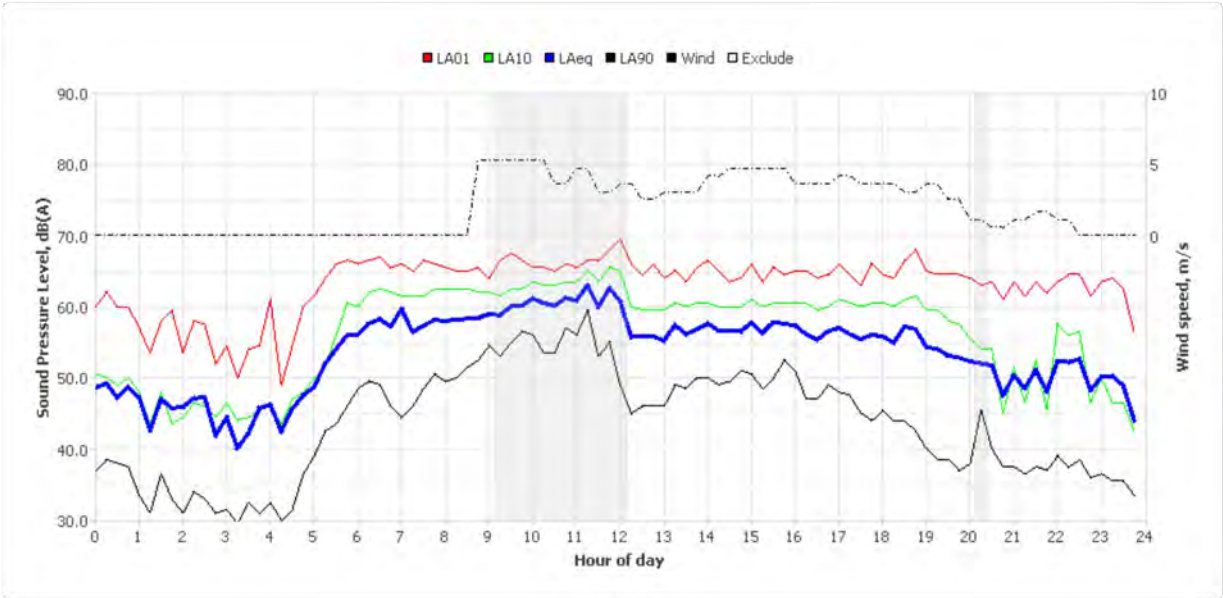
Wednesday, 04 Dec 2013



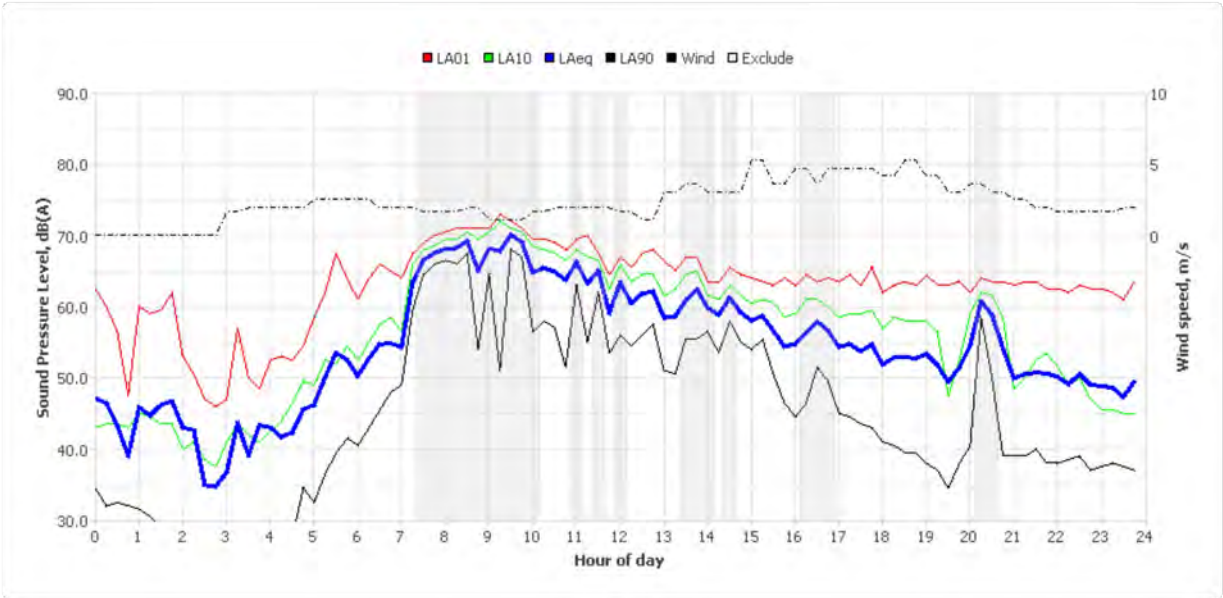
Thursday, 05 Dec 2013



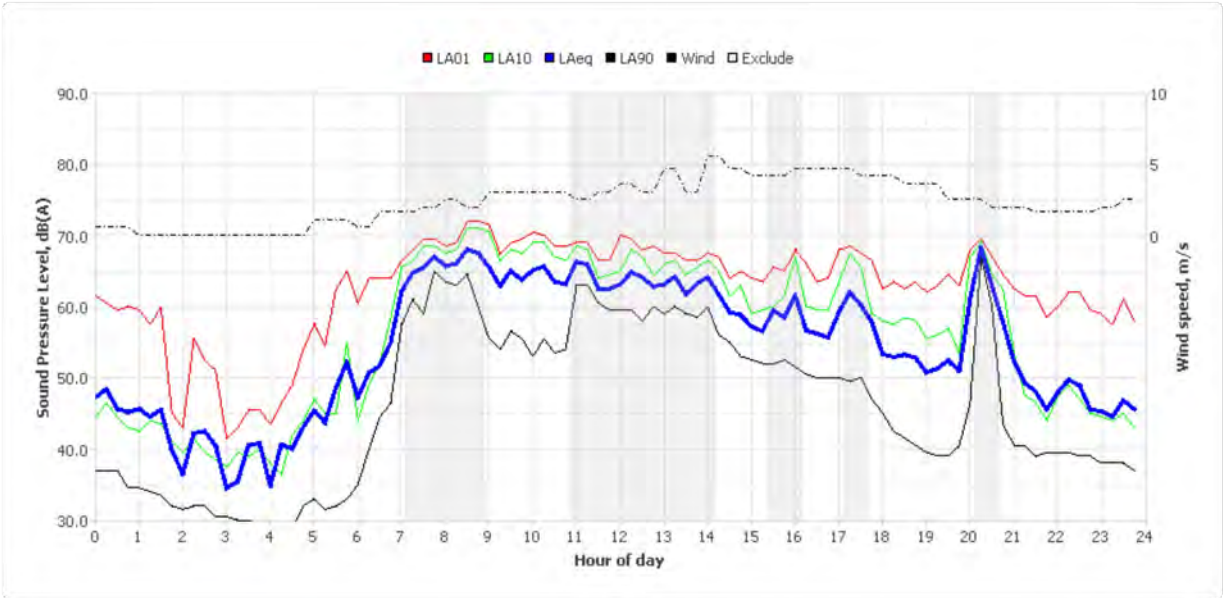
Friday, 06 Dec 2013



Saturday, 07 Dec 2013



Sunday, 08 Dec 2013



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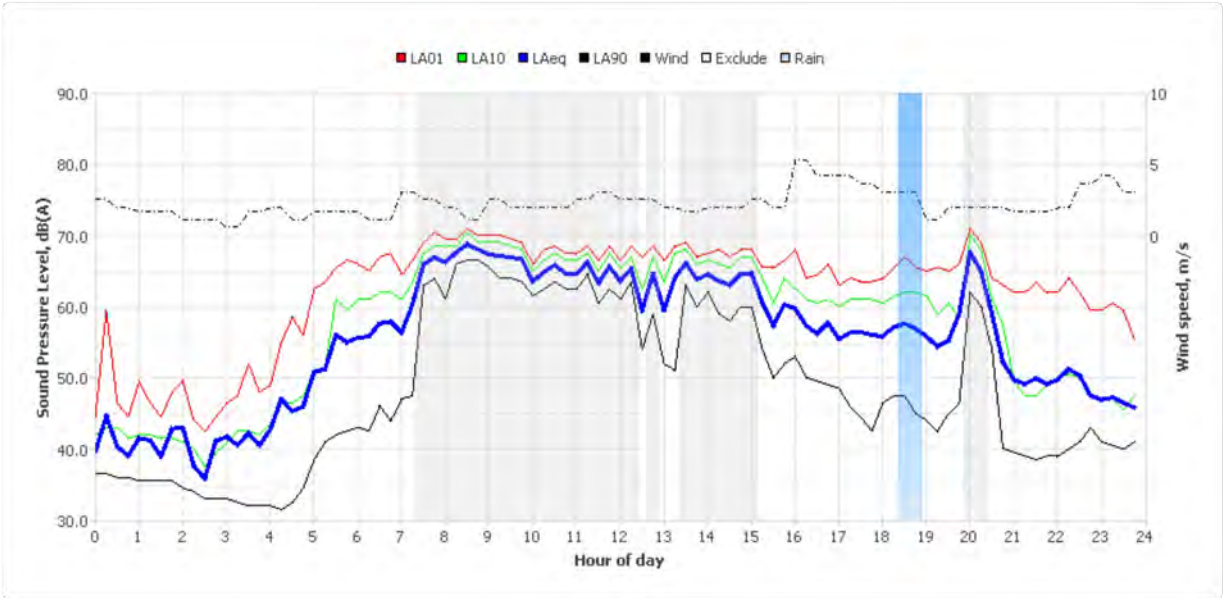

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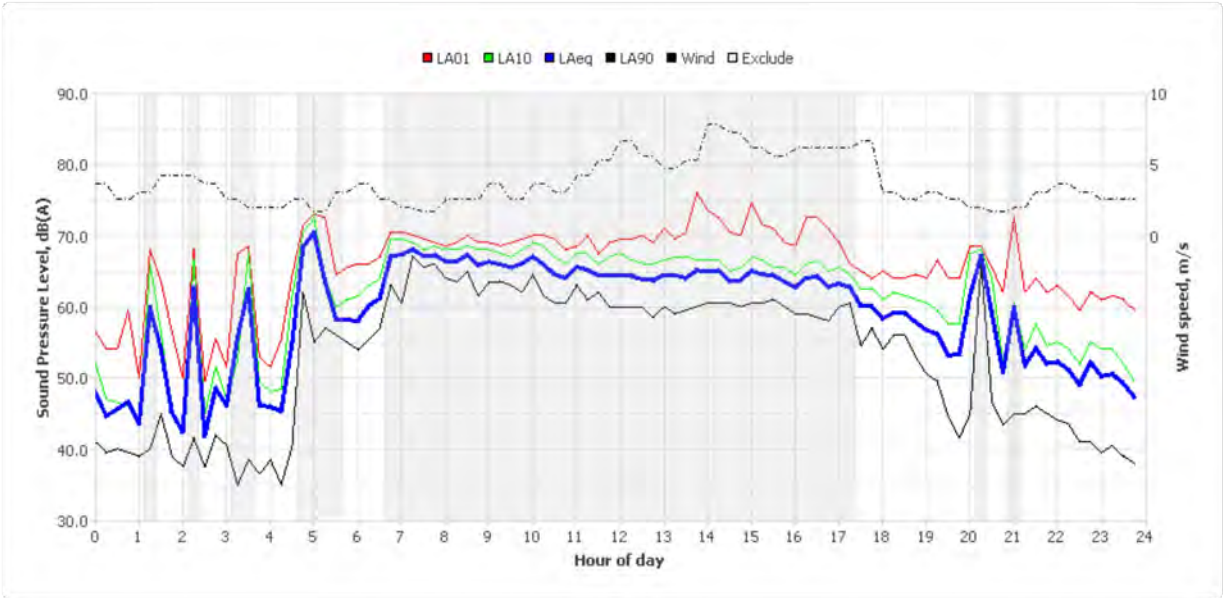

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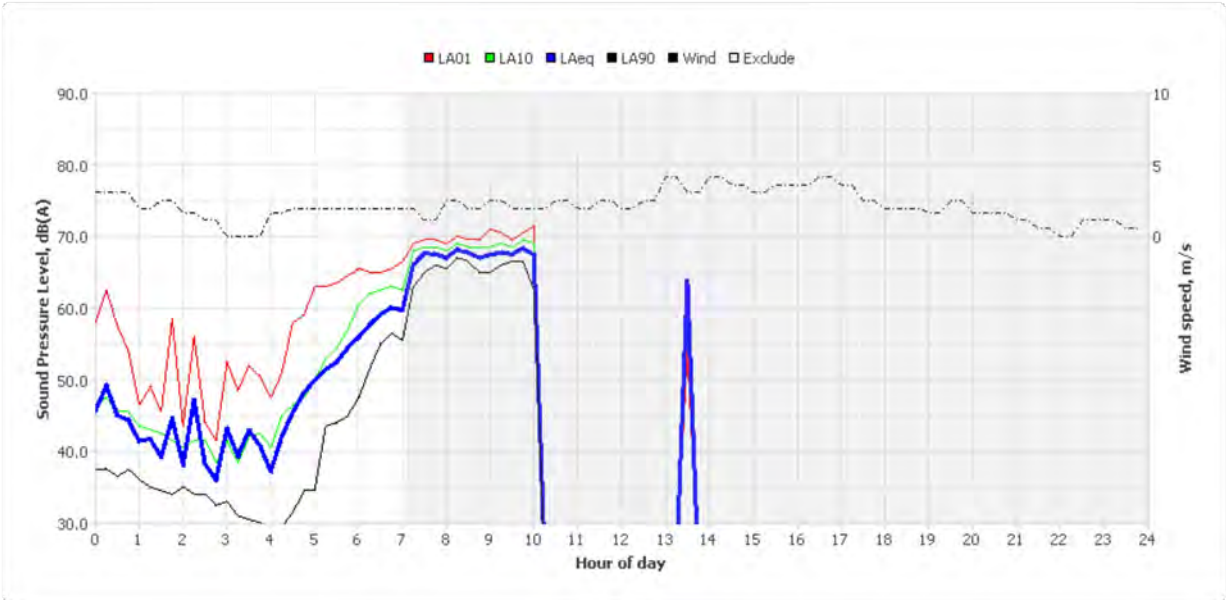


Noise Logger Report

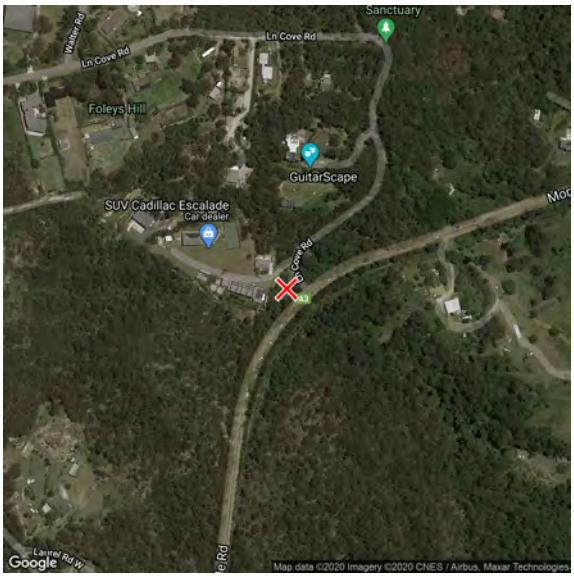
91 Lane Cove Road, Ingleside

Item	Information
Logger Type	ARL 315
Serial number	15-299-444
Address	91 Lane Cove Road, Ingleside
Location	Front Yard
Facade / Free Field	Free Field
Environment	Cicadas very loud. Traffic along Mona Vale Road also noted.

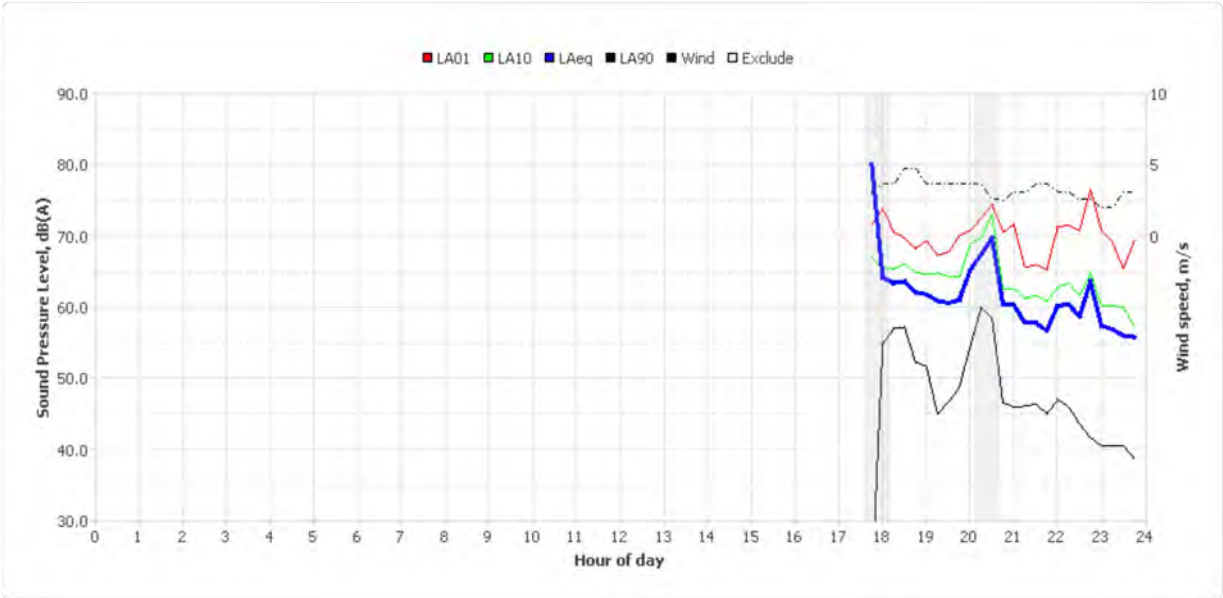
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Tue Dec 3 2013	-	61	59	-	-	-	61	59
Wed Dec 4 2013	68	64	59	-	-	35	66	59
Thu Dec 5 2013	65	61	61	-	44	-	64	61
Fri Dec 6 2013	65	61	58	-	45	33	64	58
Sat Dec 7 2013	69	64	57	-	-	32	65	57
Sun Dec 8 2013	-	67	58	-	-	34	67	58
Mon Dec 9 2013	69	58	60	-	-	37	66	60
Tue Dec 10 2013	-	61	65	-	-	-	61	65
Wed Dec 11 2013	-	-	59	-	-	-	-	59
Summary	**68**	**63**	**60**	**-**	**44**	**34**	**65**	**60**

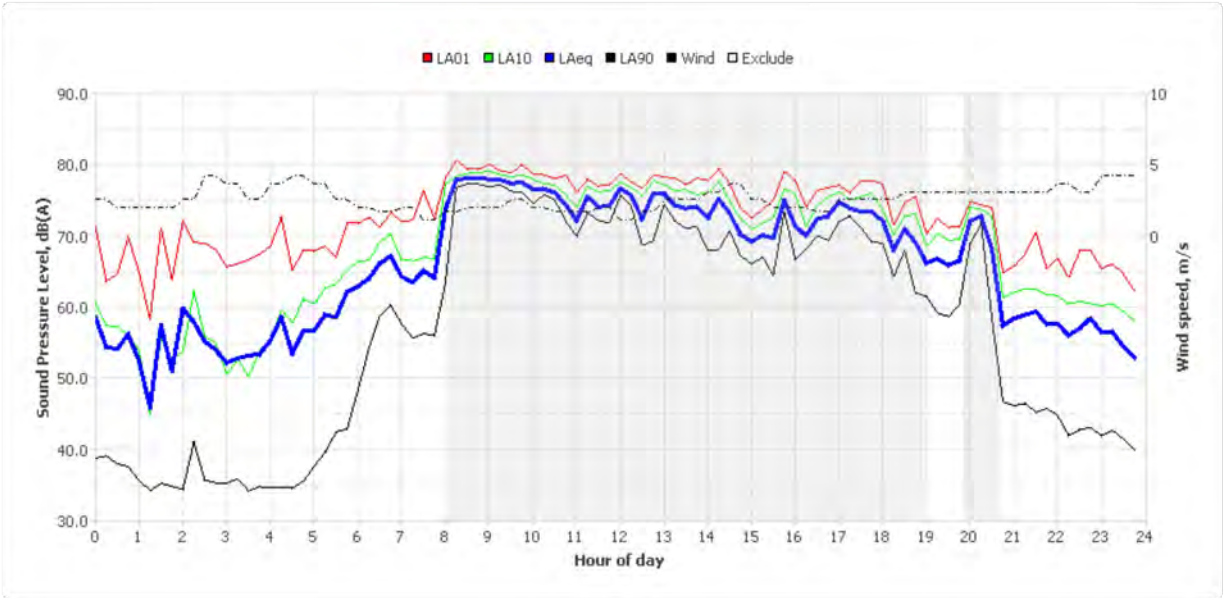
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

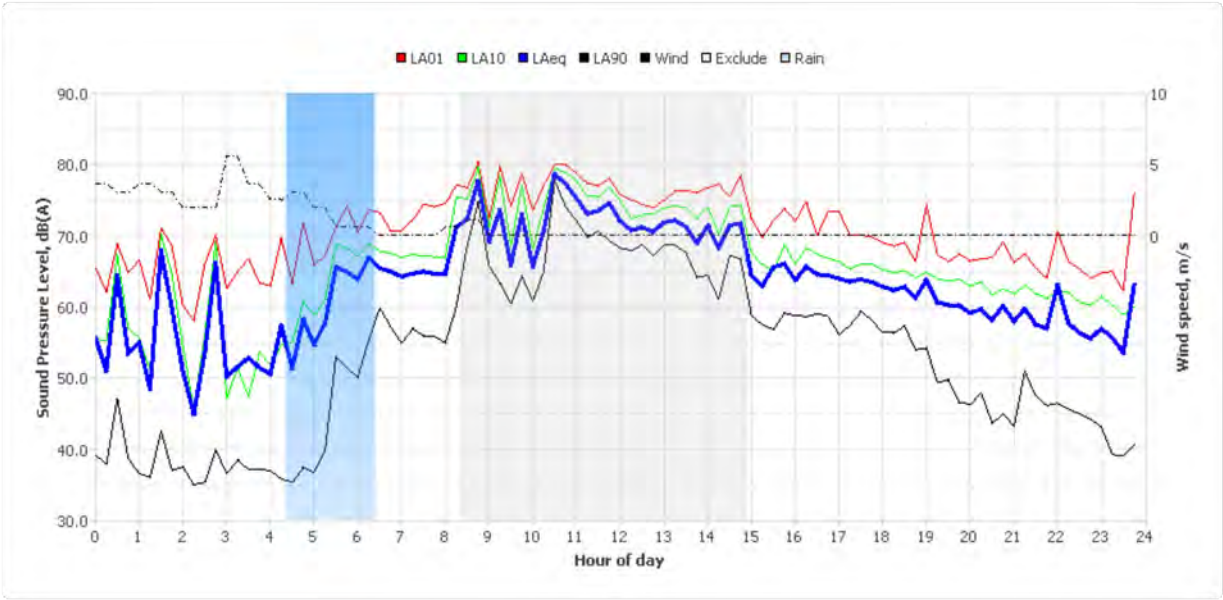
Tuesday, 03 Dec 2013



Wednesday, 04 Dec 2013



Thursday, 05 Dec 2013



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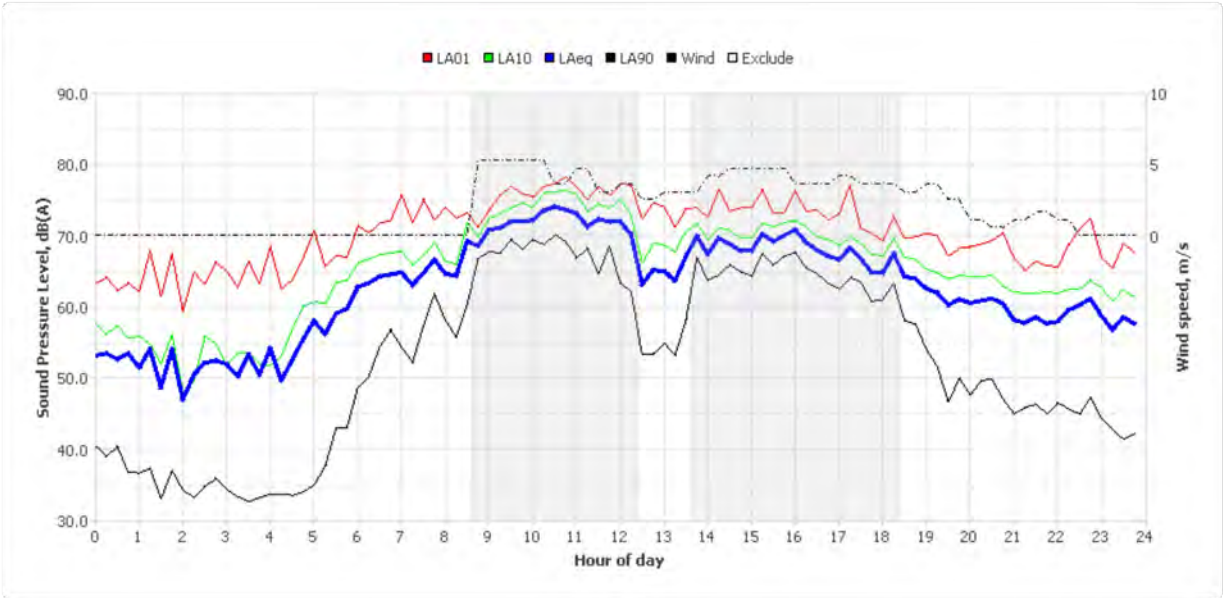
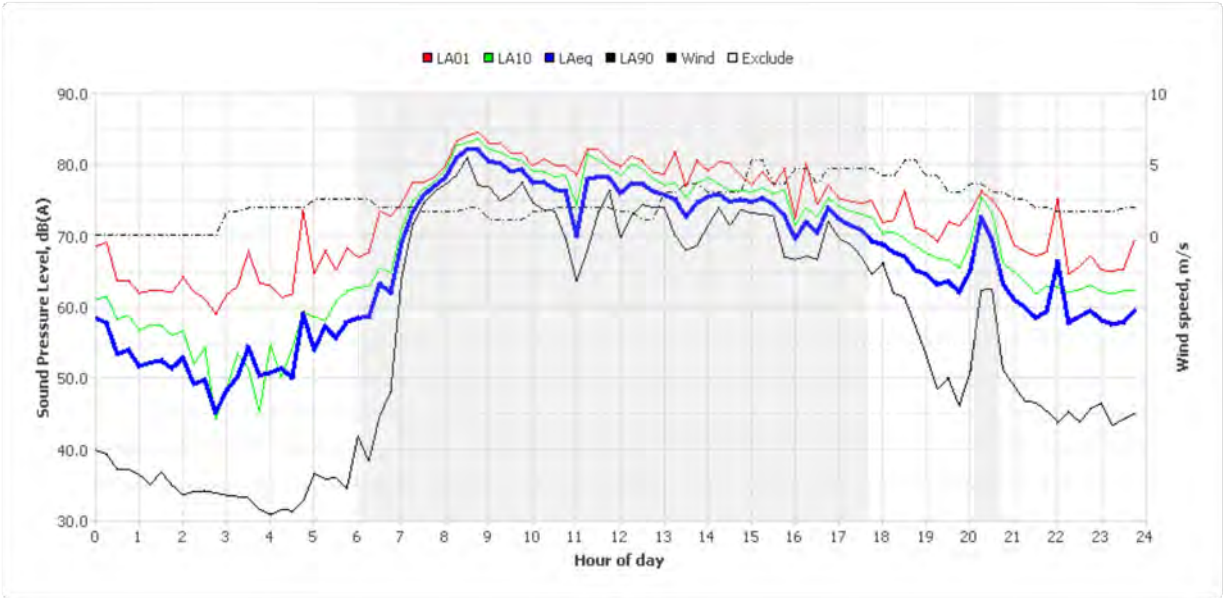


Saturday, 07 Dec 2013



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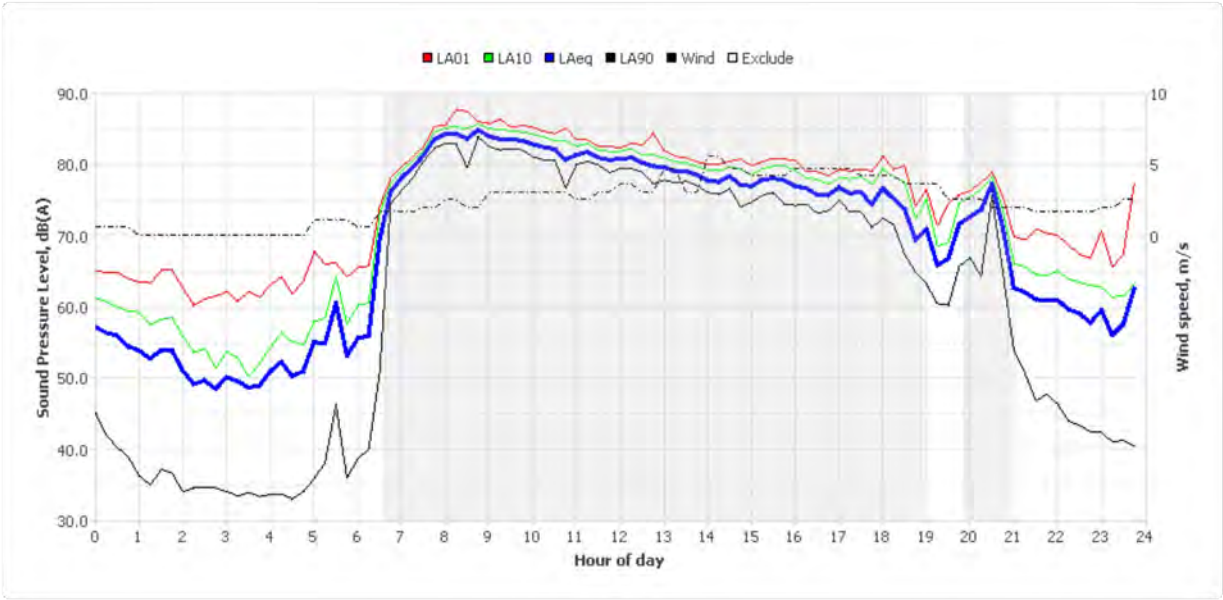

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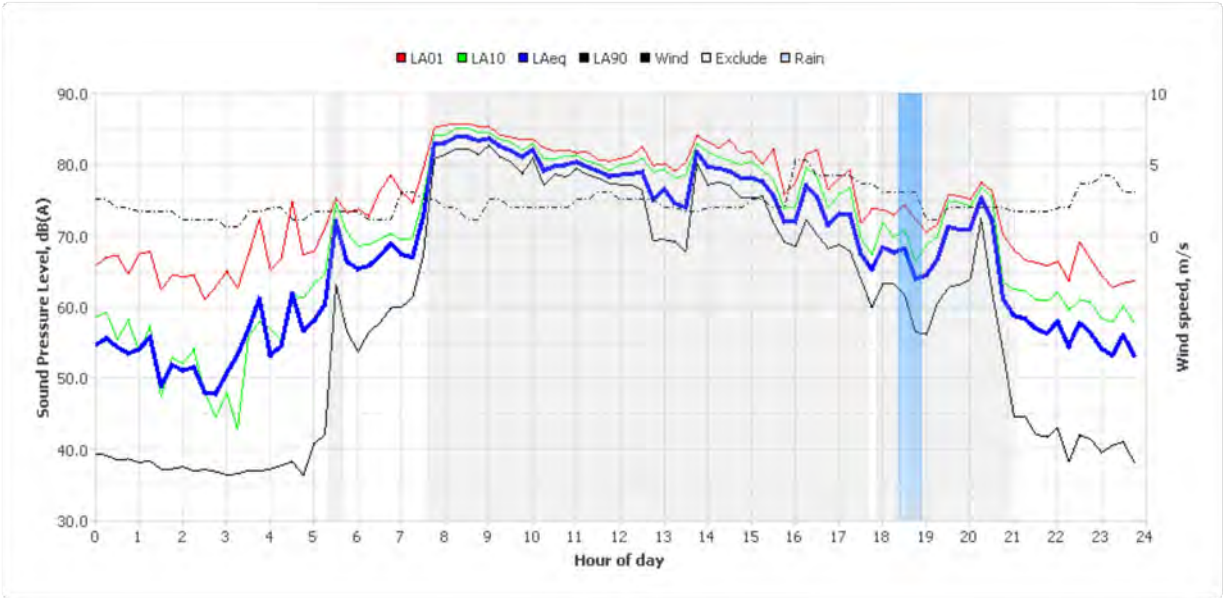

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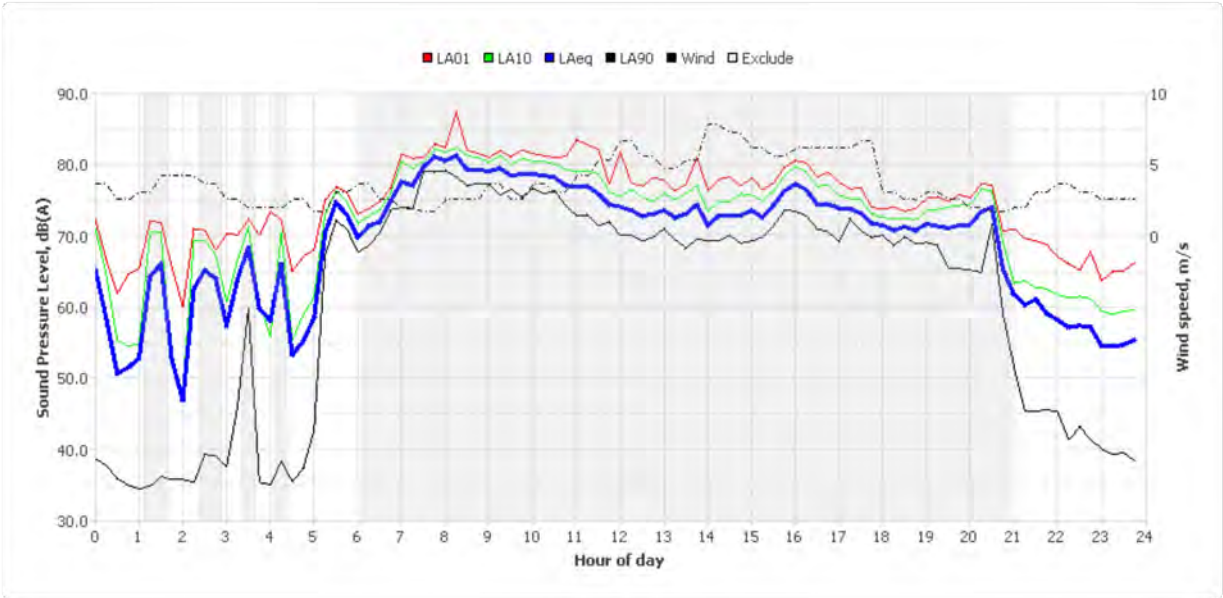

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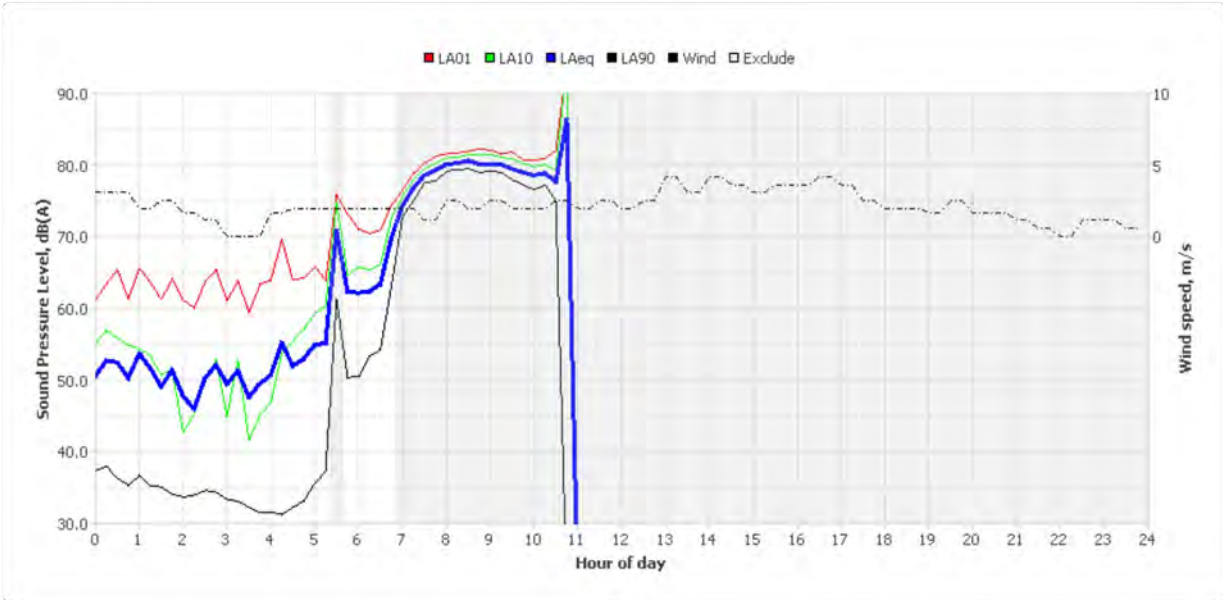


Appendix C

Traffic Volumes

Appendix C Traffic Volumes

Road	Day 15 hour		Night 9 hour		Speed, km/h
	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	
2013 Existing					
Mona Vale Road, 150 m east of Tumburra St	15075	1020	1494	153	75
Mona Vale Road, 500 m east of Lane Cove Rd	9000	660	963	108	60
Mona Vale Road, Btwn Foley St and Oliver Way	9570	615	882	99	60
Mona Vale Road, 150 m east of Tumburra St	14595	1140	2115	198	75
Mona Vale Road, 500 m east of Lane Cove Rd	8610	720	1296	90	60
Mona Vale Road, Btwn Foley St and Oliver Way	8850	1020	1026	135	60
Powderworks Road, Btwn Wattle Rd and Wilson Ave	5130	225	405	18	60
Powderworks Road, Btwn Wattle Rd and Wilson Ave	4980	180	756	36	60
Lane Cove Rd	3015	75	306	9	55
2036 No Build					
Mona Vale Road, west of Powderworks Road EB	20820	1693	2202	269	80
Mona Vale Road, west of Powderworks Road WB	19571	1878	3353	338	80
Mona Vale Road, East of Manor / Lane Cove Road EB	16585	1515	1918	260	80
Mona Vale Road, East of Manor / Lane Cove Road WB	15242	1603	2750	197	80
Powderworks Road, south of Mona Vale Rd EB	4344	277	367	4	60
Powderworks Road, south of Mona Vale Rd WB	5518	56	980	20	60
Lane Cove Rd, North of Mona Vale Road both directions	3194	135	459	9	60
2036 Build					
Mona Vale Road, west of Powderworks Road EB	25817	2100	2730	333	80
Mona Vale Road, west of Powderworks Road WB	24475	2348	4193	422	80
Mona Vale Road, East of Manor / Lane Cove Road EB	18534	1693	2143	290	80
Mona Vale Road, East of Manor / Lane Cove Road WB	17186	1808	3101	221	80
Powderworks Road, south of Mona Vale Rd EB	5907	377	500	5	60
Powderworks Road, south of Mona Vale Rd WB	7364	74	1308	27	60
Lane Cove Rd, North of Mona Vale Road both directions	6591	298	907	12	60

Appendix D

Noise Contour Maps

AECOM

Legend

- Receivers
- Existing Road Alignment
- Noise Catchment Area

© Department of Customer Service 2020

$L_{Aeq\ (15hour)}$ dB(A)

60 65

INGLESIDE RELEASE AREA

Operational Noise Contours - 2036 Daytime

0 250 500 1,000 m

N

Nov 2020

60312114

Fig. **1**

AECOM

Legend

- Receivers
- Existing Road Alignment
- Noise Catchment Area

© Department of Customer Service 2020

$L_{Aeq(9hour)}$ dB(A)

55 60

INGLESIDE RELEASE AREA

Operational Noise Contours - 2036 Night-time

0 250 500 1,000 m

N

Nov 2020

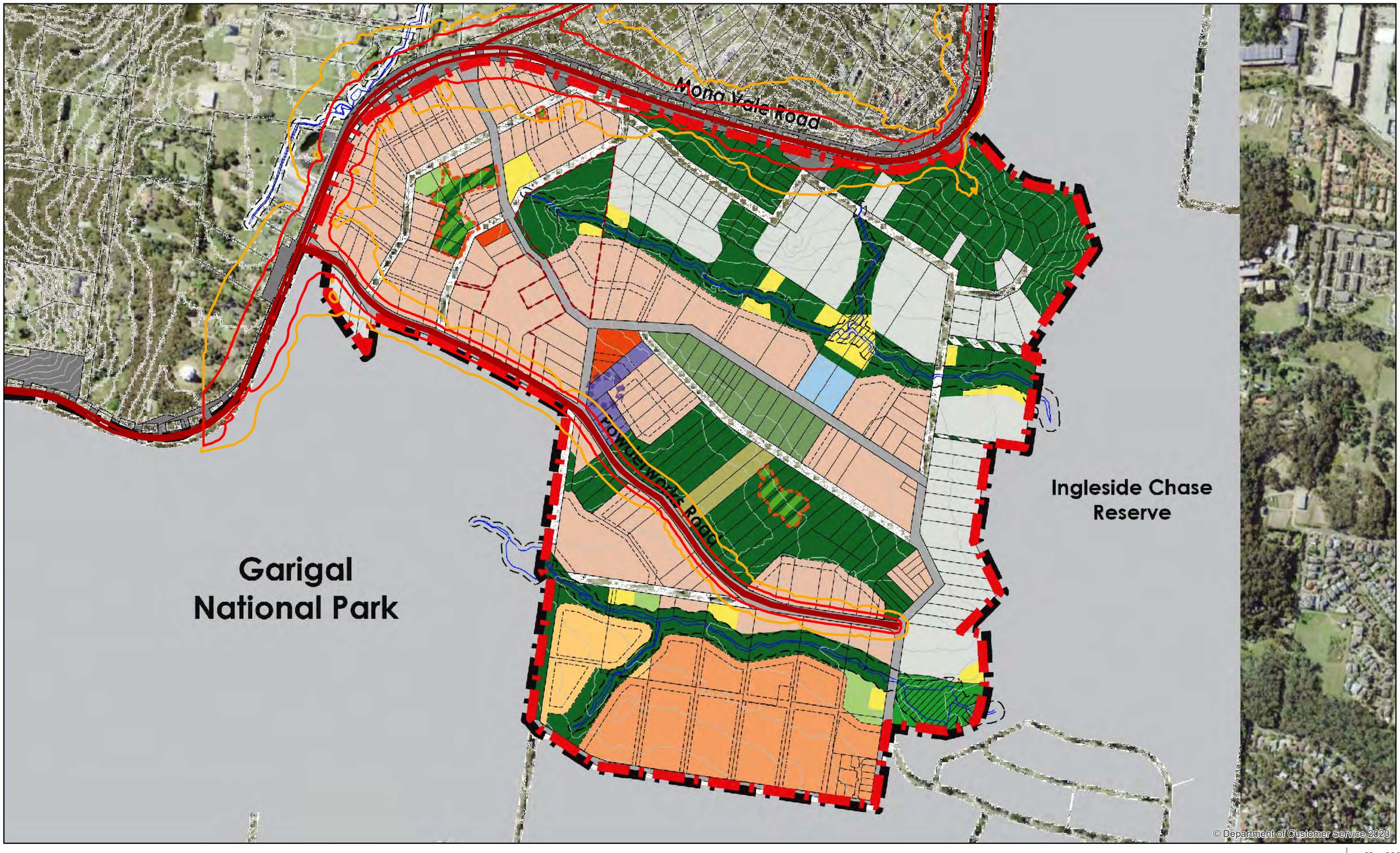
60312114

Fig. **2**

Appendix E

Structure Plan with Predicted Road Traffic Noise Levels

AECOM



$L_{Aeq\ (15hour)}$ dB(A)

60

65

INGLESIDE RELEASE AREA

Operational Noise Contours - 2036 Daytime

0 250 500 1,000 m

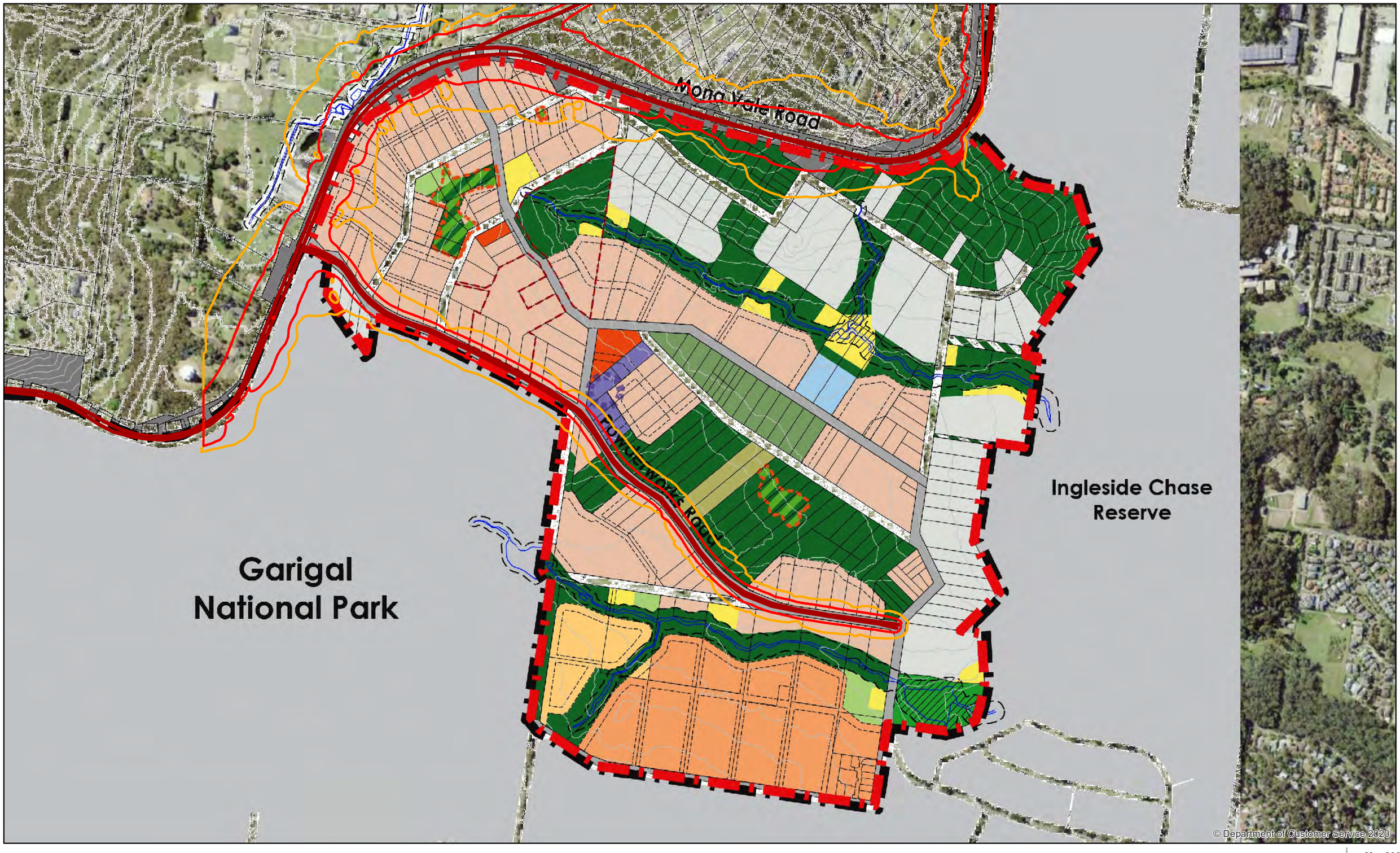
N

Mar 2021

60312114

Fig. **1**

AECOM



$L_{Aeq(9hour)}$ dB(A)

55

60

INGLESIDE RELEASE AREA

Operational Noise Contours - 2036 Night-time

0 250 500 1,000 m

N

Mar 2021

60312114

Fig. **1**