Operational Noise Management

IFC Design Documentation

PACIFIC HIGHWAY UPGRADE
OXLEY HIGHWAY TO KUNDABUNG

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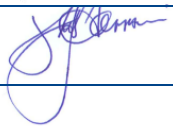
Reviewed by *(Package Manager)*	Matthew Harrison	Technical Discipline Manager	11 February 2015	
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Glossary of terms and abbreviations

AHD	Australian height datum
Ch	Chainage
CORTN	Calculation of Road Traffic Noise
dB	Un-weighted noise level, or the change between two un-weighted or weighted noise levels
dBA	'A weighted' noise level, which corresponds to the response of the human ear
EA	Environmental Assessment
ECRTN	Environmental Criteria for Road Traffic Noise
ENMM	Environmental Noise Management Manual
EPA	Environment Protection Authority
FDD	Final Design Documentation
GDA	Geocentric Datum of Australia
IFC	Issued for Construction
INP	Industrial Noise Policy
NB	Northbound
OH2Ku	Oxley Highway to Kundabung
RMS	Roads and Maritime Services
SB	Southbound
SDD	Substantial Detailed Design
SWTC	Scope of Works and Technical Criteria

1 Introduction

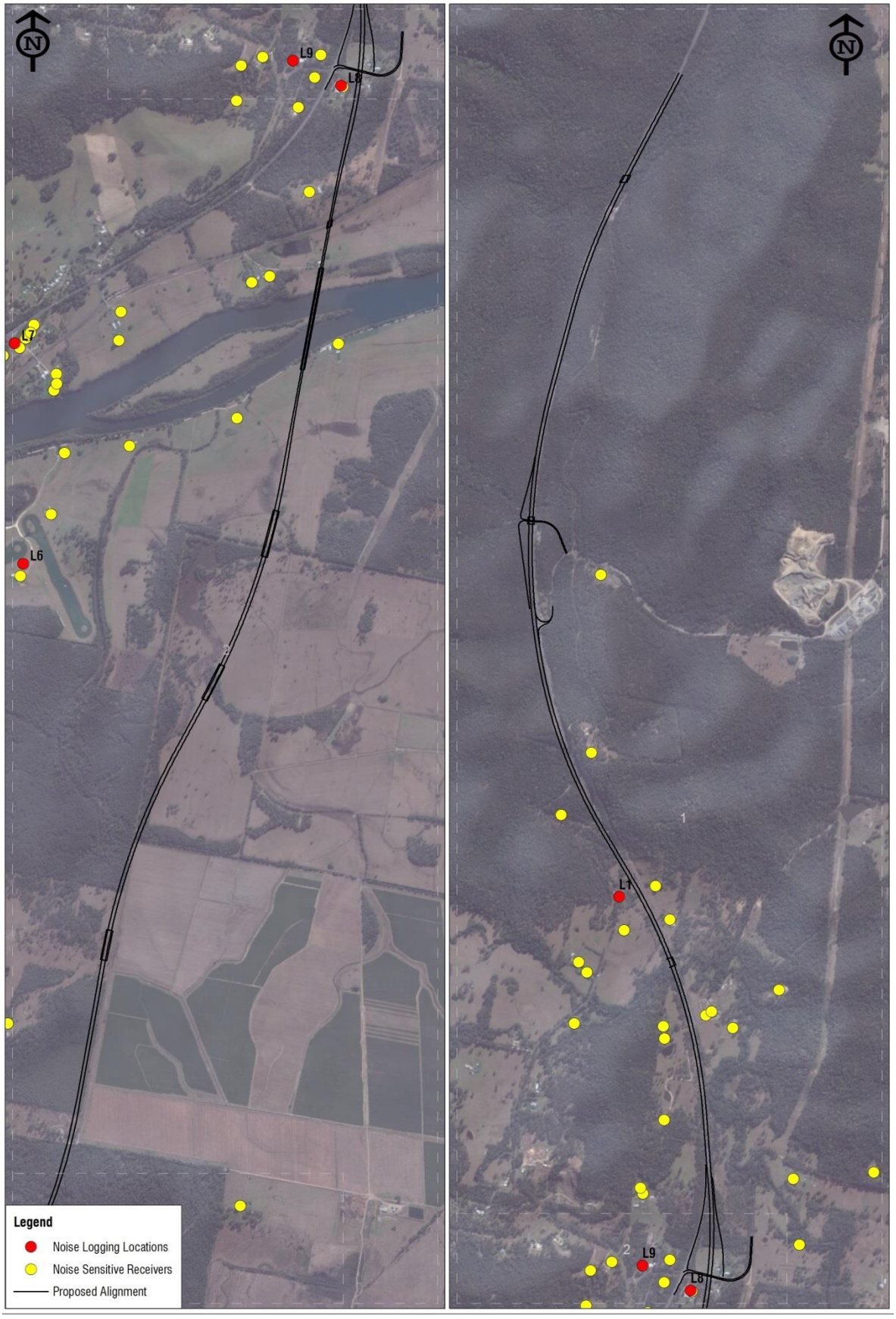
The Oxley Highway to Kempsey section of the Pacific Highway upgrade received project approval in February 2012. The 37 km upgrade is to be delivered in two sections – Oxley Highway to Kundabung and Kundabung to Kempsey.

The Oxley Highway to Kundabung project (OH2Ku) comprises the construction of 23 km of new dual-carriageway highway including four grade separated interchanges at Sancrox Road, Hastings River Drive, Haydens Wharf Road and Yarrabee Road. Major river crossings at the Hastings and Wilsons Rivers and the North Coast Railway also form significant parts of the project. The project will connect to the existing Pacific Highway just north of the Oxley Highway interchange in the south and to the Kundabung to Kempsey upgrade section (being done by others) at Kundabung. Figure 1 illustrates the OH2Ku project area.

Development of the detailed design and construction of the project is being delivered through Lend Lease Engineering Pty Ltd (Lend Lease). Construction of the project commenced in November 2014.

SLR Consulting Pty Ltd (SLR) has been commissioned by Lend Lease to provide documentation for the detailed design of the OH2Ku project. This includes ambient noise monitoring and simultaneous traffic counting, noise modelling and calculation and a review of the operational noise mitigation measures for the detailed design of the project. The work is conducted in accordance with the Planning and Infrastructure Minister's Conditions of Approval (MCoA). Section 4.19 (Noise Mitigation) and Section 4.20 (Operational Noise Management Report) of the Scope of Works and Technical Criteria (SWTC) for the project references condition C13 of the MCoA which requires an operational noise mitigation review.

Figure 1 OH2Ku Project Area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2 Project Conditions of Approval

The Planning and Infrastructure Minister's Conditions of Approval (MCoA) for OH2Ku are mandatory requirements for the project. Sections 4.19 and 4.20 of the SWTC references condition C13 of the MCoA, which is provided below:

C13. Operational Noise Mitigation Review

Unless otherwise agreed to by the Director General, within six months of commencing construction, the Proponent shall in consultation with EPA prepare and submit for the approval of the Director General, a review of the operational noise mitigation measures proposed to be implemented for the project. The review shall:

(a) confirm the operational noise predictions of the project based on detailed design. This operational noise assessment shall be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring, where necessary for calibration purposes). The assessment shall specifically include verification of noise levels at the Mingaetta Road rest areas, based on additional noise monitoring undertaken at this location;

(b) review the suitability of the operational noise mitigations measures identified in the documents listed under condition A1 to achieve the criteria outlined in the Environmental Criteria for Road Traffic Noise (Environment Protection Authority, 1999), based on the operational noise performance of the project predicted under (a) above; and

(c) where necessary, investigate additional feasible and reasonable noise mitigation measures to achieve the criteria outlined in the Environmental Criteria for Road Traffic Noise (Environment Protection Authority, 1999.

This report constitutes the required review addressing MCoA C13. Note in relation to the requirement to address noise levels at the Mingaetta Road rest areas in item a) above, this area is in the second section of the upgrade which is outside the scope of Lend Lease's contract and therefore not covered in this report.

3 Assessment Terminology

3.1 Noise and Vibration Terminology

A detailed description of the acoustic terminology used within this report is presented in **Appendix A**.

3.2 Operational Assessment Years

Throughout this Operational Noise Management Report, reference is made to two assessment situations: the Future *Existing* and the Future *Design* scenarios.

These are used to assess the noise impact of new and redeveloped road projects in accordance with the requirements of:

Environmental Criteria for Road Traffic Noise (ECRTN) (NSW EPA, 1999)

Environmental Noise Management Manual (ENMM) (RMS, 2001)

The two ECRTN-related assessment years are described as follows:

The Future *Existing* scenario represents the 'baseline' scenario and is used to determine the level of road noise, in the absence of the OH2Ku Project, predicted at the year of opening of the proposed upgrade project. This scenario makes use of the road alignment in its existing geometry, with traffic volumes extrapolated to the project opening year by applying an incremental factor to measured existing flows.

The *Future EXISTING* year is 2016.

The Future *Design* scenario represents the 'assessment' scenario for the OH2Ku and includes the proposed new alignment for the project, together with future traffic volumes predicted to 10 years after the scheduled project opening year.

The *Future DESIGN* year is 2026.

A third base line scenario was also modelled for the purposes of validating the SoundPLAN noise model developed for the project against the ambient noise survey data.

The *Model VALIDATION* year is 2014.

4 Operational Noise Criteria

4.1 Environmental Criteria for Road Traffic Noise (ECRTN)

In May 1999, the NSW EPA issued the *Environmental Criteria for Road Traffic Noise* (ECRTN). This document provides guidance for assessing traffic noise impacts through setting design objectives for a range of development types and provides procedures for determining noise mitigation in situations where exceedances of the objectives occur.

The ECRTN embodies a non-mandatory performance-based approach. The proposed criteria are to be applied as targets, applicable to the future volumes of traffic projected to occur in 10 years' time.

4.2 Environmental Noise Management Manual (ENMM)

The RMS's Environmental Noise Management Manual (ENMM) was issued in December 2001 and provides guidance in managing and controlling road traffic generated noise.

The ENMM recognises that the base criteria recommended by the ECRTN are not always practicable and that it is not always feasible or reasonable to expect that they should be achieved.

The ENMM notes that the most effective way of minimising noise from vehicles and traffic is to control vehicle noise at the source. Where source measures are not practical, or do not provide sufficient noise reduction, additional methods are required to reduce levels to within an acceptable range. Such additional methods may include the use of noise walls and/or consideration for architectural treatment of residences.

The ENMM also uses the term 'acute'. This refers to properties which are exposed to higher levels of road traffic generated noise (specifically at least 65 dBA $L_{Aeq(15hr)}$ or 60 dBA $L_{Aeq(9hr)}$). In operational road traffic noise assessments, consideration for noise mitigation treatment is typically given to properties within the project area that experience acute levels of noise at the project design year even when there is no change in noise level due to the project.

4.3 Classification of the OH2Ku Project

The ENMM defines a "new road traffic noise source" as being:

- A new road where a road of the same category (ie arterial, collector or local road) did not previously exist;
- A new road within an existing but previously undeveloped road corridor; or
- An alignment or realignment producing noise at a receptor from a different direction which makes a "significant contribution to noise exposure".

To determine whether the noise contribution attributable to the new emission direction is "significant", it is necessary to subtract the road traffic noise contribution generated from the existing alignment (after any road redevelopment or upgrade on this alignment) from the combined noise exposure. If the new noise emission direction is found to produce a "significant" contribution, the new alignment or realignment is a "new noise road traffic noise source".

When considering noise from a new direction, in instances where the most exposed facade of a residence does not have an existing road traffic noise exposure then the 'new road' criteria are applicable.

The ENMM notes that at locations where there is a transition between road development types (ie at the intersection of a new road or realignment with an existing or redeveloped road), it is necessary to assess each noise-sensitive receiver separately, facade by facade, relative to the road traffic noise source(s) under consideration and their noise contribution in order to determine whether the 'new road' or 'redeveloped road' criteria apply.

The result of this process is that different criteria can be applicable to different facades of the same residence, depending on their orientation to the existing and new sources of road traffic noise.

In situations where the existing ambient noise levels already exceed the baseline ECRTN criteria an 'allowance' criterion is applicable. For redeveloped roads this allowance criterion limits the noise increase from the project under consideration to no more than 2 dB. For a new road the allowance criterion is 0.5 dB. These allowances are however only applicable after all reasonable and feasible noise mitigation measures have been considered and implemented.

The applicable criteria for the OH2Ku project for residential receivers are provided in **Table 1**.

Table 1 ECRTN Daytime and Night-time Criteria for Residential Receivers

Type of Development	Daytime Criteria (7 am to 10 pm)	Night-time Criteria (10 pm to 7 am)	Where Criteria Are Already Exceeded
New freeway/arterial road corridor	LAeq(15hour) 55 dBA	LAeq(9hour) 50 dBA	The new road should be designed so as not to increase existing noise levels by more than 0.5 dBA.
Redevelopment of existing freeway/arterial road	LAeq(15hour) 60 dBA	LAeq(9hour) 55 dBA	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dBA.

4.4 Scope of Works and Technical Criteria (SWTC)

Noise mitigation measures for the project are to be designed such that the noise outcomes meet the requirements of Appendix 4 and Appendix 9 of the project Scope of Works and Technical Criteria (SWTC). The SWTC provides contractual requirements to ensure that the project complies with the MCoA C13 and the criteria outlined in the ECRTN. The ECRTN criteria apply for the future 10 years after opening, which in this instance is nominated to be 2026.

Accordingly for Year 2026, daytime LAeq(15hour) and night-time LAeq(9hour) noise levels at any other noise sensitive receiver location must comply with the ECRTN and RTA's Environmental Noise Management Manual (ENMM) criteria. The term noise sensitive receiver is as defined in the ENMM (including those that have been constructed or have been granted development approval by the relevant Authority under the provisions of the Environmental Planning and Assessment Act 1979 prior to September 2010).

In addition to the above criteria, the RTA's ENMM provides criteria associated with "acute" noise impacts. Where noise levels are predicted to be at or above the acute noise level thresholds indicated below, and cannot be achieved as part of the road design in a feasible and reasonable manner via quieter pavement surfaces, noise walls or noise mounds, architectural treatments of individual private dwellings are normally required to provide an acceptable indoor amenity.

- LAeq(15hour) (day) ≥ 65 dBA

- LAeq(9hour) (night) ≥ 60 dBA

In developing the noise mitigation design, Appendices 4 and 9 of the SWTC provide details relating to the computer noise modelling requirements, including traffic volumes, speeds, calculation methods and minimum mitigation measures (including areas of low noise pavements). These assumptions and the extent of the proposed mitigation measures are documented in the following sections.

SWTC Appendix 4 Section 4.19(a) notes that at-residence noise mitigation treatments will be undertaken by RMS and that the Contractor must not undertake any at-residence treatments to address the operational noise mitigation requirements. The Contractor should comply with the operational noise mitigation requirements using noise mitigation treatments other than at-residence treatments.

The appendix also notes in SWTC Appendix 4 Section 4.19(c) that notwithstanding the requirements of Practice Note ii of ENMM, noise mitigation measures are not required at commercial or industrial premises.

5 Description of the Existing Environment

5.1 Ambient Noise Surveys and Monitoring Locations

In order to characterise the existing ambient noise environment across the project area, environmental noise monitoring was performed at 10 representative locations during May 2014.

These locations, as indicated in **Table 2** and on the site plan in **Appendix B**, are the same as those used for the Environmental Assessment to maintain consistency. The locations were selected in accordance with Section 4.20 of Appendix 4 of the SWTC and giving consideration to other noise sources in the area which may adversely influence the measurements, security issues for the noise monitoring devices and gaining permission for access from the resident or landowner.

5.2 Methodology for Unattended Noise Monitoring

The purpose of the unattended noise monitoring is to determine the existing L_{Aeq}, L_{A90} and other relevant statistical noise levels during the daytime, evening and night-time periods.

Unattended noise loggers were deployed adjacent to sensitive receivers over a minimum period of one week in order to measure the prevailing levels of ambient noise. The measurements were generally conducted at a height of 1.5 m above the local ground level.

All noise measurement instrumentation used in the surveys was designed to comply with the requirements of Australian Standard AS IEC 61672.12004 *Electroacoustics – Sound level meters, Part 1: Specifications* and carried appropriate and current NATA calibration certificates.

The equipment utilised for the continuous unattended noise surveys comprised of Svantek Type 957 noise loggers and ARL Type 316 noise loggers. All noise loggers were fitted with microphone wind shields. The calibration of the loggers was checked before and after each measurement survey, and the variation in calibration at all locations was found to be within acceptable limits at all times. All noise loggers were set to record statistical noise descriptors in continuous 15 minute sampling periods for the duration of their deployment.

The results of the noise monitoring have been processed with reference to the procedures contained in the NSW EPA Industrial Noise Policy (INP) so as to establish representative sensitive receiver noise levels.

Weather data recorded during the noise monitoring survey periods by the Bureau of Meteorology (at Port Macquarie) was used to assist in identifying potentially adverse weather conditions, such as excessively windy or rainy periods, so that weather affected data could be discarded. Based on the meteorological results, rain and wind affected results have been excluded from the summary results, which is shown in **Appendix C** was minimal

5.3 Unattended Noise Monitoring Results

The results of the unattended ambient noise surveys are presented in **Table 2** and **Table 3**, with the 24 hour noise level plots for each monitoring location being shown graphically in **Appendix C**.

Representative Rating Background Levels (RBLs) and L_{Aeq} (energy averaged) noise levels during the standard INP defined daytime, evening and night-time hours are shown in **Table 3**, together with the ECRTN defined daytime $L_{Aeq(15hour)}$ and night-time $L_{Aeq(9hour)}$ noise indices.

Table 2 Summary of Noise Logging Locations

Loc.	Address	Nearest Source of Significant Road Traffic Noise	
		Approx. Distance (m)	Road
L1	Koala Park - 61 Billabong Drive, Sancrox	20	Existing Pacific Highway
L2	Cassegrain Winery - 764 Fernbank Road, Sancrox	13	Existing Pacific Highway
L3	15 Glen Ewan Road, Sancrox	150	Glenn Ewan Road and Existing Pacific Highway
L4	77 Moorside Drive, Telegraph Point	765	Localised noise sources
L5	8656 Pacific Highway, Telegraph Point	65	Existing Pacific Highway
L6	16 Hacks Ferry Road, Telegraph Point	670	Existing Pacific Highway
L7	5 Cooperabung Drive, Telegraph Point	47	Existing Pacific Highway
L8	8 Haydons Wharf Road, Telegraph point	55	Existing Pacific Highway
L9	3 Wyndell Close, Cooperabung	205	Existing Pacific Highway
L10	890 Cooperabung Drive, Cooperabung	110	Existing Pacific Highway

Table 3 Summary of Unattended Noise Logging – INP and ECRTN Periods

Loc.	Noise Level (dBA)							
	INP Periods						ECRTN Periods	
	RBL			L_{Aeq}			L_{Aeq}	
	Daytime (7am to 6pm)	Evening (6pm to 10pm)	Night-time (10pm to 7am)	Daytime (7am to 6pm)	Evening (6pm to 10pm)	Night-time (10pm to 7am)	Daytime $L_{Aeq(15hour)}$ (7am to 10pm)	Night-time $L_{Aeq(9hour)}$ (10pm to 7am)
L1	49	44	36	67	66	65	66	65
L2	50	44	42	65	64	63	65	63
L3	41	42	36	53	52	50	53	49
L4	32	37	35	49	46	46	49	46
L5	47	46	38	64	63	62	63	62
L6	34	38	34	48	50	47	48	47
L7	48	40	35	65	64	63	65	63
L8	48	41	37	61	59	58	60	58
L9	38	37	34	49	45	45	49	45
L10	49	41	35	64	63	62	64	62

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the INP.

Note 2: The INP requires that where the RBL is found to be less than 30 dBA, then it is set to 30 dBA.

Note 3: Reference to the noise logging data indicates that the prevailing L_{Aeq} noise level is dominated by typical rural environmental sources of ambient noise and not traffic noise at locations L4, L6 and L9.

5.4 Attended Airborne Noise Measurements

Attended noise measurements were undertaken at the noise logger locations listed in Table 2 and illustrated in **Figure 1** in order to quantify the relative contributions from the various noise sources in the vicinity of the unattended noise monitoring locations.

At each location, measurements were performed using a Brüel & Kjær Type 2260 sound level meter for a minimum period of 15 minutes. Calibration of the sound level meter was checked before and after each measurement and the variation in calibration at all locations was found to be within acceptable limits at all times.

During each of the attended noise measurements the observer noted the various noise sources and levels influencing the ambient noise environment. A summary of the measured noise levels and observations is provided in **Appendix C**.

6 Road Traffic Noise Assessment Methodology

In developing the OH2Ku noise model, Appendices 4 and 9 of the SWTC provide details relating to the computer noise modelling requirements, including traffic volumes, speeds, calculation methods and minimum mitigation measures (including areas of low noise pavements). These assumptions and the extent of the proposed mitigation measures are documented in the following sections.

6.1 SoundPLAN and CORTN Modelling Parameters

A three-dimensional computer noise model was developed as part of the Operation Noise Assessment for the project in accordance with SWTC Appendix 4.19 (i) (iii). Noise modelling of the project area was carried out using the UK Department of Transport, Calculation of Road Traffic Noise (CoRTN 1988) algorithms incorporated in SoundPLAN V7 noise software.

The modelling allows for traffic volume and mix, type of road surface, vehicle speed, road gradient, reflections off building surfaces, ground absorption and shielding from ground topography and other physical barriers.

The CoRTN algorithm implemented by SoundPLAN predicts the $L_{A10(18hour)}$ noise level for the daytime period and $L_{A10(1hour)}$ noise level for the night-time period. Adjusted daytime and night-time traffic flows are used for the $L_{A10(18hour)}$ calculation and night-time $L_{A10(1hour)}$ calculation. The calculated noise levels are corrected to the NSW daytime $L_{Aeq(15hour)}$ noise descriptor and night-time to the $L_{Aeq(9hour)}$ noise descriptor with a 3 dB correction being applied.

The SoundPLAN noise model calculates noise levels at receiver points for each facade of each noise sensitive receiver over the entire project area. The daytime $L_{Aeq(15hour)}$ and night-time $L_{Aeq(9hour)}$ noise emission levels at noise sensitive receivers were computed for the entire project area.

Design Inputs

The various noise modelling design inputs and assumptions which have been used in this assessment are detailed in **Table 4**. These design inputs are consistent with those specified in the SWTC for the project.

Table 4 Design Inputs and Assumptions

Input / Assumption	Description	
Noise Modelling Scenarios		
Year 2016 (at opening) and Year 2026 (ten years after opening)	LAeq(15hour) daytime (7.00 am to 10.00 pm) and LAeq(9hour) night-time (10.00 pm to 7.00 am) Consistent with the requirements of ECRTN, ENMM and SWTC.	
Acoustic Parameters		
Noise source heights / correction: Cars: Heavy vehicle Tyres: Engines: Exhausts:	 0.5 m 0.5 m 1.5 m 3.6 m	A three source height noise model has been used and the heights are known to be representative of Australian conditions. The three heights are as per the requirements of Appendix 4.19(i) (iv) of the SWTC. Correction factors of -5.4dB were applied to the heavy vehicle tyre component, -2.4dB to the engine component and -8.4dB to the exhaust component.

Input / Assumption	Description	
Pavement corrections: Concrete: Dense graded asphalt: Stone mastic asphalt:	 +3.0 dB +0.0 dB -2.0 dB	As per requirements of Appendix 4.19(i) (v) of the SWTC. The pavement corrections were applied to the car source component and the heavy vehicle tyre component
Minimum receiver height: Ground: First:	 1.5m 4.5m	As per requirements of Appendix 4.19(i) (vi) of the SWTC.
Ground Absorption: Grass: Bushland: Water:	 75% 100% 0%	As per requirements of Appendix 4.19(i) (vii) of the SWTC.
Noise Contour Calculations: Max. Search Radius: Grid Space: Height above ground:	 2500m 20m 1.5m	As per requirements of Appendix 4.19(i) (viii) and (ix) of the SWTC.
Calibration: Daytime: Night-time:	 -0.2 dB +0.5 dB	The daytime and night-time validation factors were added to the existing and future noise model based on the May 2014 measured noise levels minus the modelled noise levels. The differences show a general trend of the noise model being an under-prediction of 0.5 dB for the night-time period and an over prediction of 0.2 dB for the daytime period. As per requirements of Appendix 4.19(i) (x) of the SWTC.
Safety Factor:	1.0 dB	Add a safety factor of 1.0 dB to the 'build' and 'no-build' noise levels. The safety factor should not contribute to the 2 dB feasible and reasonable allowance. The above adjustment is a requirement of Appendix 4.19(i) (xii) of the SWTC.
Facade Reflections: ARRB Australian condition correction:	+2.5 dB -1.7 dB Façade reflection -0.7 dB Free field	A 2.5 dB facade reflection in accordance with the UK developed CoRTN model and ARRB corrections to account for Australian conditions are required to be added to the noise level predictions at 1 m from a façade and also for free field predictions as per Appendix 4.19(i) (xiii) of the SWTC.
Minimum Noise Mitigation Requirements		
Low noise pavements on main carriageways and ramps: Between Ch11.600km and CH17.800km		As per requirements of Appendix 4.19 (f) of the SWTC. For these areas, the pavement corrections for stone mastic asphalt (SMA) in Appendix 4.19(i) (v) of the SWTC have been applied.
Additional Noise Mitigation Measures		
Nil		
Road, Road Surface, Topography		
Road Alignment	Road carriageway alignment for main highway, ramps and intersections as per the Lend Lease detailed design alignment (model issue on 5 June 2014)	

Input / Assumption	Description	
Road Surface	For areas where a low noise pavement is required as part of the SWTC a SMA road surface has been applied. There is also SMA surfacing from CH5320 to CH6450. All mainline bridgeworks have SMA and a 650 mm parapet. For other areas on the main carriageways, a concrete pavement type has been applied. For all local roads and service roads, a dense graded asphalt road surface has been assumed in the noise.	
Ground Contours	All ground contours used in the modelling are as supplied by the Contractor.	
Traffic and Speeds		
Traffic Volumes	Traffic volumes for Year 2016 and Year 2026 (ten years after opening) are as per the requirements of Appendix 9 Table 9.9 (2016), Table 9.10 (2026), and Appendix 4.19(i) (ii) of the SWTC.	
Traffic Speeds: Main-line daytime: Main-line night-time: Local roads, service roads and ramps:	 115km/h 120km/h Posted traffic speeds as per Appendix 9 of SWTC	Traffic speeds for 2016 (at opening) and 2026 (ten years after opening) as per the requirements of Appendix 4.19(i) (i) and Appendix 9 Figure 9.2 of the SWTC. A speed of 80 km/h has been assumed for all ramps.
Receivers		
Receiver Locations	Sensitive receiver locations are as per those contained in SWTC Appendix 4, Tables 4.1 and 4.2 and 4.3.	
Receiver Heights: Ground floor: 1.5m above ground Second floor: 4.5m above ground	As per requirements of Appendix 4.19(i) (vi) of the SWTC.	

Assessment Criteria

Existing noise levels were predicted at every dwelling within the project area. The appropriate criterion (ie “new” or “redeveloped”) was determined, with reference to Practice Note (i) of the ENMM.

6.2 Traffic Volumes – Vehicle Types and Vehicle Speed

2014 Base Year Traffic Figures (Validation Model)

For the 2014 Validation Scenario, the traffic volumes and speeds along the various sections of the existing Pacific Highway and surrounding road network were derived from traffic counts conducted in conjunction with the baseline ambient monitoring described in **Section 5**. These figures, as used in the noise model validation process, are summarised in **Table 5**.

Table 5 2014 Base Traffic Volumes for Existing Roads

Site	Location	Period	Traffic Data							
			Light Vehicles		Heavy Vehicles		Speed (km/h)1			
			NB	SB	NB	SB	NB		SB	
							Ave.	85%ile	Ave.	85%ile
S1	Pacific Highway, south of Sancrox (North of Oxley Highway interchange)	Day 15hr	3504	3656	924	956	90	98	91	98
		Night 9hr	538	385	361	337	94	100	97	102
S2	Pacific Highway, between Sancrox and Hastings River Drive	Day 15hr	3853	3615	912	909	76	82	83	90
		Night 9hr	381	358	375	349	80	88	86	93
S3	Pacific Highway, between Sancrox and Rolland's Plain Road[2]	Day 15hr	4066	4769	894	1086	90	98	73	79
		Night 9hr	483	385	380	372	94	100	79	85
S4	Pacific Highway, North of Rolland's Plain Road	Day 15hr	4066	5037	894	919	97	102	94	100
		Night 9hr	483	698	380	347	99	103	97	101

Note 1: The measured 85% speed has been used in the noise modelling.

Note 2: Northbound data at site S3 was unable to be retrieved due to truck damage. North bound traffic volumes used in the validation model were interpolated from the S1 and S4 results.

2016 Future Existing Traffic Figures

The 2016 Future Existing traffic data for the OH2Ku project have been based on the 2016 volumes as agreed with RMS and based on the flows provided in Appendix 9 of the SWTC, noting the 2016 Environmental Assessment predicted volumes are lower.

	Location	Period	Predicted Traffic Flows		
			Light Vehicles NB+SB	Heavy Vehicles NB+SB	Speed (km/h) – Listed Speeds
1	South of Sancrox	Day 15hr	9550	1990	100
		Night 9hr	1300	960	100
2	Sancrox to Hastings Drive	Day 15hr	10230	2470	100
		Night 9hr	1360	1040	100
3	Hastings Drive to Blackmans Point Road	Day 15hr	12060	2630	80
		Night 9hr	1320	1060	80

	Location	Period	Predicted Traffic Flows		
			Light Vehicles NB+SB	Heavy Vehicles NB+SB	Speed (km/h) – Listed Speeds
4	Blackmans Point Road to Bill Hill Road	Day 15hr	11620	2490	100
		Night 9hr	1350	1050	100
5	Bill Hill Road to Haydons Wharf Road	Day 15hr	11620	2490	100
		Night 9hr	1350	1050	100
6	Haydons Wharf Road to Yarrabee	Day 15hr	10260	2350	100
		Night 9hr	1140	1020	100

2016 Opening and 2026 Future Design Traffic Figures

The projected traffic data for the OH2Ku project are detailed in **Table 6** and **Table 7**. The data is taken from Table 9.9 and Table 9.10 of Appendix 9 of the SWTC.

Table 6 Traffic Volumes Year 2016

Location	day 15hr		night 9hr	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
Main Carriageway				
South of Sancrox Traffic Arrangement	9550	1990	1300	960
Sancrox Traffic Arrangement to Blackmans Point Road Interchange	6940	2240	1000	920
Blackmans Point Road Interchange to Haydons Wharf Road Half Interchange	9360	2200	1030	940
Haydons Wharf Road Half Interchange to Yarrabee Road Traffic Arrangement	10260	2350	1140	1020
North of Yarrabee Road Traffic Arrangement	10220	2350	1110	1020
Sancrox Traffic Arrangement				
Northbound On Ramp	460	150	50	40
Northbound Off Ramp	1860	270	300	100
Southbound Off Ramp	470	290	60	110
Southbound On Ramp	1680	150	110	100
Blackmans Point Road Interchange				
Northbound On Ramp	1730	120	180	90
Northbound Off Ramp	480	110	110	40

Location	day 15hr		night 9hr	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
Southbound On Ramp	470	150	110	60
Southbound Off Ramp	1740	90	50	30
Haydons Wharf Road Half Interchange				
Northbound On Ramp	400	60	60	40
Southbound Off Ramp	520	100	50	60
Yarrabee Road Traffic Arrangement				
Northbound On Ramp	40	30	20	20
Northbound Off Ramp	60	30	30	20
Southbound Off Ramp	90	30	30	30
Southbound On Ramp	80	40	20	20
Local Roads				
Sancrox Road Overbridge	3200	50	400	180
Service Road A	3290	230	360	120
Service Road B	5120	390	320	140
Blackmans Point Road Overbridges	3990	410	410	180
Service Road C	2260	290	320	110
Bill Hill Overbridge	110	30	30	30
Haydons Wharf Road A	660	180	100	80
Yarrabee Road Connection	100	50	40	30

Table 7 Traffic Volumes Year 2026

Location	day 15hr		night 9hr	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
Main Carriageway				
South of Sancrox Traffic Arrangement	13470	2340	1980	1170
Sancrox Traffic Arrangement to Blackmans Point Road Interchange	10910	3140	1480	1160
Blackmans Point Road Interchange to Haydons Wharf Road Half Interchange	13120	3000	1460	1180
Haydons Wharf Road Half Interchange to Yarrabee Road Traffic Arrangement	14190	3120	1560	1250
North of Yarrabee Road Traffic Arrangement	14150	3120	1540	1240
Sancrox Traffic Arrangement				
Northbound On Ramp	1860	780	220	120
Northbound Off Ramp	2940	410	720	180

Location	day 15hr		night 9hr	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
Southbound Off Ramp	1890	810	220	230
Southbound On Ramp	3350	390	240	120
Blackmans Point Road Interchange				
Northbound On Ramp	1960	120	220	100
Northbound Off Ramp	830	170	140	50
Southbound On Ramp	960	210	170	80
Southbound Off Ramp	2030	110	90	40
Haydons Wharf Road Half Interchange				
Northbound On Ramp	500	60	60	40
Southbound Off Ramp	600	90	50	60
Yarrabee Road Traffic Arrangement				
Northbound On Ramp	40	20	20	20
Northbound Off Ramp	80	30	30	20
Southbound Off Ramp	90	40	30	30
Southbound On Ramp	80	30	20	30
Local Roads				
Sancrox Road Overbridge	8630	1440	960	440
Service Road A	5760	410	630	170
Service Road B	5120	390	320	150
Blackmans Point Road Overbridges	4180	460	470	200
Service Road C	2430	380	350	120
Bill Hill Overbridge	120	30	30	30
Haydons Wharf Road A	770	180	110	80
Yarrabee Road Connection	110	50	40	30

6.3 Noise Modelling Validation

The validation of the noise model was performed by comparing the 2014 Validation Scenario noise level predictions with the results from the ambient noise monitoring survey presented in **Section 5**. The Validation Scenario makes use of the road traffic volumes measured during the ambient noise monitoring survey presented in **Table 5**. The CoRTN validation noise model used a road surface correction of 0 dB for dense graded asphalt.

Comparison of measured and predicted levels has been performed by undertaking single point receiver calculations at noise model locations coinciding with the ambient monitoring locations.

Small variations between measured and predicted values are to be expected within any noise model. This is due to the dependence of measured noise levels on road surface characteristics near the specific measurement sites, the incidence of vehicles changing gears near the site, the use of brakes (in particular truck exhaust brakes in downhill sections and approaching local road intersections, the bias in use of multiple lanes during different periods of the day, the effects of local screening (eg fences, sheds), etc.

The comparison of the daytime and night-time noise level predictions for the 2014 Validation Scenario is shown in **Table 8**.

Table 8 Comparison of Measured and Predicted Noise Data (2014 Validation Scenario)

No.	Address [1]	Noise Level (dBA)					
		Measured		Predicted		Predicted MINUS Measured [2]	
		LAeq(15hr)	LAeq(9hr)	LAeq(15hr)	LAeq(9hr)	LAeq(15hr)	LAeq(9hr)
L1	Koala Park - 61 Billabong Drive, Sancrox	66	65	67	64	0.2	-0.3
L2	Cassegrain Winery - 764 Fernbank Road, Sancrox	65	63	65	63	0.4	-0.2
L3	15 Glen Ewan Road, Sancrox	53	49	52	49	-1.0	0.5
L4	77 Moorside Drive, Telegraph Point [3]	49	46	47	44		
L5	8656 Pacific Highway, Telegraph Point	63	62	63	61	-0.3	-1.6
L6	16 Hacks Ferry Road, Telegraph Point [3]	48	47	48	45		
L7	5 Cooperabung Drive, Telegraph Point	65	63	64	61	-1.0	-1.7
L8	8 Haydons Wharf Road, Telegraph point	60	58	59	58	-.4	0.0
L9	3 Wyndell Close, Cooperabung [4]	49	45	51	49		
L10	890 Cooperabung Drive, Cooperabung	64	62	64	62	0.4	-0.3
Average { PREDICTED – MEASURED } Difference						**-0.2 dB**	**-0.5 dB**

Note 1: All noise monitoring locations except L5 were specified by SWTC Appendix 4.20 (c), to be 'those sensitive receivers which have been identified in the Environmental Documents'. As such the distant receivers represent 'background' rather than traffic noise levels.

Note 2: Predicted minus measurements are presented to one decimal place to increase the 'Average Difference' accuracy

Note 3: Noise logging location L4 and L6 and were excluded from the validation process as these locations are not significantly affected by road traffic noise from the existing highway. Predicted noise levels are presented for information only.

Note 4: Noise logging location L9 was excluded from the validation process as at this location there was traffic noise from Wyndell Close and Cundabung Drive as well as the existing highway. Predicted noise levels are presented for information only.

Reference to the above indicates that for the daytime LAeq(15hour) period, the predicted noise levels are on average 0.2 dB below the measured data. For the night-time LAeq(9hour) period, the predicted noise levels are on average 0.5 dB below the measured data.

The ENMM notes that "*it should be recognised that noise prediction modelling has some accuracy limitations and will commonly produce acceptable errors of around 2 dBA*".

On the basis of the comparison of OH2Ku noise model predictions with baseline measurement results, it is concluded that the noise model provides results which enable a reliable assessment of the project.

7 Operational Noise Assessment Results

Noise modelling has been undertaken for the OH2Ku Design and includes all of the minimum noise mitigation requirements identified in Table 4 of this report.

Operational noise levels from the project have been assessed against the requirements of the ECRTN and ENMM – this is detailed in **Section 7.4**, and also contained in **Appendix E**.

7.1 Changes to Concept Design

The road alignment documented in the IFC Design submission does not vary significantly from the Concept Design. There are minor changes as follows:

- Lowering of alignment through the Sancrox interchange to omit a retaining wall;
- Navigation envelope at Hastings River shifted south;
- Haydons Wharf overbridge lowered by 600mm, reducing height of approach embankments, whilst achieving minimum vertical clearances to the main alignment;
- Introduced vertical crest curve over Blackman's interchange to lower ramps and service roads;
- Reducing horizontal curve at CH 3700 from 1500m to 1200m to shift the NB carriageway away from the existing road in order to accommodate the Stage 1 site access;
- Raising vertical alignment over culvert at CH 9210 to ensure minimum cover over culvert;
- Revise horizontal alignment to include compound curve through deep cuttings at Cooperabung;
- Revised horizontal geometry for Service Roads B and C at Blackman's Point interchange to remove adverse crossfall.

7.2 Comparison with the Environmental Assessment

The NSW EPA's ECRTN as described in Section 4 provides guidance for assessing traffic noise impacts, and as presented in Table 1 the night-time criteria for a 'new freeway/arterial road corridor' is an $L_{Aeq(9hour)}$ of 50 dBA for the night-time period. Furthermore assessment of a road project is conducted 10 years after opening which in this instance is year 2026. Of the daytime and night-time periods the night-time period is the overriding criteria for compliance for the project.

All inputs in Table 4 have been incorporated into the IFC Design computer noise model. Single point calculations have been performed at the nearest sensitive receivers to predict the $L_{Aeq(9hour)}$ noise level in accordance with the specified calculation procedure for the noise modelling scenario defined in Section 6.

The $L_{Aeq(9hour)}$ noise levels at these receivers for the year 2026 have been compared to those presented in the Noise and Vibration Working Paper of the Environmental Assessment (EA), dated September 2010. IFC Design predicted noise levels as well as those from the EA are presented in **Appendix E**. The results of the comparison are summarised as follows, and for simplicity the Noise Catchment Areas (NCAs) defined in the EA have been adhered to:

- Oxley Highway to 1km north of the Sancrox Road Intersection
  The section comprises NCA 21 to the west and NCA 22 to the east. Similar $L_{Aeq(9hour)}$ noise levels have been predicted at the residences for the IFC Design to the west, and lower levels to the east up until 0.5km before Sancrox Road, with marginally higher levels there after. The inclusion of the upgraded Sancrox Interchange into the noise model, and the re-classification of

receivers where the interchange is located between the receiver and the redeveloped road, has resulted in receiver IDs 43, 61 and 68 and being identified as requiring architectural treatment.

- 1km north of the Sancrox Road Intersection to 1km north of the Hastings River
  The section comprises NCA 19 to the west and NCA 20 to the east. Similar $L_{Aeq(9hour)}$ noise levels have been predicted at the residences for the IFC Design to both the west and east of the alignment.
- Moorside Drive
  The section comprises NCA 17 to the west and NCA 18 to the east. Lower $L_{Aeq(9hour)}$ noise levels have been predicted at the residences for the IFC Design to both the west and east of the alignment. The lower levels are considered to result from the use of SMA pavement in this section of the highway upgrade and results in receiver IDs 116, 119, 123, 131, 133, 135, 583, 846 and 850 no longer being identified as requiring architectural treatment.
- Hacks Ferry Road to 1.5 km north of Telegraph Point
  The section comprises NCA 13 and 15 to the west and NCA 14 to the east. Marginally lower $L_{Aeq(9hour)}$ noise levels have been predicted at the residences for the IFC Design to both the west and east of the alignment. The lower levels are considered to result from the use of SMA pavement for the southern part of this section of the highway upgrade and results in receiver IDs 322, 323, 840, 270 and 271 no longer being identified as requiring architectural treatment.
- 1.5 km north of Telegraph Point to Cooperabung Drive
  The section comprises NCA 13 and 15 to the west and NCA 14 to the east. Similar $L_{Aeq(9hour)}$ noise levels have been predicted at the residences for the IFC Design to the west, and marginally higher levels to the east.
- Cooperabung Drive to end of the the OH2Ku project
  This section comprises NCA 11 to the west and NCA 12 to the east. Similar $L_{Aeq(9hour)}$ noise levels have been predicted at the residences for the IFC Design to the west and to the east.

The differences between receivers that were identified in the EA for treatment, and those identified in the detailed design is presented in **Table 9** and **Table 10**.

Table 9 Sensitive Receivers Eligible for Treatment in the EA but not in the Detailed Design Noise Model

NCA	Receiver ID	Comments
17	116	The EA design and hence the EA noise model did not include any at-road noise treatments. The detailed design, and detailed design noise model, now includes a section of low noise pavement on the main carriageways and ramps between Ch11.600km and CH17.800km. The lower levels at these receivers are considered to result from the use of this pavement in this section of the highway upgrade.
17	119	
17	123	
17	131	
17	133	
17	135	
17	583	
17	846	
18	850	
13	322	
13	323	
13	840	

NCA	Receiver ID	Comments
15	270	
15	271	
20	106	Demolished as part of the construction of the project.
20	103	These properties appear to have been incorrectly identified as requiring treatment in the EA: ID93 had a criterion of 58.5 and a 2026 predicted noise level of 53.5, and ID103 had a criterion of 57.5 and a 2016 predicted noise level of 55.5. As such, the conclusion in this report that these properties are not eligible for treatment is not considered to be a change from the EA.
20	93	

Table 10 Sensitive Receivers not Eligible for Treatment in the EA but now Eligible in the Detailed Design Noise Model

NCA	Receiver ID	Comments
21	12	This is due to a slight reduction in the predicted future existing noise level at these locations, which changed the applicable ECRTN criteria, making these properties eligible for treatment.
21	20	
21	529	
22	867	
22	865	
22	31	
21	63	Slight increase in 2026 predicted noise levels, making this property eligible for treatment.
21	43	The upgraded Sancrox interchange being located between these receivers and the redeveloped road has resulted in a change to the criterion to that of a new road. These three receivers are now found to be eligible for treatment.
21	61	
21	68	
19	2063	These properties were not modelled as sensitive receivers in the EA report, however have now been included and found to be eligible for acoustic treatment.
20	2065	
11	654	
11	362	This property is no longer habitable, so whilst identified as being eligible for architectural treatment won't be treated
12	380	The predicted future existing noise level at this location has reduced slightly from the EA, and the predicted 2026 noise levels have increased slightly, making this property eligible for acoustic treatment. This change can be linked to the design refinements in Section 7.1, which includes a change in the horizontal alignment in this area, resulting in the alignment sitting slightly further east than the concept design.

The summary shows good correlation between noise level predictions for the IFC Design when compared to the EA for the overriding night time period, with the exception of receivers adjacent to the SMA pavement, where lower levels are expected. Significantly no NCA areas are expected to experience noise levels above those predicted in the EA.

Despite the above, all properties identified as being eligible for architectural treatment in the EA will be offered architectural treatment, except those that have been identified as errors in the EA report, specifically 230, 229, 231, 234 & 209.

7.3 Year 2016 and Year 2026 Design Noise Contours

Noise contours have been generated in accordance with the specified calculation procedure for each of the four noise modelling scenarios required by SWTC Appendix 4 Section 4.20(o). Appendix 4 Section 4.20(o) requires well presented noise contour maps for the four scenarios listed below, and identifying all sensitive receiver locations. The noise contours are to have intervals of not greater than 5 dBA and extending out to 45 dBA.

- 2016 Daytime – LAeq(15hour);
- 2016 Night-time – LAeq(9hour);
- 2026 Daytime – LAeq(15hour); and
- 2026 Night-time – LAeq(9hour)

These are presented in **Appendix D**.

7.4 ECRTN/ENMM Assessment

Road traffic noise levels have been predicted to all identified residential sensitive receiver locations, as shown in Figure 1 and illustrated on the site plan in **Appendix B**, for the Future Design assessment year of 2026. The predictions are based on the design inputs detailed in Table 4 and include the specification of low noise pavement on the main carriageway, as a minimum, from chainage 11km600 to chainage 17km800.

Of the 139 total sensitive receiver locations modelled as part of the ECRTN Operational Noise Assessment, 49 are predicted to experience levels exceeding the appropriate criterion. These locations are indicated on the site plan in **Appendix B**, whilst the full assessment results at every receiver are detailed in **Appendix E**.

Those receivers predicted to experience 'acute' noise levels are also presented in **Appendix E**, with 13 receivers identified.

7.5 Maximum Noise Level Assessment

A maximum noise level assessment has been conducted on the new section of roadway. It is noted that the ENMM both state that whilst a maximum noise level assessment is required to be undertaken for new and upgraded road infrastructure projects, it should only be used as a tool to help prioritise and rank mitigation strategies, and should not be applied as a decisive criterion in itself.

The objective of the maximum noise level assessment is to determine whether maximum noise levels are likely to increase or decrease as a result of the project.

From the measurements conducted, for residents close to the existing alignment, the relationship between the L_{Aeq} and L_{Amax} is approximately 15 dB:

L_{AMax} ~ L_{Aeq} +15 dB.

The maximum noise level assessment includes an evaluation of the number and distribution of night-time passby events in accordance with the ENMM. A maximum noise level event is defined within the ENMM as being any pass by where:

- The maximum noise level of the event is greater than 65 dBA, and
- The L_{AFmax} – $L_{Aeq(1hour)}$ is greater than or equal to 15 dB.

It should be noted that strategies are currently being implemented to reduce road traffic noise across the state's road network which may reduce the number of maximum noise levels events over the longer term.

In addition, state wide strategies for sharing freight with rail modes are expected to result in reduced noise from heavy vehicle freight on roads in many areas and a corresponding reduction in high noise level events from road traffic.

7.5.1 Maximum Noise Level Measurements

Maximum noise level events were measured as part of the ambient noise study undertaken at noise monitoring location L5, being 8656 Pacific Highway, Telegraph Point. The noise monitoring location and measurement methodologies are described in detail in Section 5. This location is approximately 65 m from the existing Pacific Highway, and therefore representative of typical nearby residences to the existing alignment. Furthermore the difference between the L_{AFmax} – $L_{Aeq(1hour)}$ is relatively insensitive to distance, enabling the analysis of location L5 to be applicable to residences that are marginally closer to the roadway and those further distant.

The results of the maximum noise level assessments are provided in **Appendix F** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments is presented in **Table 11**.

Table 11 Maximum Noise Level Events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level LAmax,fast (dBA)	
			Range	Average
L5	20/5/2014 – 29/5/2014	169	71-83	76

From the results presented within Table 9 it can be seen that average maximum noise level events typically range from 71 dBA to 83 dBA at monitoring locations L5.

An analysis of the maximum noise level events presented in **Appendix F** shows there is a range of maximum noise level events of 1 to 6 for the weekdays, and on weekends the number of maximum noise level events range from 34 to 67. The increase in the number of events occurring on the weekend is a result of the increased difference between the L_{AFmax} – $L_{Aeq(1hour)}$. It is noted that whilst during weekdays there is a higher percentage of heavy vehicles when compared to the weekend, the difference between the L_{AFmax} – $L_{Aeq(1hour)}$ is lower when compared to the weekend, resulting in a decrease in the number of maximum noise level events.

A comparison of the traffic volumes presented in **Table 5**, which presents the base case corresponding to the analysis of **Appendix F** and **Table 7** which presents the year 2026, shows night-time traffic volumes will increase by 1.7 times, with the percentage of heavy vehicles remaining

constant at typically 45 percent. The number of maximum noise level events will therefore be expected to increase by a similar ratio, resulting in an increase in maximum noise level events from typically 2 to 10 during the weekday night-time periods and from 58 to 114 events during the weekend night-time periods. No change in the number of maximum noise level events is anticipated to the roadway gradient changes as the vertical alignment is improved.

7.6 Noise Mitigation Options

The two most common forms of noise mitigation that provide significant noise reduction to dwellings are:

- Roadside noise barriers;
- Noise mitigation applied to the building envelope.

The SWTC has identified a range of individual properties for which a commitment has been made to provide at-dwelling noise mitigation.

Where properties are clustered in groups of four or more, the ENMM requires that there be consideration of a noise barrier.

There are a group of four residents which are impacted by the project and for which consideration of noise mitigation is warranted. At this location, the residents are near an elevated section of the highway (on approach to a bridge). The road surface from and including the southern Hastings Floodplain Bridge to and including the Hastings River Bridge is low noise SMA pavement. As such these residences have low noise pavement for the main angle of view to the roadway. Providing an SMA road surface further south of the Hastings Floodplain Bridge would reduce noise levels by less than 1 dB and therefore not considered a reasonable mitigation measure.

Accordingly a noise wall was modelled and the insertion loss (or noise reduction) was compared with the requirements of the ENMM to determine feasibility. The ENMM requires a barrier that is greater than 3 m to achieve an insertion loss of at least 5 dB to be considered reasonable for noise mitigation. A barrier that is greater than 8 m should achieve an insertion loss of at least 10 dB to be considered reasonable for noise mitigation.

In this instance the target barrier (or barrier to meet the ECRTN criteria) is required to be greater than 8 m to achieve the required reduction to meet the ECRTN at the four residences, and at this height it achieved less than the required 10 dB insertion loss. Accordingly a target noise barrier is not reasonable as a mitigation measure in accordance with the ENMM at this location.

In accordance with the ENMM an ‘assessed’ barrier (or barrier were the noise reduction is optimised as a tradeoff against barrier height) has been considered. The assessed barrier height was determined to be 4 m, and provides a corresponding noise reduction of 4.4 dB. This does not meet the ENMM insertion loss requirement that a barrier of greater than 3 m must achieve an insertion loss of at least 5 dB. Accordingly the assessed noise barrier is not reasonable as a mitigation measure in accordance with the ENMM at this location.

There are other factors for an assessed (or target) barrier which need to be included in consideration of the barrier’s feasibility and reasonability. In this context, “feasibility” refers to engineering practicality, while “reasonableness” is to be judged by taking account of the following:

- Noise mitigation benefits and costs – the noise wall would be required to extend for typically 350 m to the north and south of the residences and be located on the southern Hastings Floodplain Bridge and include 50 percent of the Hastings River Bridge.
- Community views and aesthetic impacts – the noise wall at 4 m would reduce community views and potentially reduce afternoon sun for a period of time.
- The affected residences are already affected by noise from the existing Pacific Highway alignment.

In summary a noise barrier at this location is not feasible as it fails to provide the noise reduction requirements mandated in the ENMM, and be constructed on two bridges resulting in only a marginal noise benefit to the residences, at significant cost.

It is also noted these dwellings are already nominated in the SWTC as receiving at-dwelling mitigation treatments.

Architectural property treatments

At-property architectural acoustic treatments should aim to achieve internal noise levels in habitable rooms 10 dB below the external noise level criteria. In some cases this will be limited by the existing construction and condition of the residence.

Building element treatments are more effective when they are applied to masonry structures than lightly clad timber frame structures. Caution should be exercised before providing treatments for buildings in a poor state of repair, as they will be less effective and may not provide any appreciable noise reduction benefit.

The acoustic treatments provided by Roads and Maritime are typically limited to:

- Fresh air ventilation systems that meet the Building Code of Australia requirements with the windows and doors closed (in certain circumstances air conditioning that includes fresh air intake may also be considered, particularly where adverse climate conditions prevail).
- Upgraded windows and glazing and solid core doors on the exposed facades of the substantial structures only (eg masonry or insulated weather board cladding with sealed underfloor). These techniques would be unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls.
- Upgrading window or door seals and appropriately treating sub-floor ventilation.
- The sealing of wall vents.
- The sealing of the underfloor below the bearers.
- The sealing of eaves.

In accordance with the ENMM, where facade treatment is undertaken, there is no guarantee that remedial works will achieve any specific noise levels.

Where multi-level residential buildings are apparent, Roads and Maritime policy is to only consider architectural treatment options at the ground and first floor levels.

The recommended residual noise impact mitigation package for all habitable rooms of eligible locations is as follows:

Architectural treatment of exceeding dwellings <=10 dB over the criteria

- Where external noise levels are less than 10 dB above the base criteria, acceptable internal noise levels may be achieved with windows closed on exposed facades.
- A light framed building with single glazed (closed) windows with sealed wall vents will typically provide an external to internal noise reduction of 20 dB. Where the internal base criteria in habitable rooms can only be achieved with windows and vents closed, then mechanical ventilation should be provided (subject to individual consultation with dwelling owners) to ensure sufficient airflow inside the dwelling, so as to meet the requirements of the Building Code of Australia.

Architectural treatment of exceeding dwellings >10 dB over the criteria

- Where the external levels are 10 dB or higher than the base criteria, then upgraded windows, doors and/or seals (depending on individual assessment and generally only suitable for masonry type buildings) is necessary, in addition to the above.

8 Conclusion

Noise level predictions shows good correlation between noise level predictions for the IFC Design when compared to the EA for the overriding night time period, with the exception of receivers adjacent to the SMA pavement, where lower levels are expected.

One hundred and thirty nine receivers were included in the noise model. When the 2026 traffic noise levels are assessed against the requirements of the ECRTN, 52 unique properties are predicted to qualify for noise mitigation. Of these 52 properties, 13 have been identified to have acute levels of noise. The number of properties with exceedances of the ECRTN criterion arising from the IFC Design is seven less than was predicted at the EA stage.

Appendix A Acoustic Terminology

Appendix A Acoustic Terminology

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3 Sound Power Level

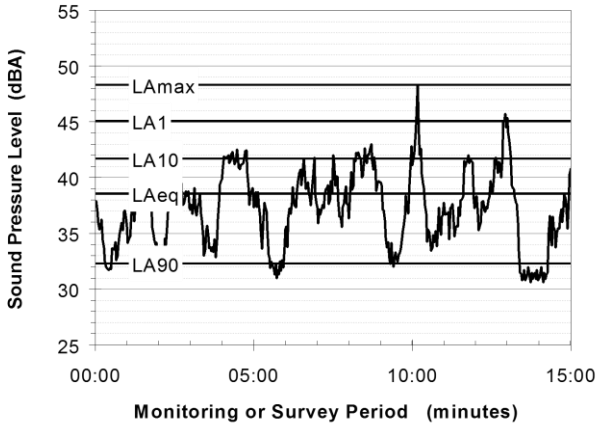
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

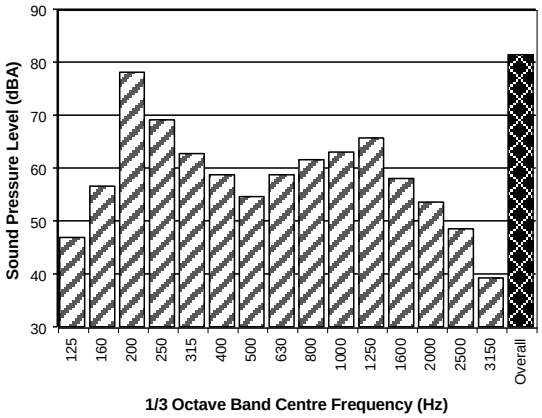
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula $20 \log (V/V_0)$, where V_0 is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

9 Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

10 Over-Pressure

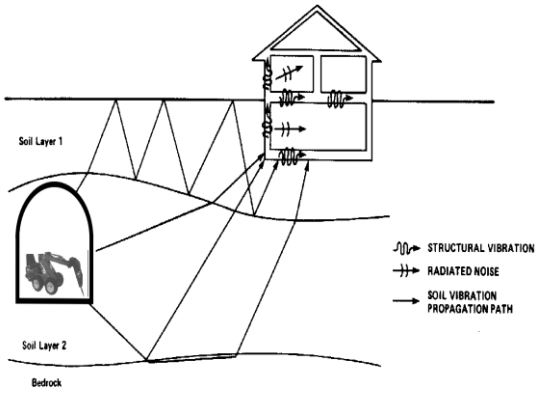
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise

Appendix B Site Plan

Appendix B Site Plan

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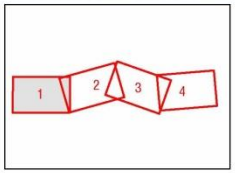
Scale:	1:20,000
Sheet Size:	A3
Projection:	GDA 1994 MGA Zone 56



Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Noise Logging Locations
Proposed Alignment

Lend Lease

Oxley Highway to Kundaberg

Site Plan

APPENDIX B1

Appendix B Site Plan

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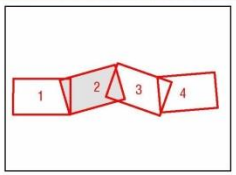
Projection:	GDA 1994 MGA Zone 56



Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Noise Logging Locations
Proposed Alignment

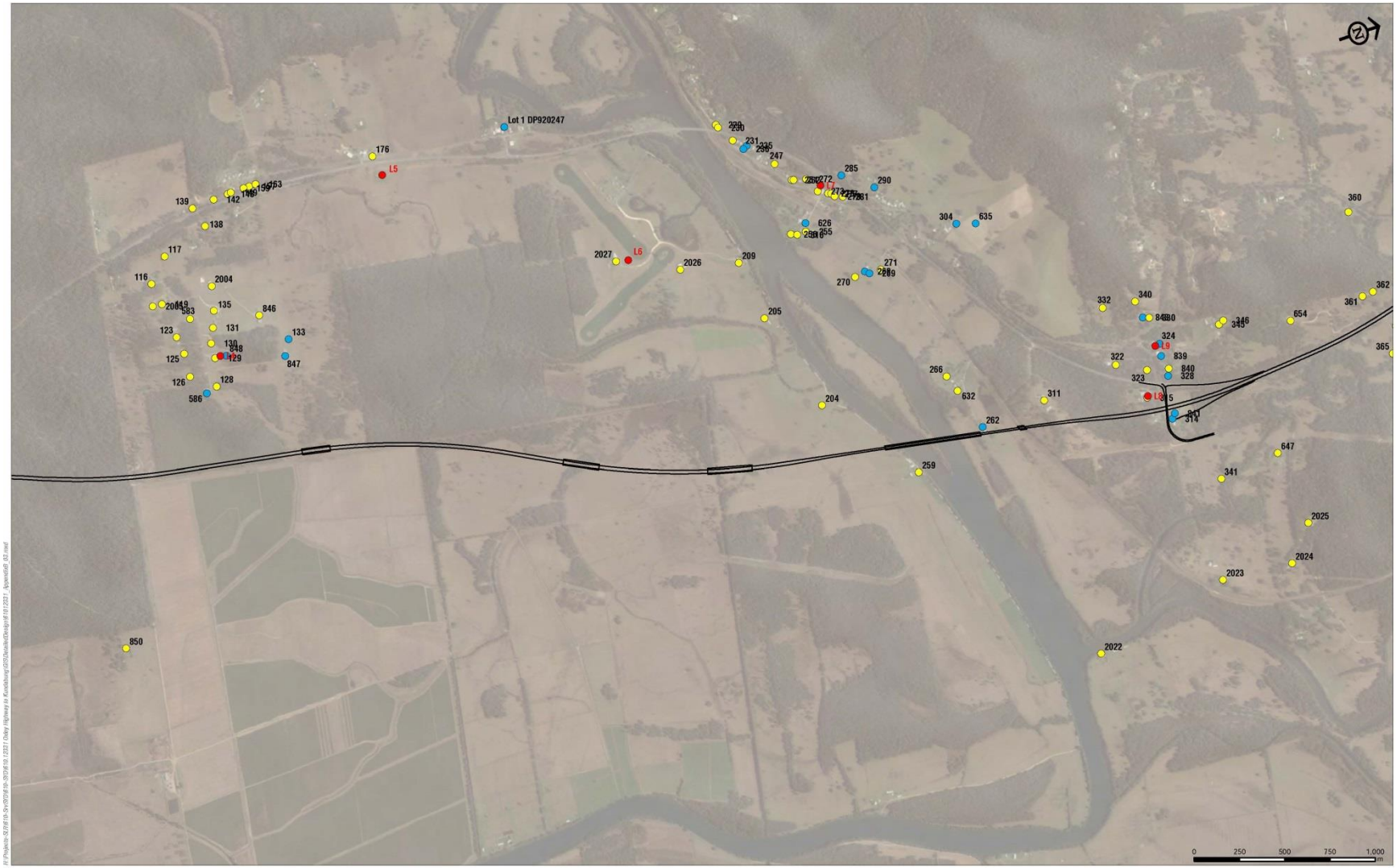
Lend Lease

Oxley Highway to Kundaberg

Site Plan

APPENDIX B2

Appendix B Site Plan



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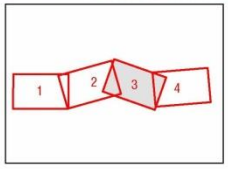
Projection:	GDA 1994 MGA Zone 56



Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Noise Logging Locations
Proposed Alignment

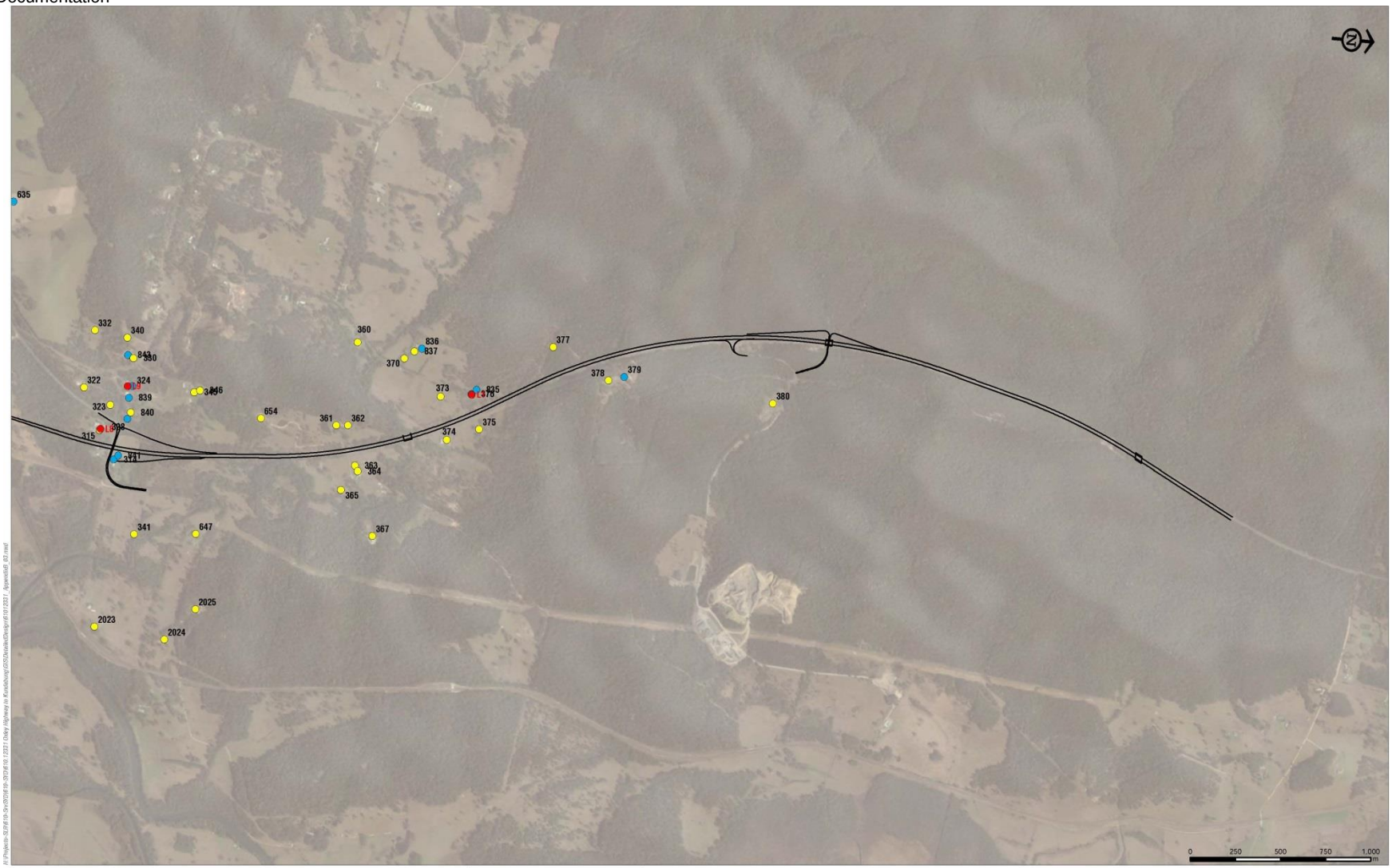
Lend Lease

Oxley Highway to Kundaberg

Site Plan

APPENDIX B3

Appendix B Site Plan



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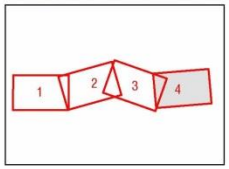


Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Noise Logging Locations
Proposed Alignment

Lend Lease

Oxley Highway to Kundaberg

Site Plan

APPENDIX B4

Appendix B Site Plan

Appendix C Ambient Noise Logging Results

Appendix C Ambient Noise Logging Results

Noise Monitoring Location:	**L1**
Noise Monitoring Address:	**Koala Park – 61 Billabong Drive, Sancrox**

Logger Device Type: ARL316
Logger Serial No: 16-207-042

Ambient noise logger deployed in a free field location between the eastern boundary of the Koala Park and Pacific Highway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically 64-69 dBA, Pacific Highway Heavy-vehicle road traffic: typically 70-79 dBA, Insects/Birds: 50-54 dBA, Koala Park activity: 56dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods				
Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	49	67	71	78
Evening	44	66	69	78
Night-time	36	65	68	78

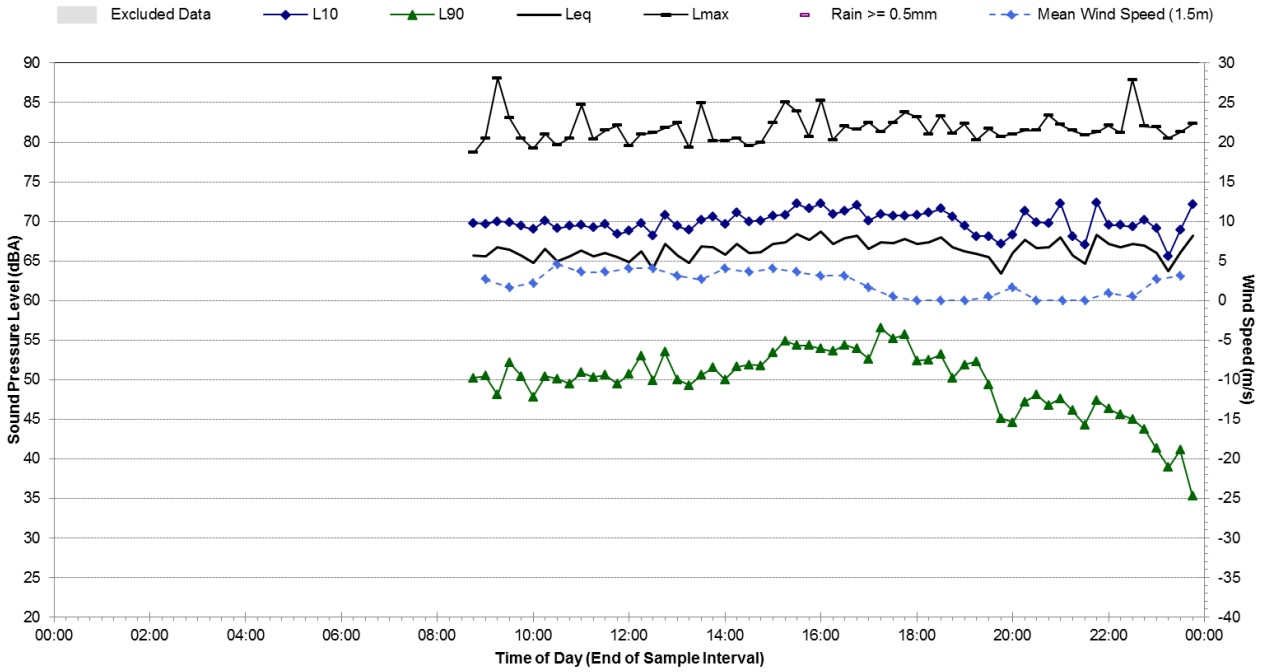
Ambient Noise Logging Results – RNP Defined Time Periods			
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	2	N/A
Daytime (7am-10pm)	68	66	66
Night-time (10pm-7am)	66	61	65

Attended Noise Measurement Results				
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
21/05/2014	08:44am	49	64	79

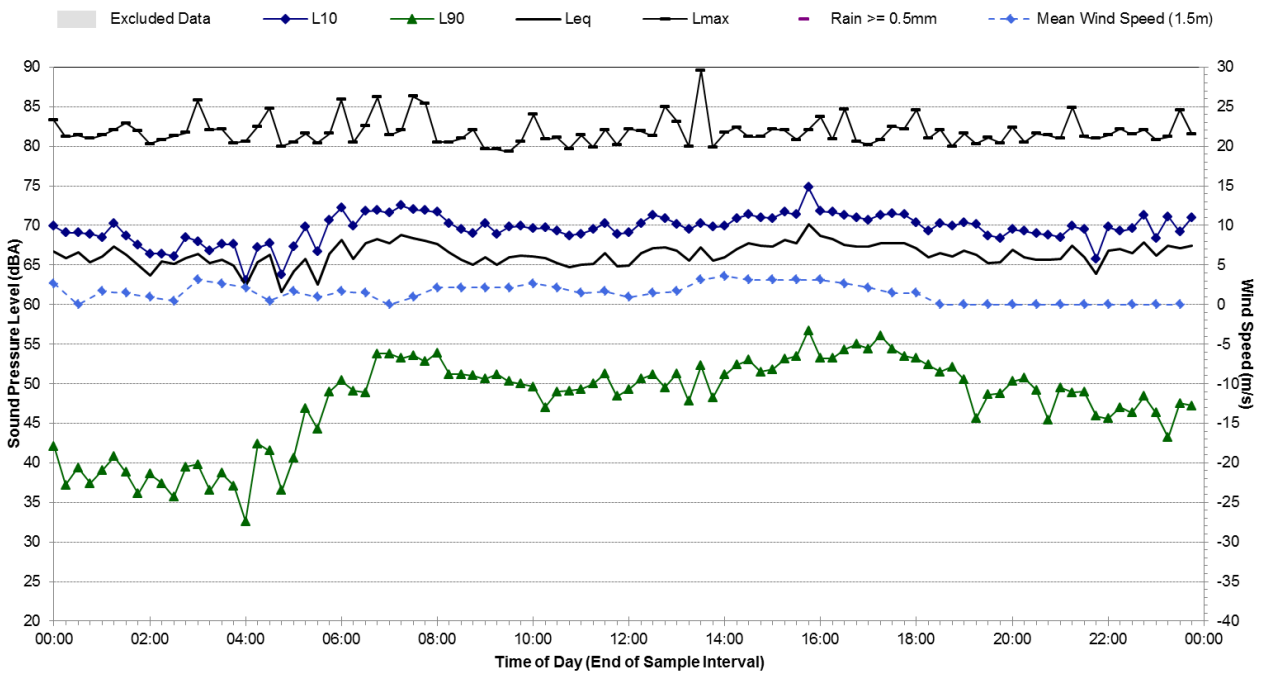
Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L1 - Koala Park - 61 Billabong Drive, Sancrox - Wednesday, 21 May 2014

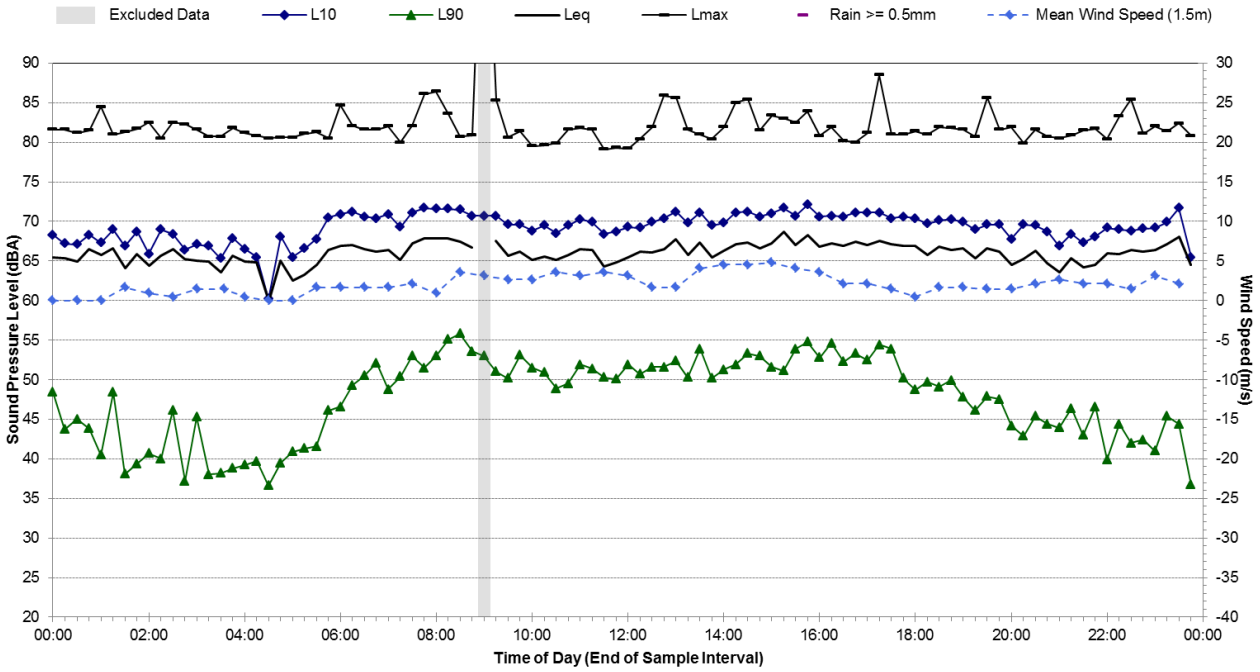


Statistical Ambient Noise Levels
L1 - Koala Park - 61 Billabong Drive, Sancrox - Thursday, 22 May 2014

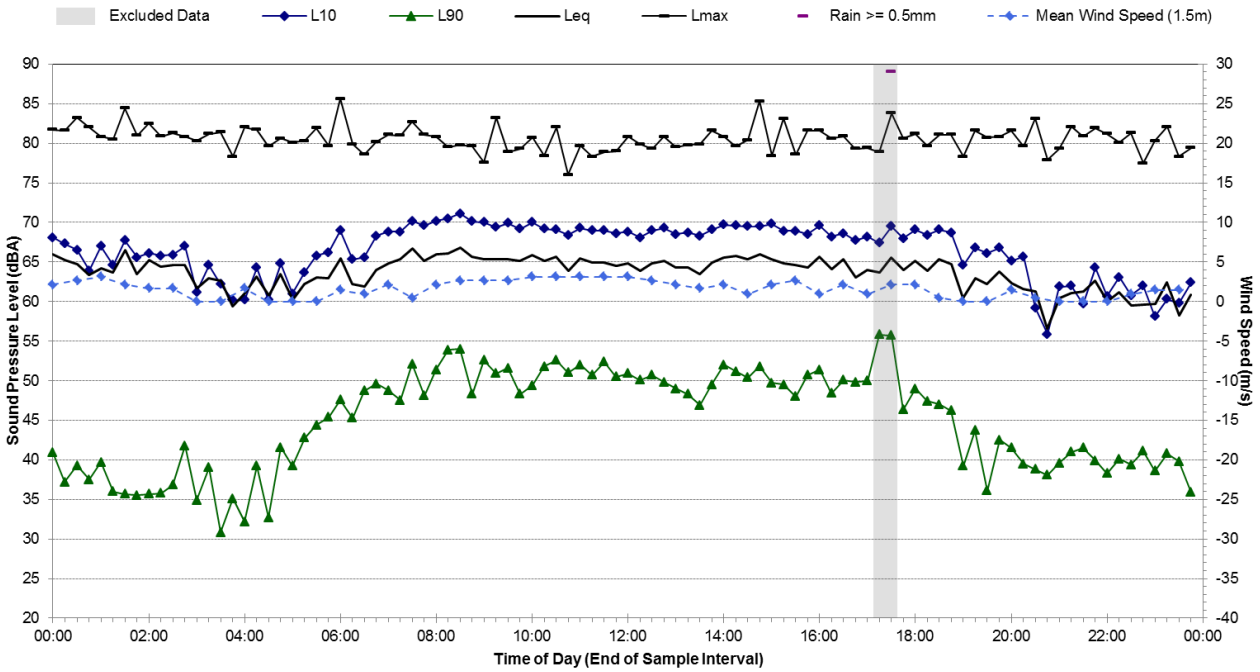


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L1 - Koala Park - 61 Billabong Drive, Sancrox - Friday, 23 May 2014



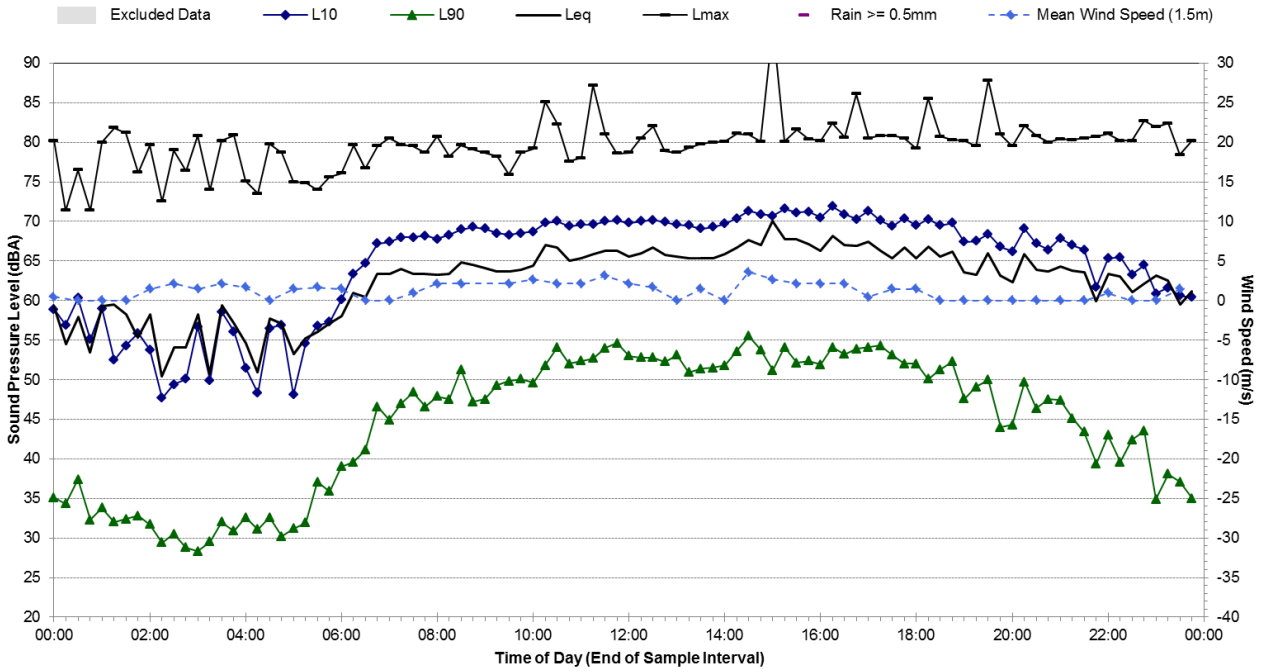
Statistical Ambient Noise Levels
L1 - Koala Park - 61 Billabong Drive, Sancrox - Saturday, 24 May 2014



Appendix C Ambient Noise Logging Results

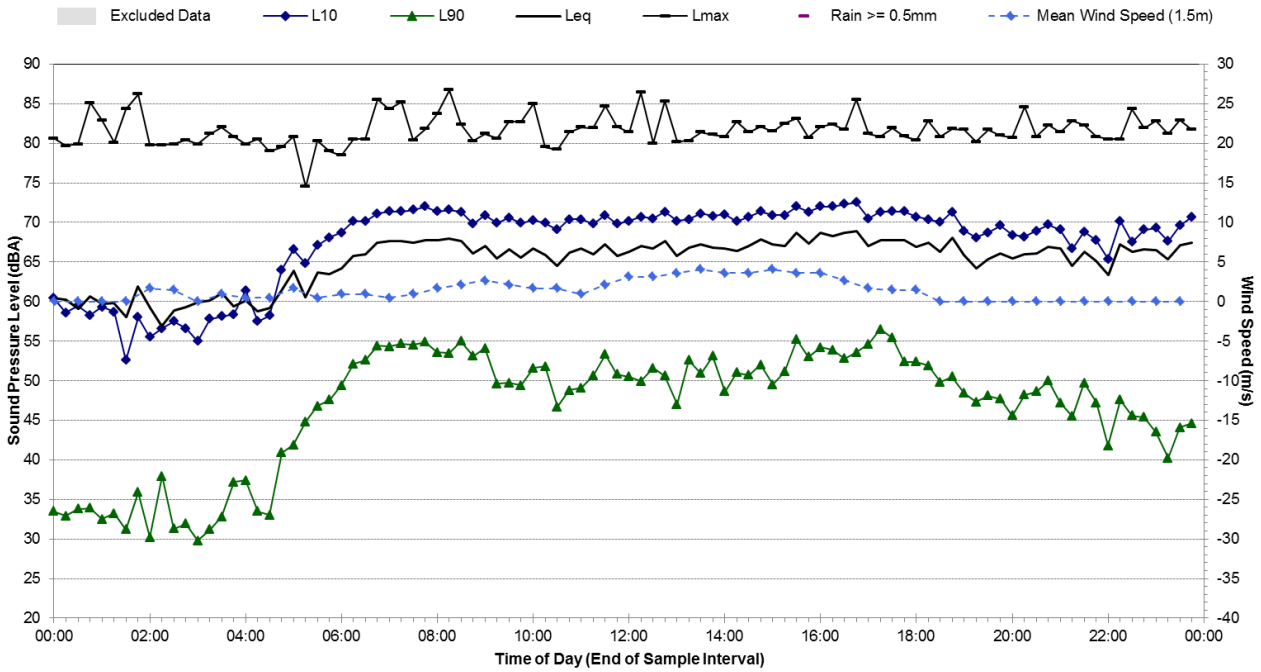
Statistical Ambient Noise Levels

L1 - Koala Park - 61 Billabong Drive, Sancrox - Sunday, 25 May 2014



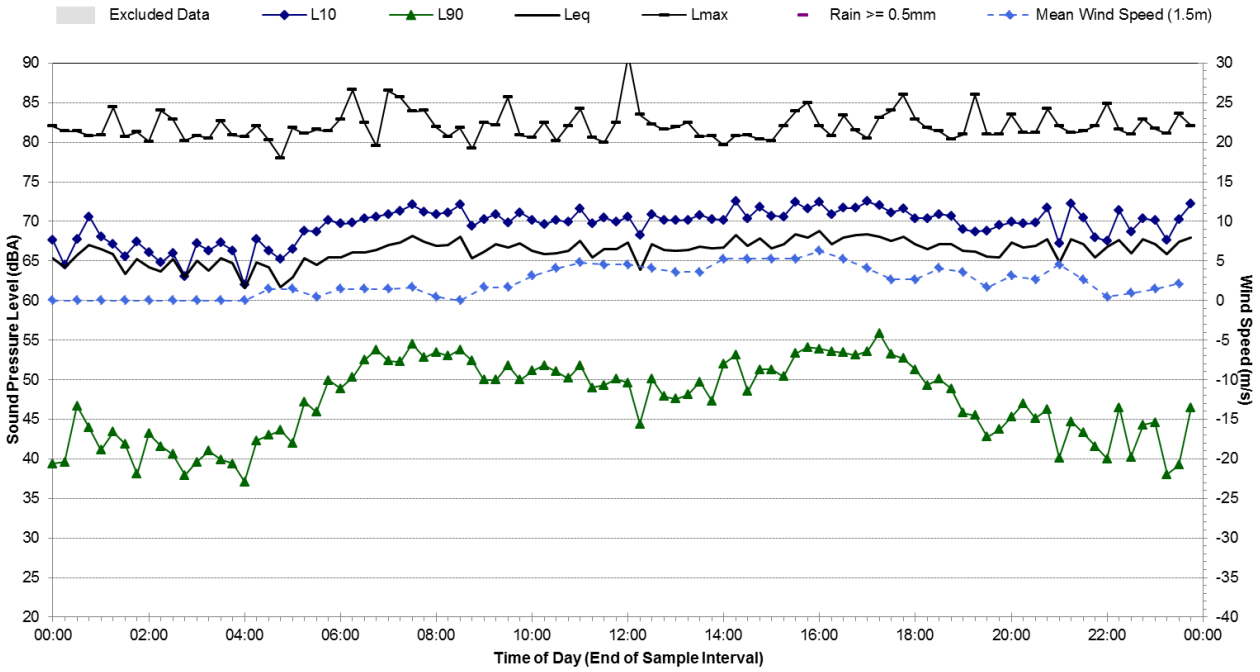
Statistical Ambient Noise Levels

L1 - Koala Park - 61 Billabong Drive, Sancrox - Monday, 26 May 2014

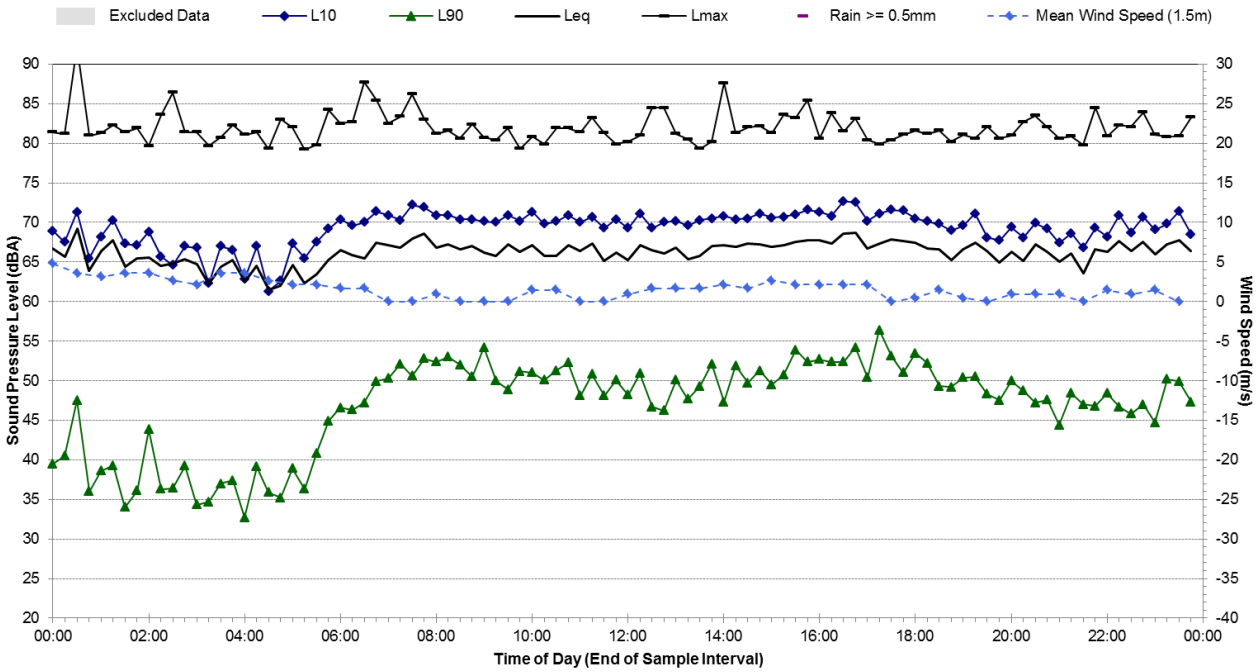


Appendix C Ambient Noise Logging Results

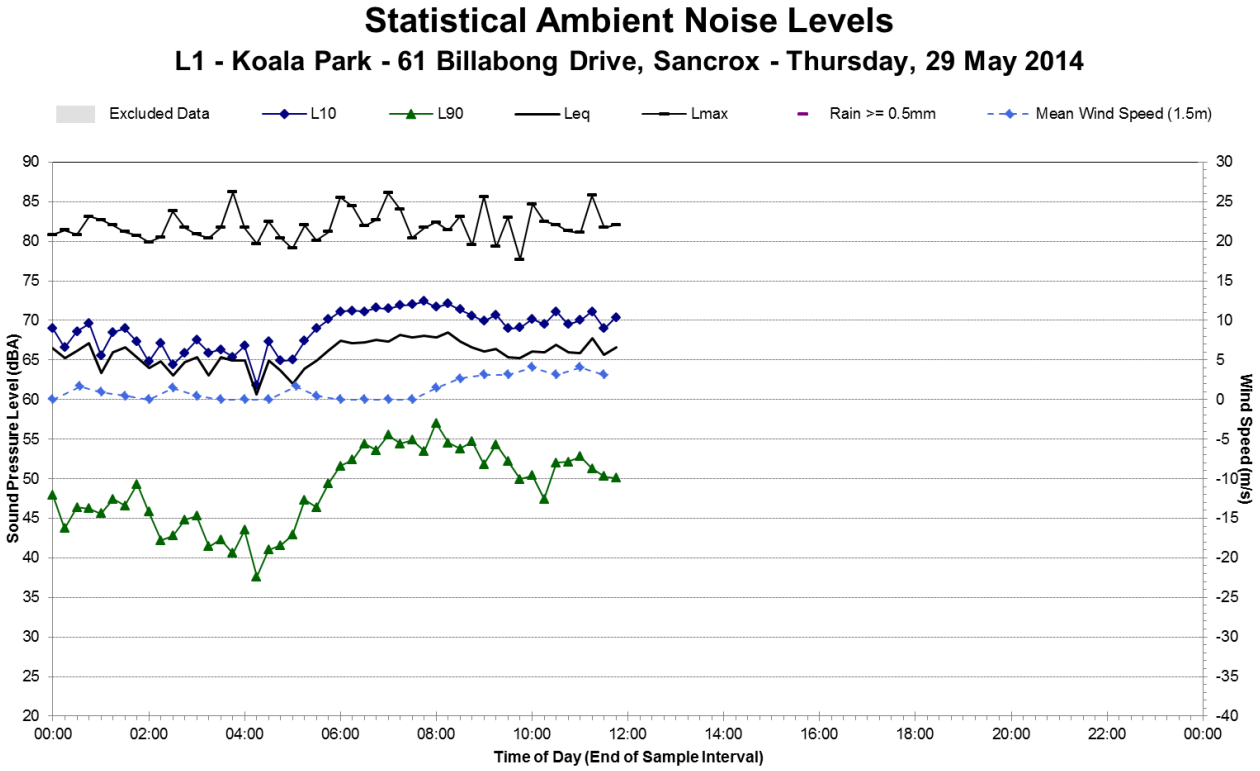
Statistical Ambient Noise Levels
L1 - Koala Park - 61 Billabong Drive, Sancrox - Tuesday, 27 May 2014



Statistical Ambient Noise Levels
L1 - Koala Park - 61 Billabong Drive, Sancrox - Wednesday, 28 May 2014



Appendix C Ambient Noise Logging Results



Noise Monitoring Location:	**L2**
Noise Monitoring Address:	**Cassegrain Winery – 764 Fernbank Road, Sancrox**

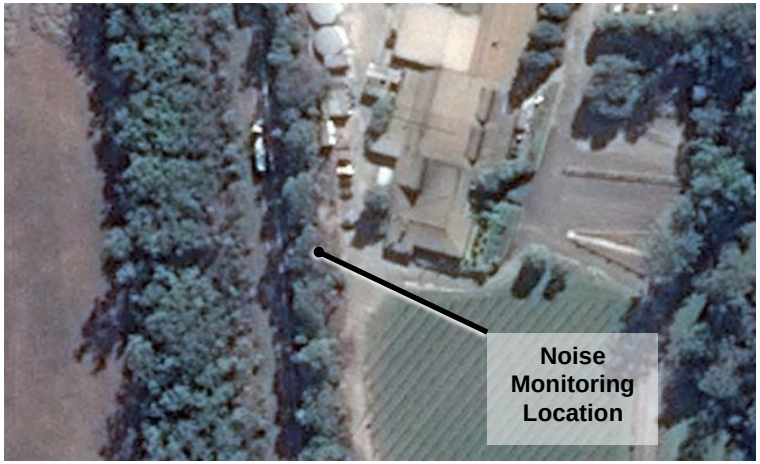
Logger Device Type: ARL316
Logger Serial No: 16-306-047

Ambient noise logger deployed in a free field location on western boundary of winery, adjacent to car park.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically 61-70 dBA, Pacific Highway Heavy-vehicle road traffic: typically 70-79 dBA, Car park activity: ~55 dBA

Map of Noise Monitoring Location



Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	**LAeq**	**L10**	**L1**
Daytime	50	65	68	75
Evening	44	64	68	76
Night-time	42	63	67	76

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	2	N/A
Daytime (7am-10pm)	65	64	65
Night-time (10pm-7am)	64	59	63

Attended Noise Measurement Results

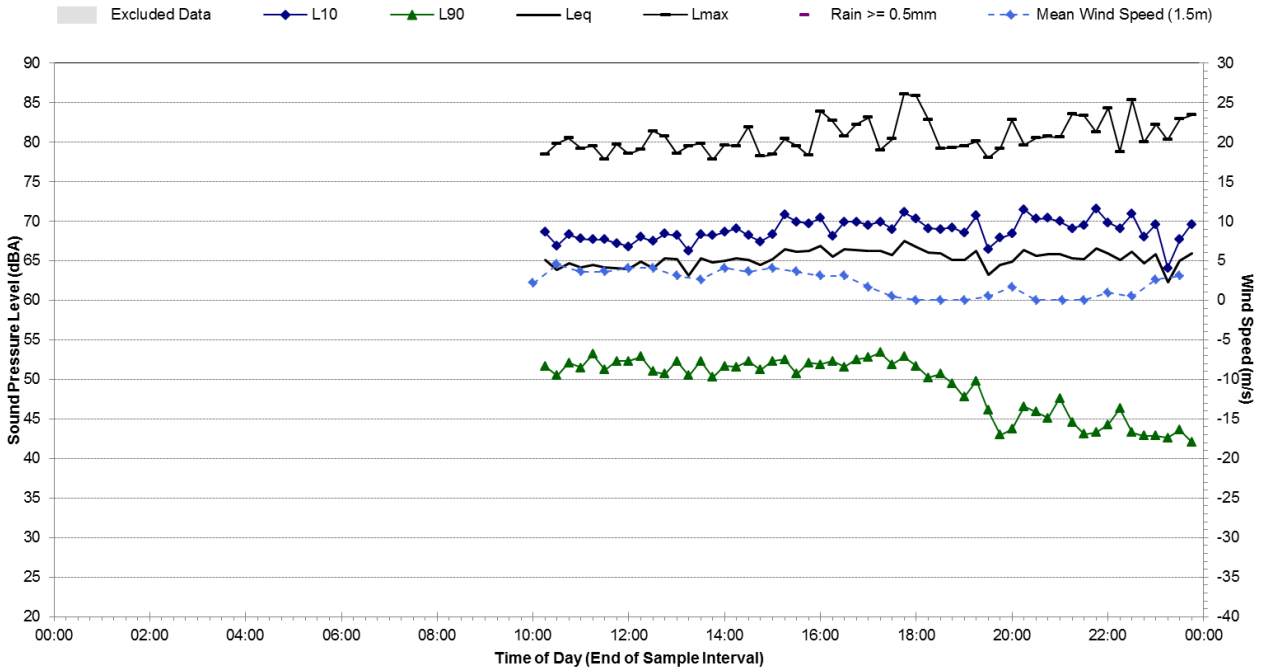
Date	Start Time	Measured Noise Level (dBA)		
		LA90	**LAeq**	**LAmax**
21/05/2014	09:44am	52	65	79

Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

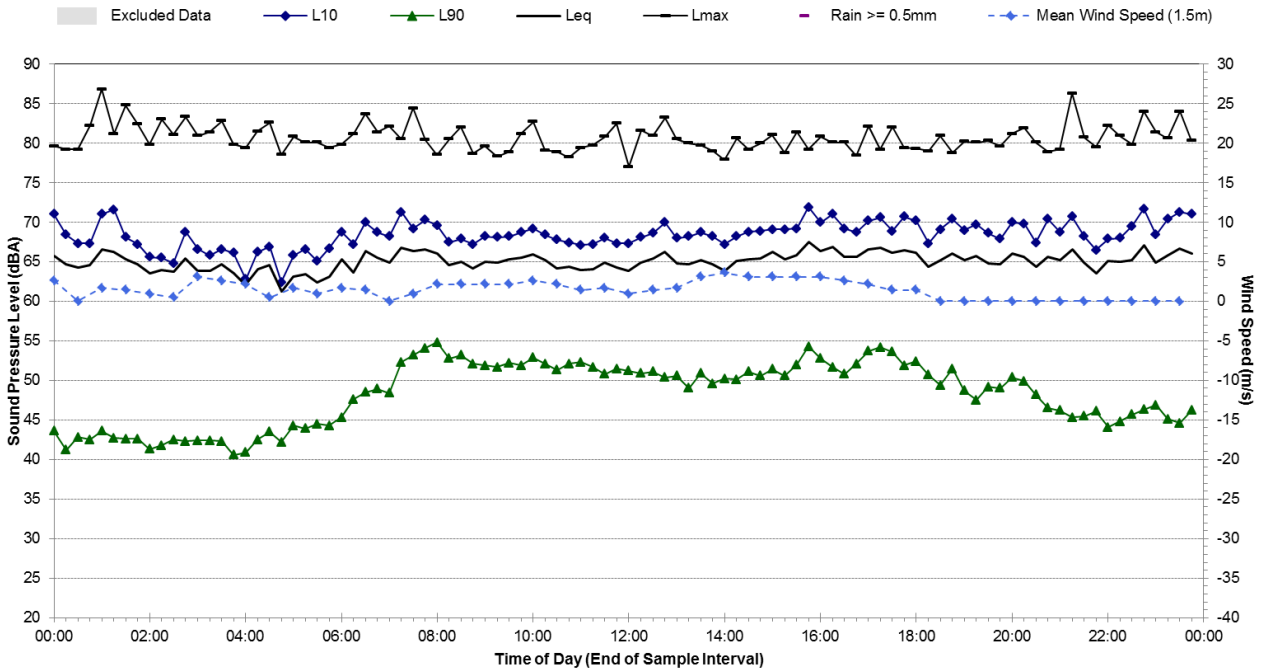
Statistical Ambient Noise Levels

L2 - Cassegrain Winery - 764 Fernbank Road, Sancrox - Wednesday, 21 May 2014

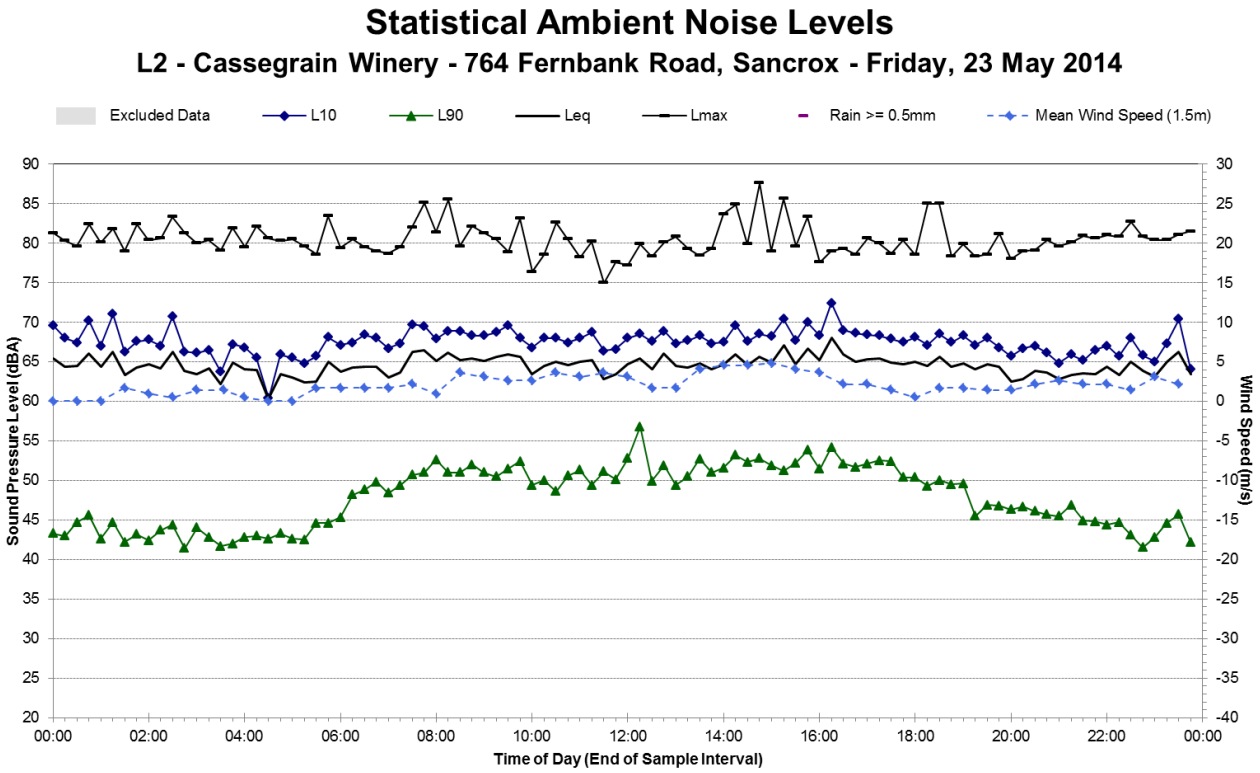


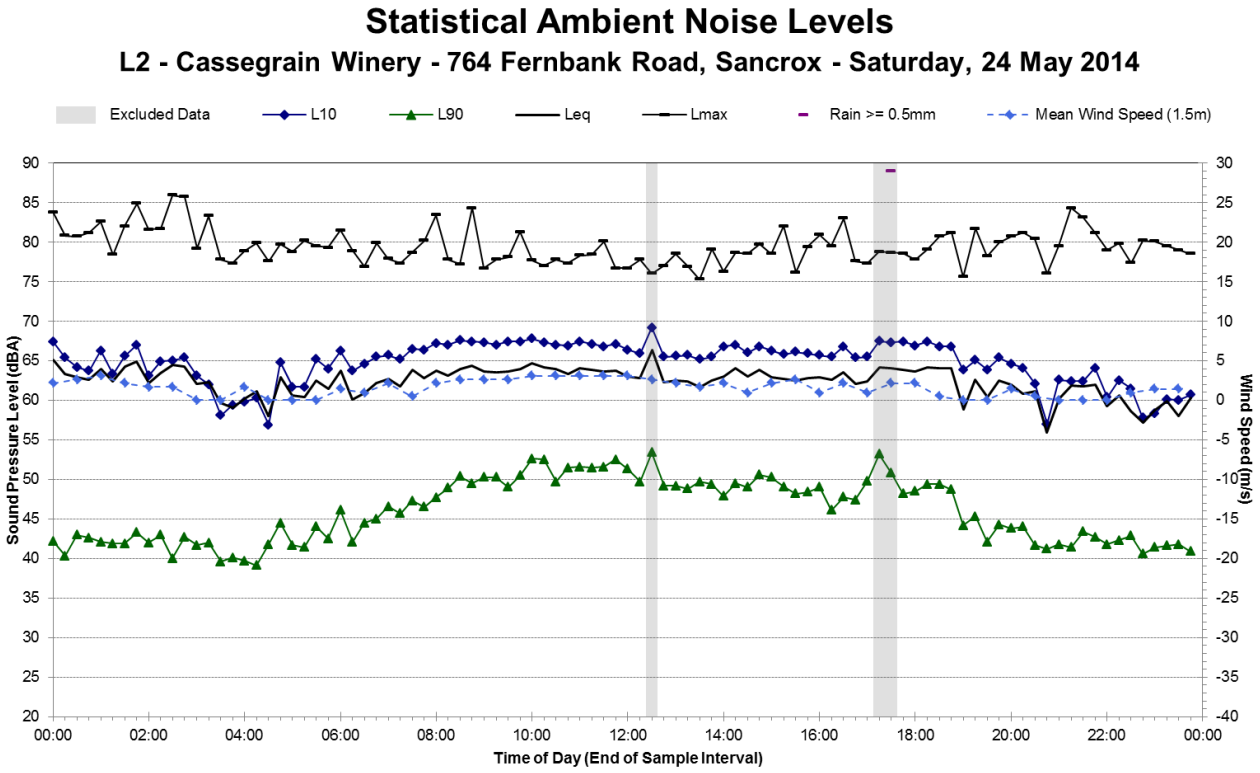
Statistical Ambient Noise Levels

L2 - Cassegrain Winery - 764 Fernbank Road, Sancrox - Thursday, 22 May 2014



Appendix C Ambient Noise Logging Results

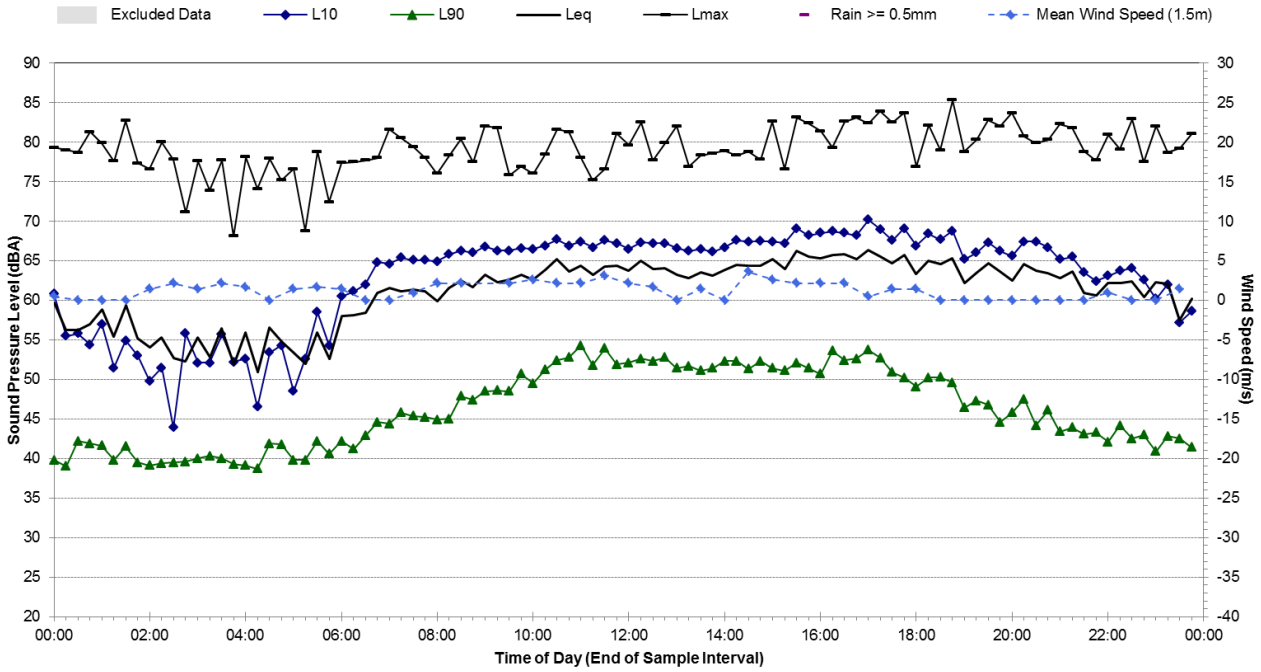




Appendix C Ambient Noise Logging Results

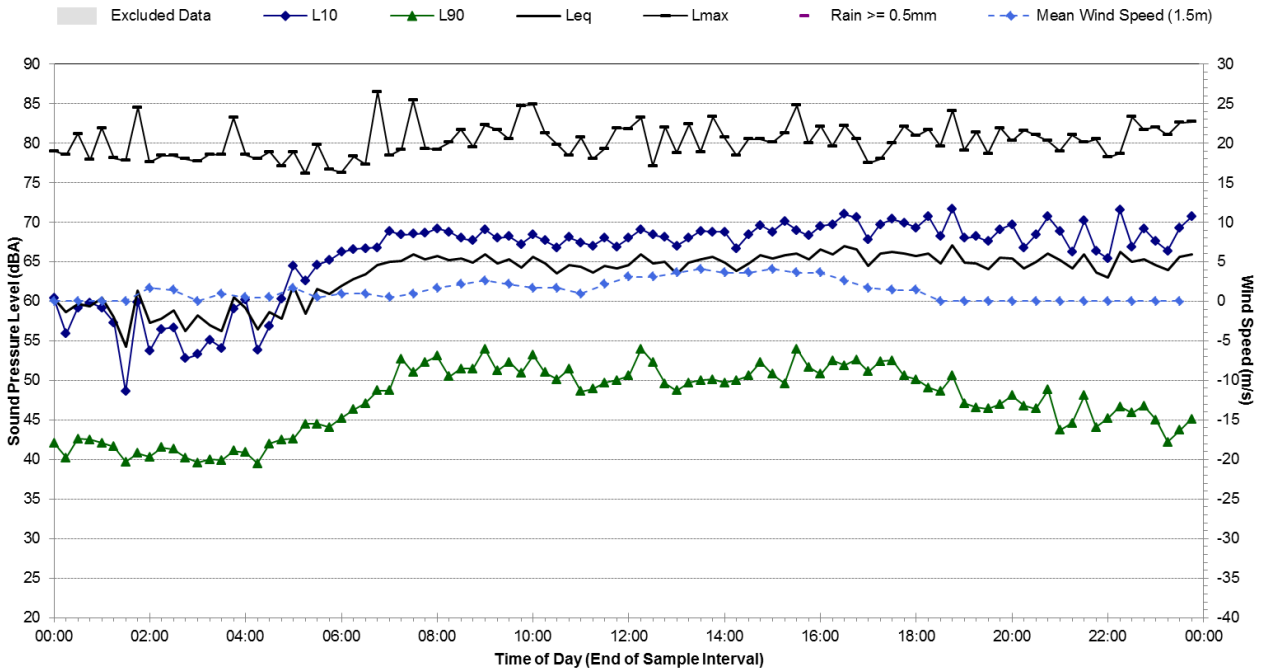
Statistical Ambient Noise Levels

L2 - Cassegrain Winery - 764 Fernbank Road, Sancrox - Sunday, 25 May 2014



Statistical Ambient Noise Levels

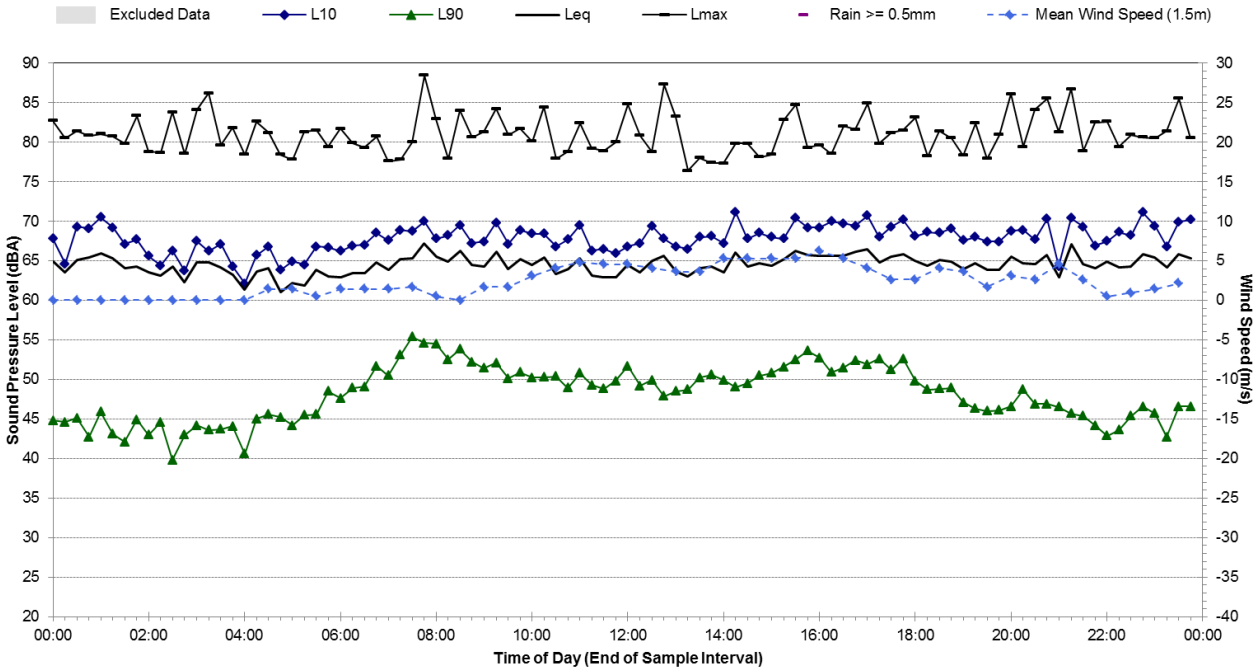
L2 - Cassegrain Winery - 764 Fernbank Road, Sancrox - Monday, 26 May 2014



Appendix C Ambient Noise Logging Results

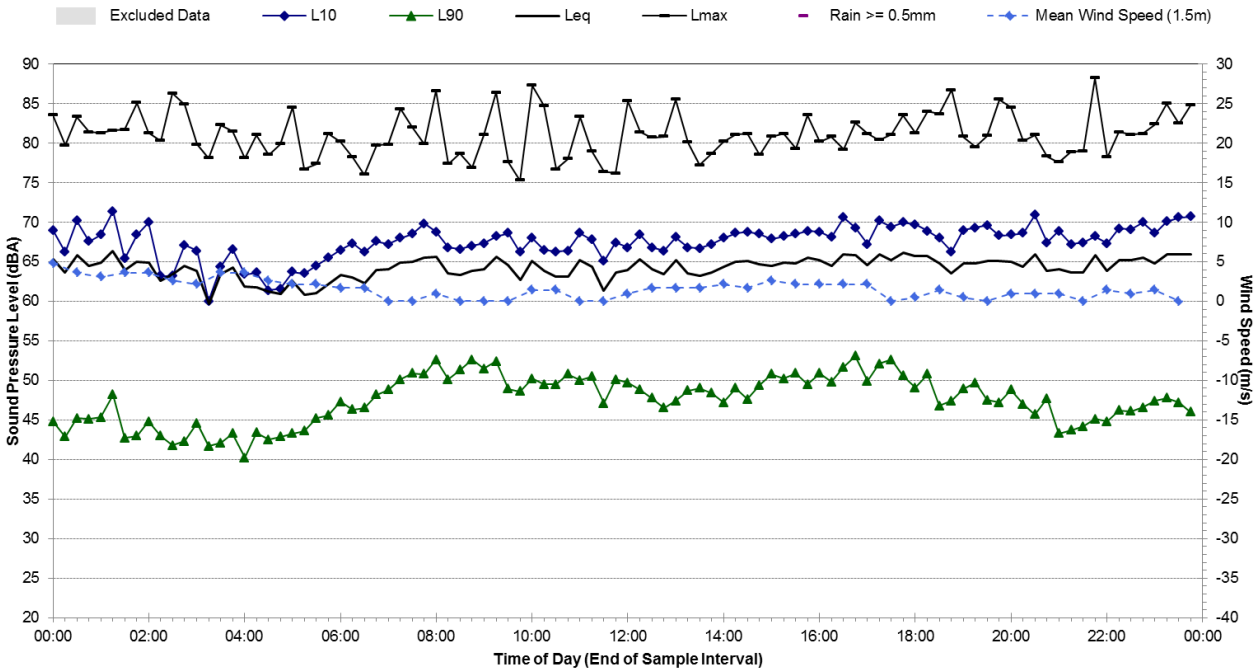
Statistical Ambient Noise Levels

L2 - Cassegrain Winery - 764 Fernbank Road, Sancrox - Tuesday, 27 May 2014

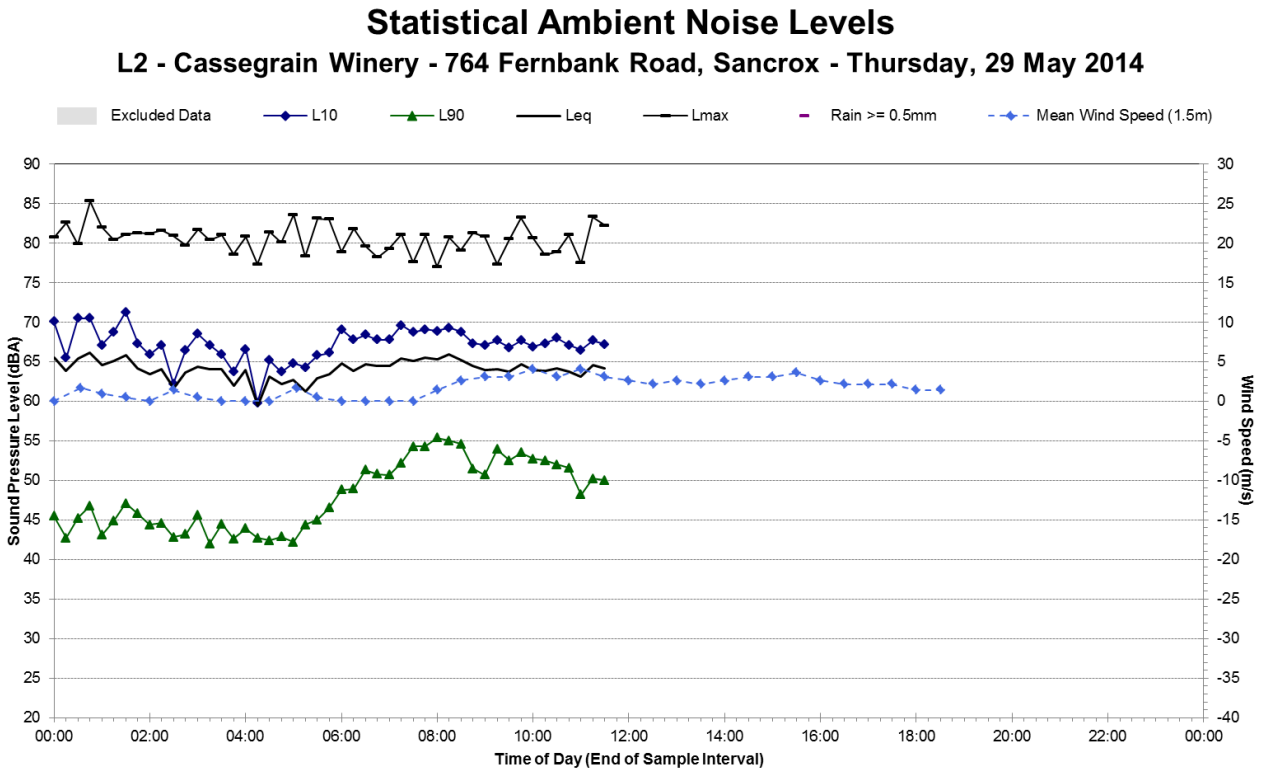


Statistical Ambient Noise Levels

L2 - Cassegrain Winery - 764 Fernbank Road, Sancrox - Wednesday, 28 May 2014



Appendix C Ambient Noise Logging Results



Noise Monitoring Location:	**L3**
Noise Monitoring Address:	**15 Glen Ewan Road, Sancrox**

Logger Device Type: ARL316
Logger Serial No: 16-207-045

Ambient noise logger deployed in a free field location in front yard of property, chained to tree adjacent to driveway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically 43-47 dBA, Pacific Highway Heavy-vehicle road traffic: typically 50-56 dBA, Glen Ewan Rd car passbys: ~55-62 dBA , Insects/birds: 40-55 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	41	53	54	57
Evening	42	52	55	57
Night-time	36	50	54	56

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	Weekend LAeq(Period)	Weekly LAeq(Period)
Number of Valid Days	6	2	N/A
Daytime (7am-10pm)	53	52	53
Night-time (10pm-7am)	50	45	49

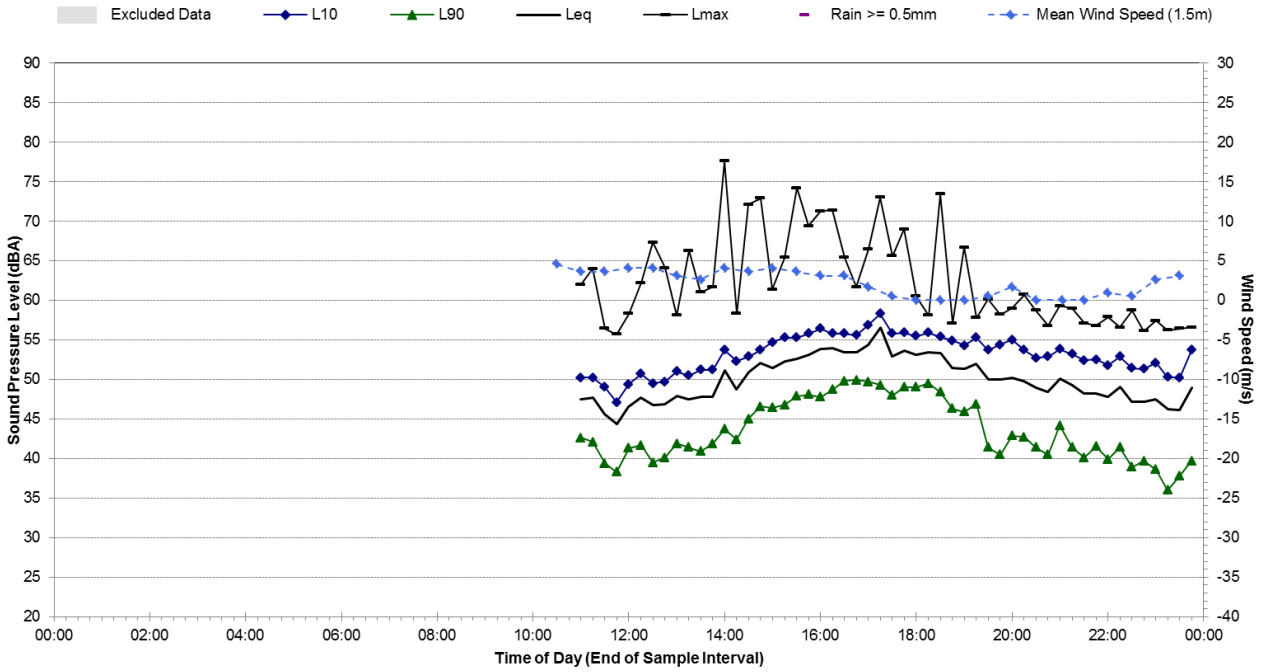
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
21/05/2014	10:18am	41	46	62

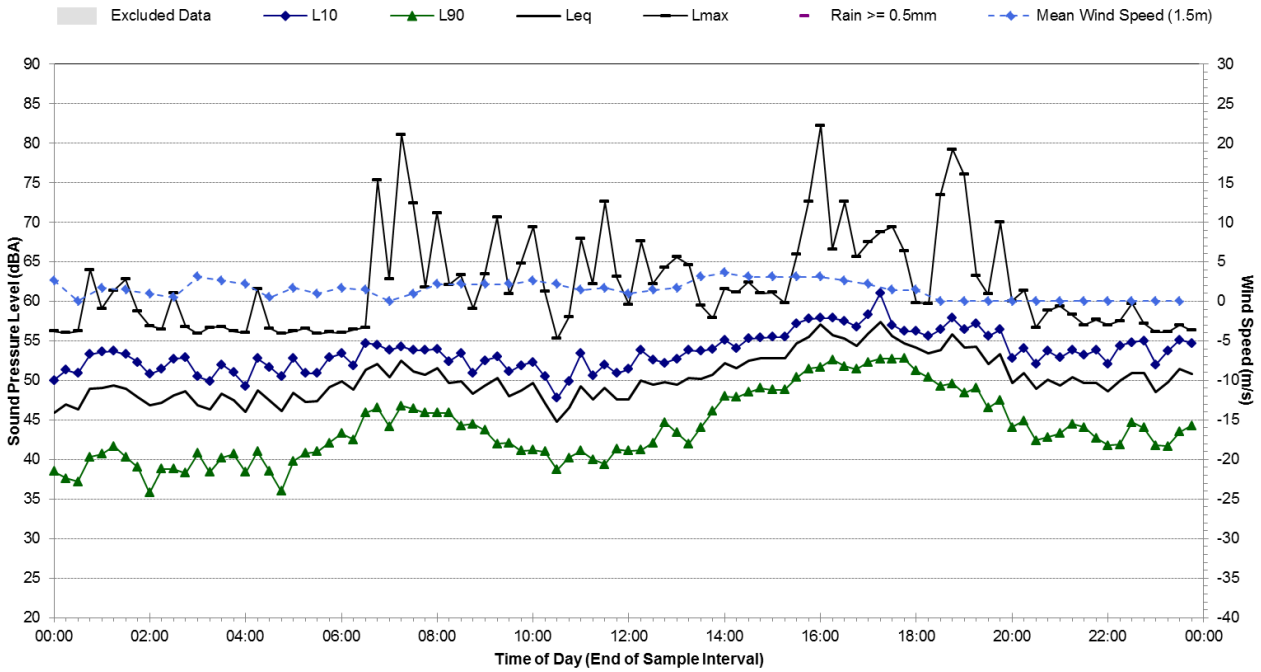
Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

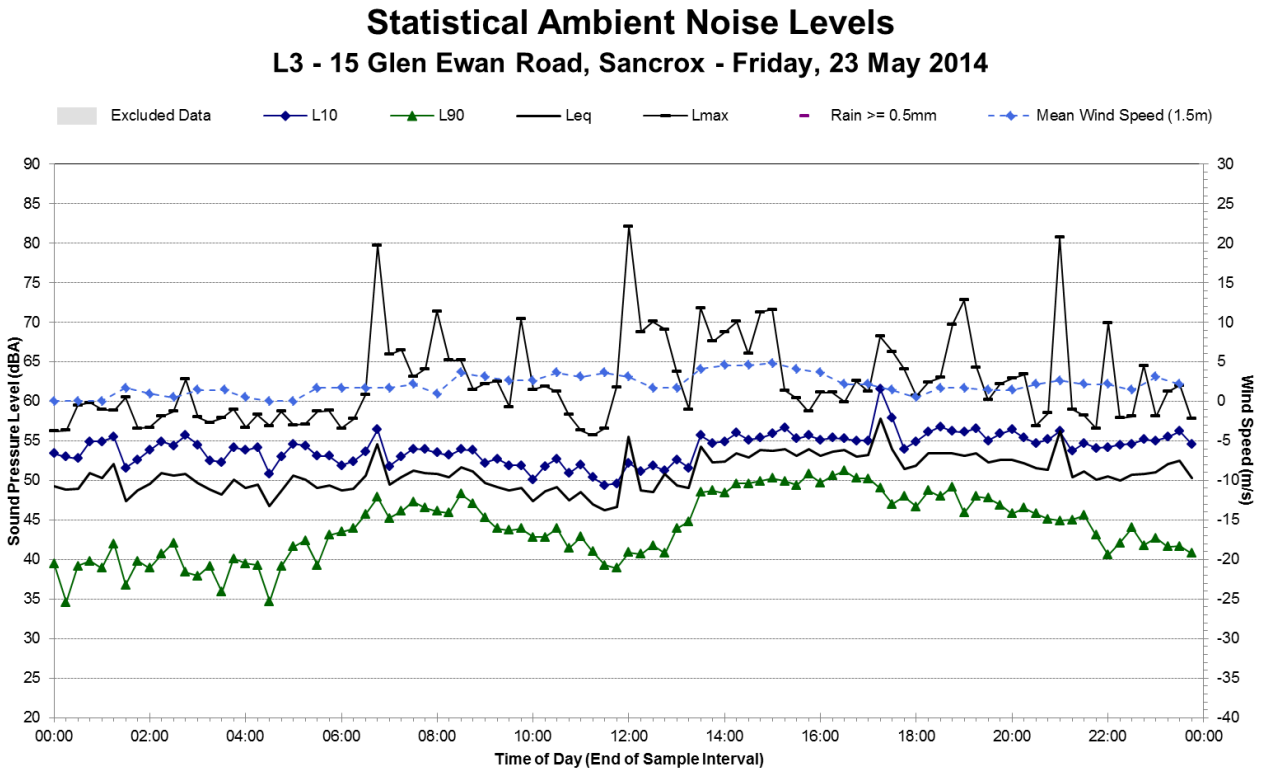
Statistical Ambient Noise Levels
L3 - 15 Glen Ewan Road, Sancrox - Wednesday, 21 May 2014

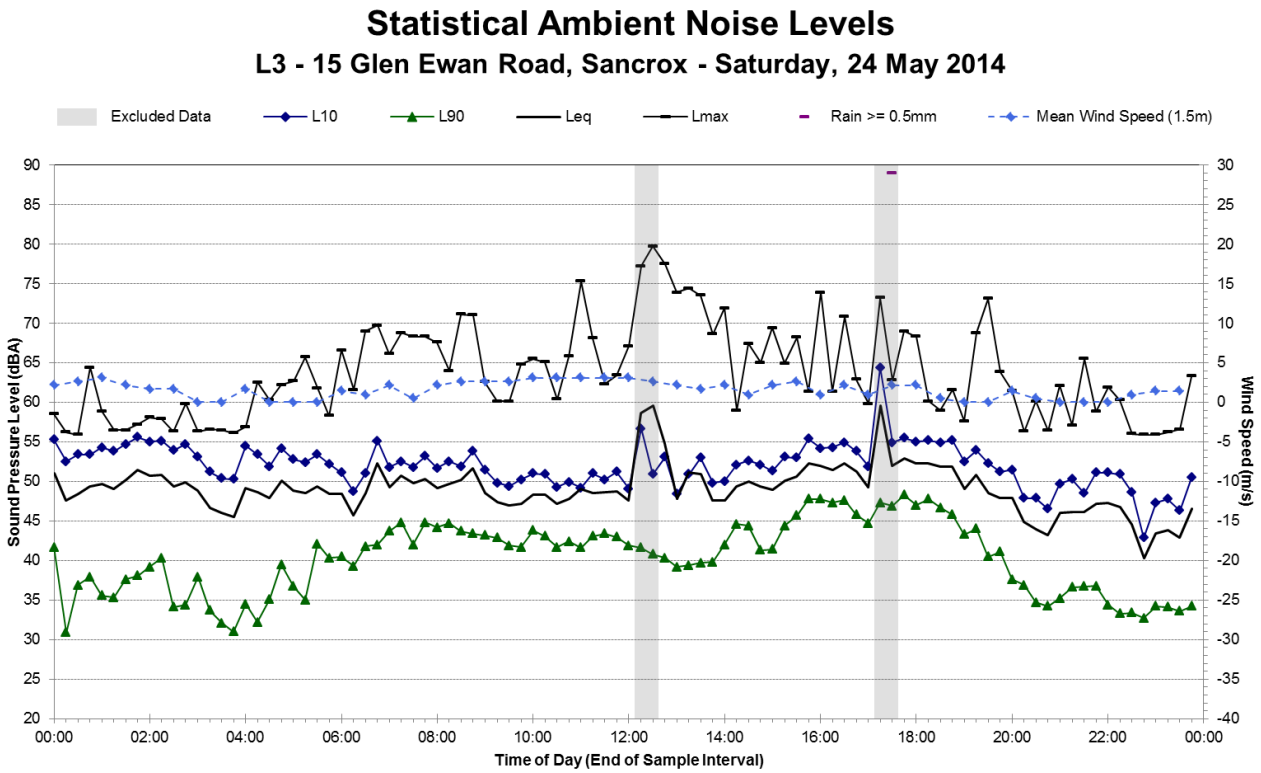


Statistical Ambient Noise Levels
L3 - 15 Glen Ewan Road, Sancrox - Thursday, 22 May 2014



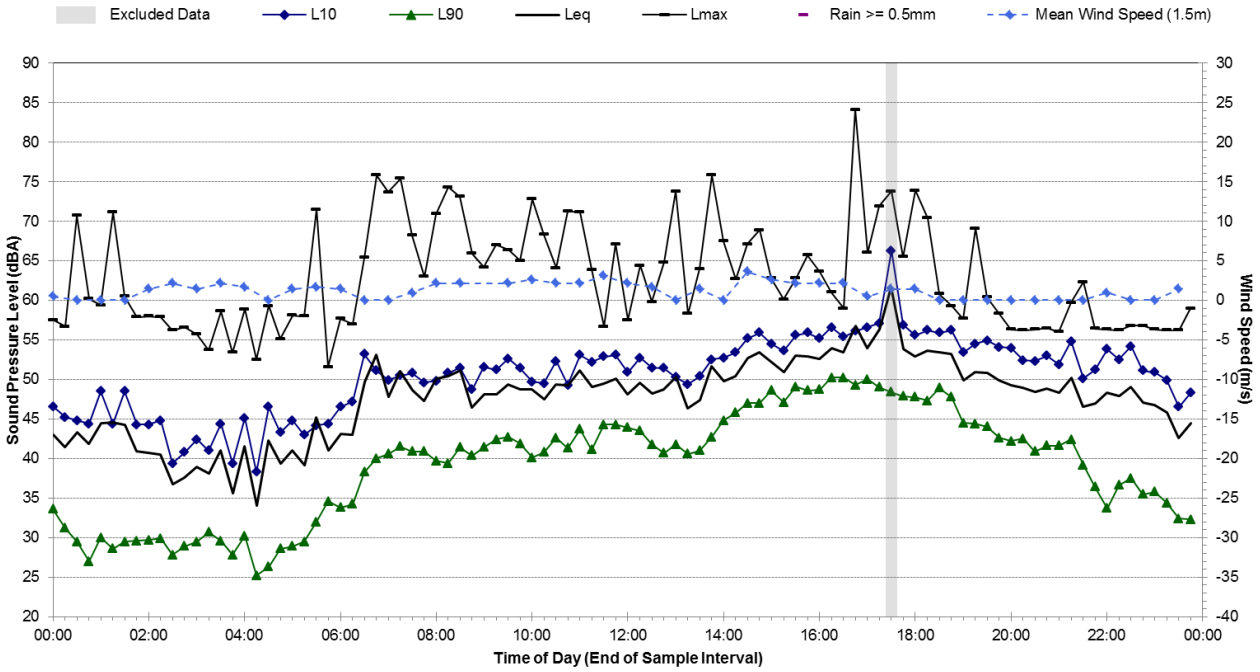
Appendix C Ambient Noise Logging Results



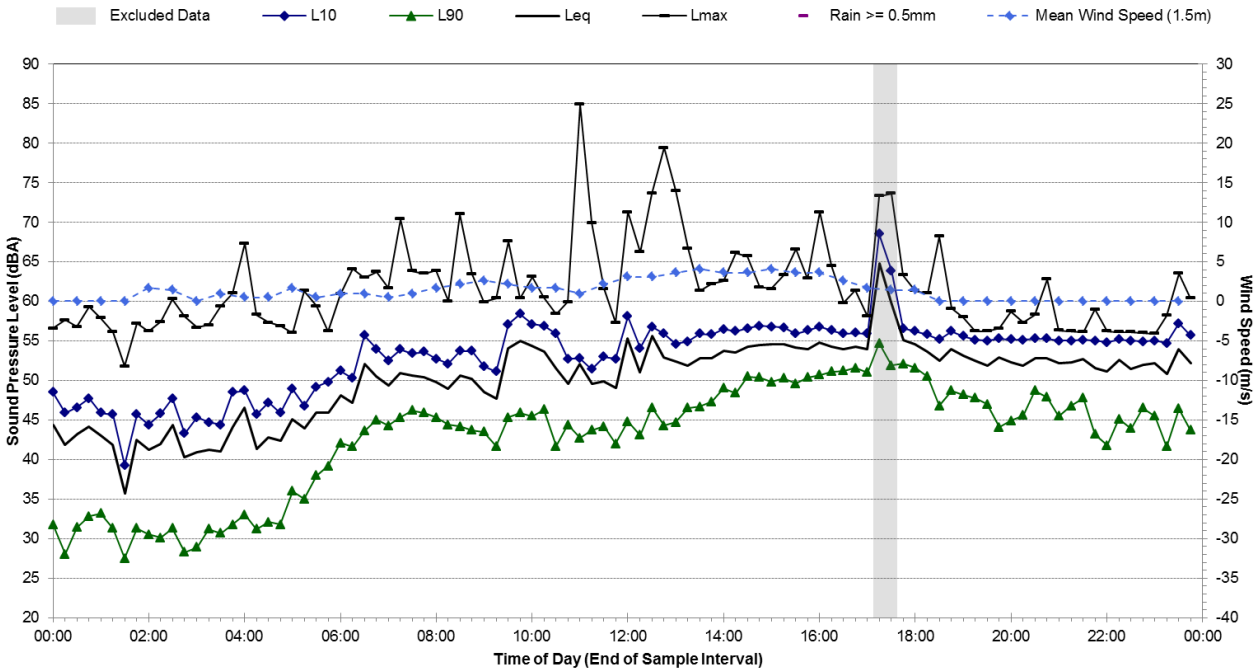


Appendix C Ambient Noise Logging Results

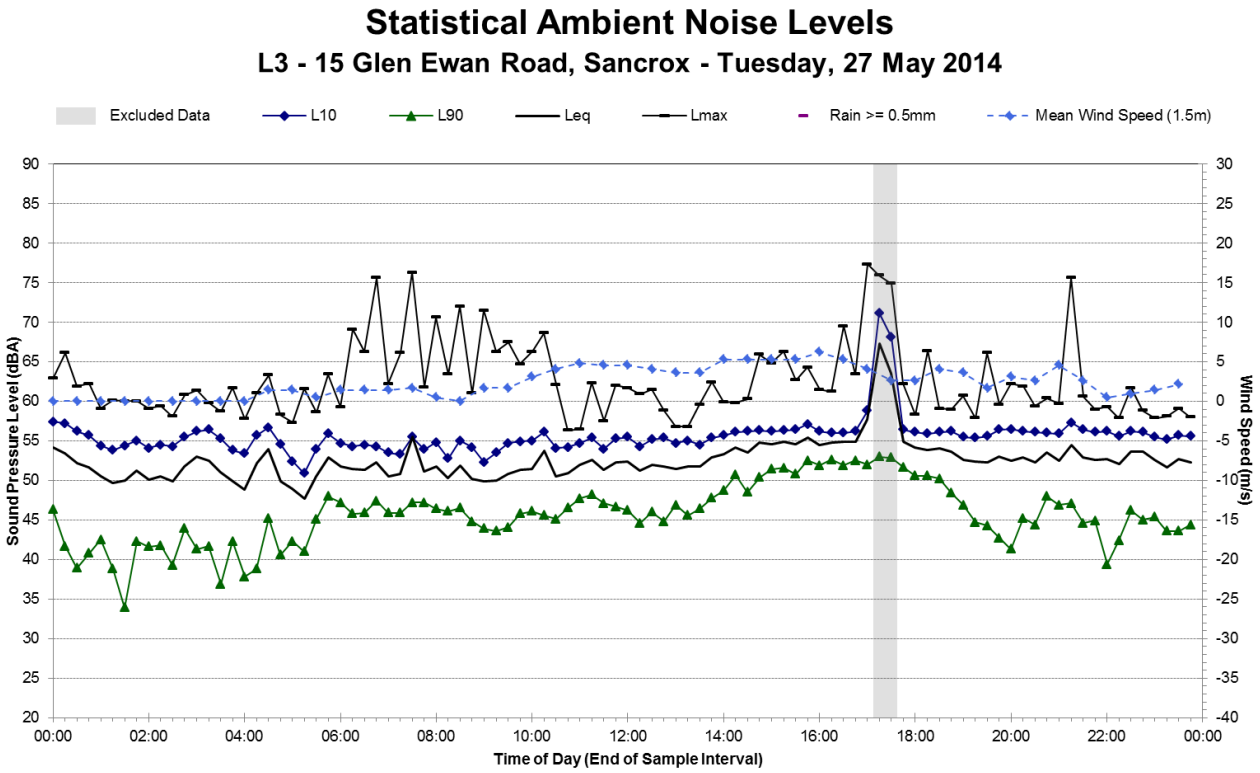
Statistical Ambient Noise Levels
L3 - 15 Glen Ewan Road, Sancrox - Sunday, 25 May 2014

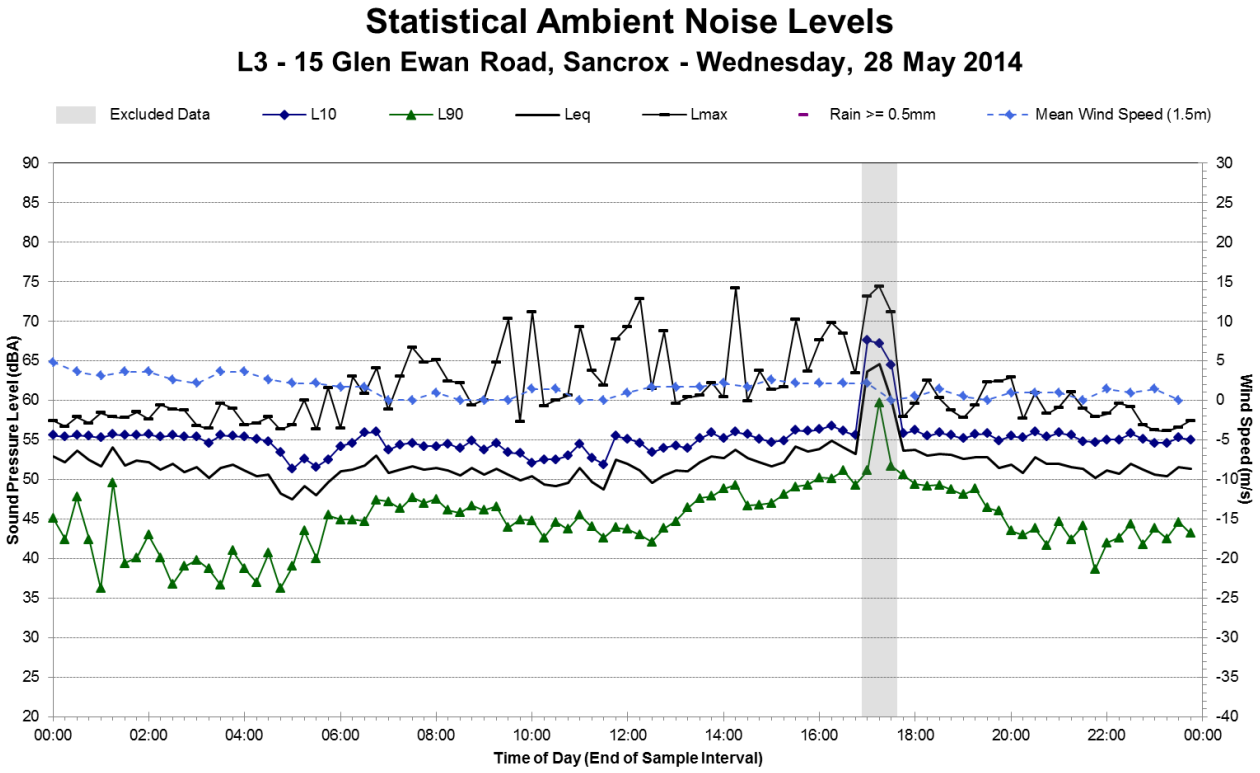


Statistical Ambient Noise Levels
L3 - 15 Glen Ewan Road, Sancrox - Monday, 26 May 2014

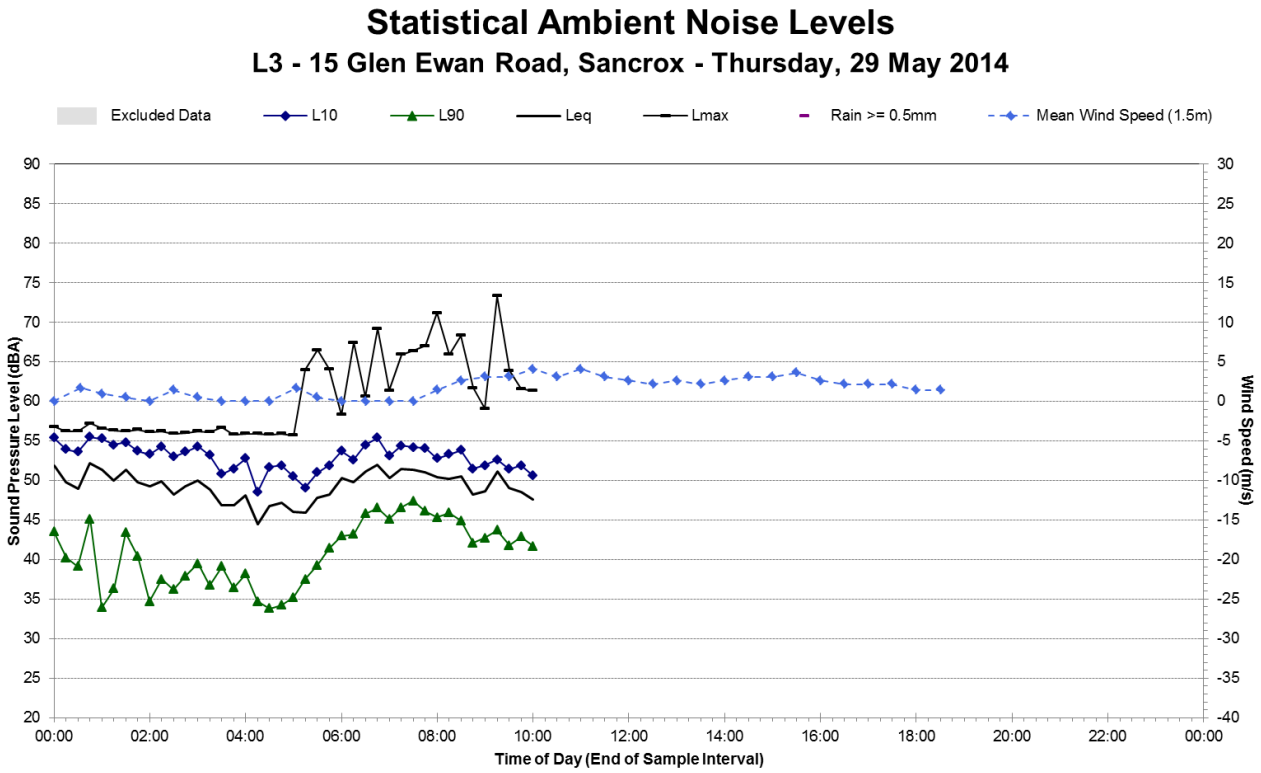


Appendix C Ambient Noise Logging Results





Appendix C Ambient Noise Logging Results



Noise Monitoring Location:	**L4**
Noise Monitoring Address:	**77 Moorside Drive, Telegraph Point**

Logger Device Type: ARL316

Logger Serial No: 16-207-050

Ambient noise logger deployed in a free field location at rear of property, adjacent to driveway between the residential house and work shed.

Attended noise measurements indicate the ambient noise environment at this location is dominated by local and neighbouring activities. Pacific Highway road traffic noise inaudible at the time of measurement.

Recorded Noise Levels (LAmax):

Residents working at shed: 45-66 dBA, Operating whipper snipper ~ 100m away: 44-47 dBA, Birds: 45-54 dBA, Three dogs barking on the property at different distances from the microphone: 80-97 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	32	49	44	52
Evening	37	46	48	50
Night-time	35	46	48	51

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	50	45	49
Night-time (10pm-7am)	46	43	46

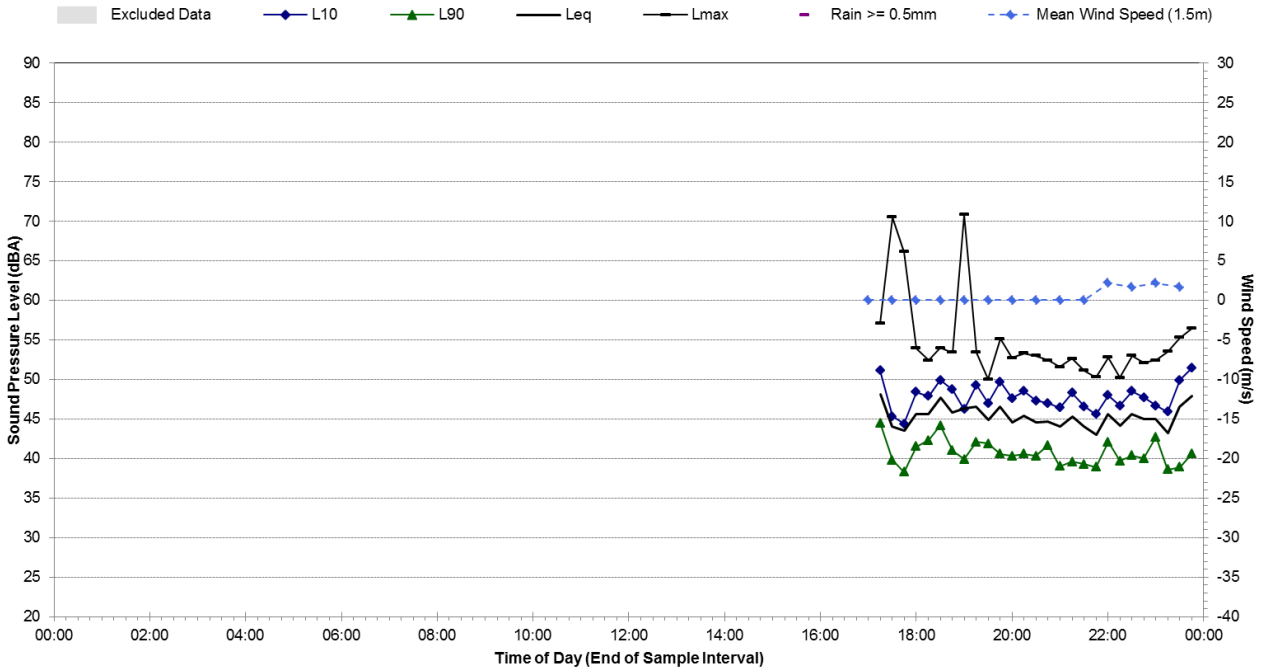
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
20/05/2014	16:34pm	40	69	97

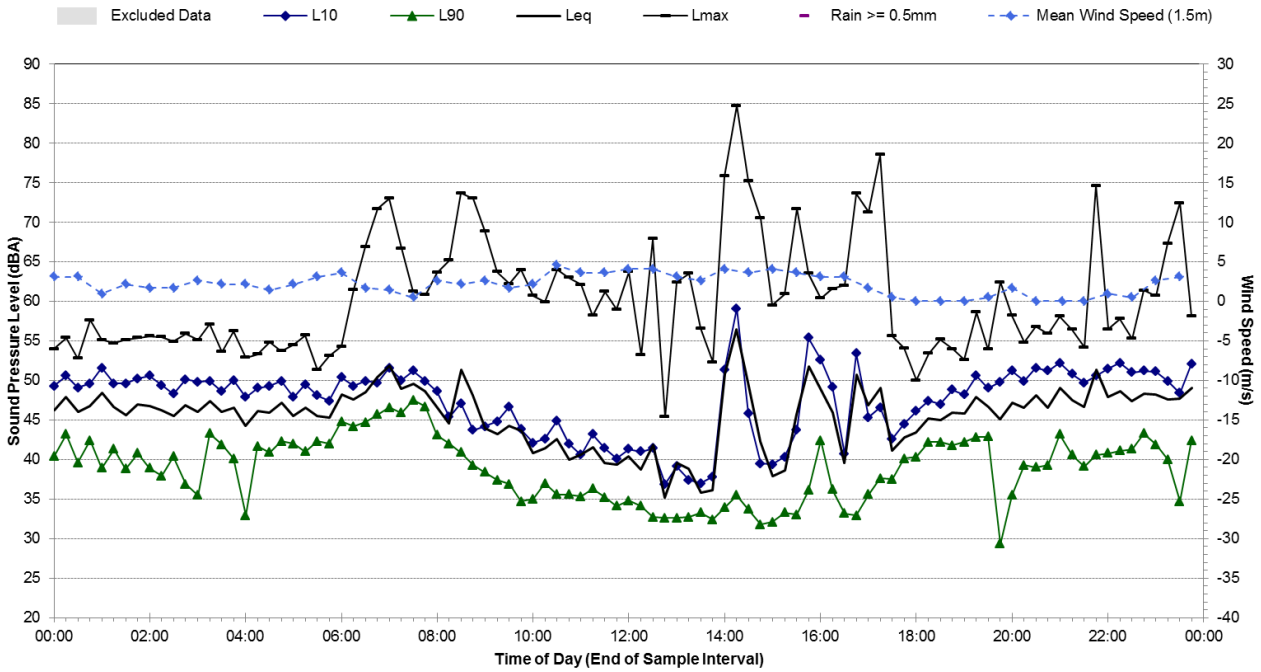
Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

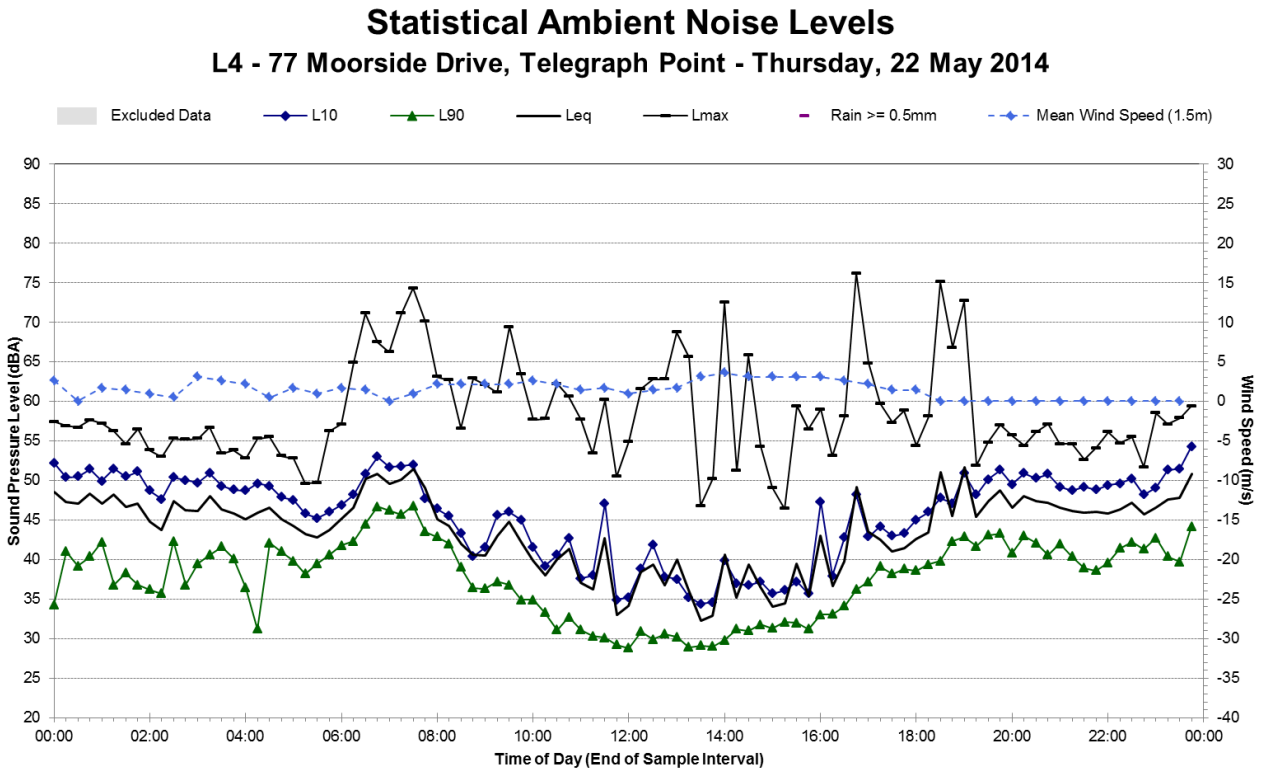
Statistical Ambient Noise Levels
L4 - 77 Moorside Drive, Telegraph Point - Tuesday, 20 May 2014

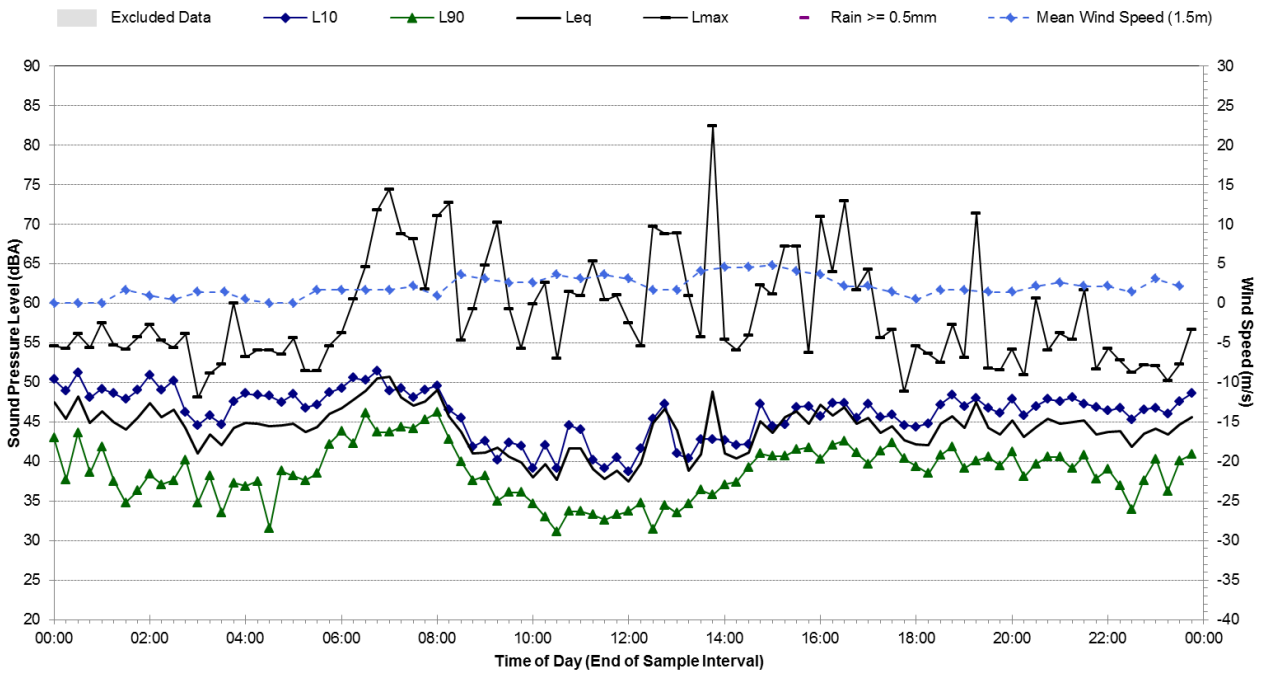


Statistical Ambient Noise Levels
L4 - 77 Moorside Drive, Telegraph Point - Wednesday, 21 May 2014



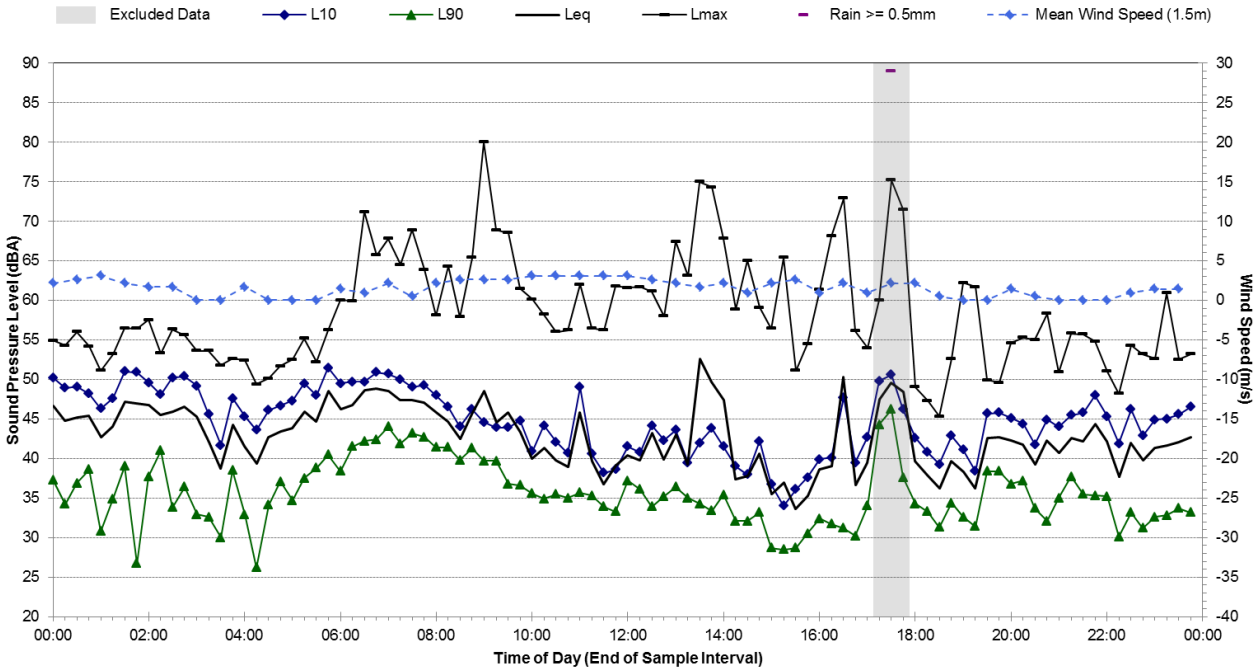
Appendix C Ambient Noise Logging Results



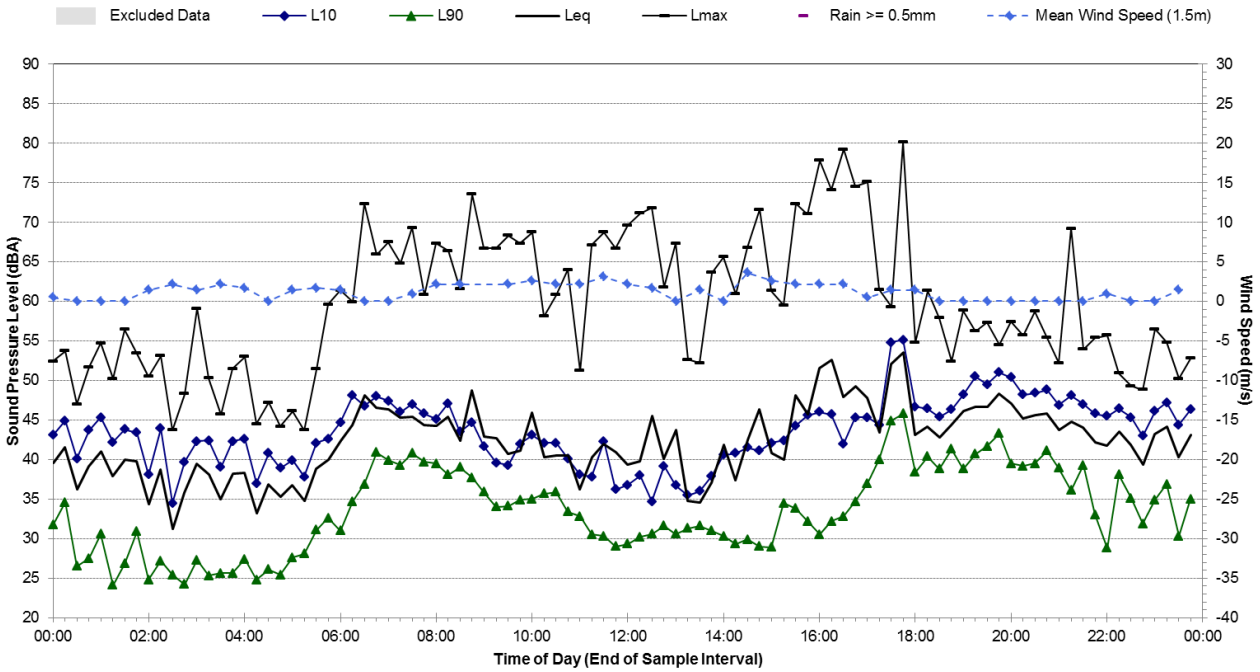


Appendix C Ambient Noise Logging Results

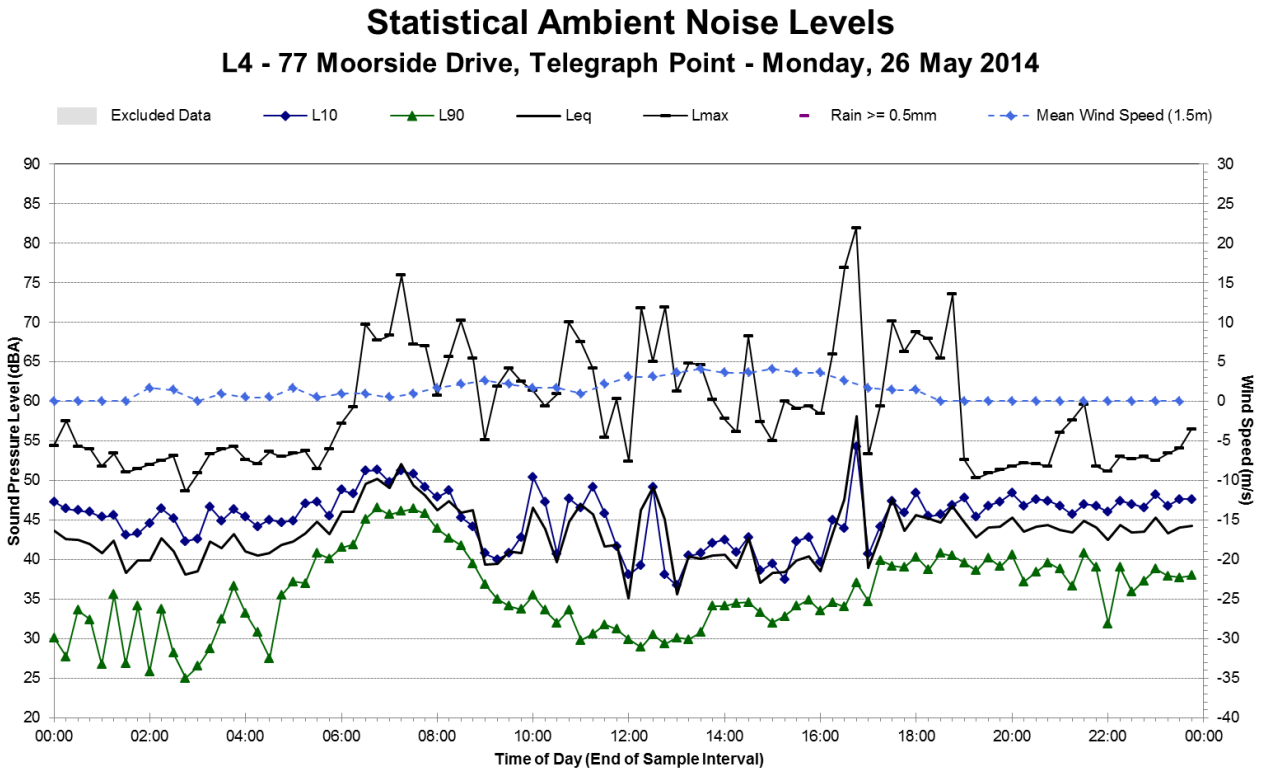
Statistical Ambient Noise Levels
L4 - 77 Moorside Drive, Telegraph Point - Saturday, 24 May 2014

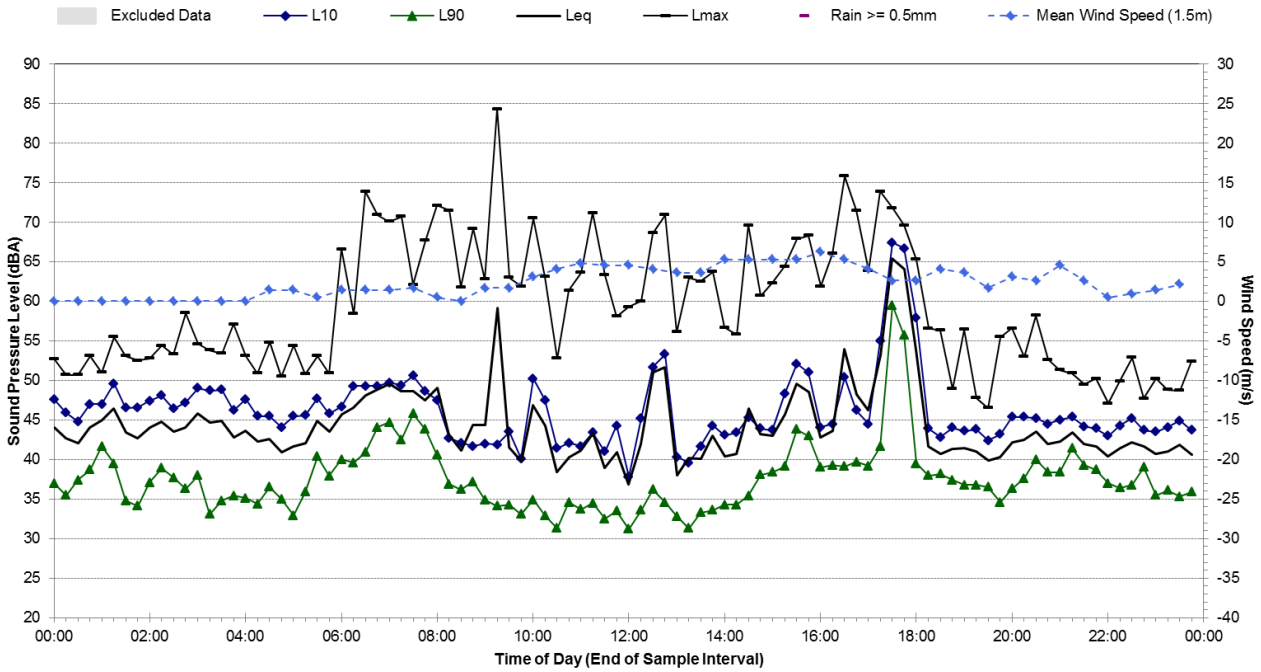


Statistical Ambient Noise Levels
L4 - 77 Moorside Drive, Telegraph Point - Sunday, 25 May 2014



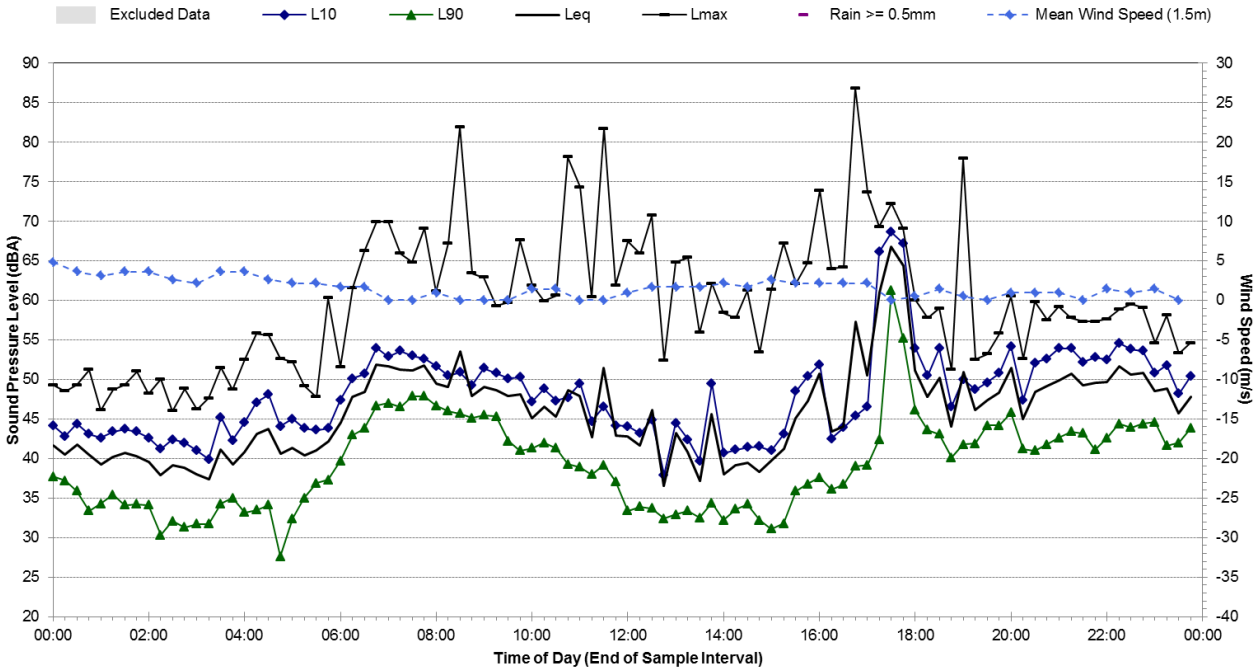
Appendix C Ambient Noise Logging Results



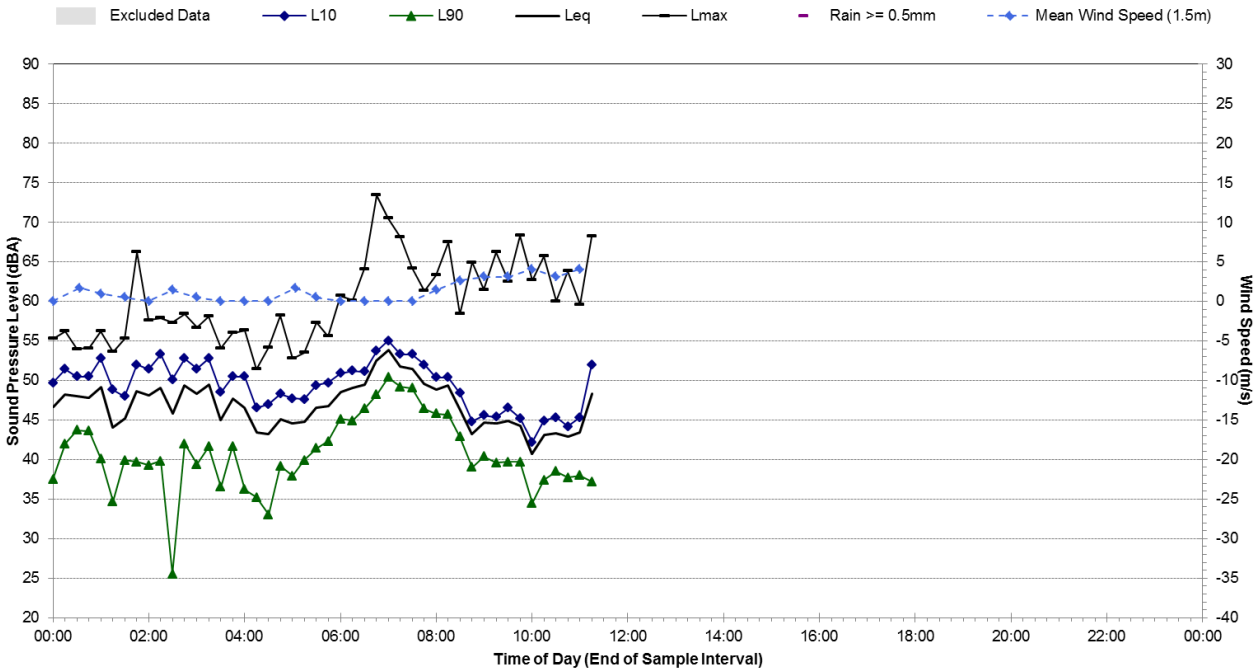


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L4 - 77 Moorside Drive, Telegraph Point - Wednesday, 28 May 2014



Statistical Ambient Noise Levels
L4 - 77 Moorside Drive, Telegraph Point - Thursday, 29 May 2014



Noise Monitoring Location:	**L5**
Noise Monitoring Address:	**8656 Pacific Highway, Telegraph Point**

Logger Device Type: SVAN957
Logger Serial No: 27580

Ambient noise logger deployed in a free field location north of residence, in line with the front facade of the house.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically 59-68 dBA, Pacific Highway Heavy-vehicle road traffic: typically 69-73 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	47	64	67	71
Evening	46	63	68	72
Night-time	38	62	67	72

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	64	62	63
Night-time (10pm-7am)	63	58	62

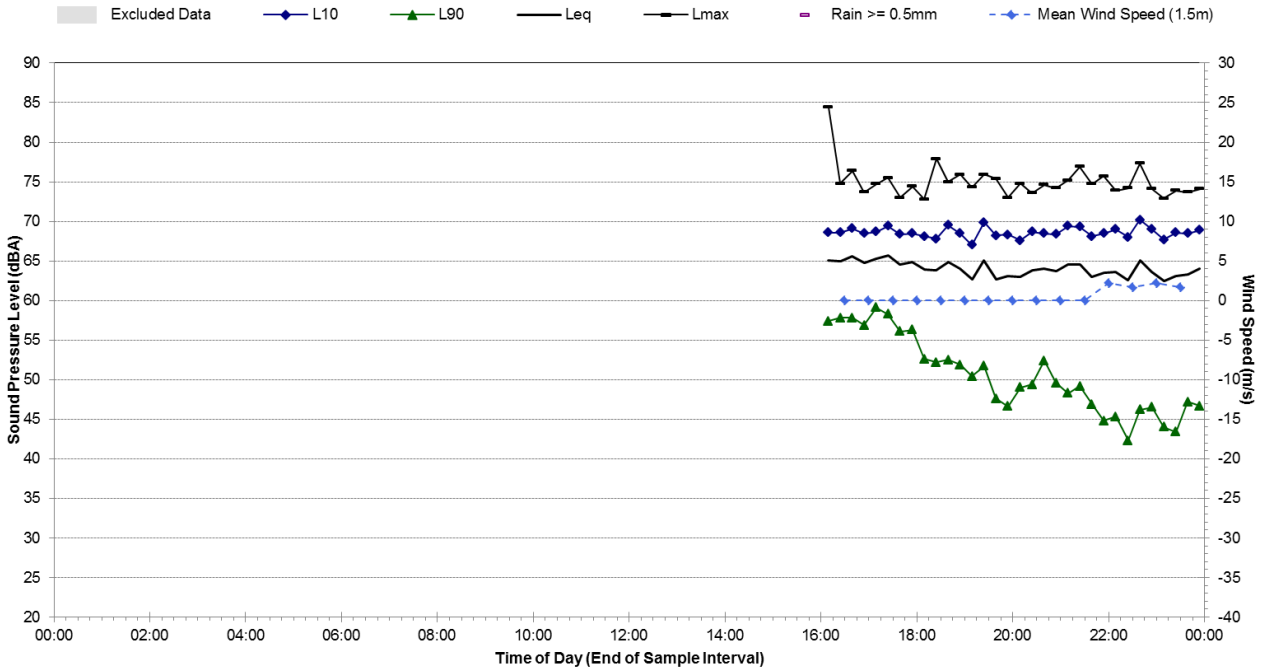
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
20/05/2014	16:03pm	58	65	73

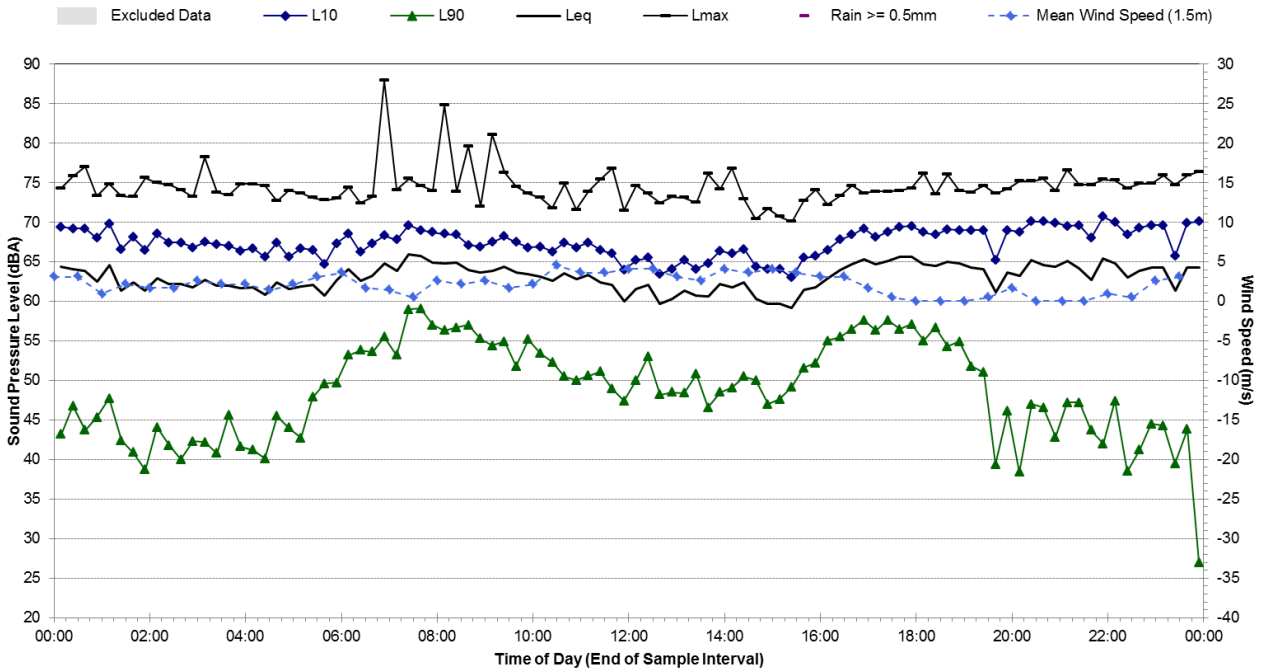
Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

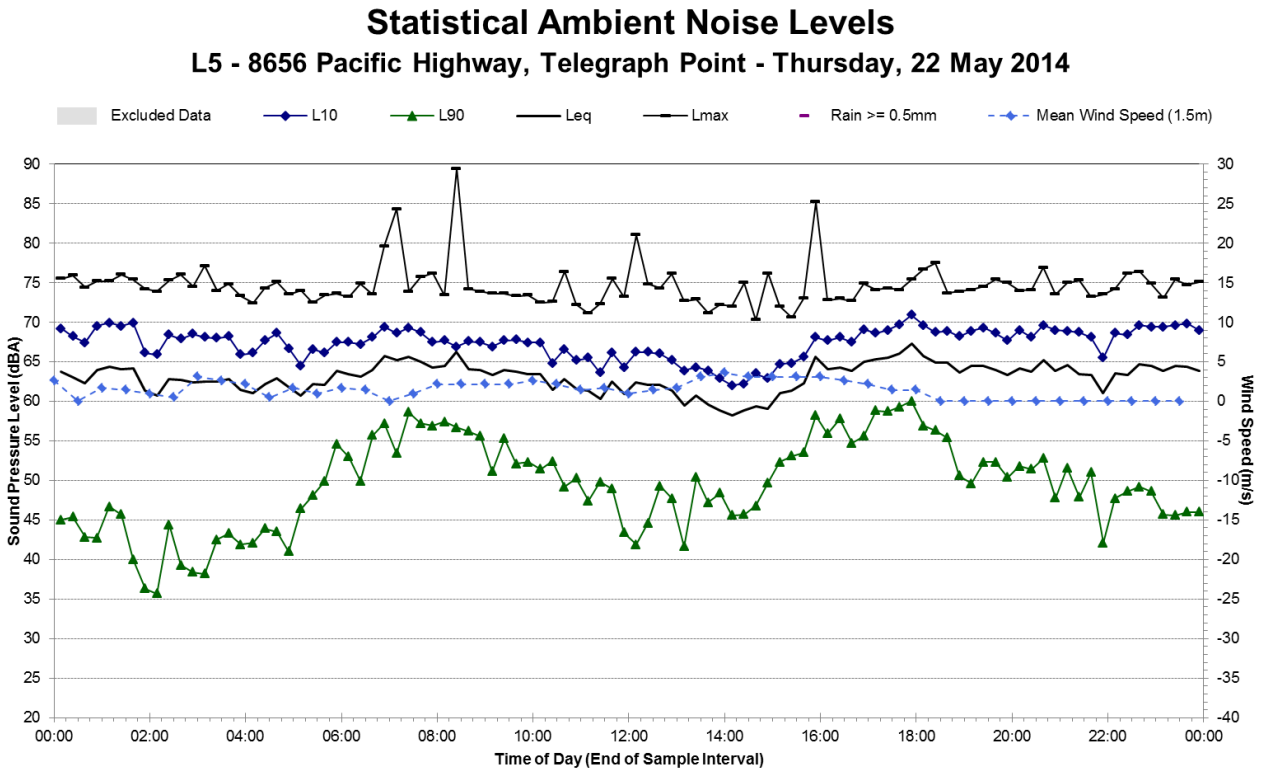
Statistical Ambient Noise Levels
L5 - 8656 Pacific Highway, Telegraph Point - Tuesday, 20 May 2014

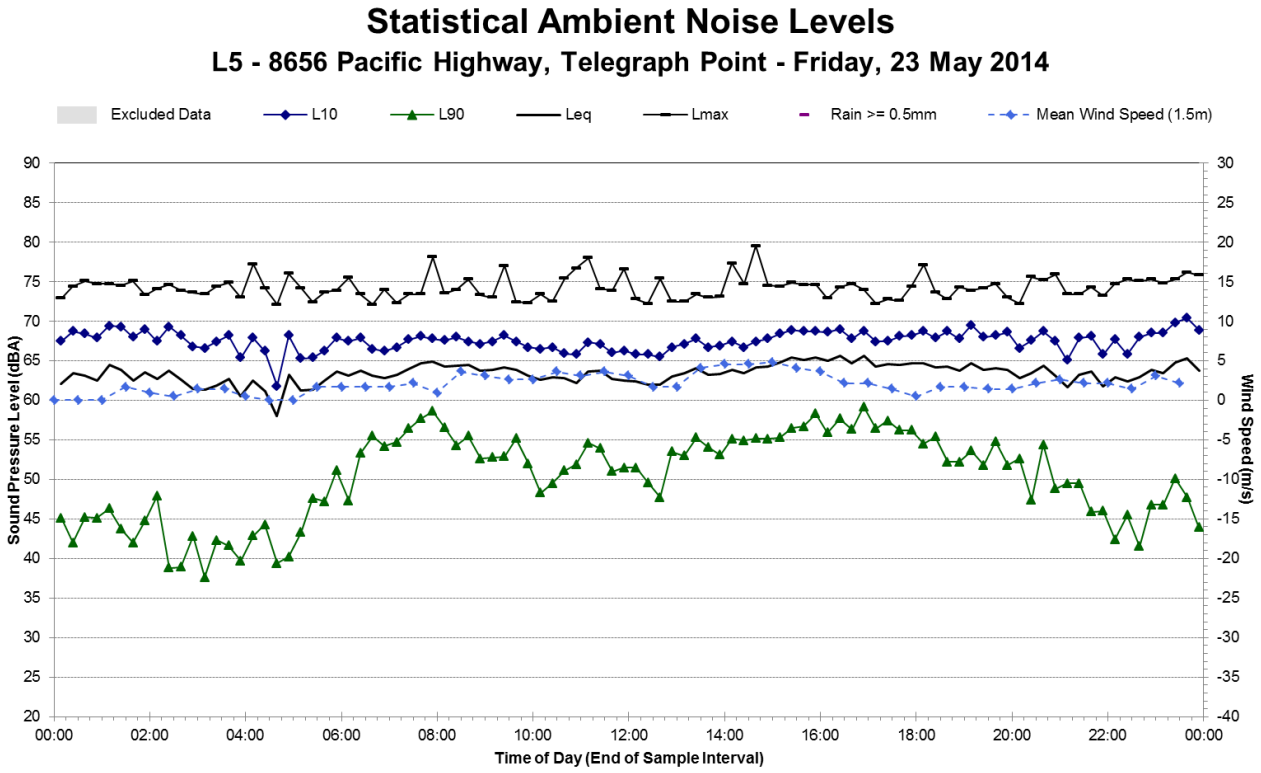


Statistical Ambient Noise Levels
L5 - 8656 Pacific Highway, Telegraph Point - Wednesday, 21 May 2014



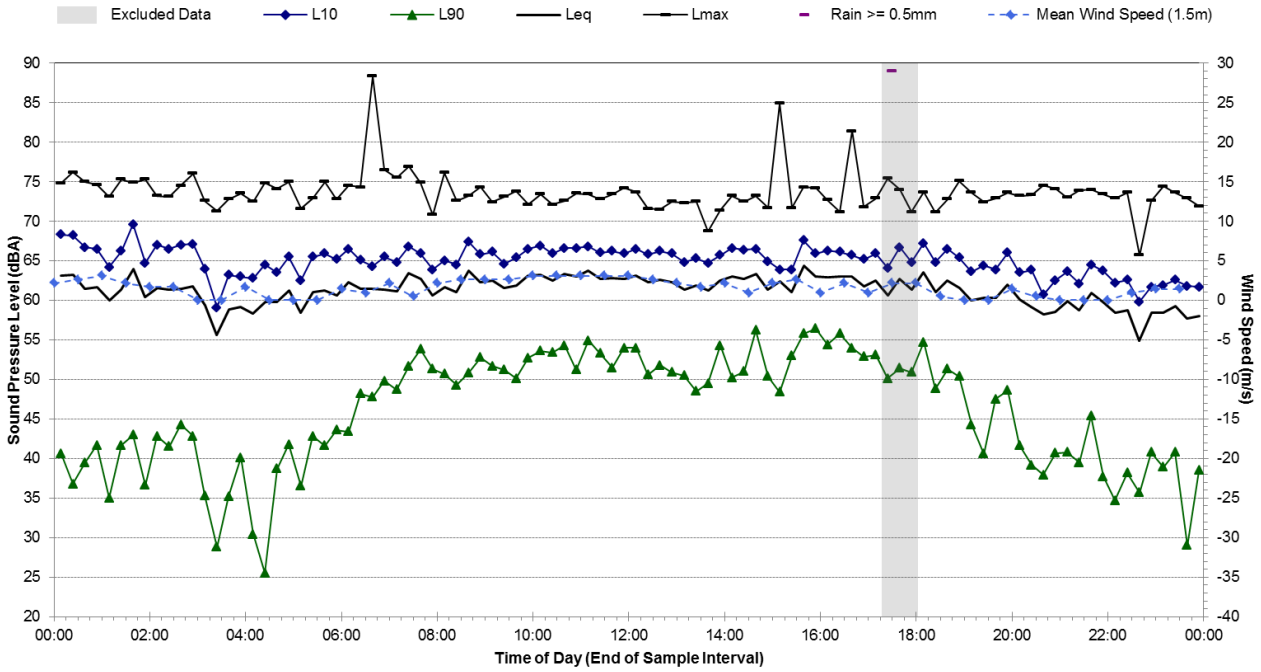
Appendix C Ambient Noise Logging Results



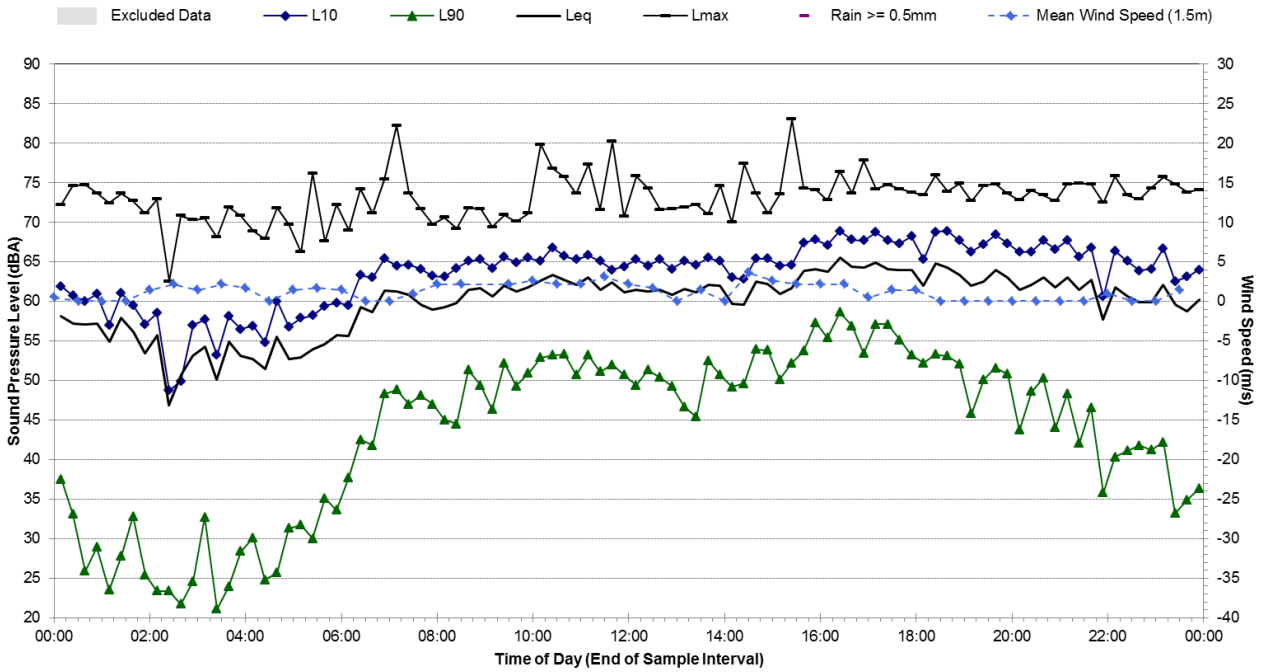


Appendix C Ambient Noise Logging Results

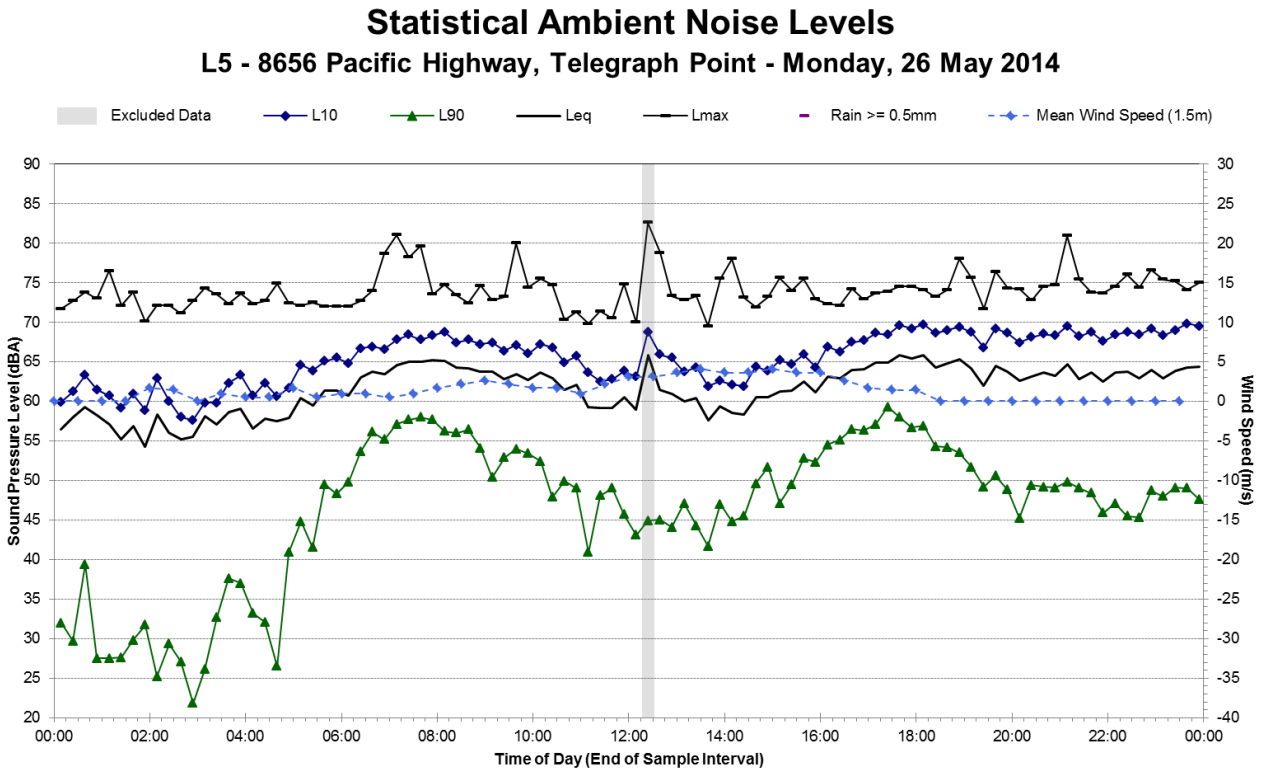
Statistical Ambient Noise Levels
L5 - 8656 Pacific Highway, Telegraph Point - Saturday, 24 May 2014

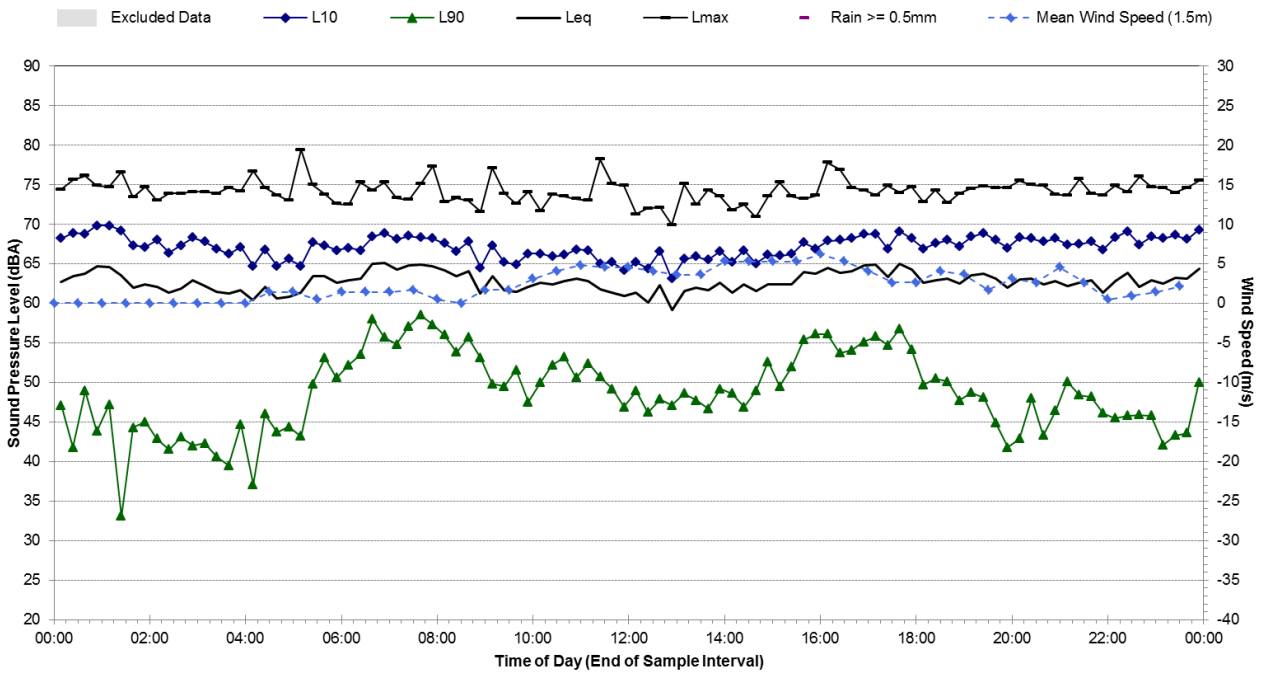


Statistical Ambient Noise Levels
L5 - 8656 Pacific Highway, Telegraph Point - Sunday, 25 May 2014



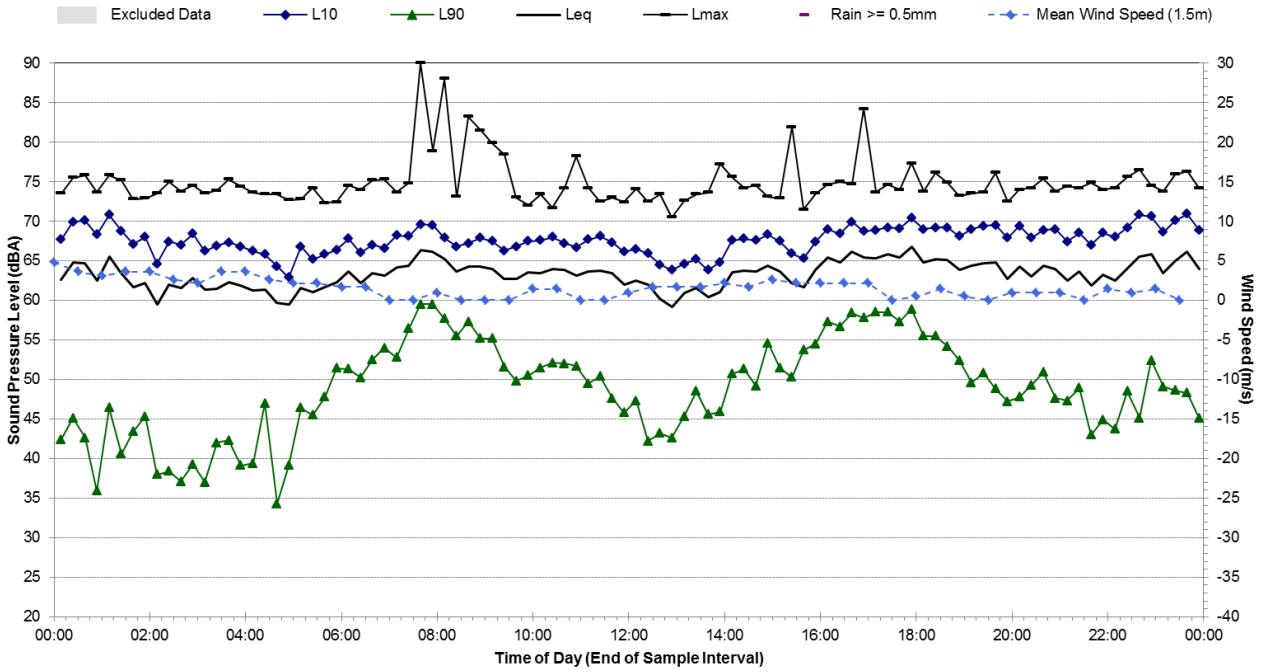
Appendix C Ambient Noise Logging Results





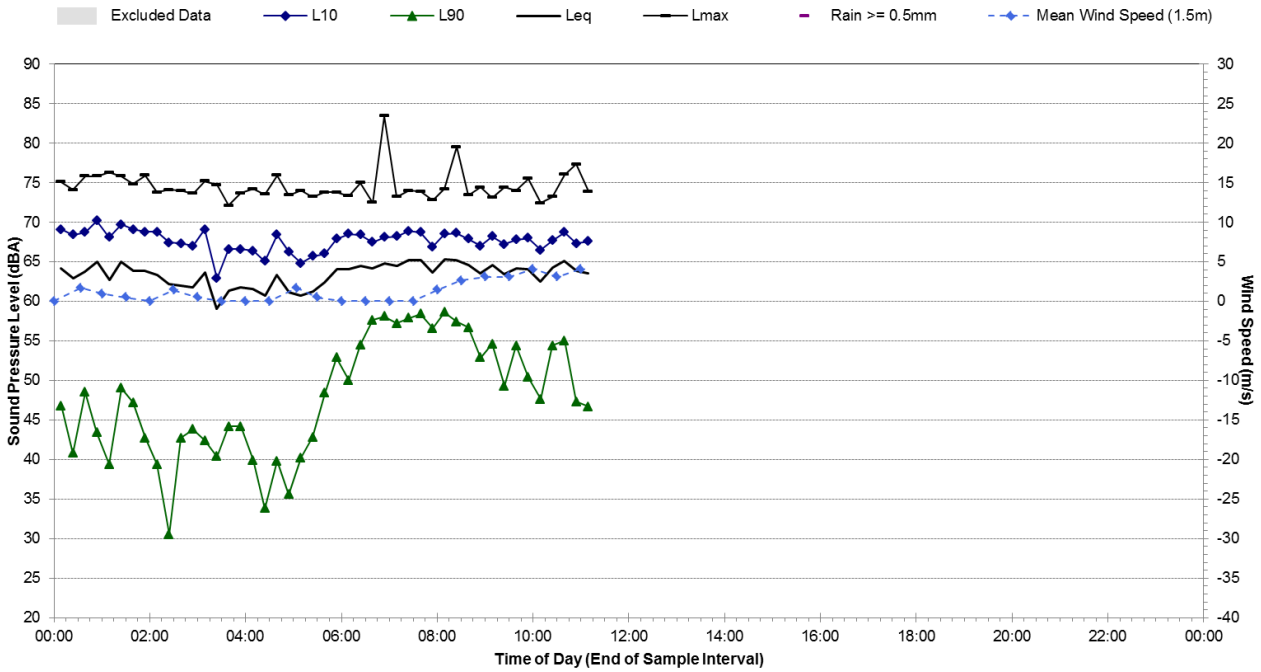
Statistical Ambient Noise Levels

L5 - 8656 Pacific Highway, Telegraph Point - Wednesday, 28 May 2014



Statistical Ambient Noise Levels

L5 - 8656 Pacific Highway, Telegraph Point - Thursday, 29 May 2014



Noise Monitoring Location:	**L6**
Noise Monitoring Address:	**16 Hacks Ferry Road, Telegraph Point**

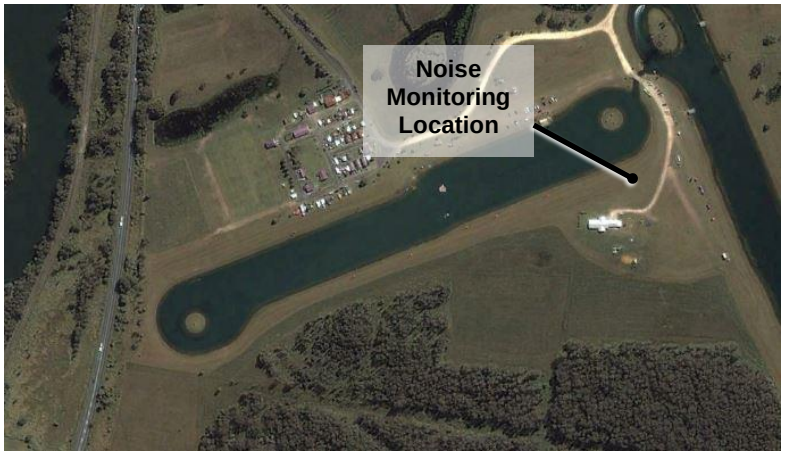
Logger Device Type: ARL316
Logger Serial No: 16-207-047

Ambient noise logger deployed in a free field location approximately 680m east of Pacific Highway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway and bird activity

Recorded Noise Levels (LAmax):
Pacific Highway road traffic noise: ~42-51 dBA, Birds: 40-54 dBA, Dog bark: 58-62

Map of Noise Monitoring Location



Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	34	48	45	49
Evening	38	50	51	54
Night-time	34	47	50	53

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	2	N/A
Daytime (7am-10pm)	49	44	48
Night-time (10pm-7am)	48	44	47

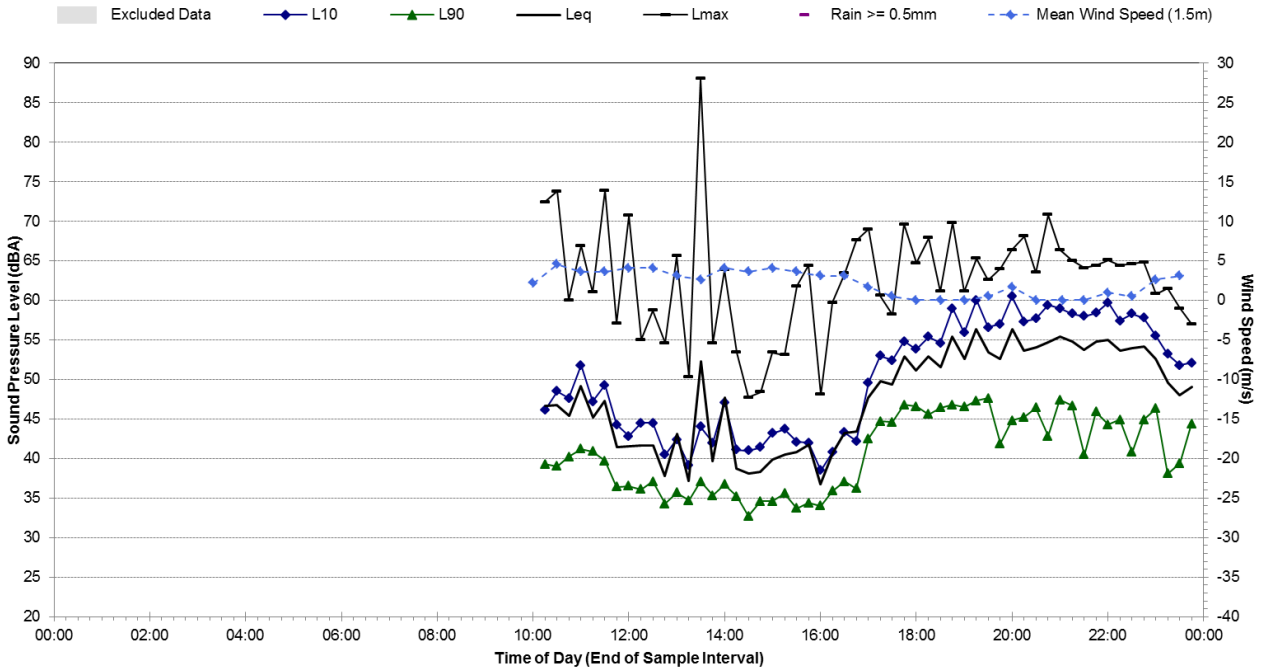
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
21/05/2014	10:02am	41	46	63

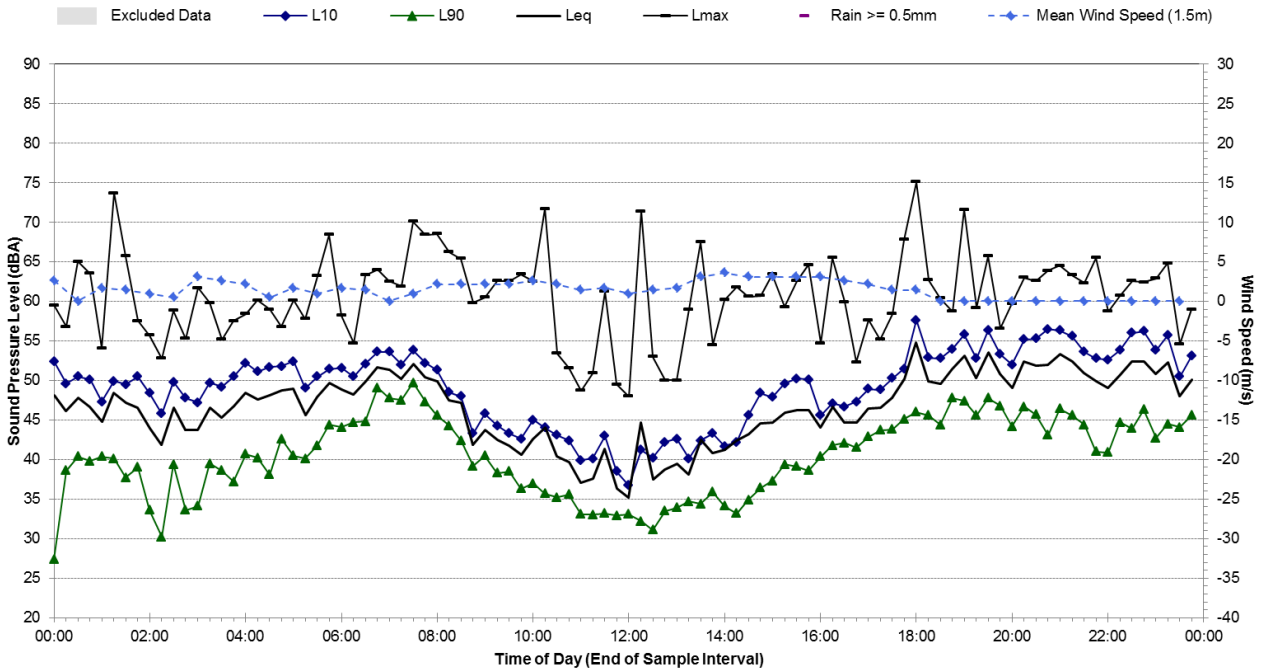
Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

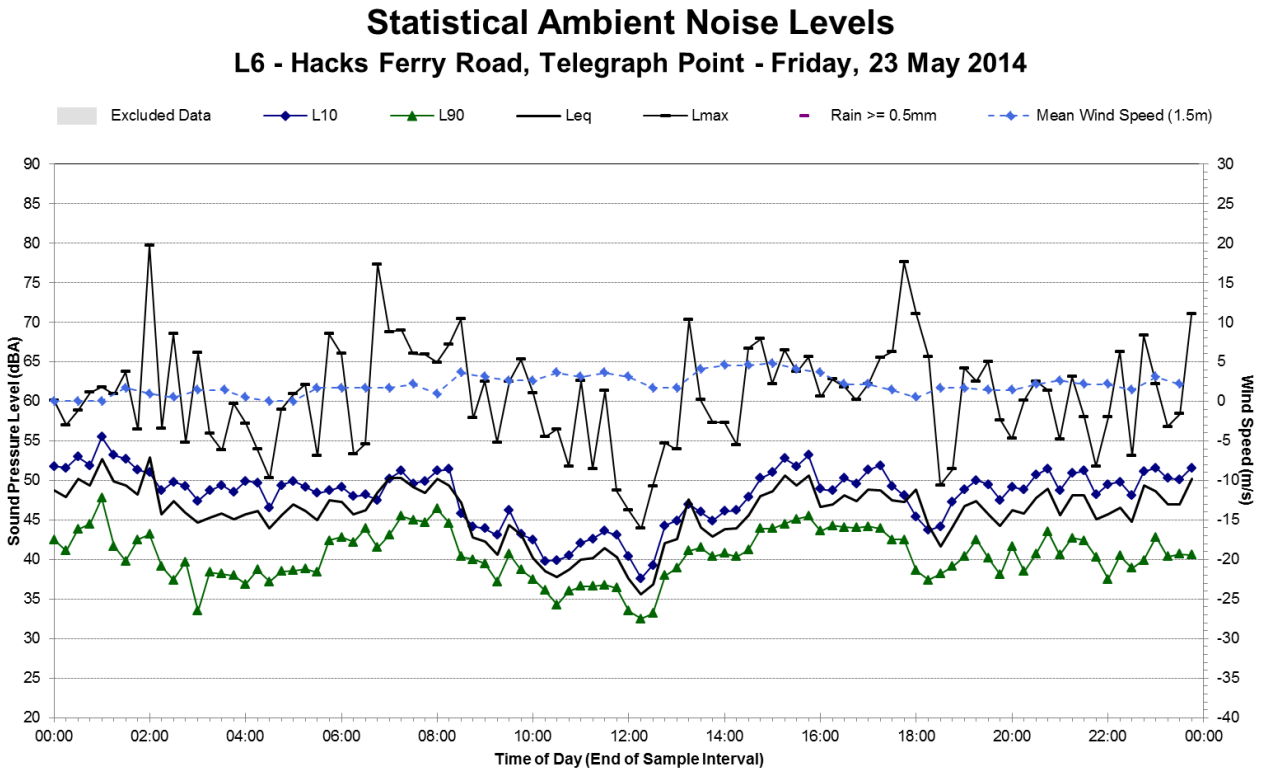
Statistical Ambient Noise Levels
L6 - Hacks Ferry Road, Telegraph Point - Wednesday, 21 May 2014

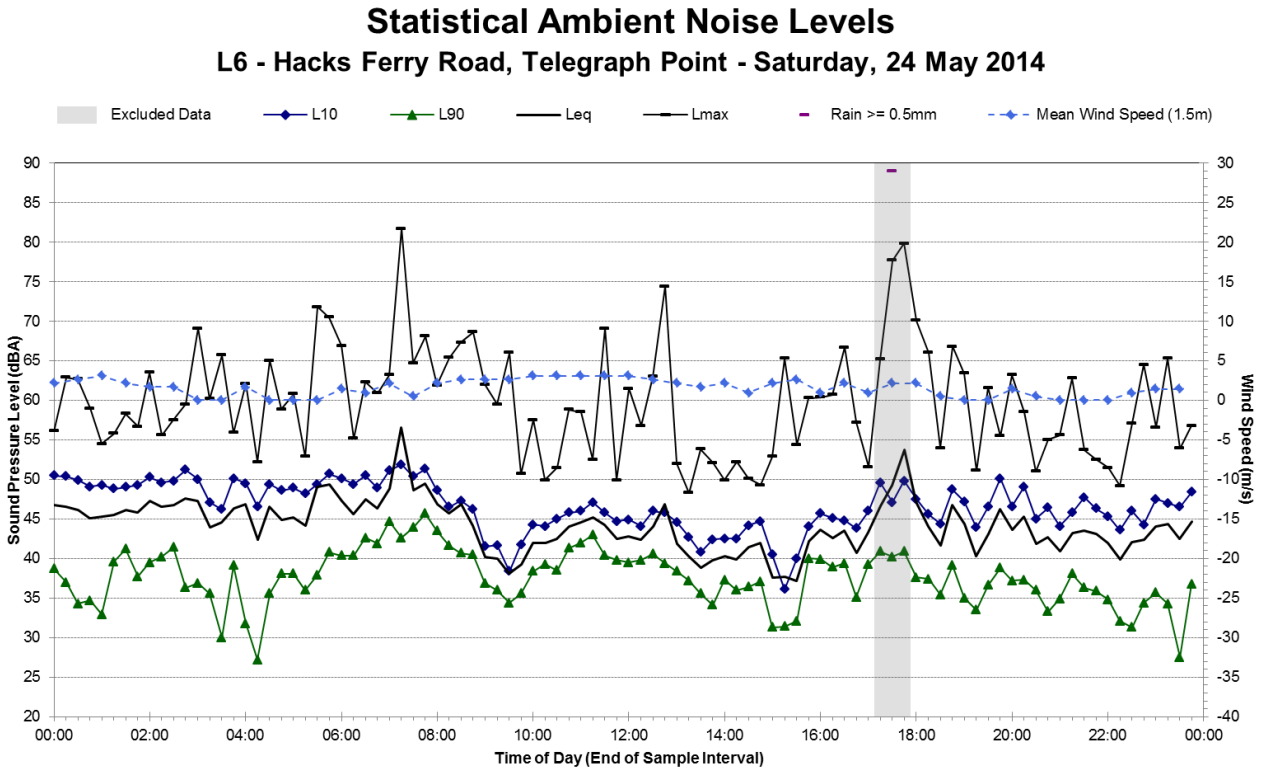


Statistical Ambient Noise Levels
L6 - Hacks Ferry Road, Telegraph Point - Thursday, 22 May 2014



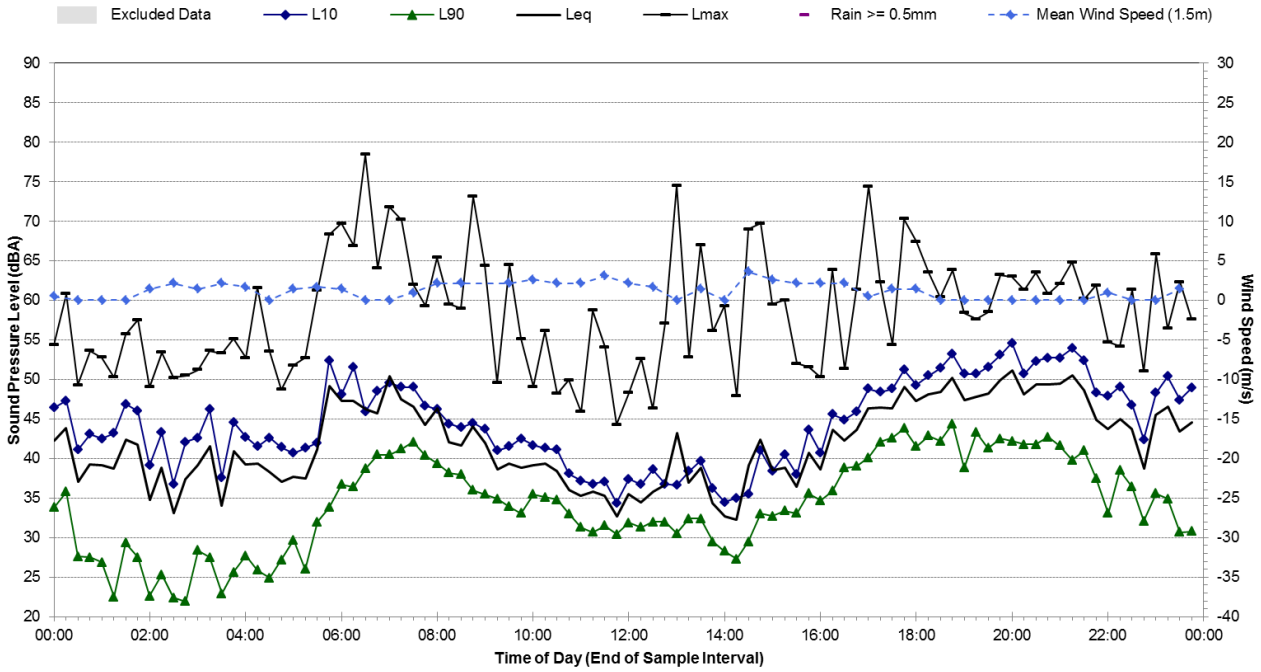
Appendix C Ambient Noise Logging Results





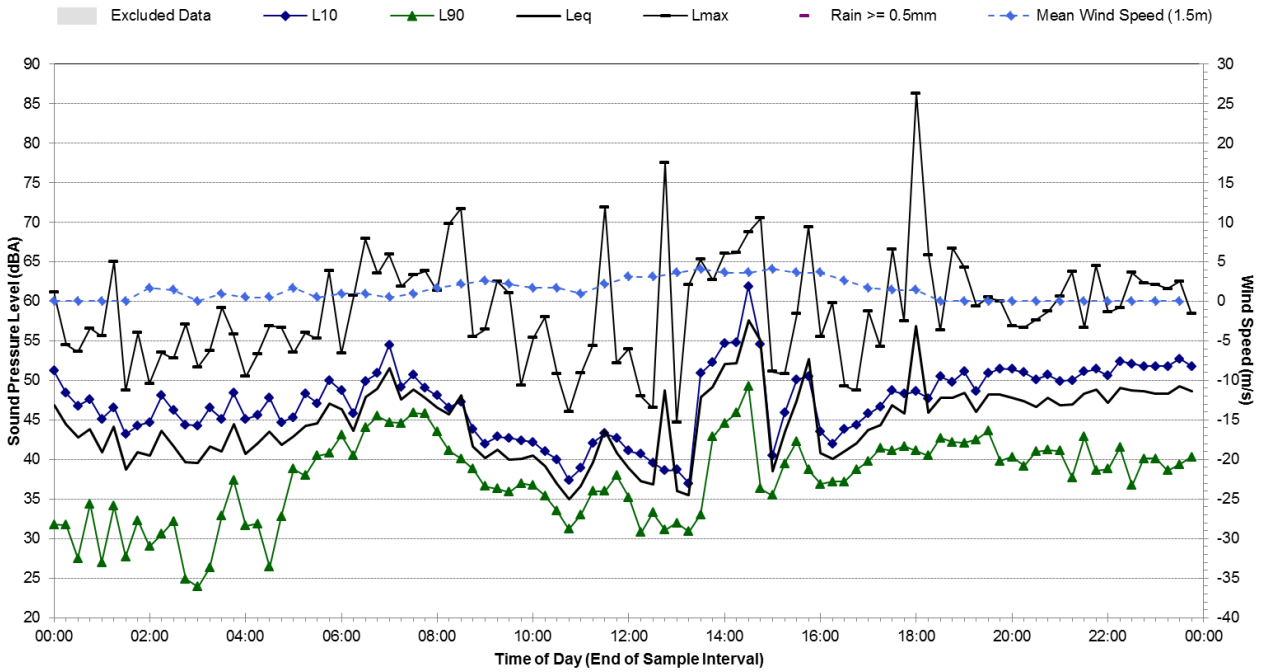
Statistical Ambient Noise Levels

L6 - Hacks Ferry Road, Telegraph Point - Sunday, 25 May 2014

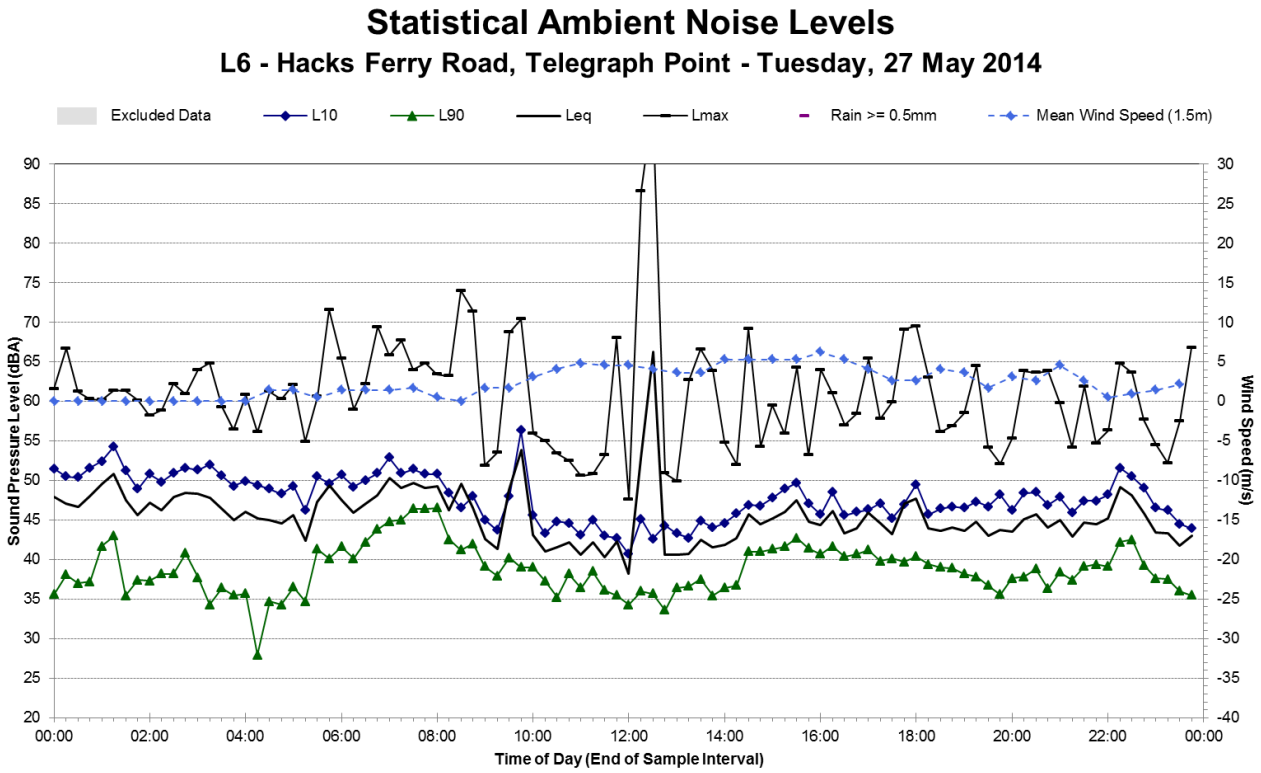


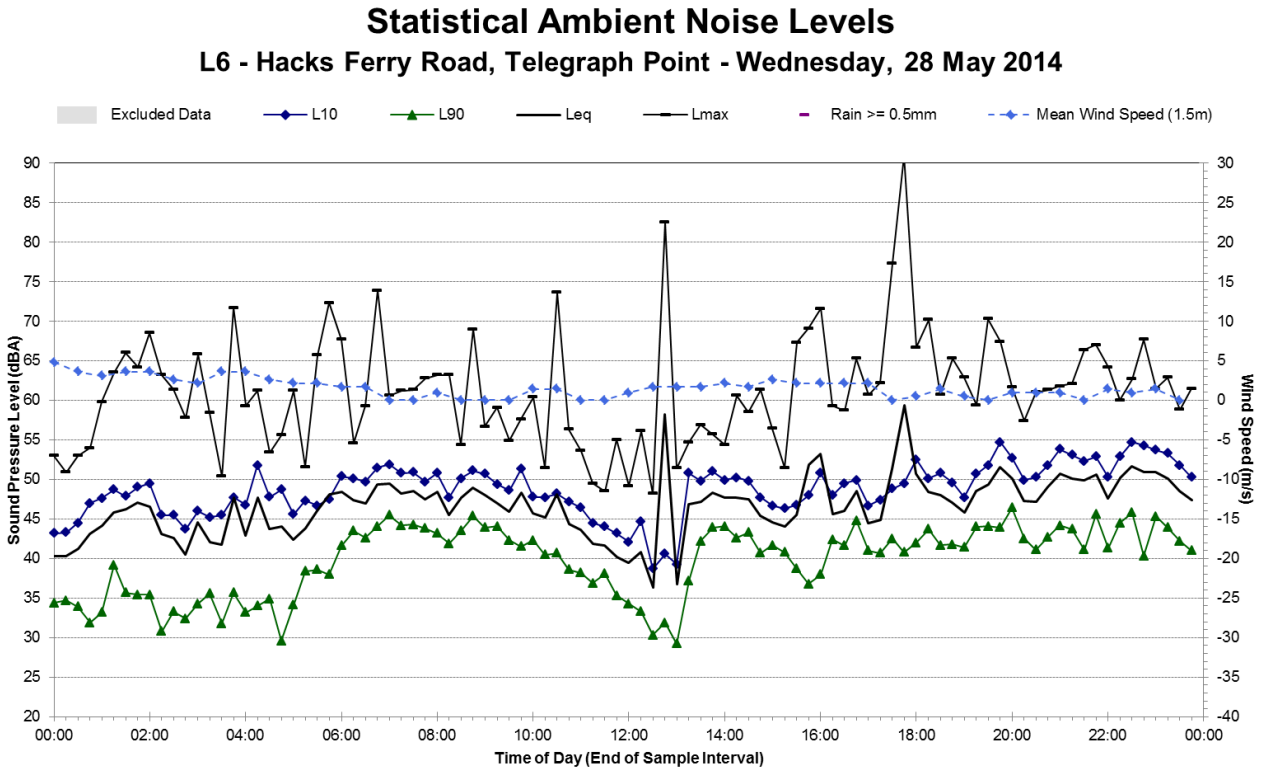
Statistical Ambient Noise Levels

L6 - Hacks Ferry Road, Telegraph Point - Monday, 26 May 2014

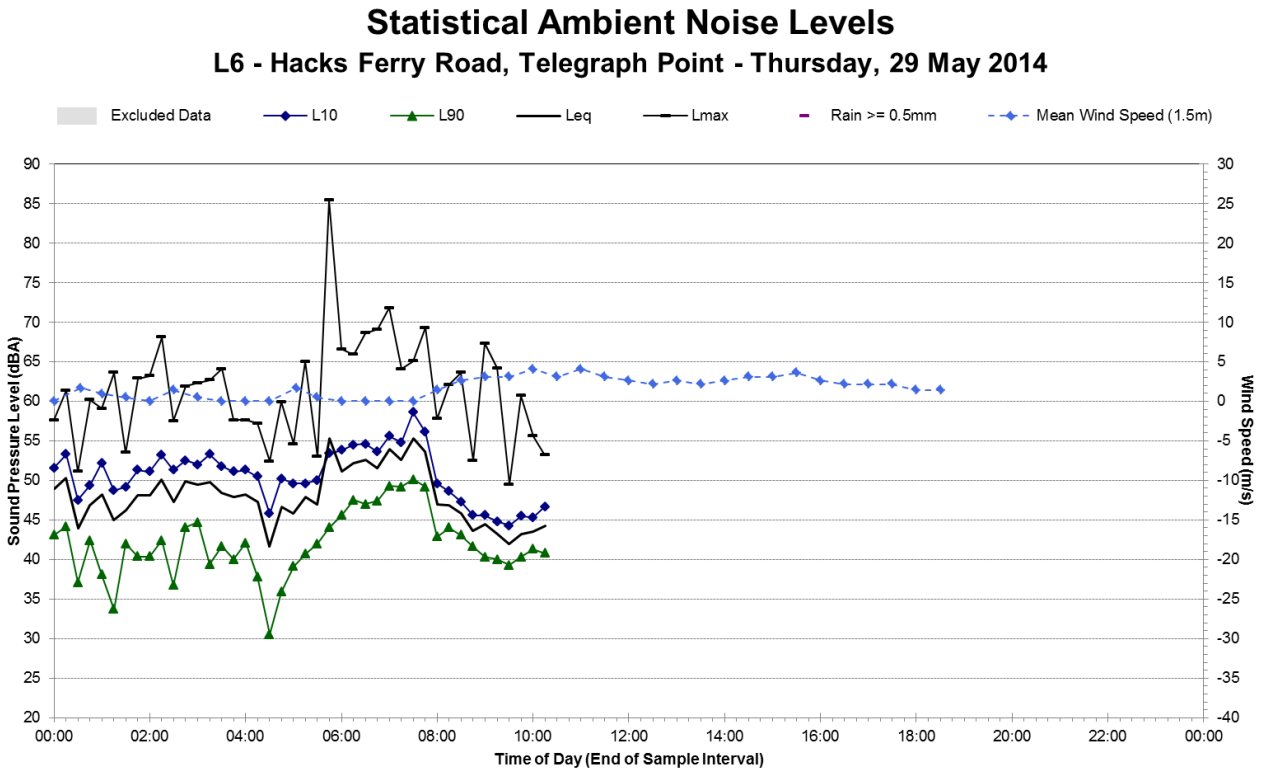


Appendix C Ambient Noise Logging Results





Appendix C Ambient Noise Logging Results



Noise Monitoring Location:	**L7**
Noise Monitoring Address:	**5 Cooperabung Drive, Telegraph Point**

Logger Device Type: ARL316
Logger Serial No: 16-306-038

Ambient noise logger deployed 1m from the north-west facade of the property.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically 59-68 dBA, Pacific Highway Heavy-vehicle road traffic: typically 67-74 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	48	65	67	72
Evening	40	64	68	74
Night-time	35	63	67	73

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	2	N/A
Daytime (7am-10pm)	66	63	65
Night-time (10pm-7am)	64	58	63

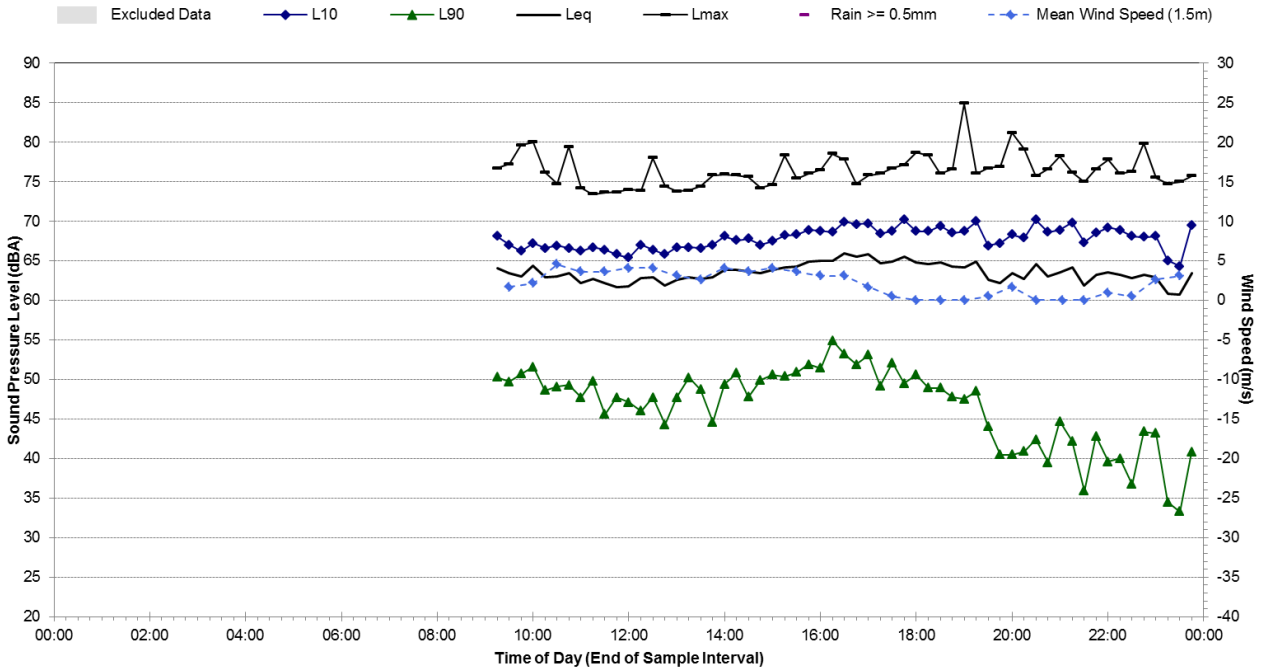
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
21/05/2014	09:06am	48	62	75

Photo of Noise Monitoring Location

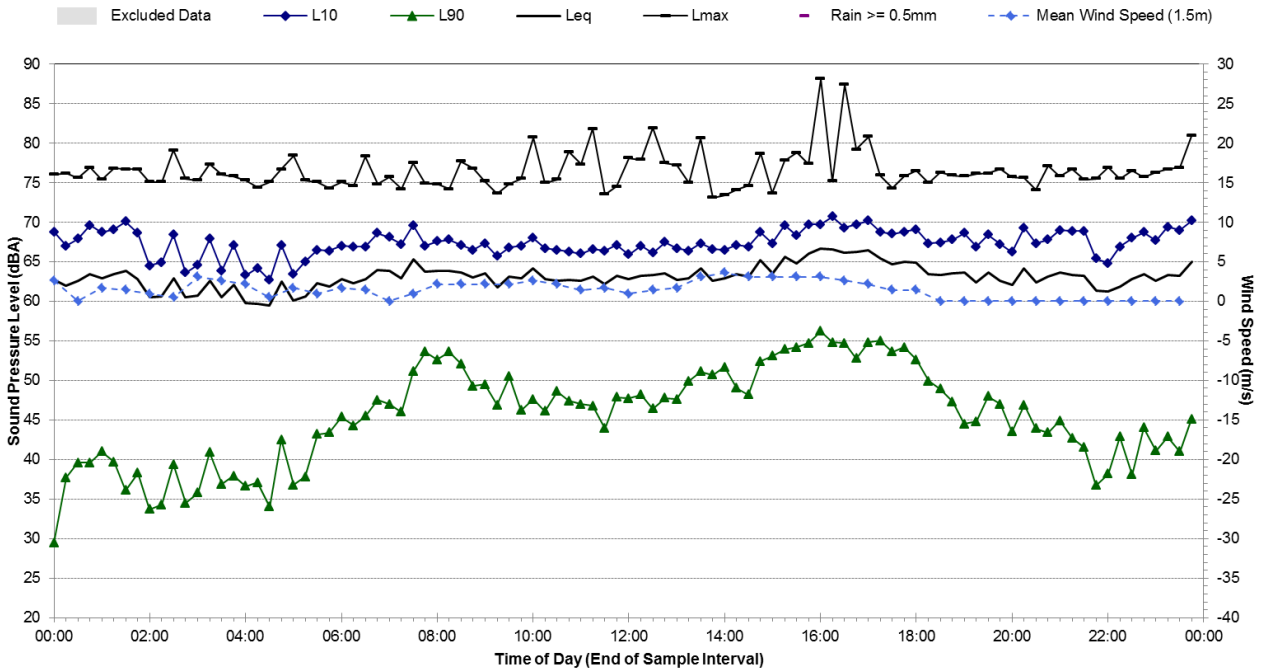
Statistical Ambient Noise Levels

L7 - 5 Cooperabung Drive, Telegraph Point - Wednesday, 21 May 2014

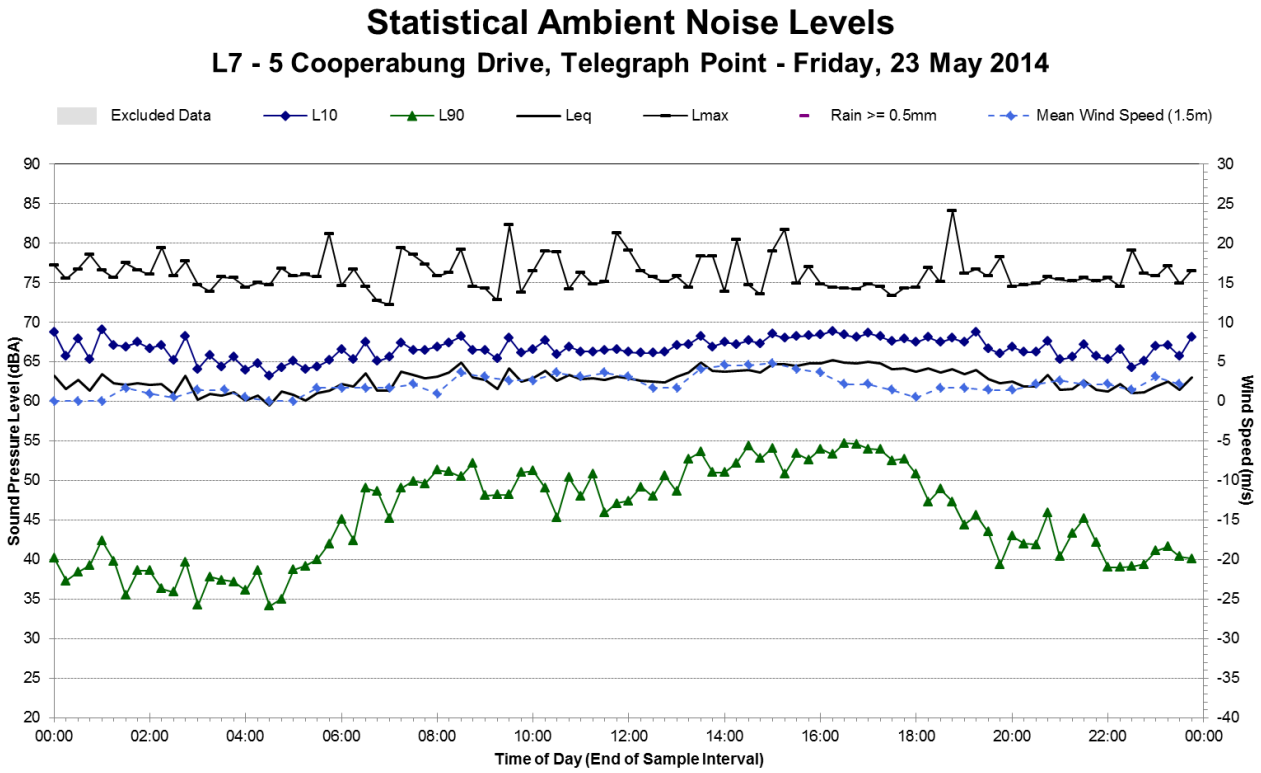


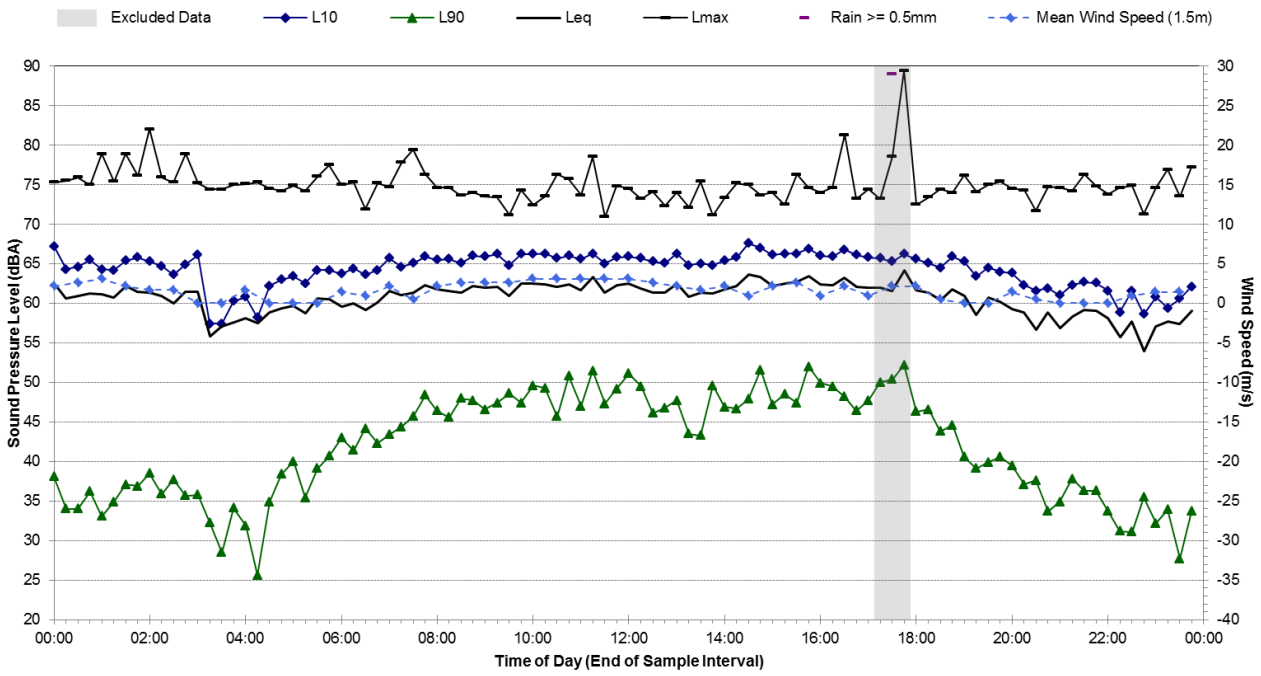
Statistical Ambient Noise Levels

L7 - 5 Cooperabung Drive, Telegraph Point - Thursday, 22 May 2014



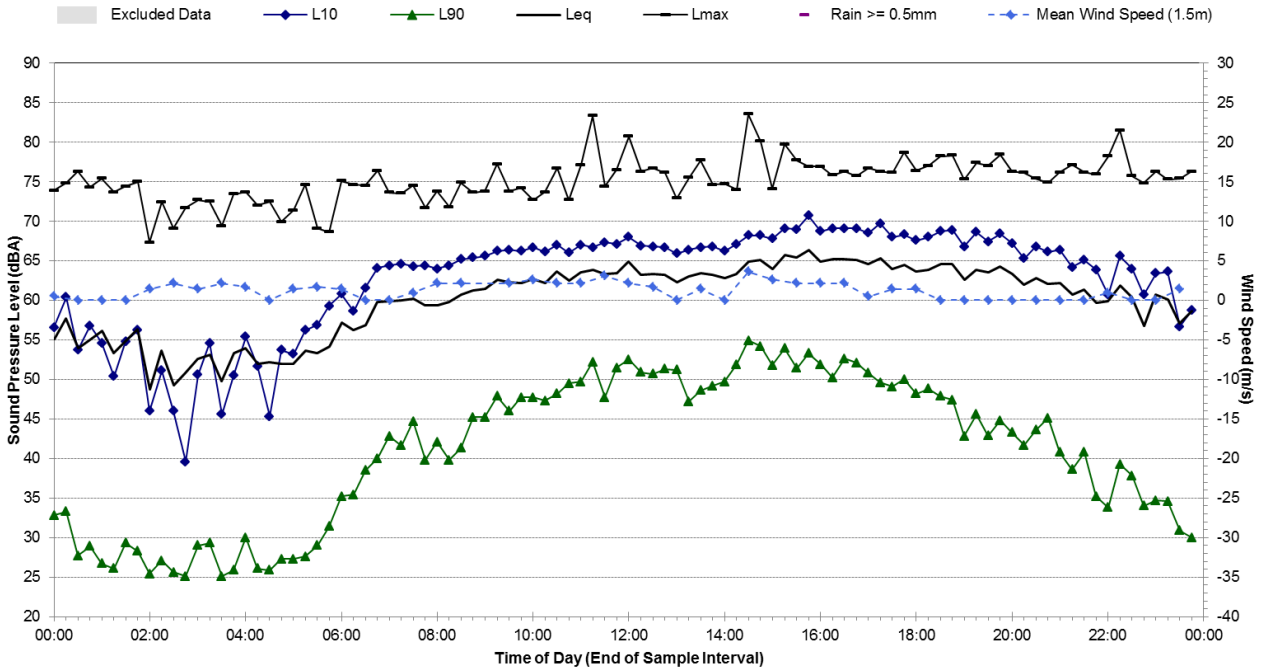
Appendix C Ambient Noise Logging Results





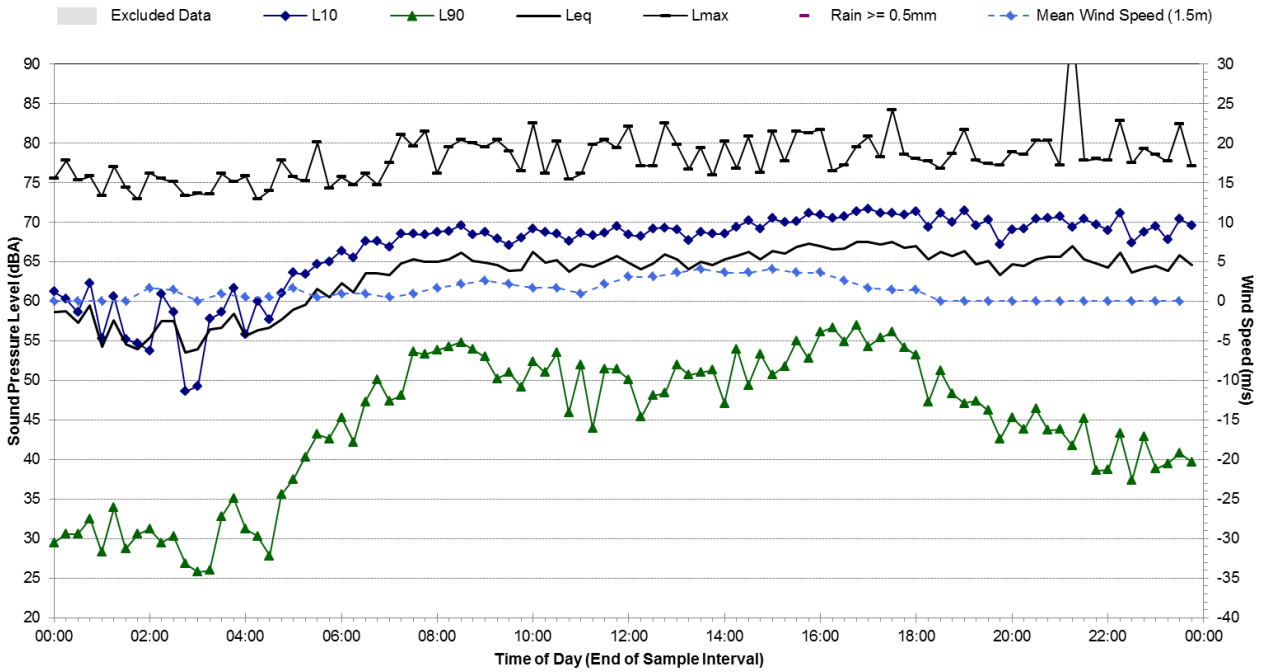
Statistical Ambient Noise Levels

L7 - 5 Cooperabung Drive, Telegraph Point - Sunday, 25 May 2014



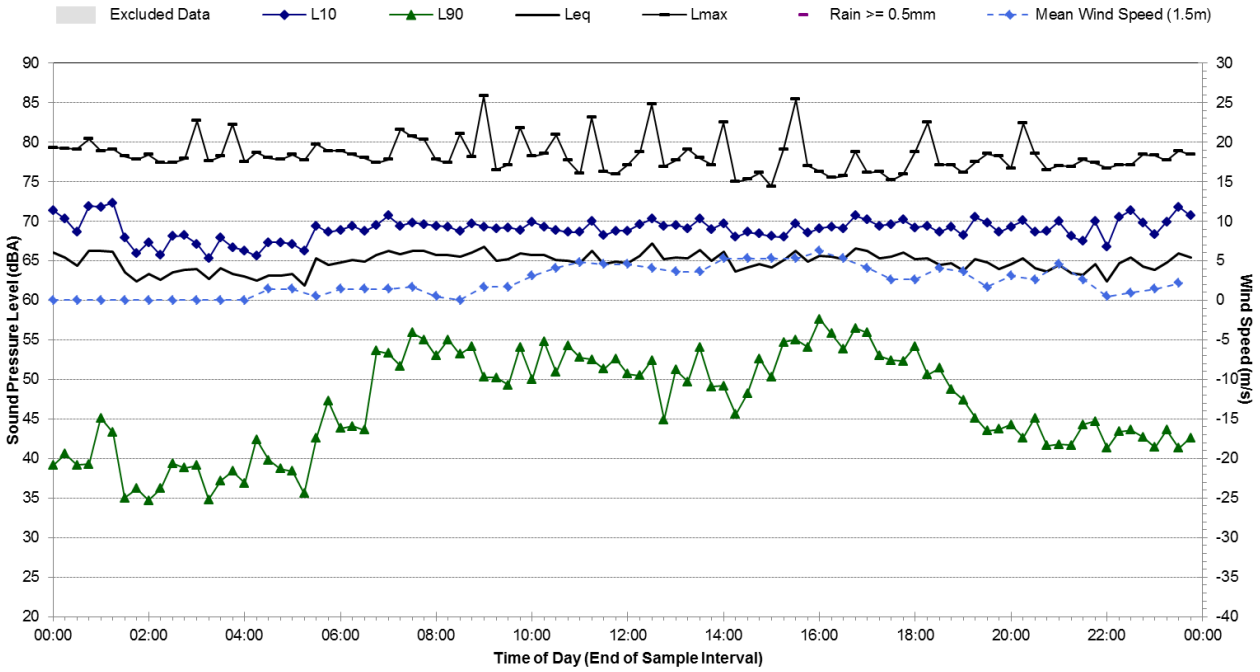
Statistical Ambient Noise Levels

L7 - 5 Cooperabung Drive, Telegraph Point - Monday, 26 May 2014

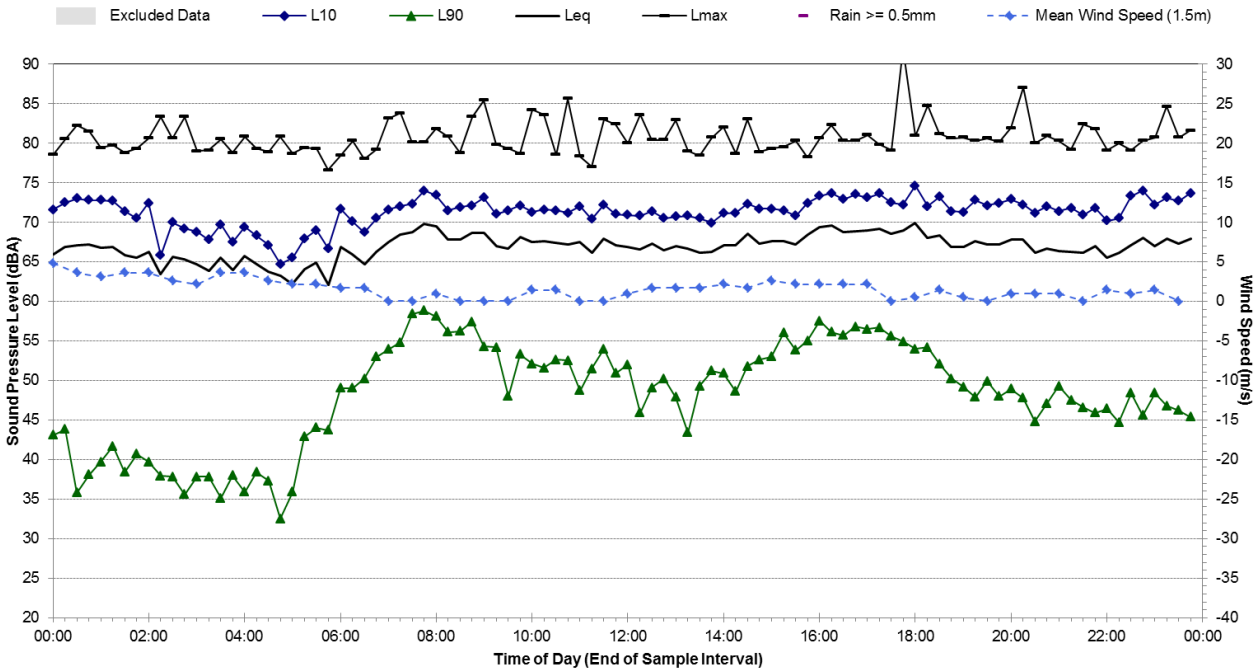


Appendix C Ambient Noise Logging Results

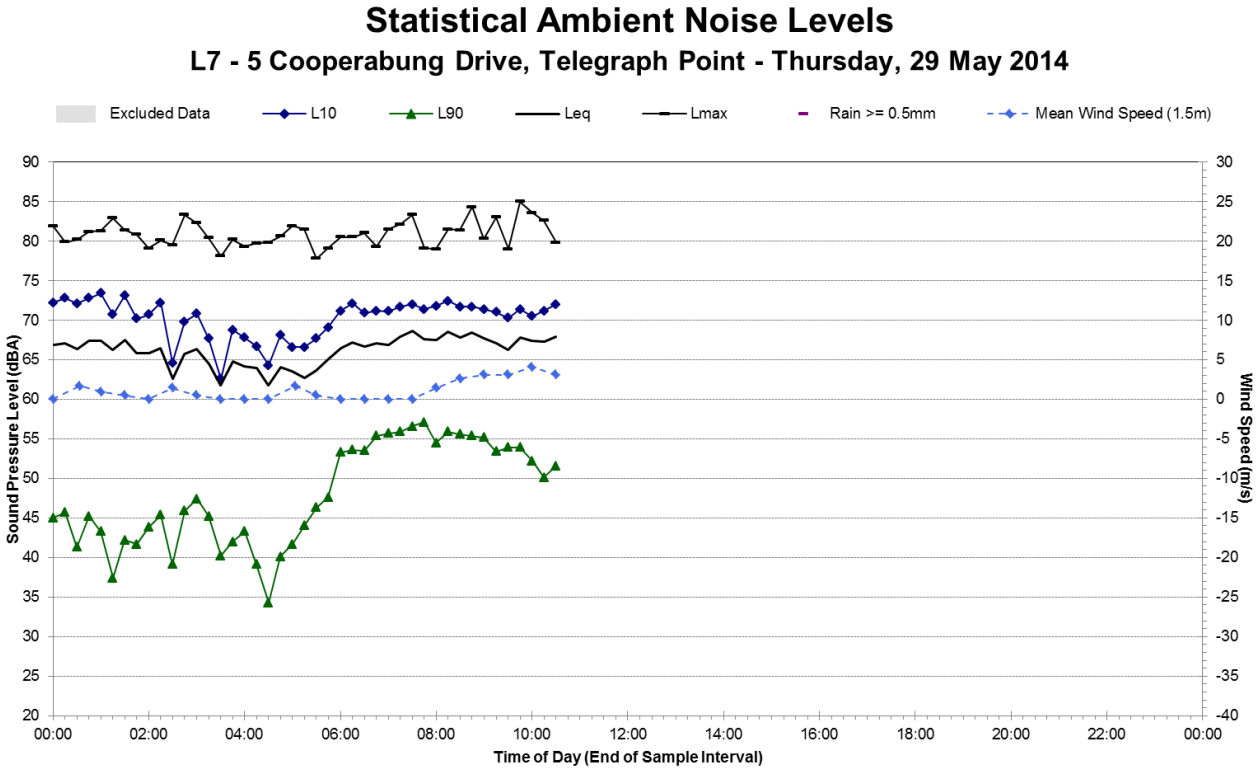
Statistical Ambient Noise Levels
L7 - 5 Cooperabung Drive, Telegraph Point - Tuesday, 27 May 2014



Statistical Ambient Noise Levels
L7 - 5 Cooperabung Drive, Telegraph Point - Wednesday, 28 May 2014



Appendix C Ambient Noise Logging Results



Noise Monitoring Location:	**L8**
Noise Monitoring Address:	**8 Haydons Wharf Road, Telegraph Point**

Logger Device Type: ARL316
Logger Serial No: 16-004-034

Ambient noise logger deployed on second floor balcony corner facing Pacific Highway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway, and local industrial noise on the property.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically 59-68 dBA, Pacific Highway Heavy-vehicle road traffic: typically 69-71 dBA, Local industrial noise, including grinding/sawing and crane operations: 68-83 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	48	61	63	68
Evening	41	59	64	68
Night-time	37	58	63	68

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	Weekend LAeq(Period)	Weekly LAeq(Period)
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	61	58	60
Night-time (10pm-7am)	58	54	58

Attended Noise Measurement Results

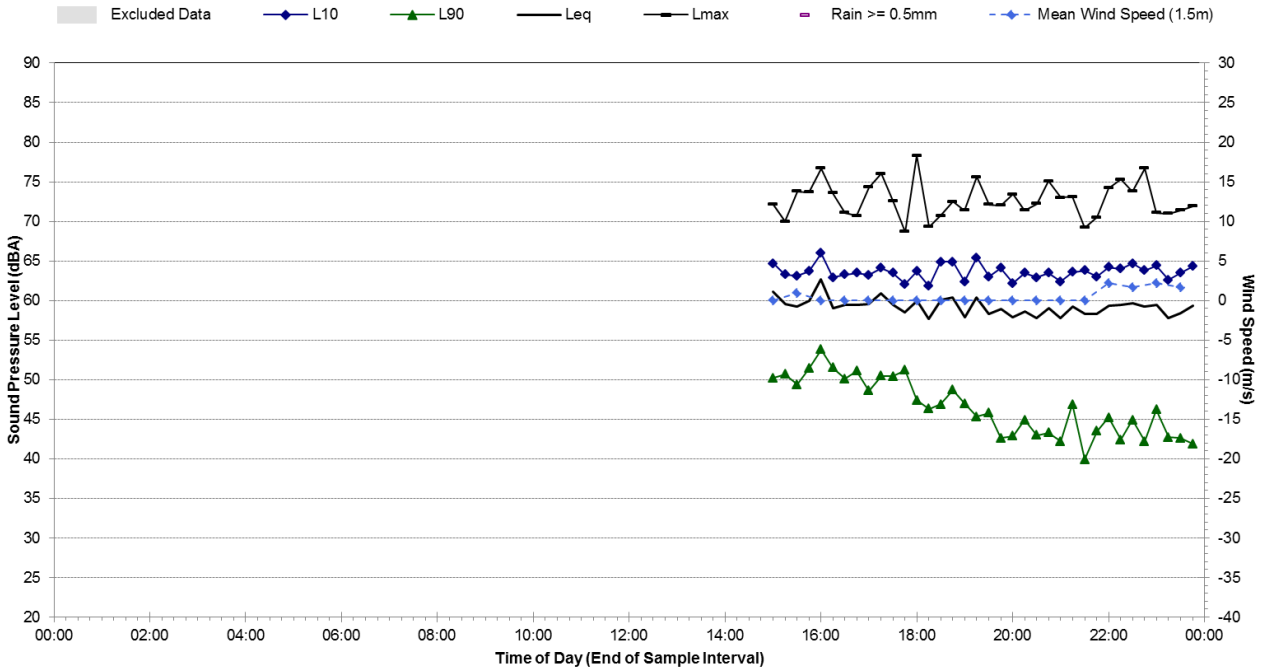
Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
20/05/2014	14:31	55	66	83

Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

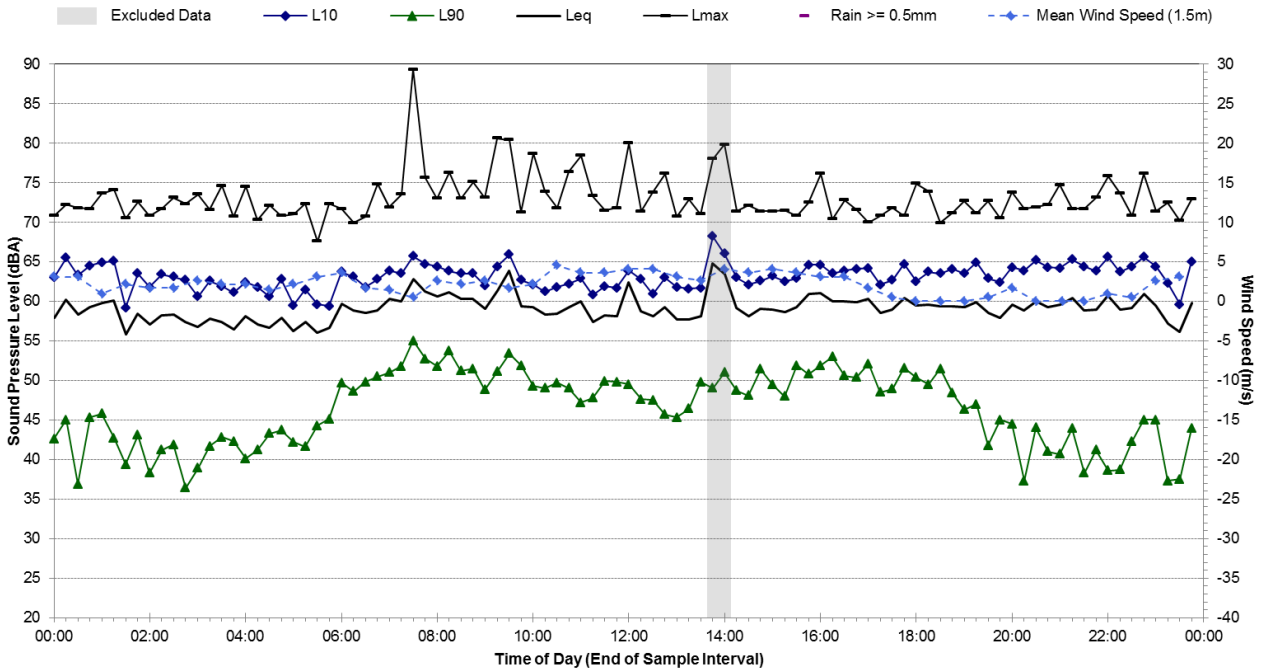
Statistical Ambient Noise Levels

L8 - 8 Haydons Wharf Road, Telegraph Point - Tuesday, 20 May 2014



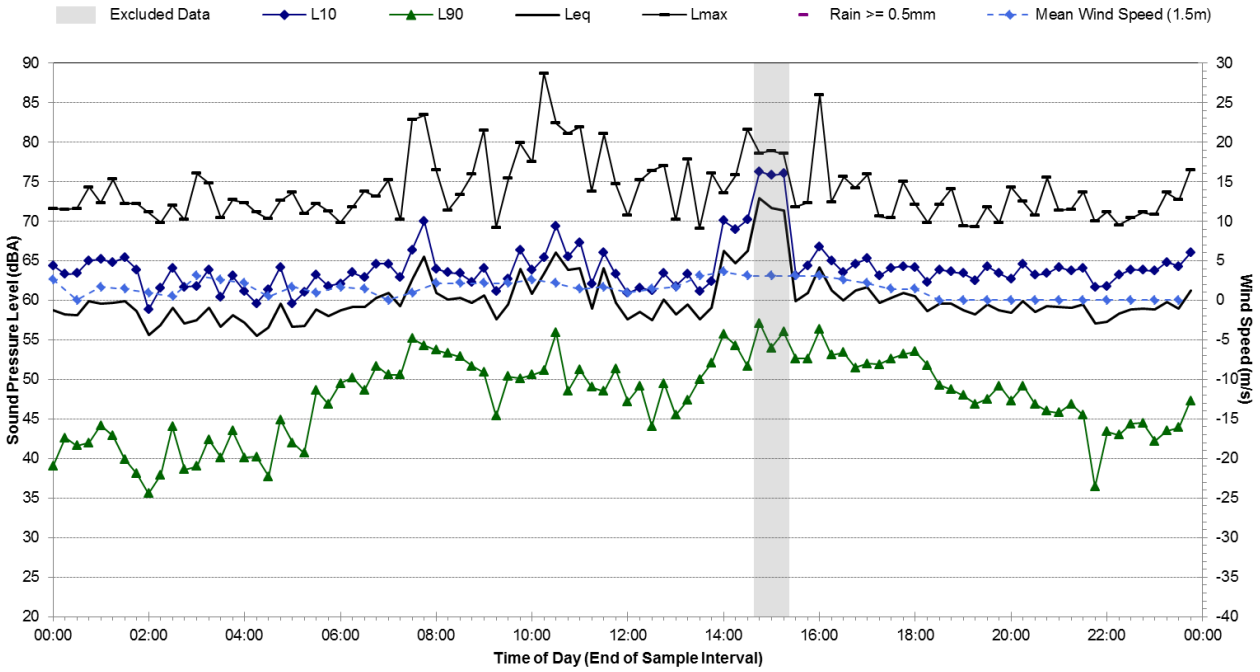
Statistical Ambient Noise Levels

L8 - 8 Haydons Wharf Road, Telegraph Point - Wednesday, 21 May 2014

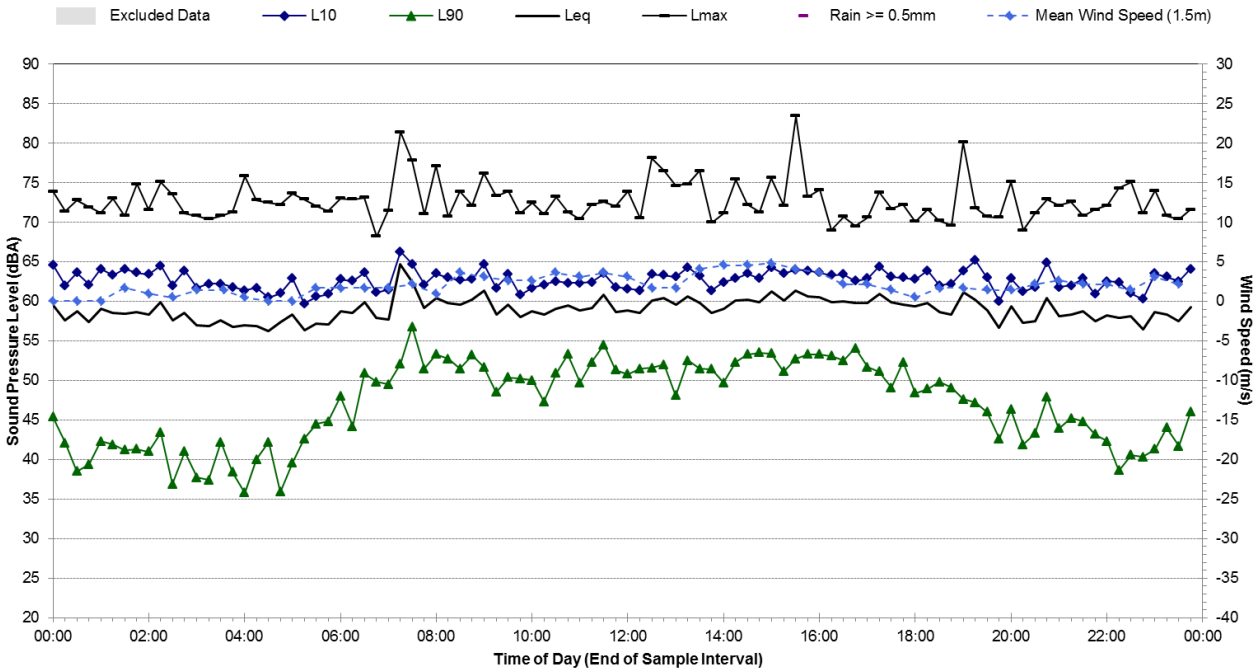


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L8 - 8 Haydons Wharf Road, Telegraph Point - Thursday, 22 May 2014



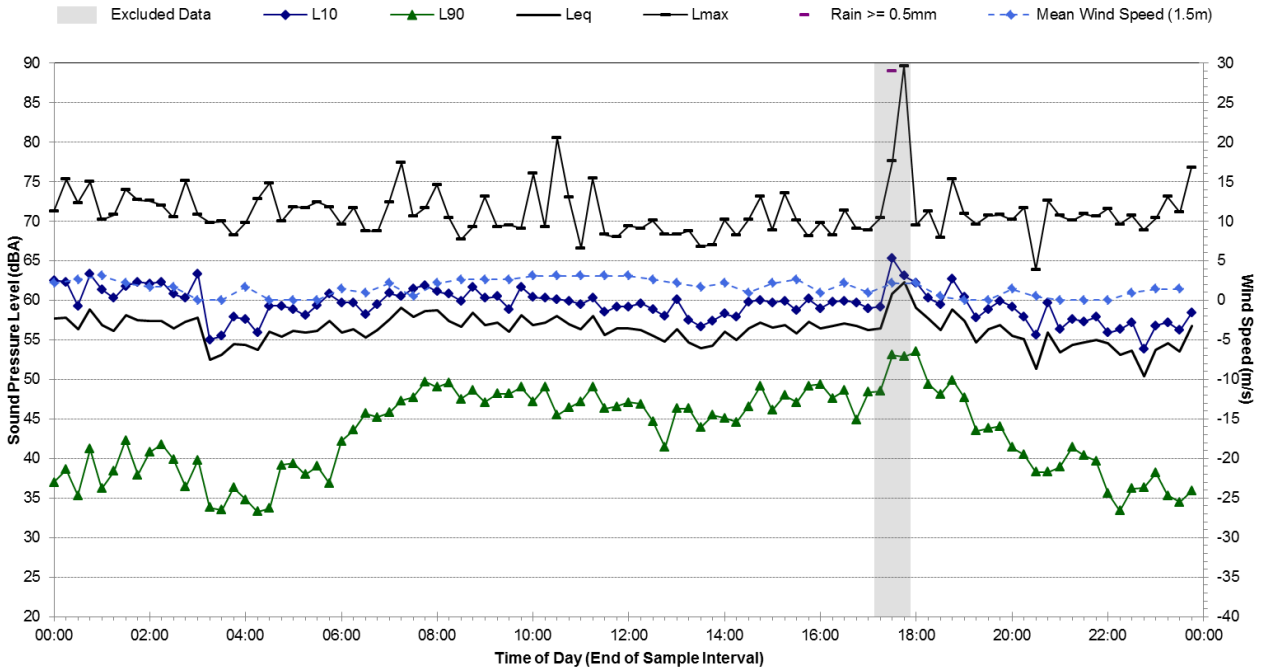
Statistical Ambient Noise Levels
L8 - 8 Haydons Wharf Road, Telegraph Point - Friday, 23 May 2014



Appendix C Ambient Noise Logging Results

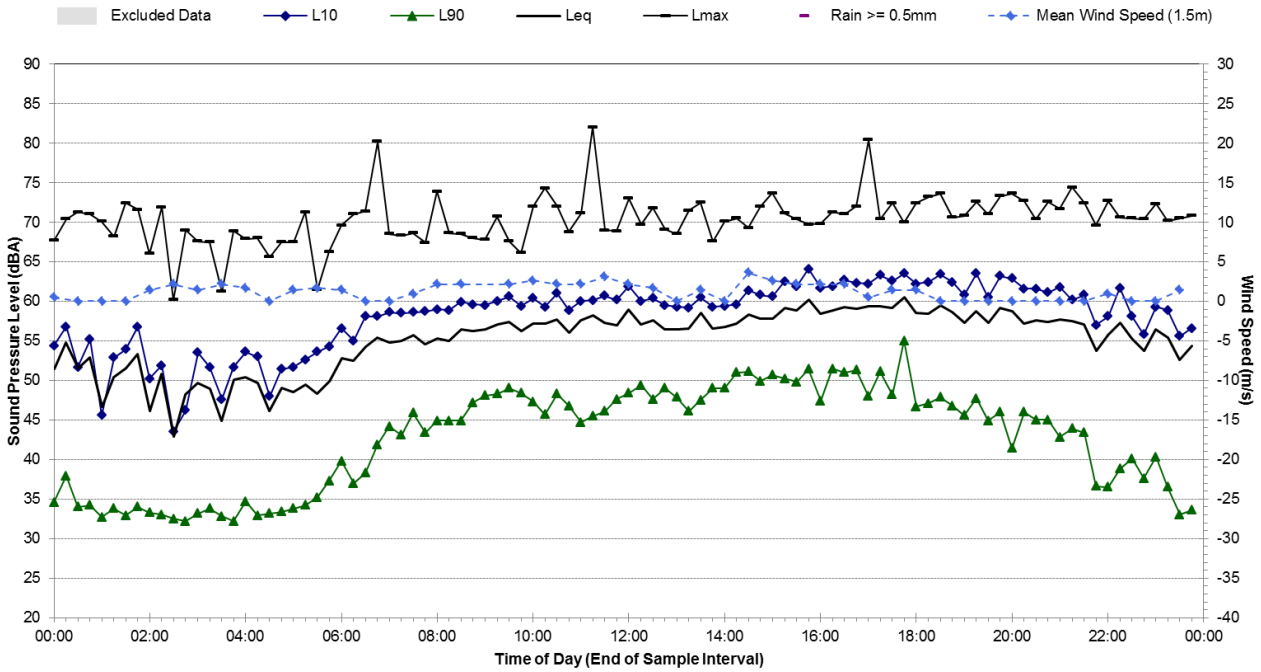
Statistical Ambient Noise Levels

L8 - 8 Haydons Wharf Road, Telegraph Point - Saturday, 24 May 2014



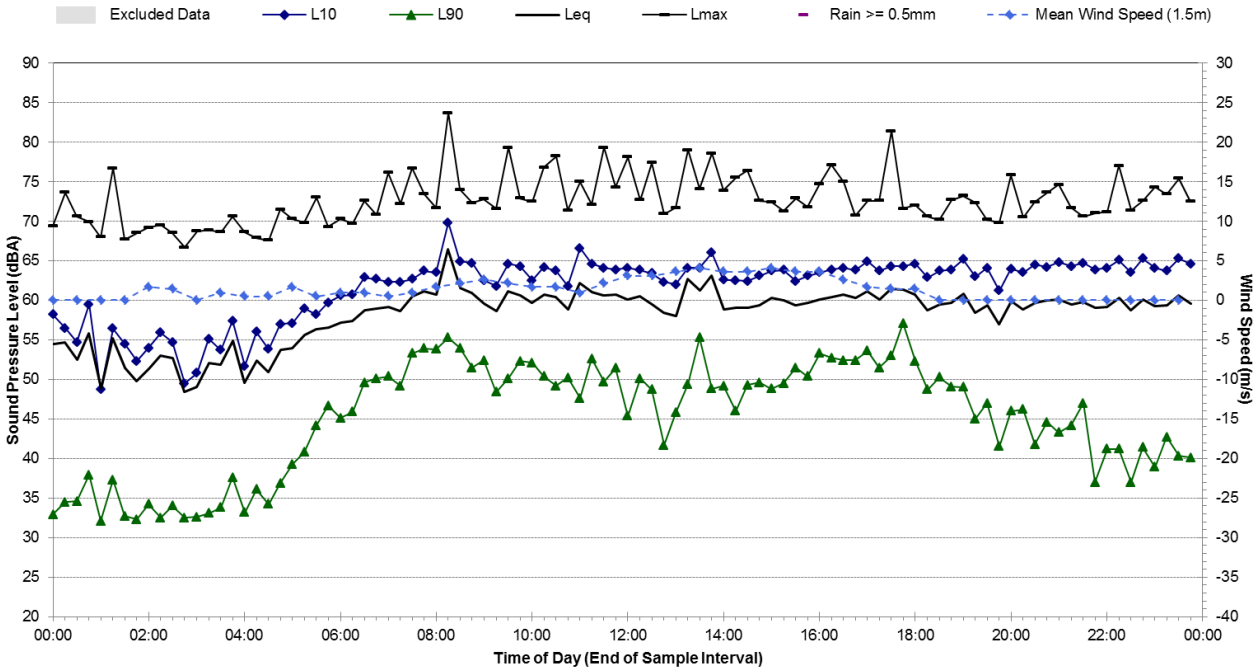
Statistical Ambient Noise Levels

L8 - 8 Haydons Wharf Road, Telegraph Point - Sunday, 25 May 2014

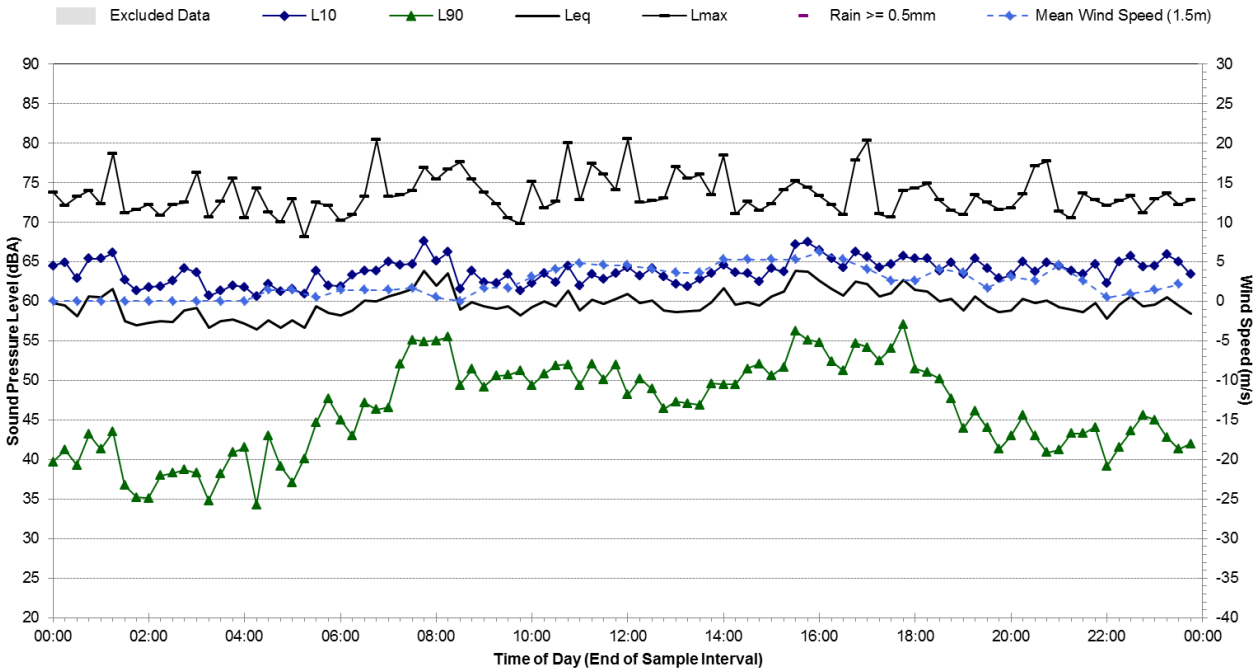


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L8 - 8 Haydons Wharf Road, Telegraph Point - Monday, 26 May 2014

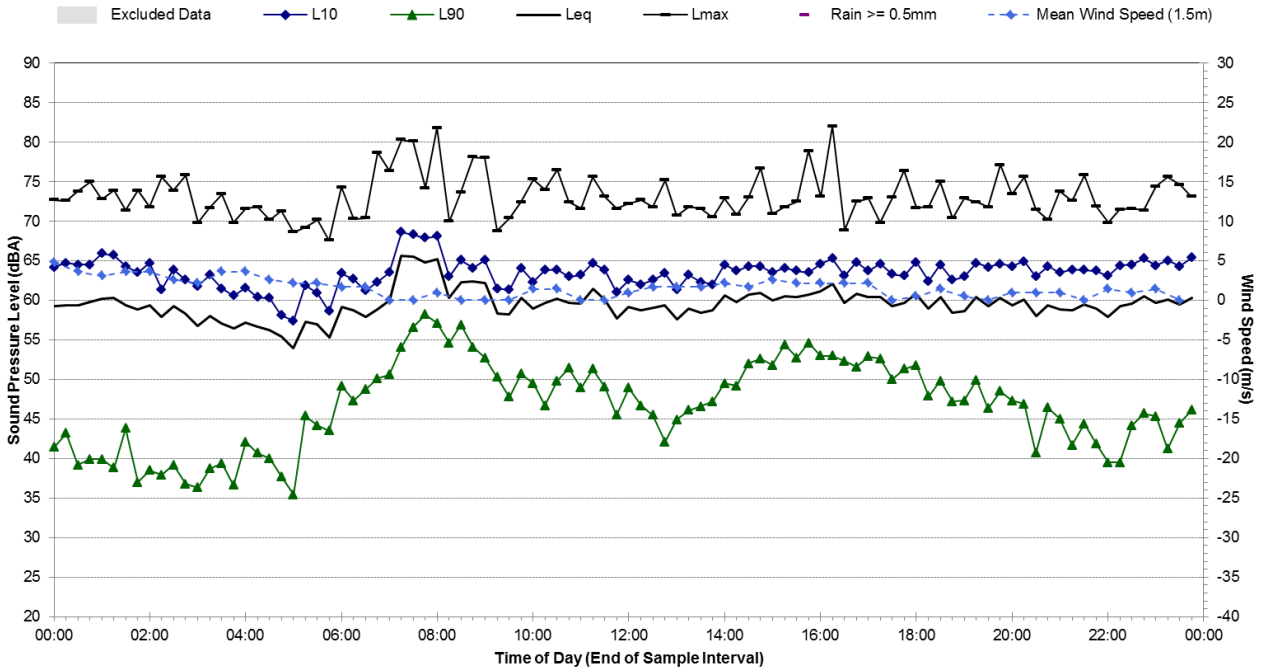


Statistical Ambient Noise Levels
L8 - 8 Haydons Wharf Road, Telegraph Point - Tuesday, 27 May 2014

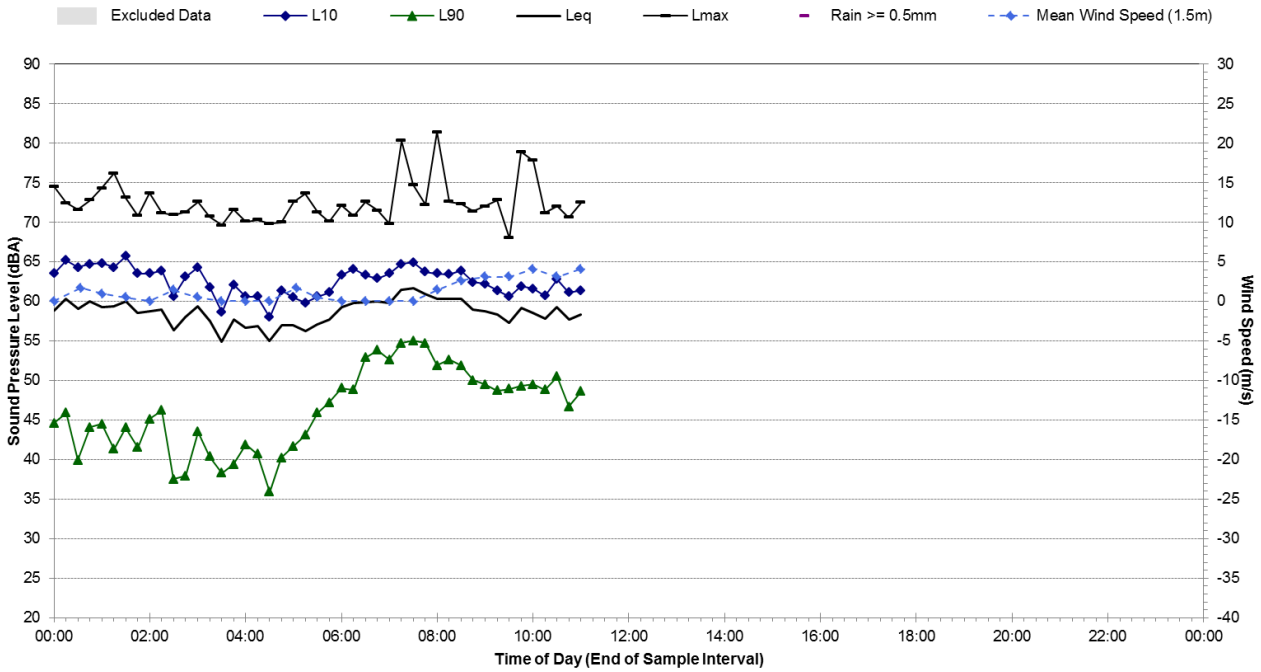


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L8 - 8 Haydons Wharf Road, Telegraph Point - Wednesday, 28 May 2014



Statistical Ambient Noise Levels
L8 - 8 Haydons Wharf Road, Telegraph Point - Thursday, 29 May 2014



Noise Monitoring Location:	**L9**
Noise Monitoring Address:	**3 Wyndell Close, Cooperabung**

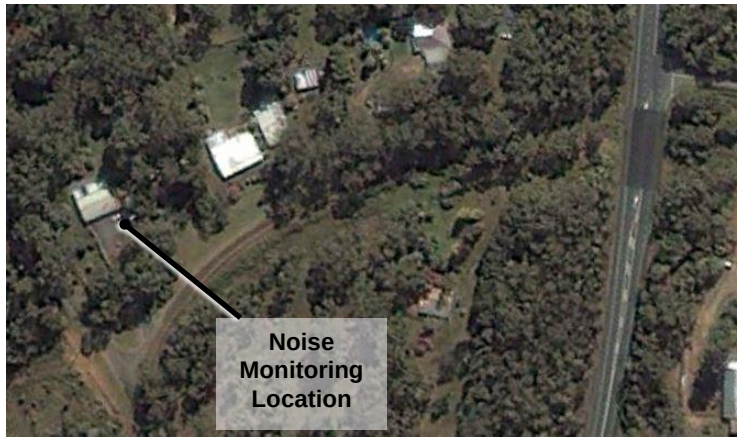
Logger Device Type: ARL316
Logger Serial No: 16-203-508

Ambient noise logger deployed in a free field location in property yard on the north-eastern boundary.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway and local traffic. Occasional noise from work in property shed also measured.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically ~49-51 dBA, Wyndell Close and Cundabung Drive road traffic: ~56-61 dBA , pet birds/chickens: ~40-50 dBA, work in property shed: 45-56 dBA

Map of Noise Monitoring Location



Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	38	49	50	57
Evening	37	45	49	53
Night-time	34	45	48	52

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	49	49	49
Night-time (10pm-7am)	45	42	45

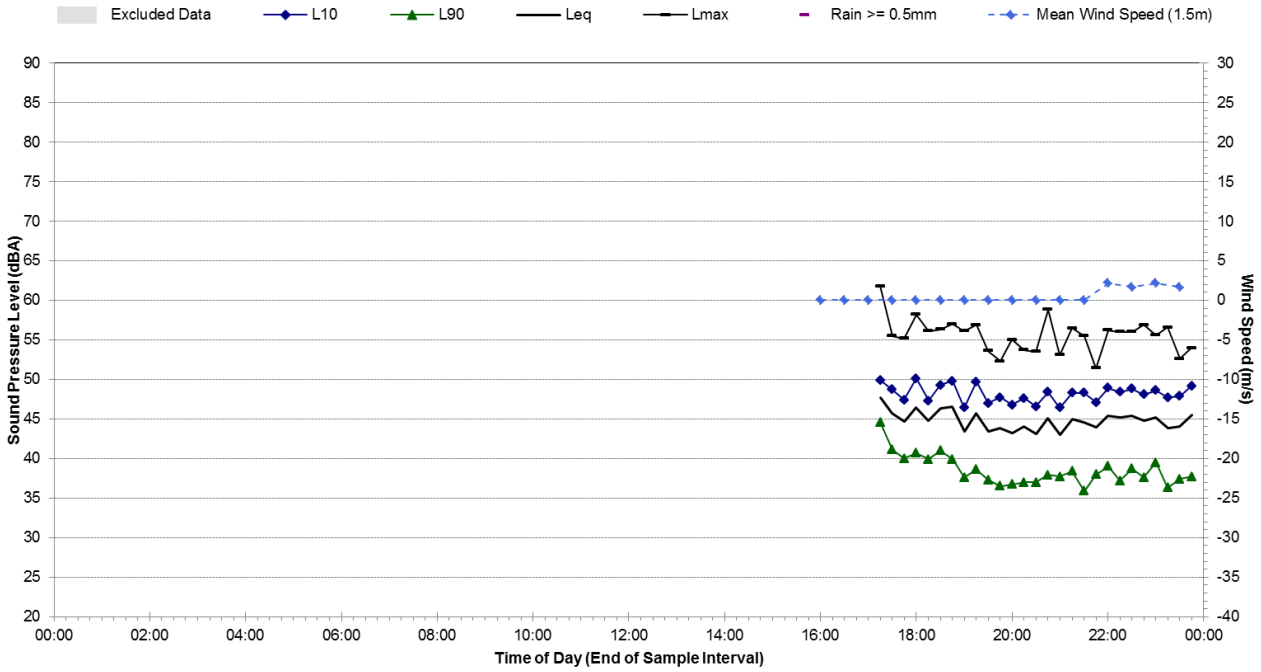
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
20/05/2014	15:26pm	39	46	62

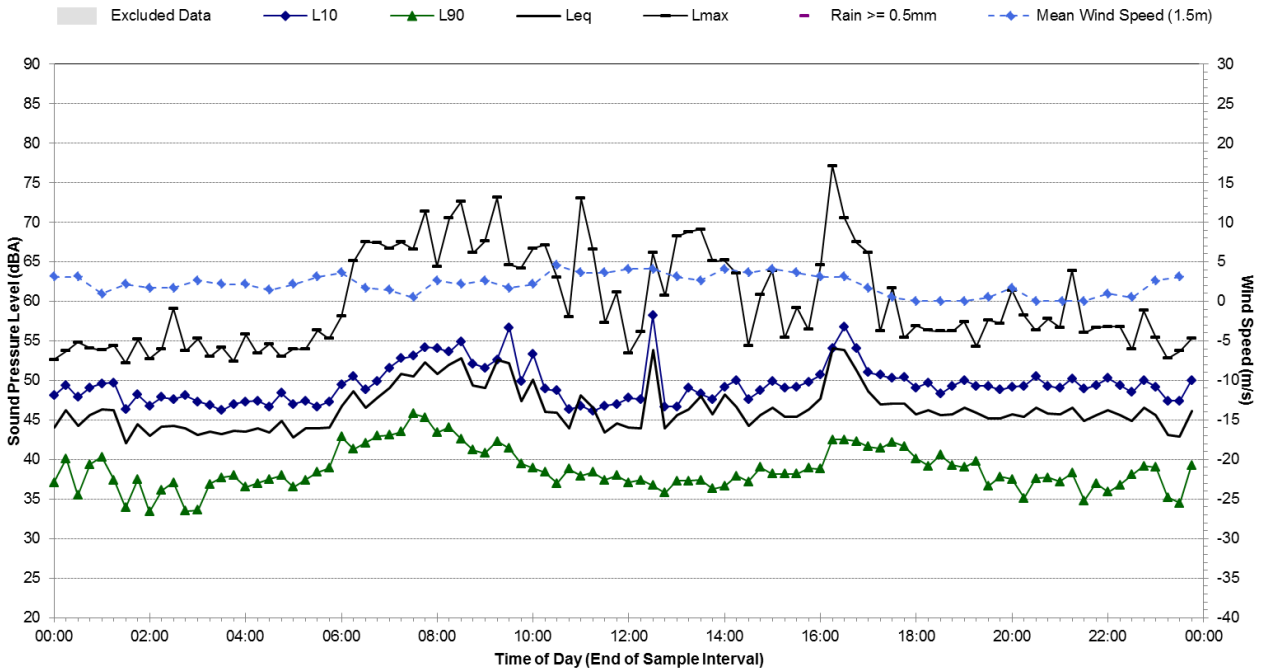
Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Tuesday, 20 May 2014

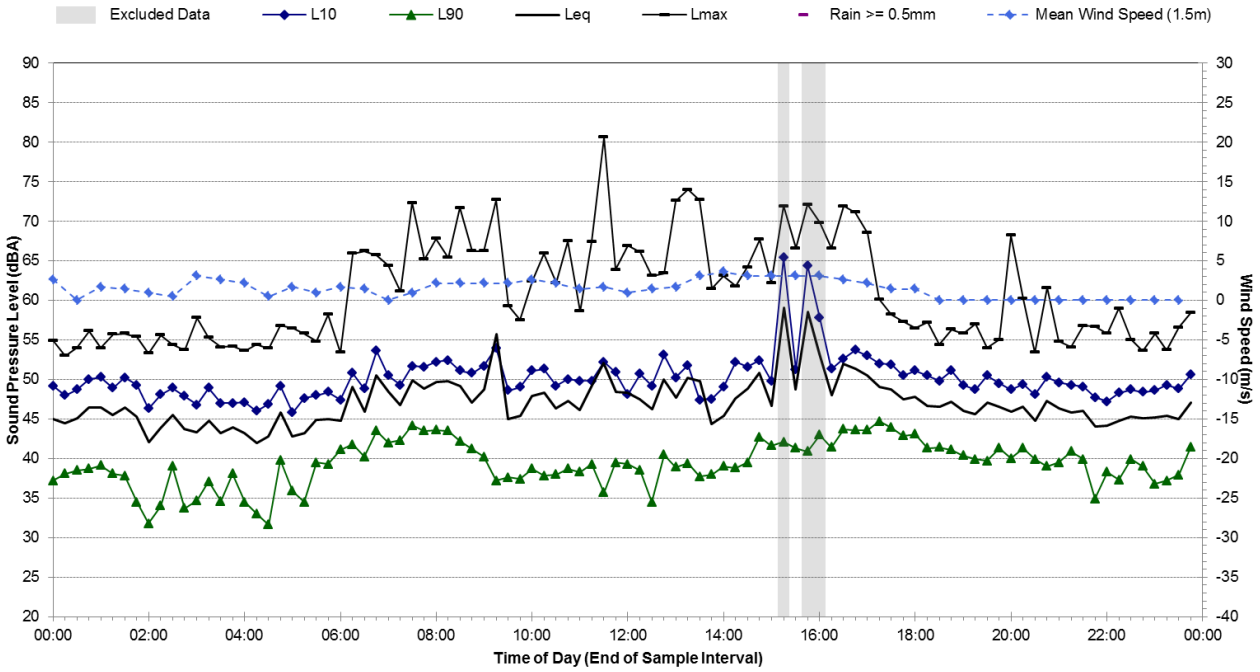


Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Wednesday, 21 May 2014

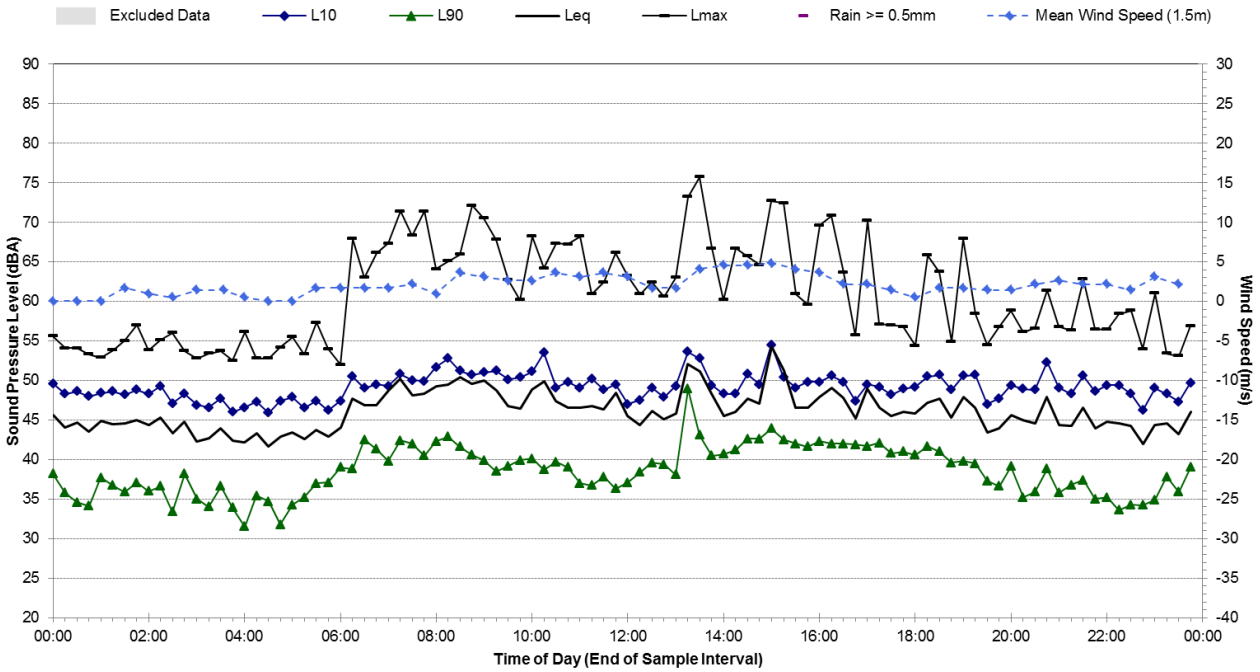


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Thursday, 22 May 2014

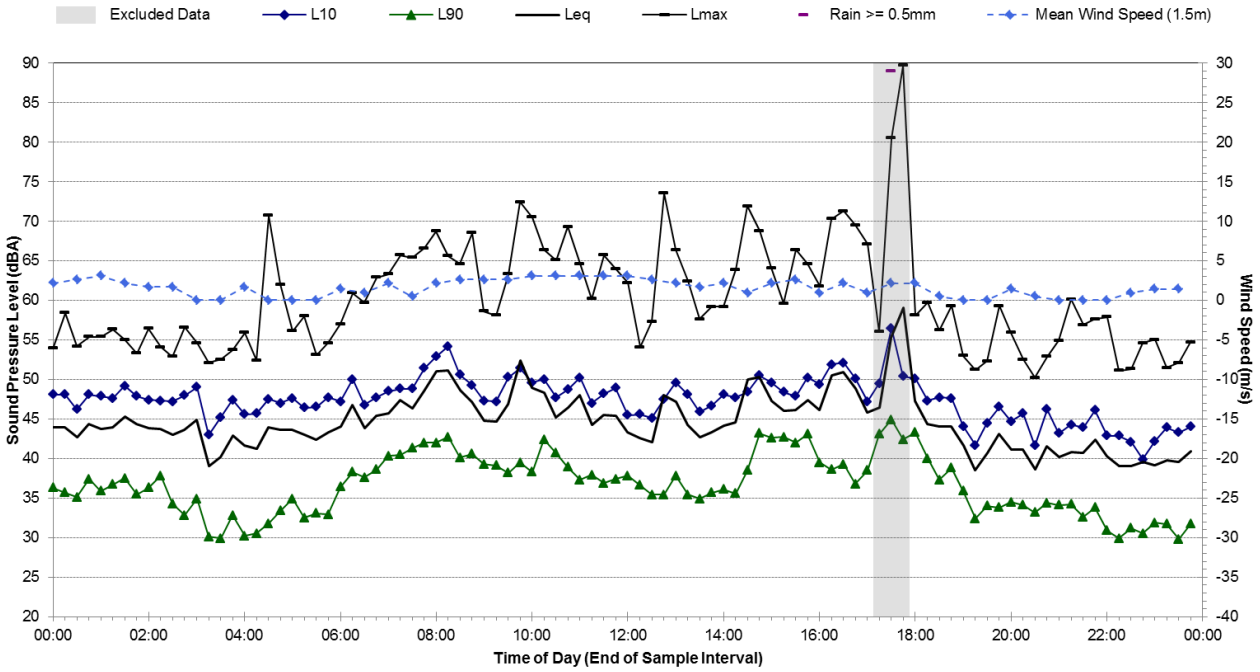


Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Friday, 23 May 2014

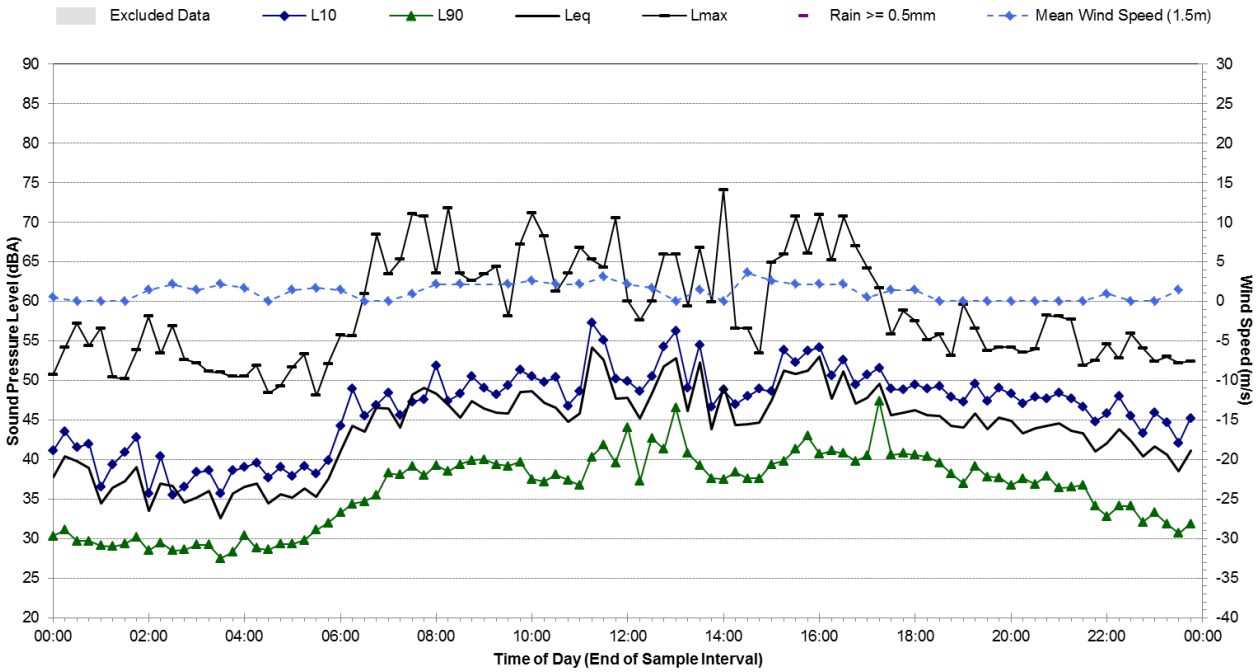


Appendix C Ambient Noise Logging Results

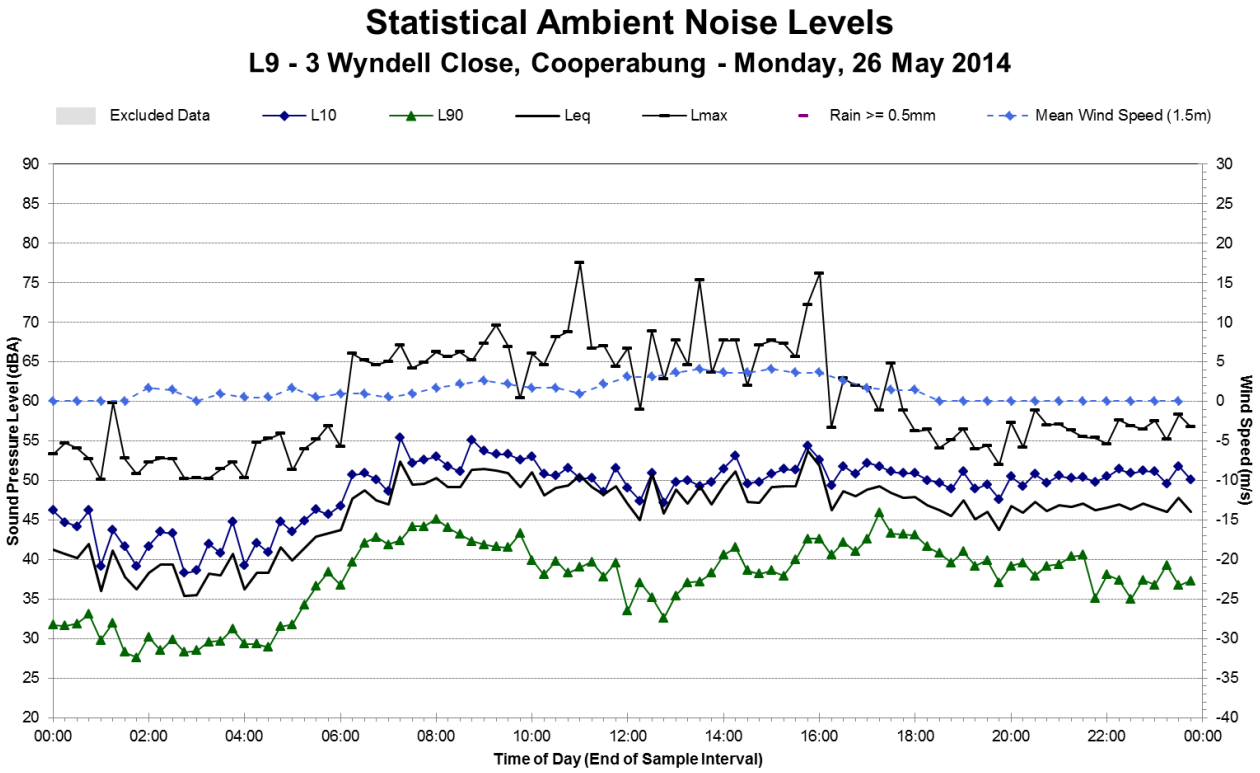
Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Saturday, 24 May 2014

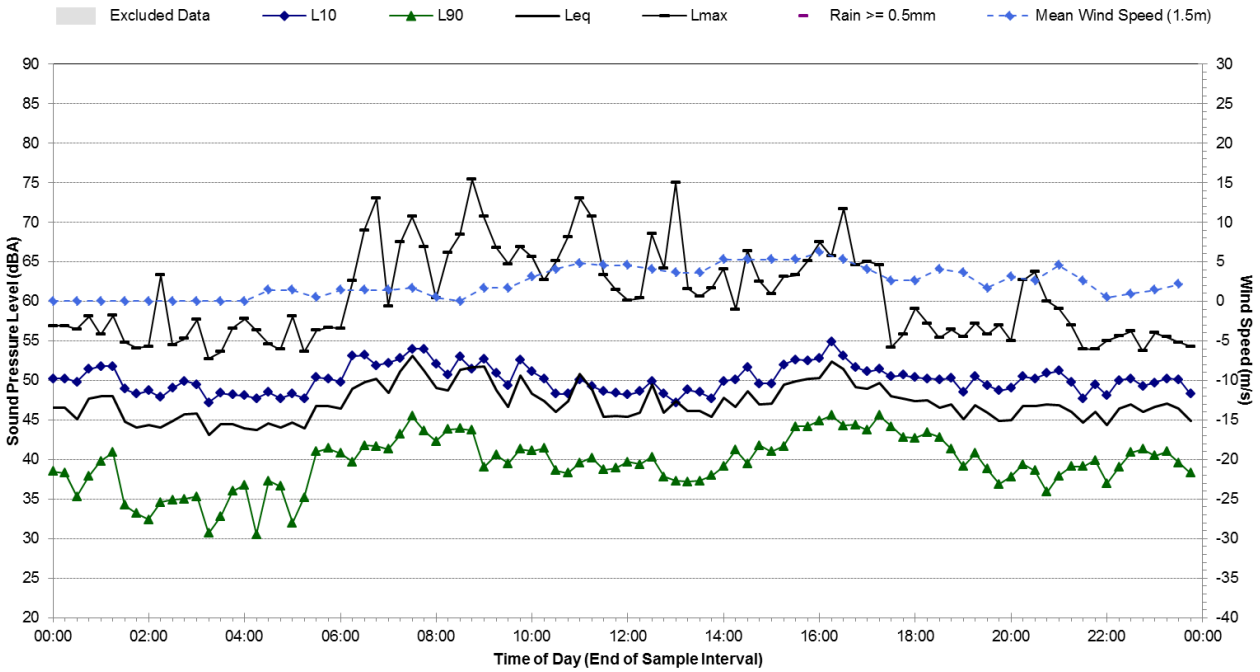


Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Sunday, 25 May 2014



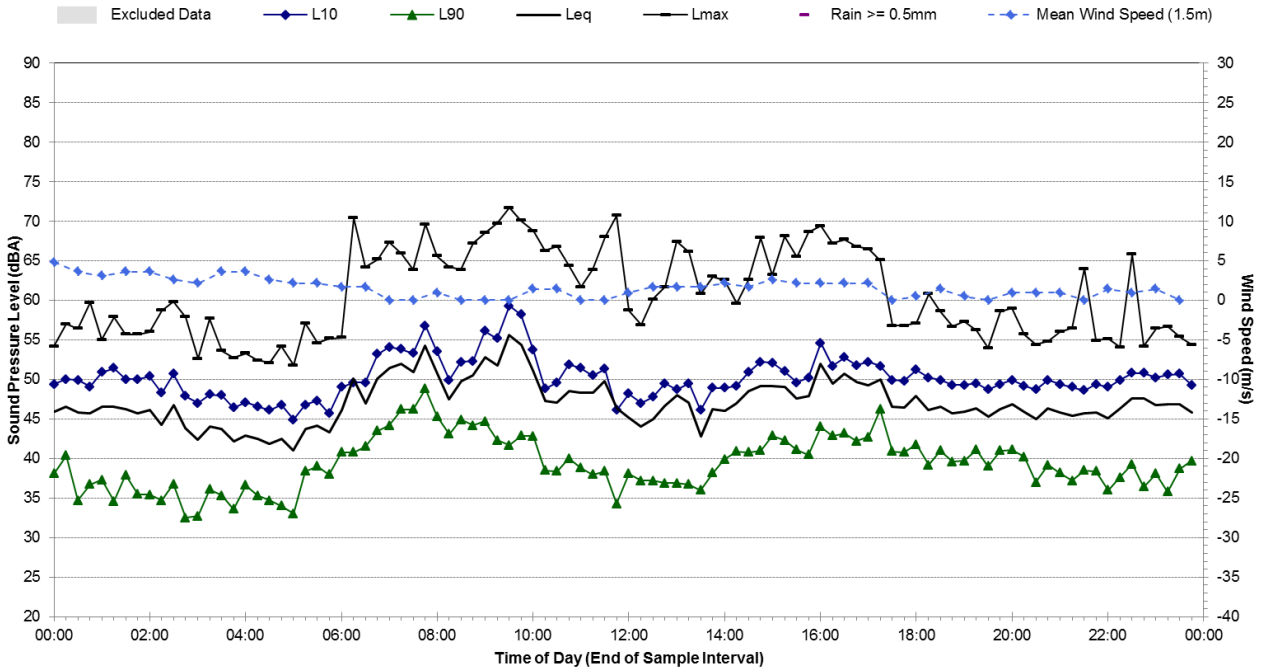
Appendix C Ambient Noise Logging Results



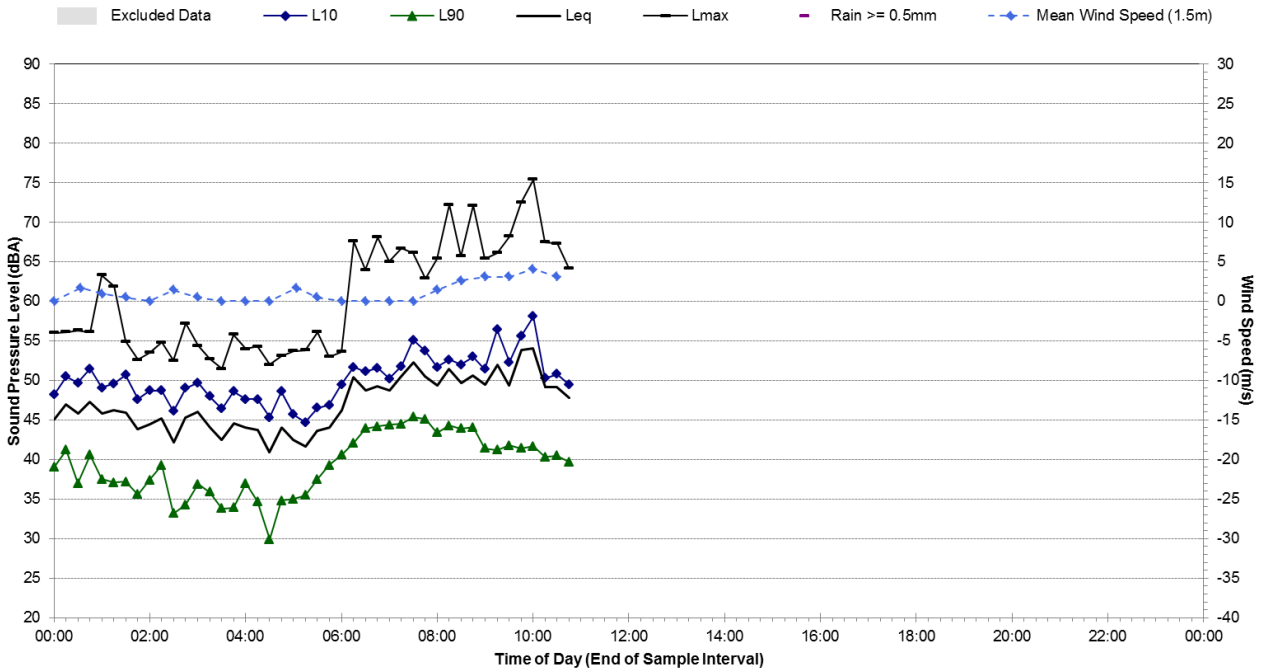


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Wednesday, 28 May 2014



Statistical Ambient Noise Levels
L9 - 3 Wyndell Close, Cooperabung - Thursday, 29 May 2014



Noise Monitoring Location:	**L10**
Noise Monitoring Address:	**890 Cooperabung Drive, Cooperabung**

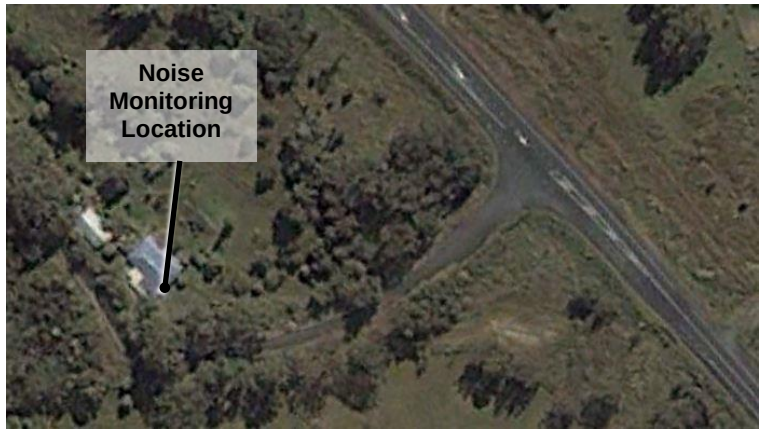
Logger Device Type: ARL316
Logger Serial No: 16_207-048

Ambient noise logger deployed 1m from the facade of the property, on the balcony facing Pacific Highway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pacific Highway.

Recorded Noise Levels (LAmax):
Pacific Highway Light-vehicle road traffic: typically 57-64 dBA, Pacific Highway Heavy-vehicle road traffic: typically 68-74 dBA

Map of Noise Monitoring Location



Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	49	64	67	72
Evening	41	63	68	72
Night-time	35	62	68	72

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	64	63	64
Night-time (10pm-7am)	63	58	62

Attended Noise Measurement Results

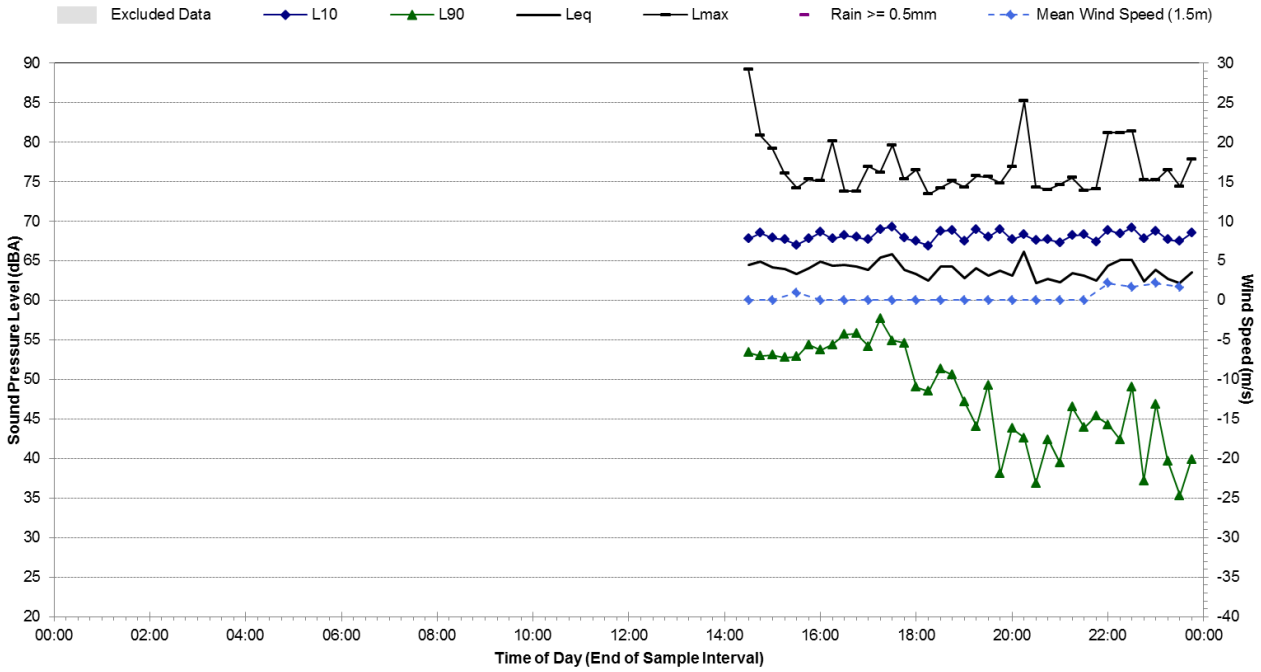
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
20/05/2014	14:31pm	53	64	74

Photo of Noise Monitoring Location

Appendix C Ambient Noise Logging Results

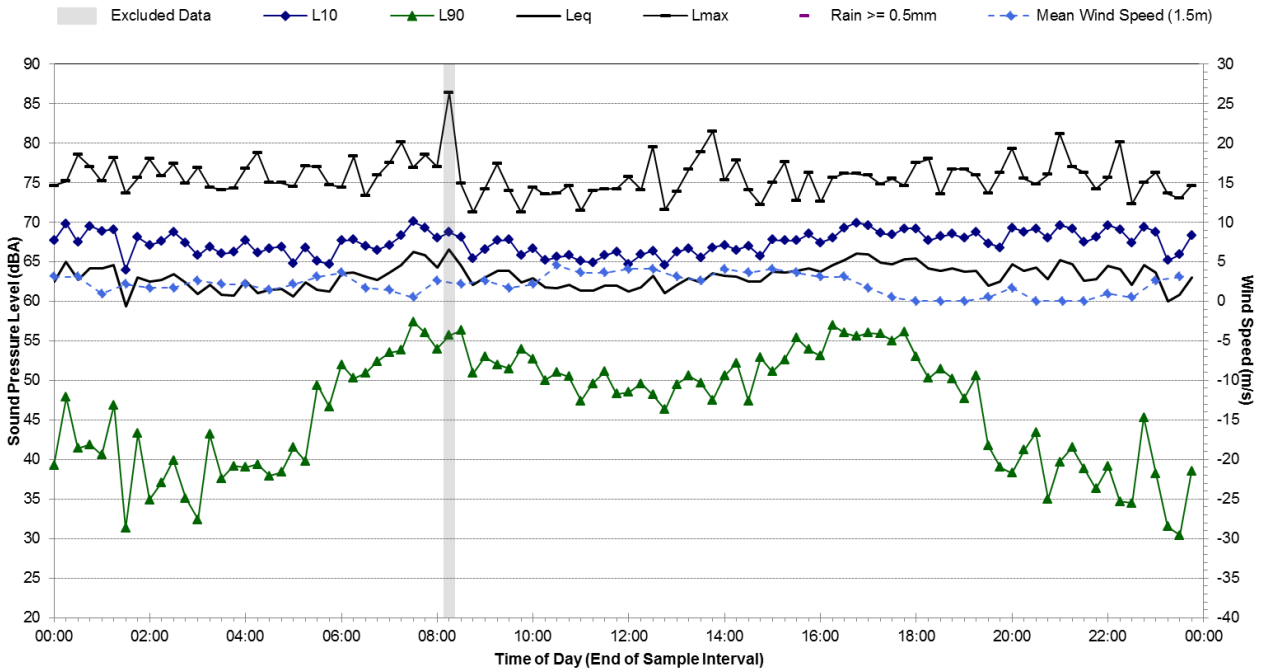
Statistical Ambient Noise Levels

L10 - 890 Cooperabung Drive, Cooperabung - Tuesday, 20 May 2014



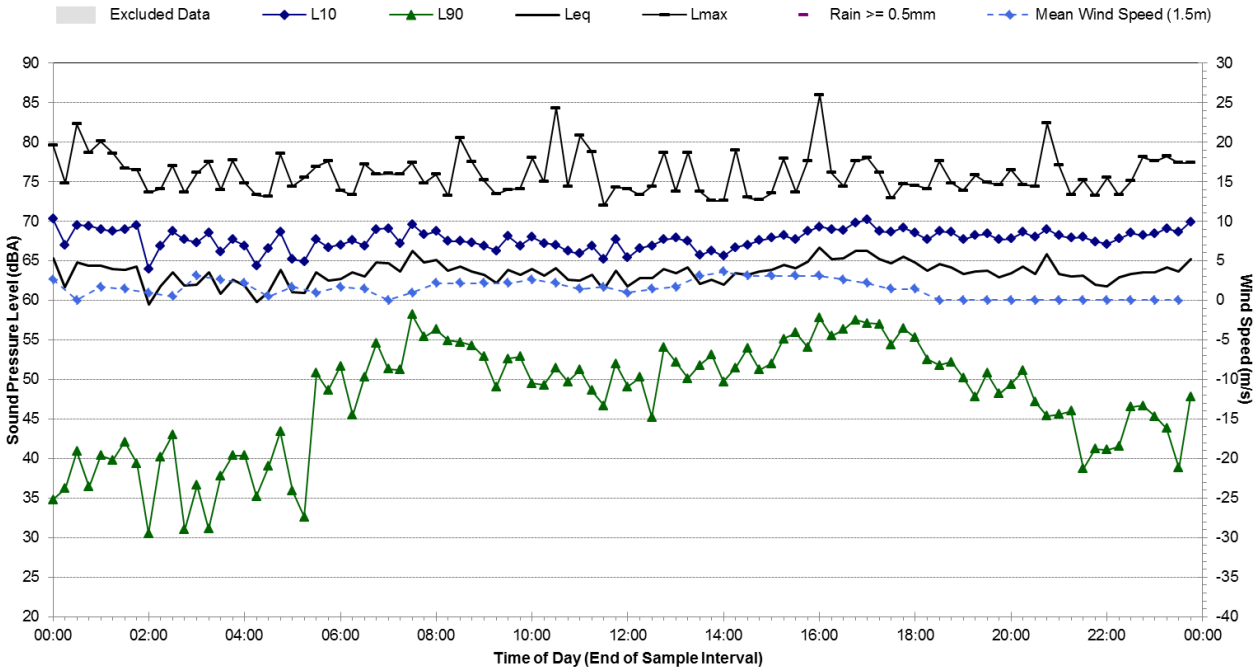
Statistical Ambient Noise Levels

L10 - 890 Cooperabung Drive, Cooperabung - Wednesday, 21 May 2014

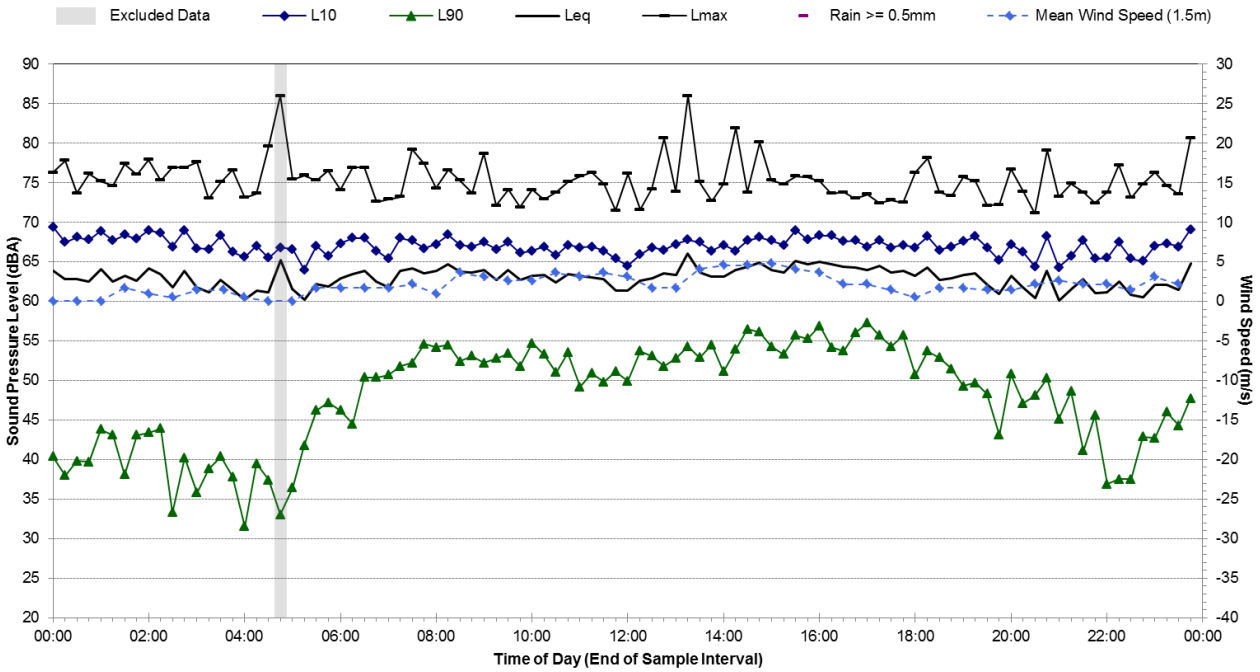


Appendix C Ambient Noise Logging Results

Statistical Ambient Noise Levels
L10 - 890 Cooperabung Drive, Cooperabung - Thursday, 22 May 2014

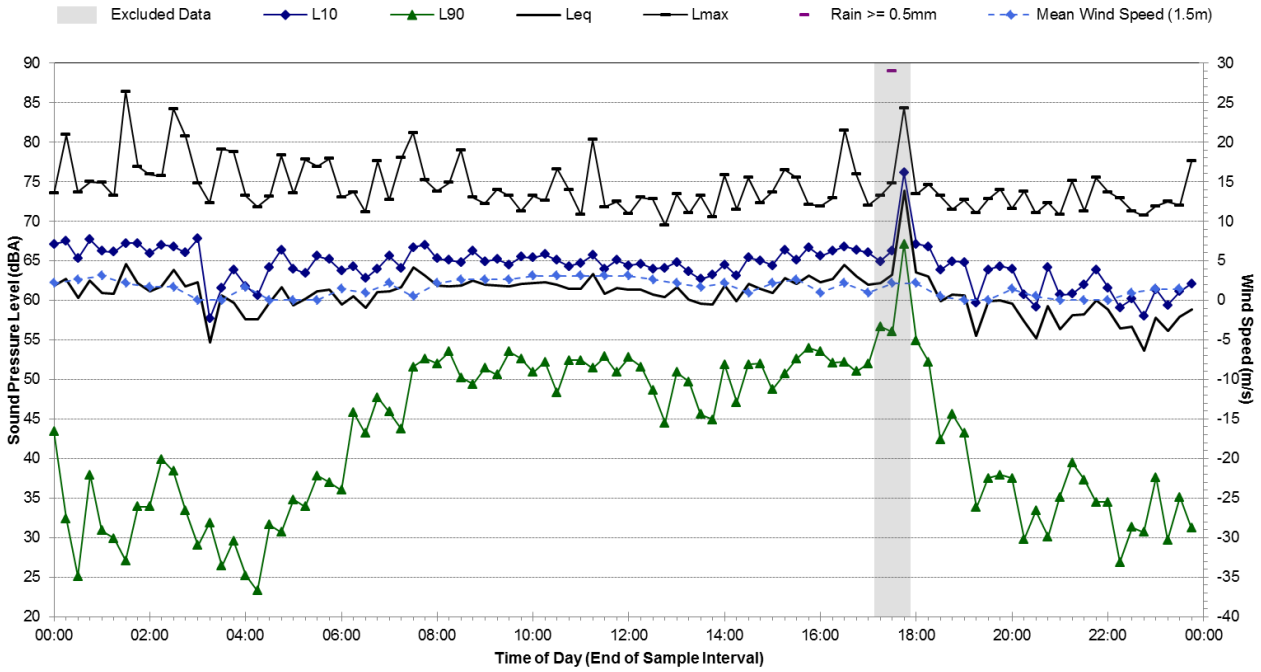


Statistical Ambient Noise Levels
L10 - 890 Cooperabung Drive, Cooperabung - Friday, 23 May 2014



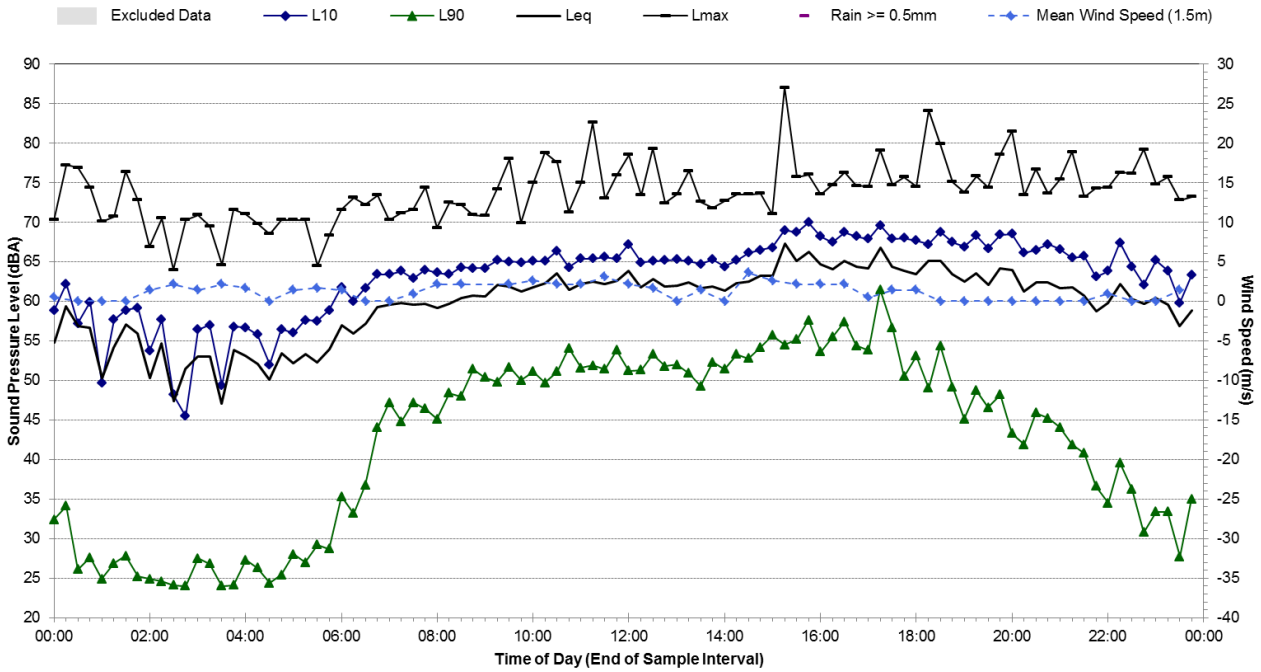
Statistical Ambient Noise Levels

L10 - 890 Cooperabung Drive, Cooperabung - Saturday, 24 May 2014



Statistical Ambient Noise Levels

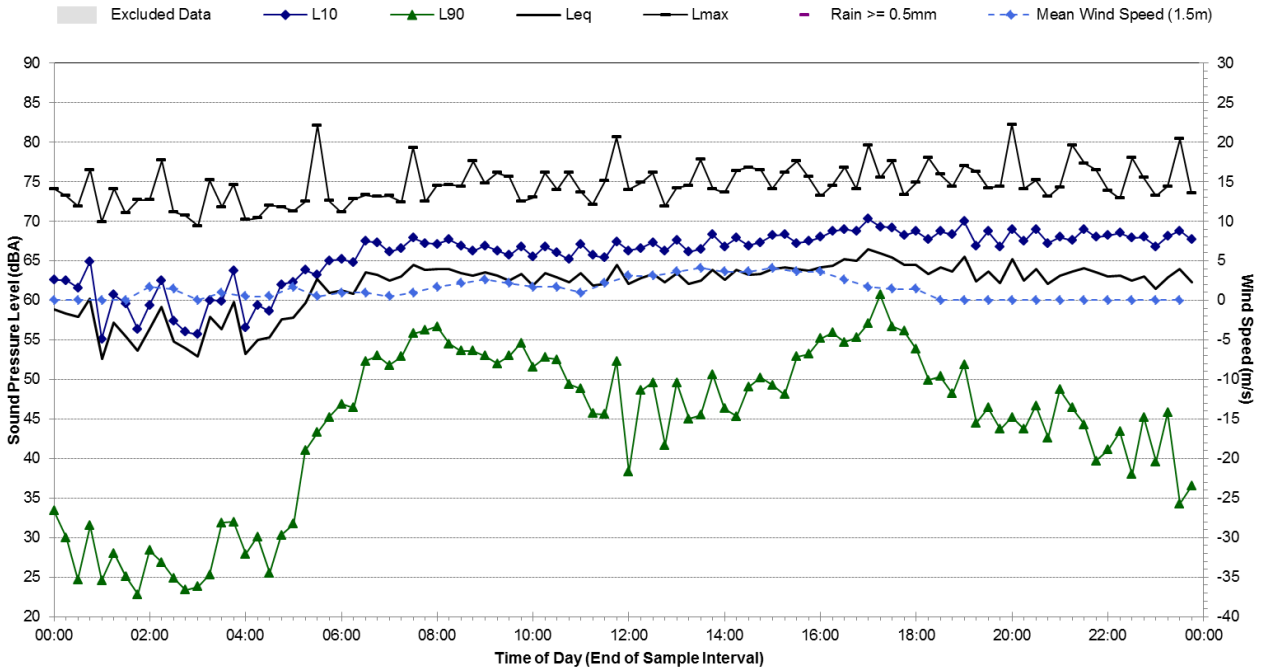
L10 - 890 Cooperabung Drive, Cooperabung - Sunday, 25 May 2014



Appendix C Ambient Noise Logging Results

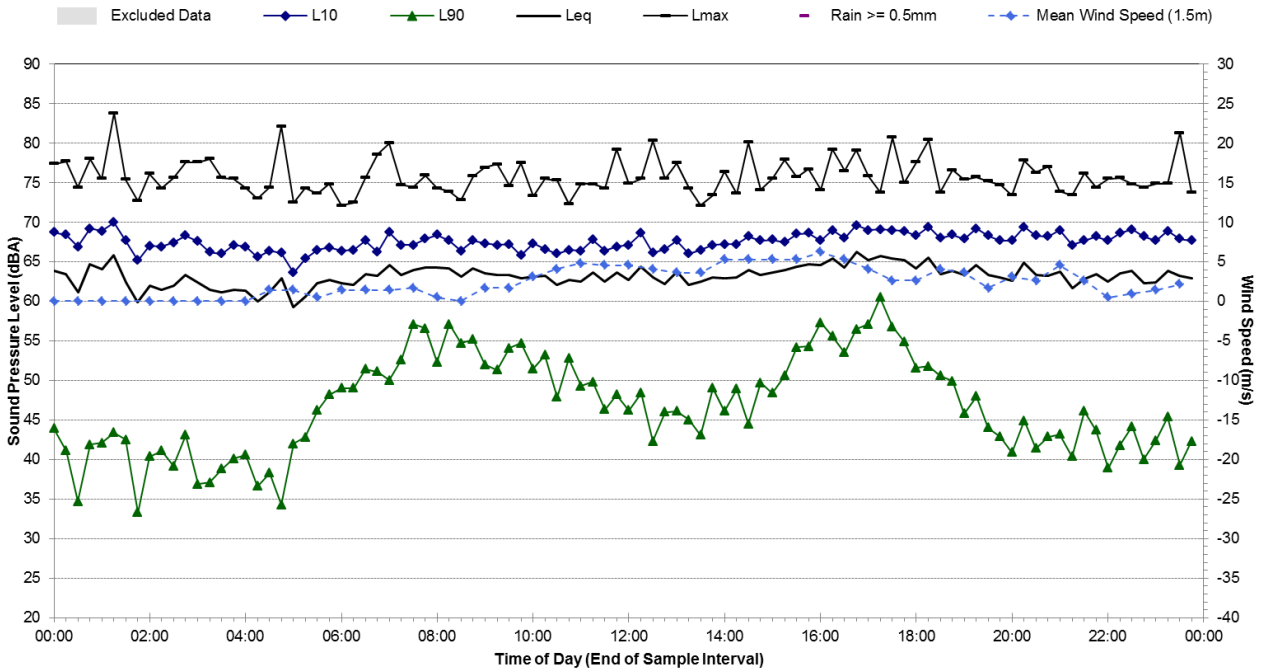
Statistical Ambient Noise Levels

L10 - 890 Cooperabung Drive, Cooperabung - Monday, 26 May 2014



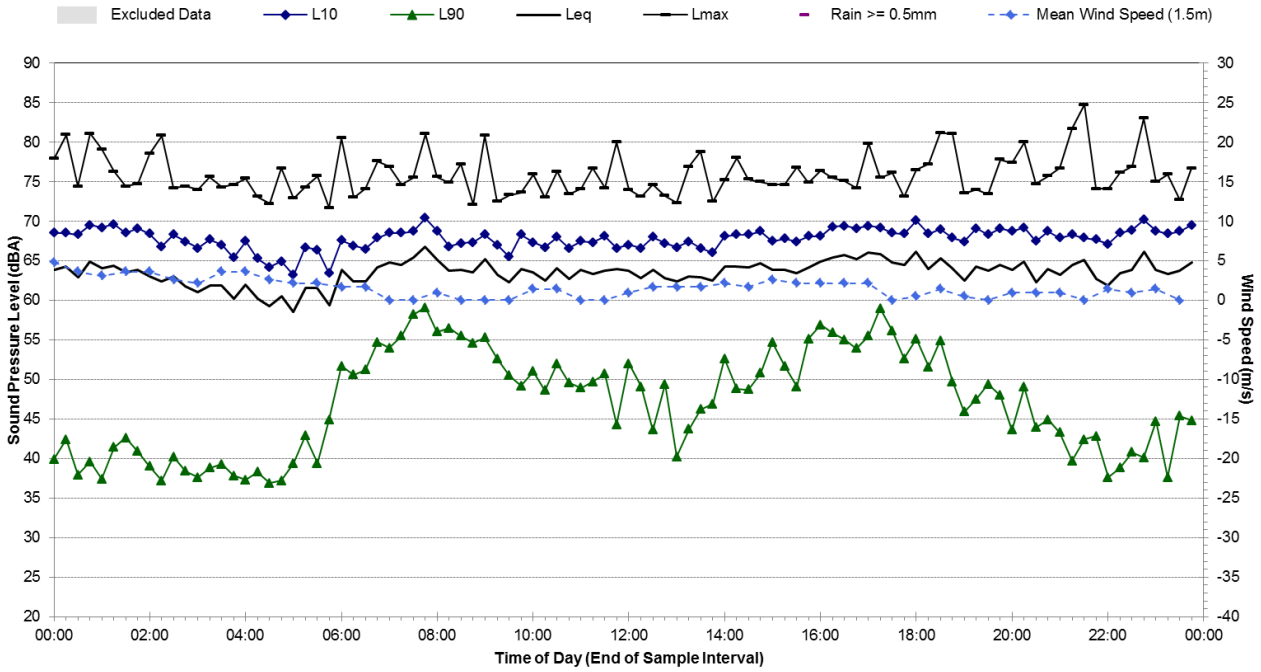
Statistical Ambient Noise Levels

L10 - 890 Cooperabung Drive, Cooperabung - Tuesday, 27 May 2014



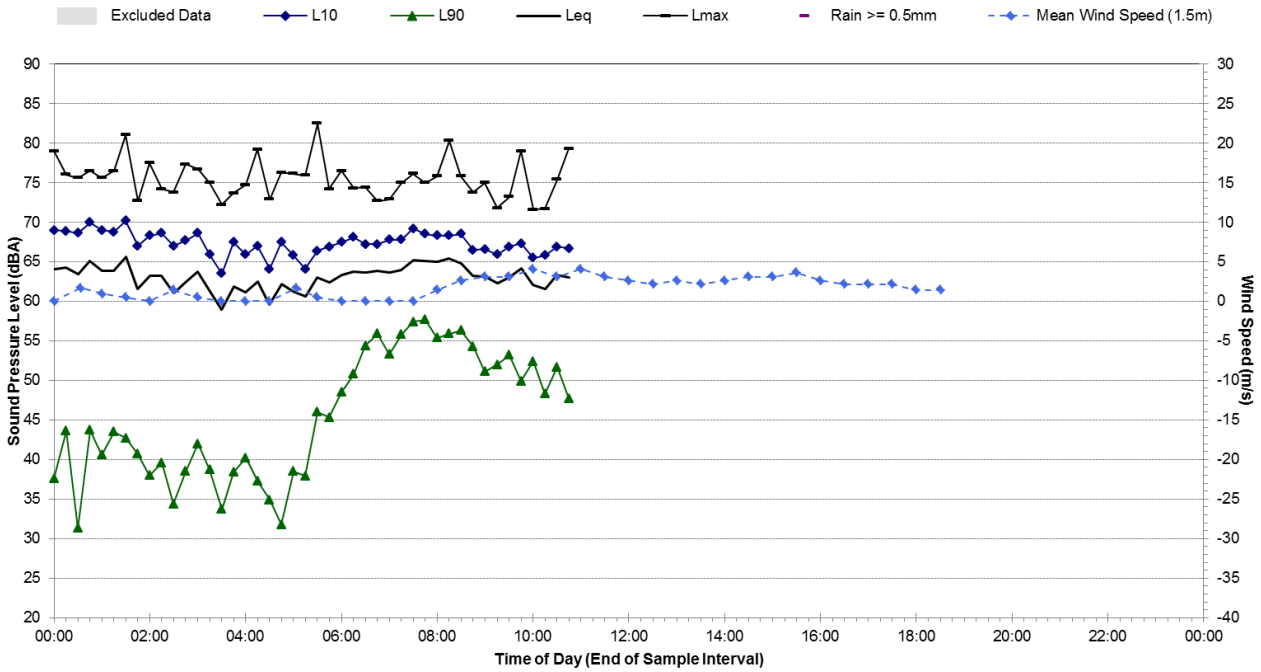
Statistical Ambient Noise Levels

L10 - 890 Cooperabung Drive, Cooperabung - Wednesday, 28 May 2014



Statistical Ambient Noise Levels

L10 - 890 Cooperabung Drive, Cooperabung - Thursday, 29 May 2014



Appendix D 2016 and 2026 Noise Contours

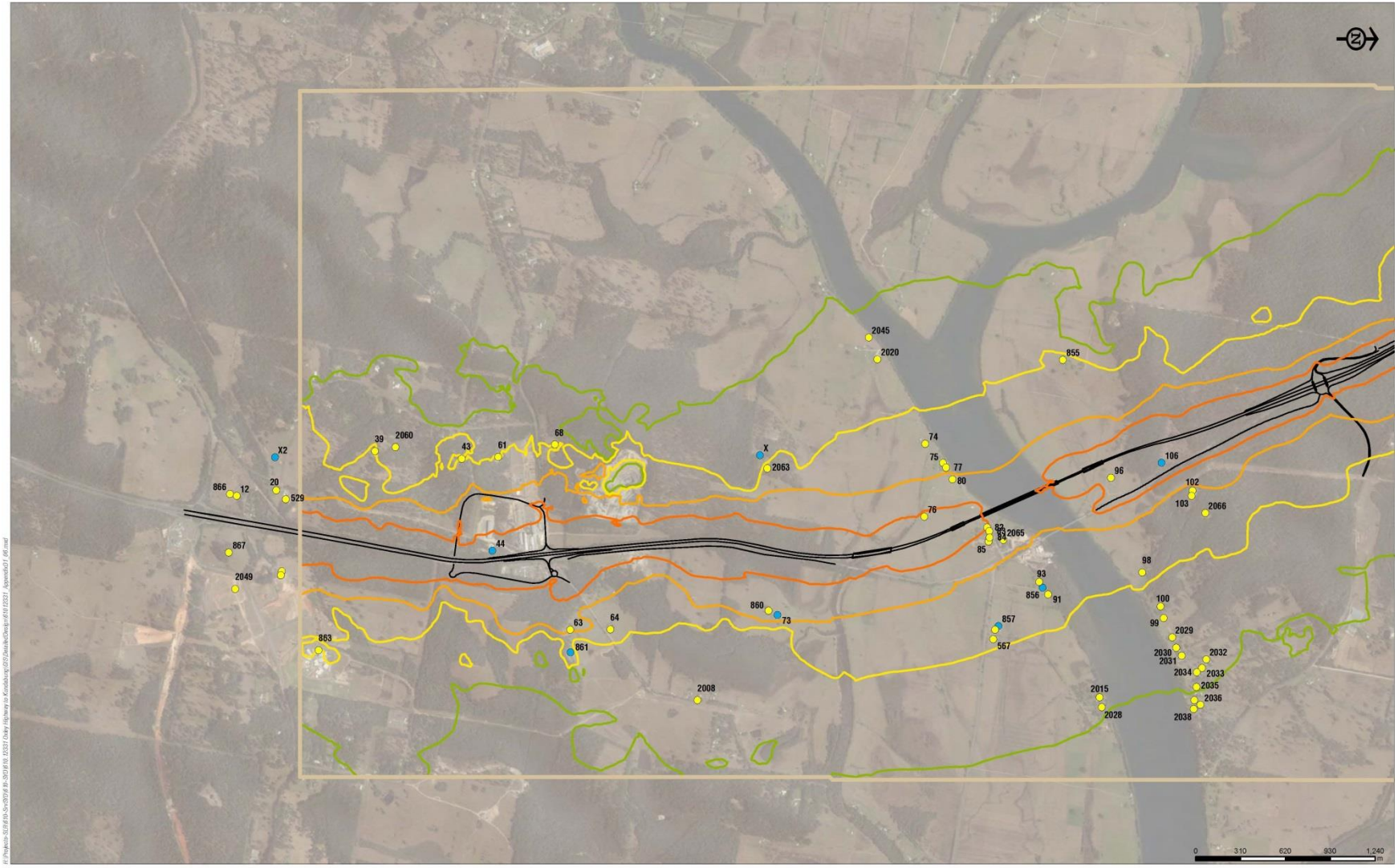
Appendix D1 2016 Day

Appendix D2 2016 Night

Appendix D3 2026 Day

Appendix D4 2026 Night

Appendix D 2016 and 2026 Noise Contours



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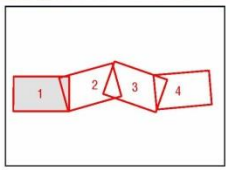


Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Day Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

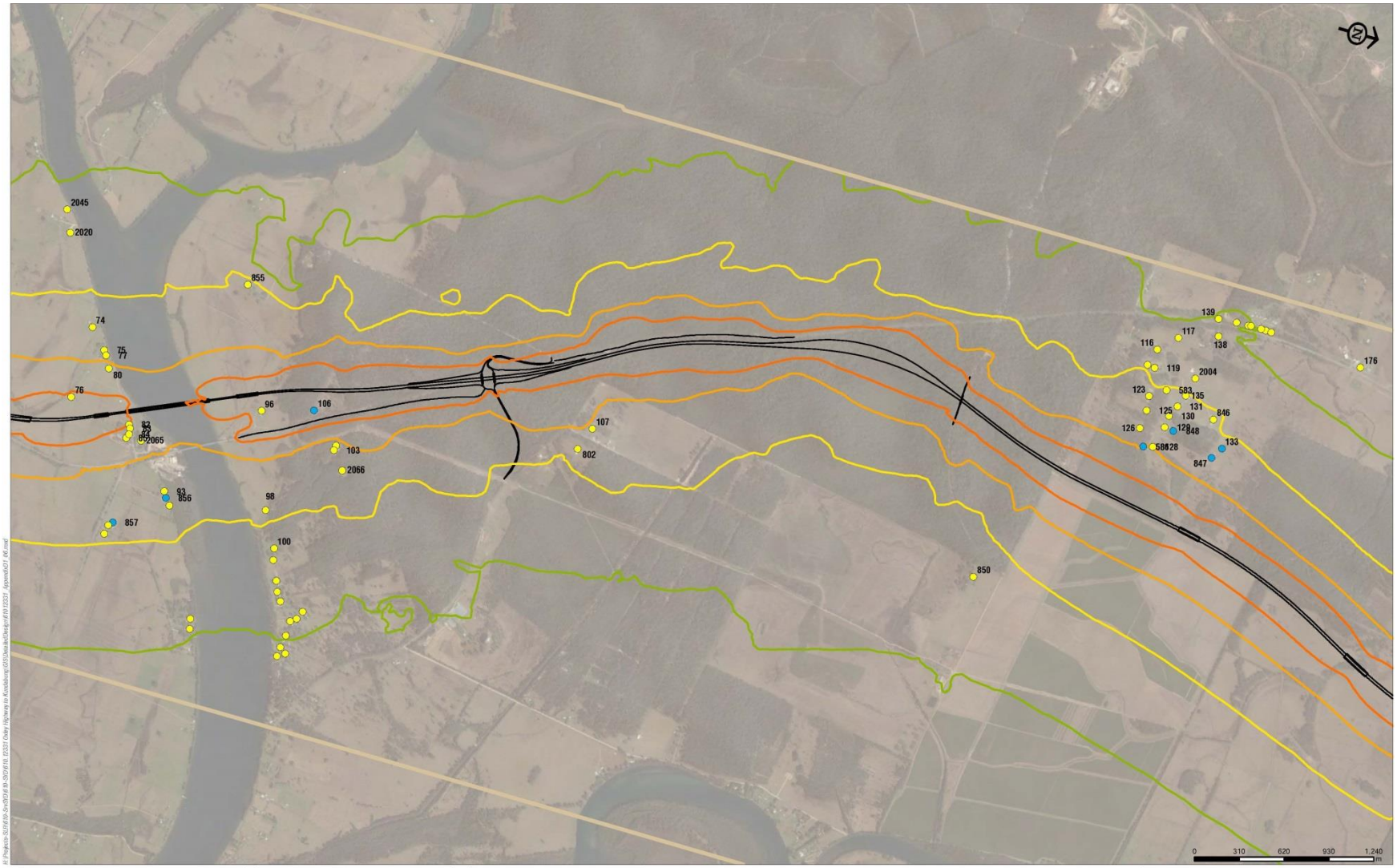
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(15hr)}$ (Day)
Noise Contours

APPENDIX D1-1

Appendix D 2016 and 2026 Noise Contours



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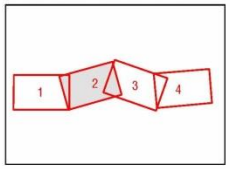


Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Day Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

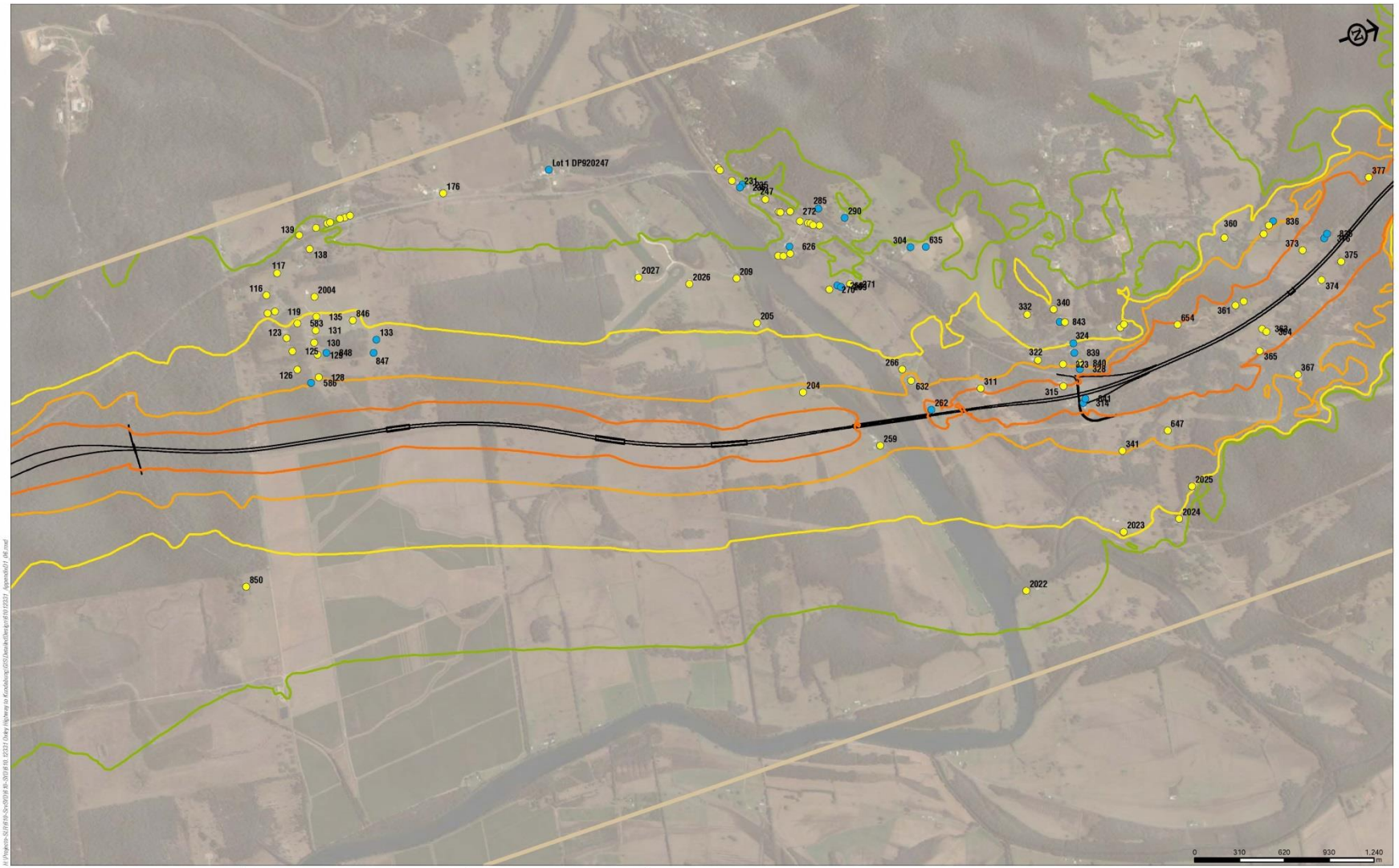
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(15hr)}$ (Day)
Noise Contours

APPENDIX D1-2

Appendix D 2016 and 2026 Noise Contours



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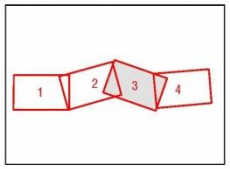
Sheet Size:	A3
Projection:	GDA 1994 MGA Zone 56



Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Day Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

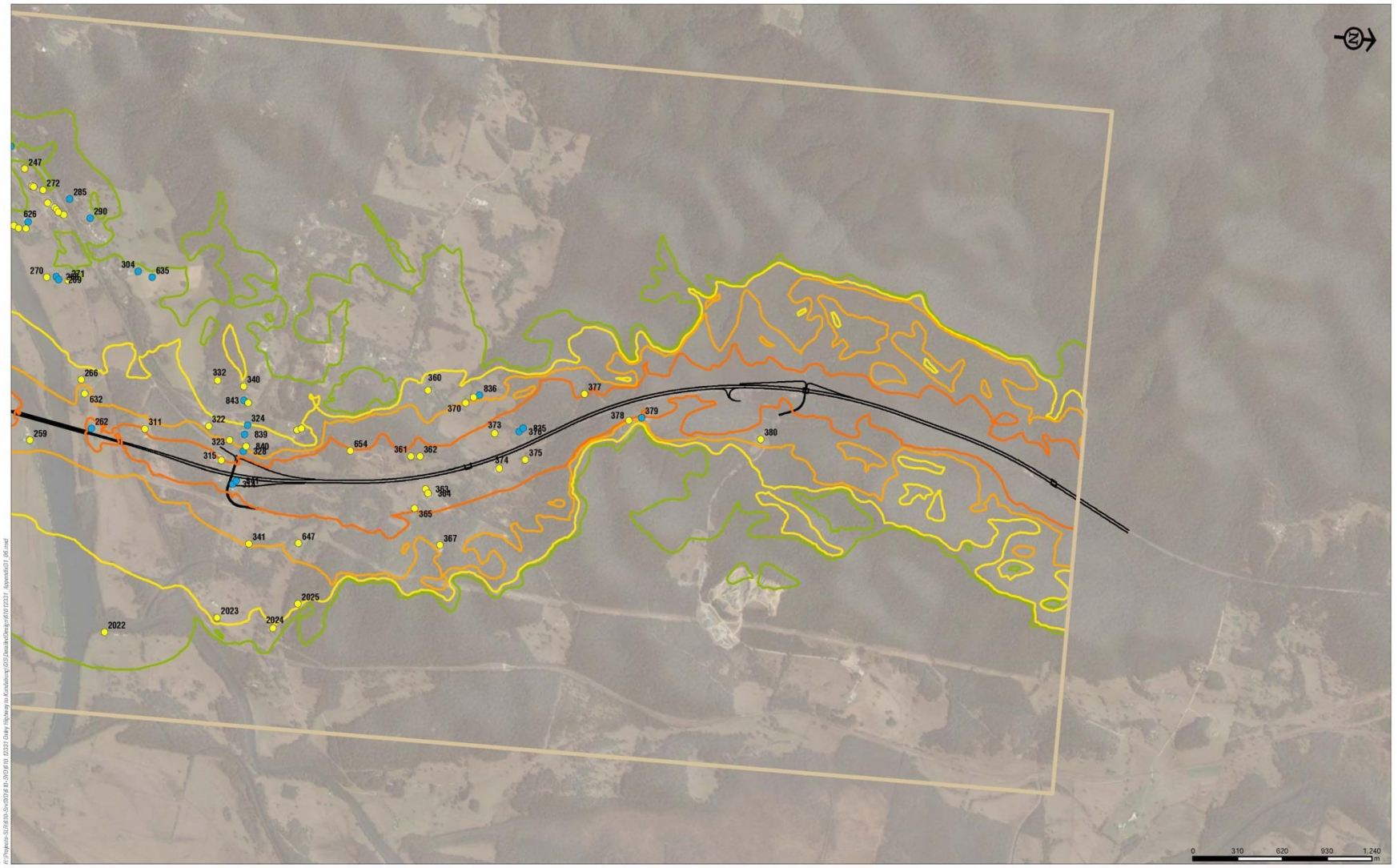
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(15hr)}$ (Day)
Noise Contours

APPENDIX D1-3

Appendix D 2016 and 2026 Noise Contours



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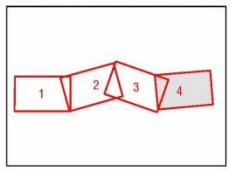
Projection:	GDA 1994 MGA Zone 56



Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Day Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

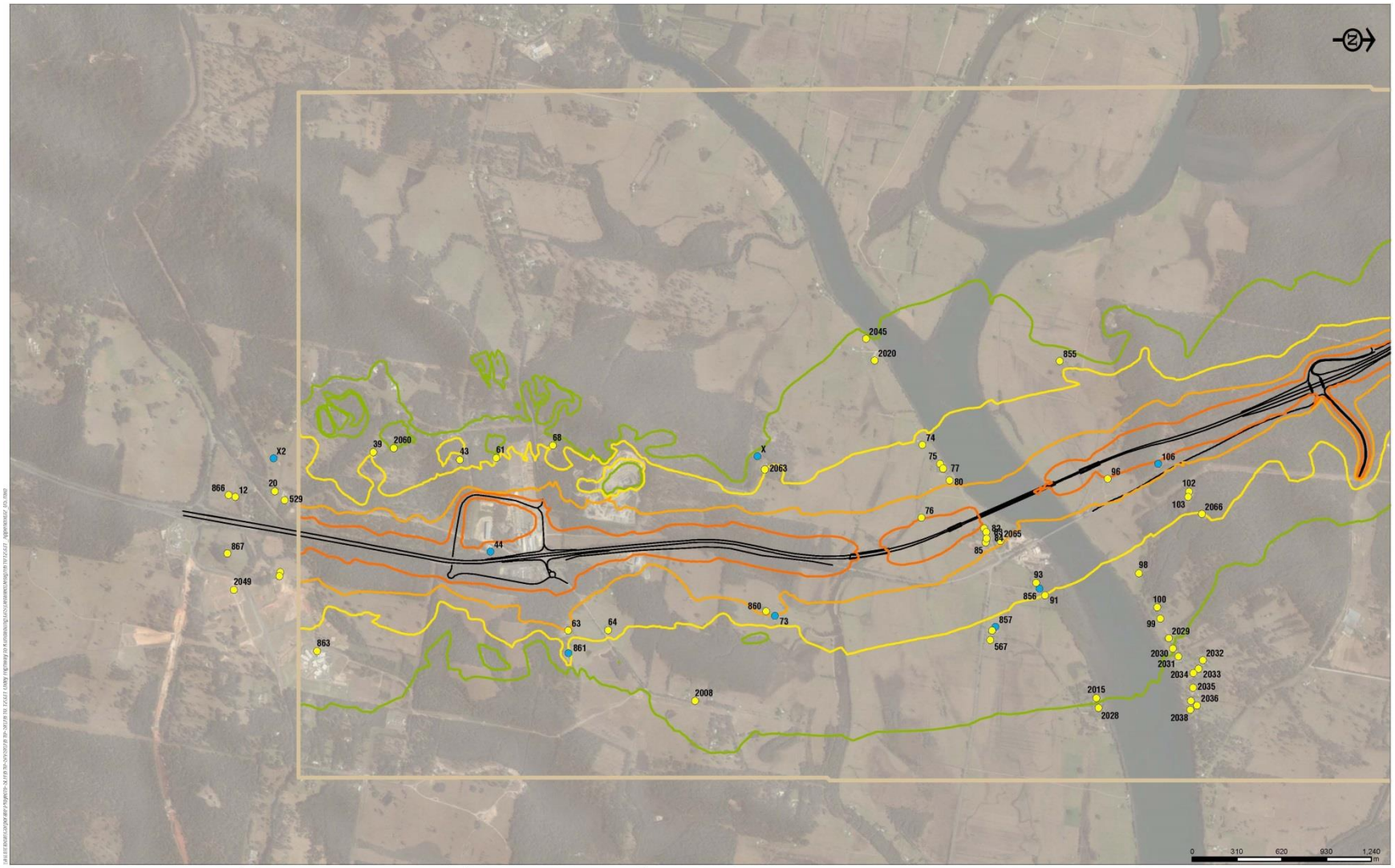
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(15hr)}$ (Day)
Noise Contours

APPENDIX D1-4

Appendix D 2016 and 2026 Noise Contours



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1 2 3 4

Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

0 310 620 930 1,240 m

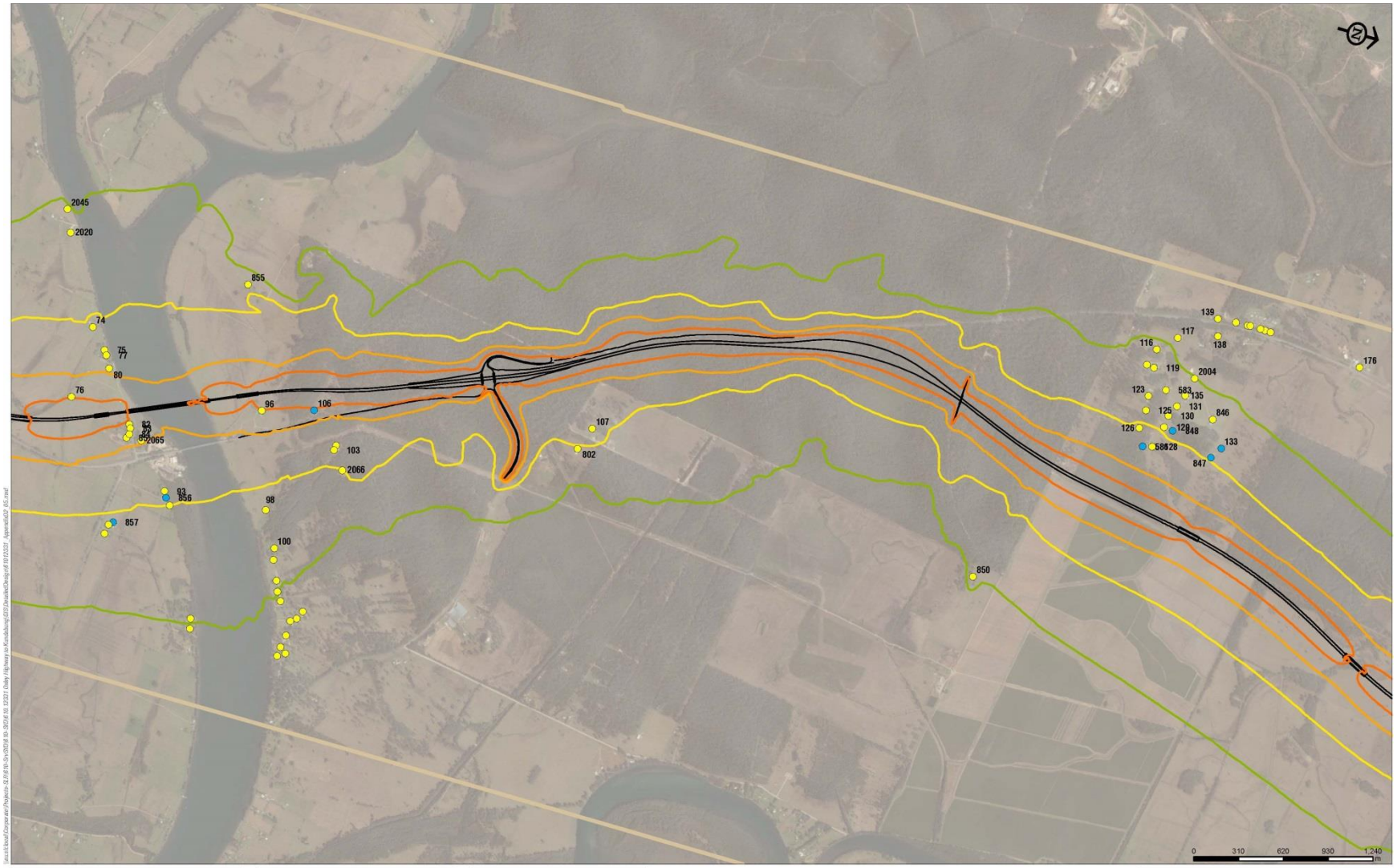
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(9hr)}$(Night) Noise Contours

APPENDIX D2-1

Appendix D 2016 and 2026 Noise Contours



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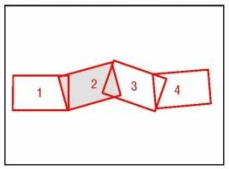


Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

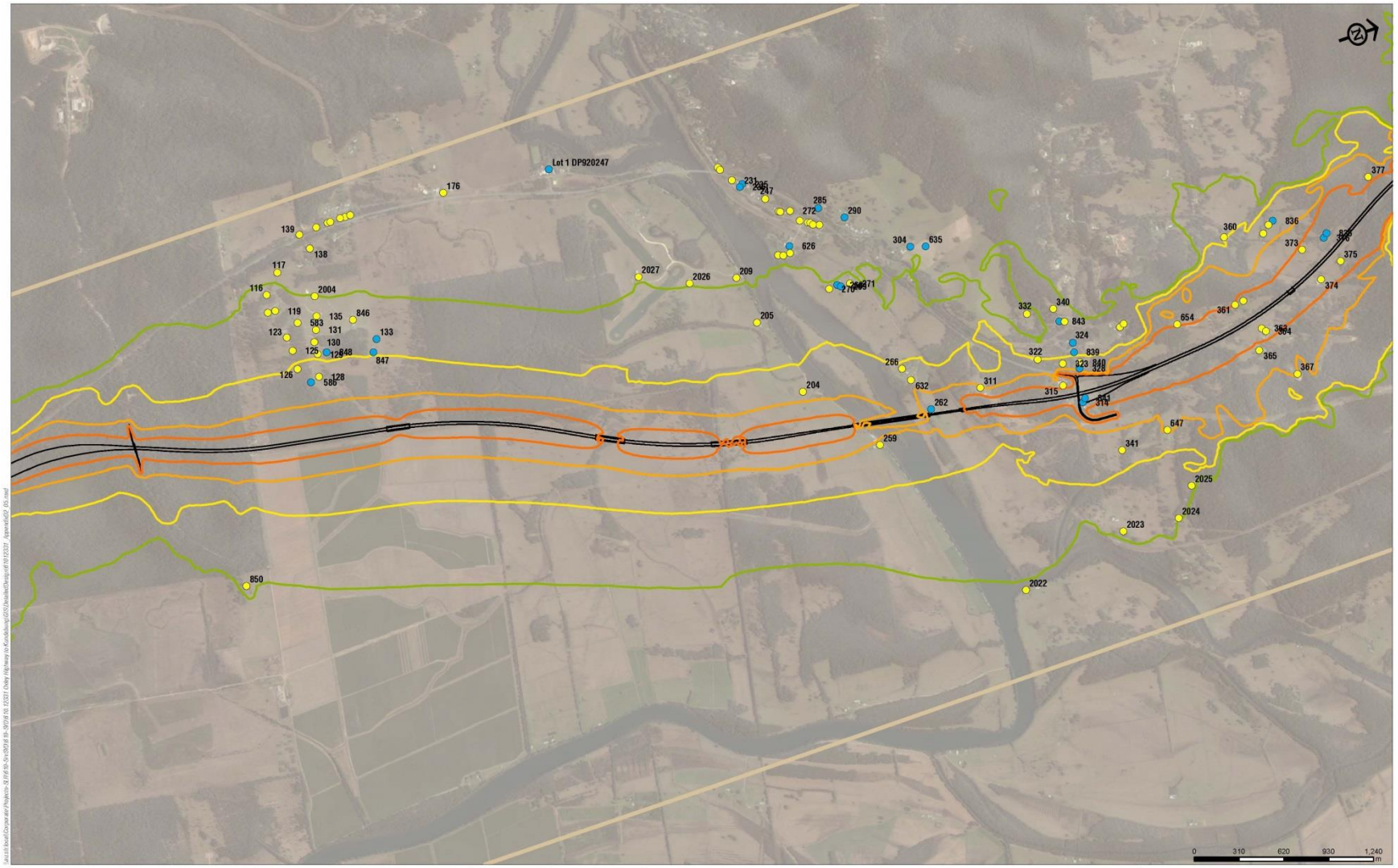
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(9hr)}$(Night)
Noise Contours

APPENDIX D2-2

Appendix D 2016 and 2026 Noise Contours



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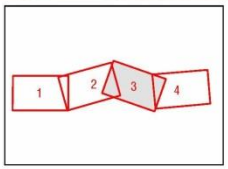

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Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

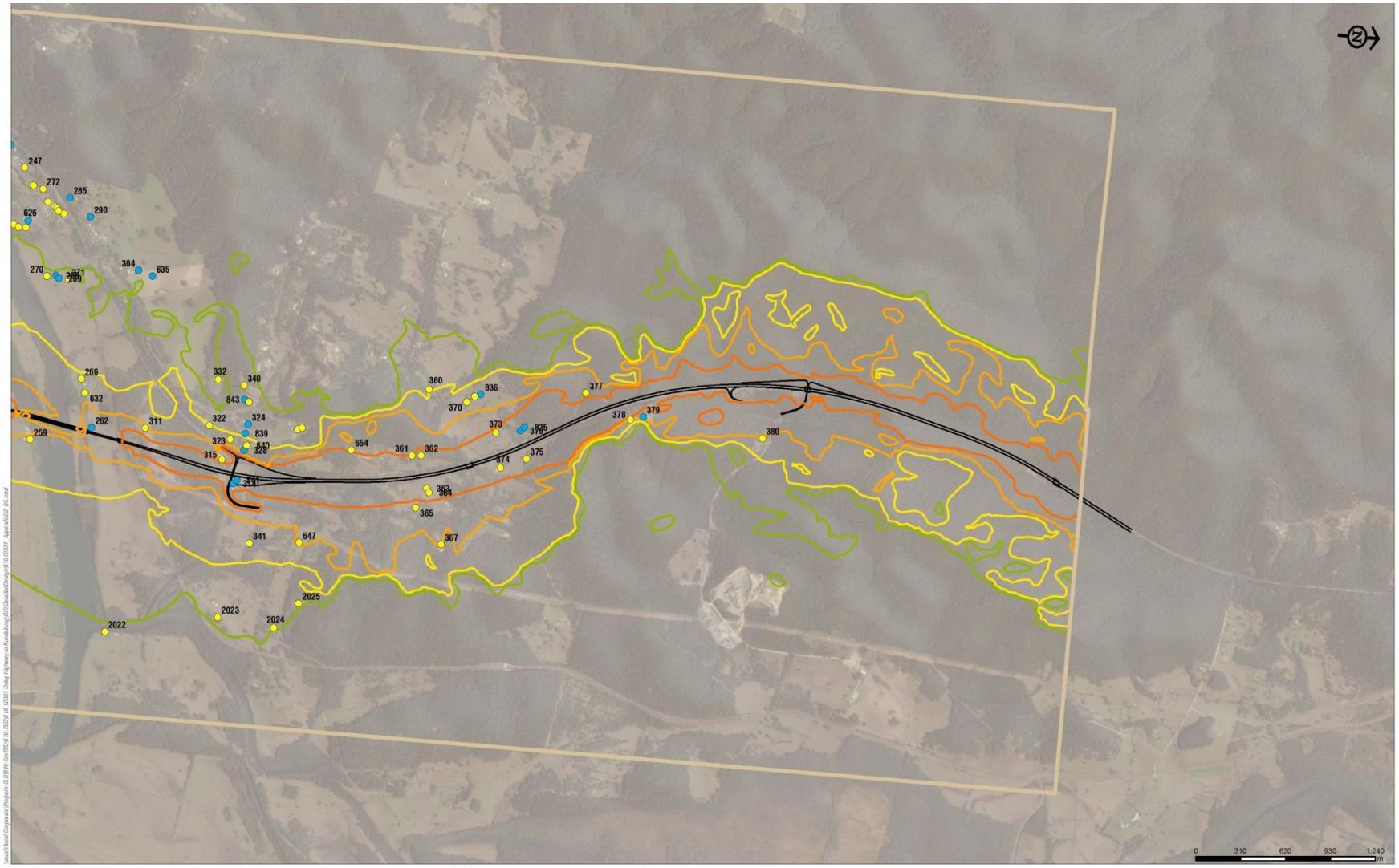
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(9hr)}$(Night)
Noise Contours

APPENDIX D2-3

Appendix D 2016 and 2026 Noise Contours



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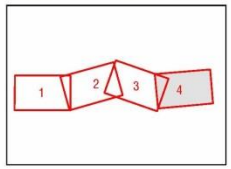


Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

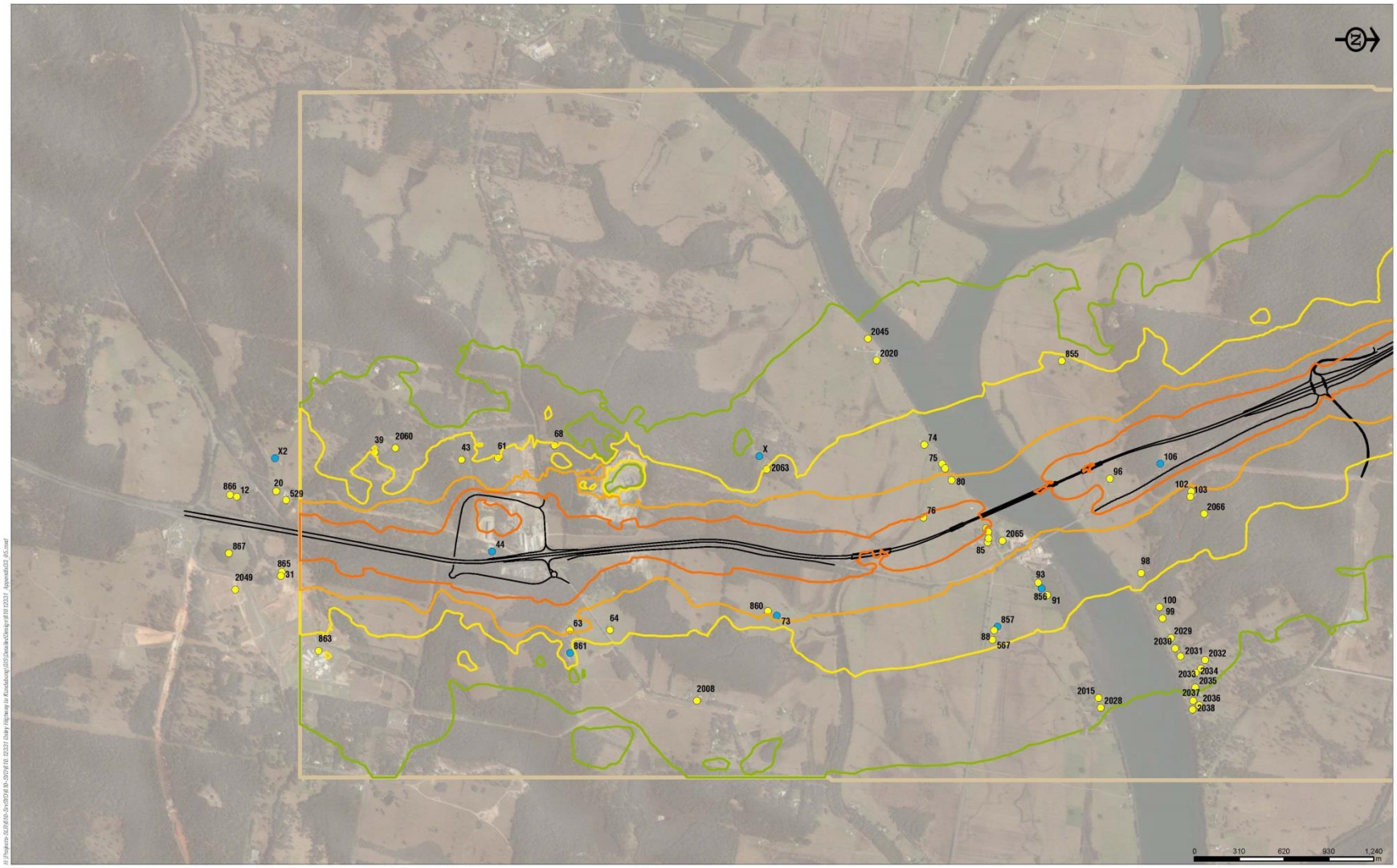
Lend Lease

Oxley Highway to Kundabung

IFC Design
2016 $L_{Aeq(9hr)}$(Night)
Noise Contours

APPENDIX D2-4

Appendix D 2016 and 2026 Noise Contours



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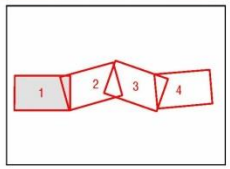


Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

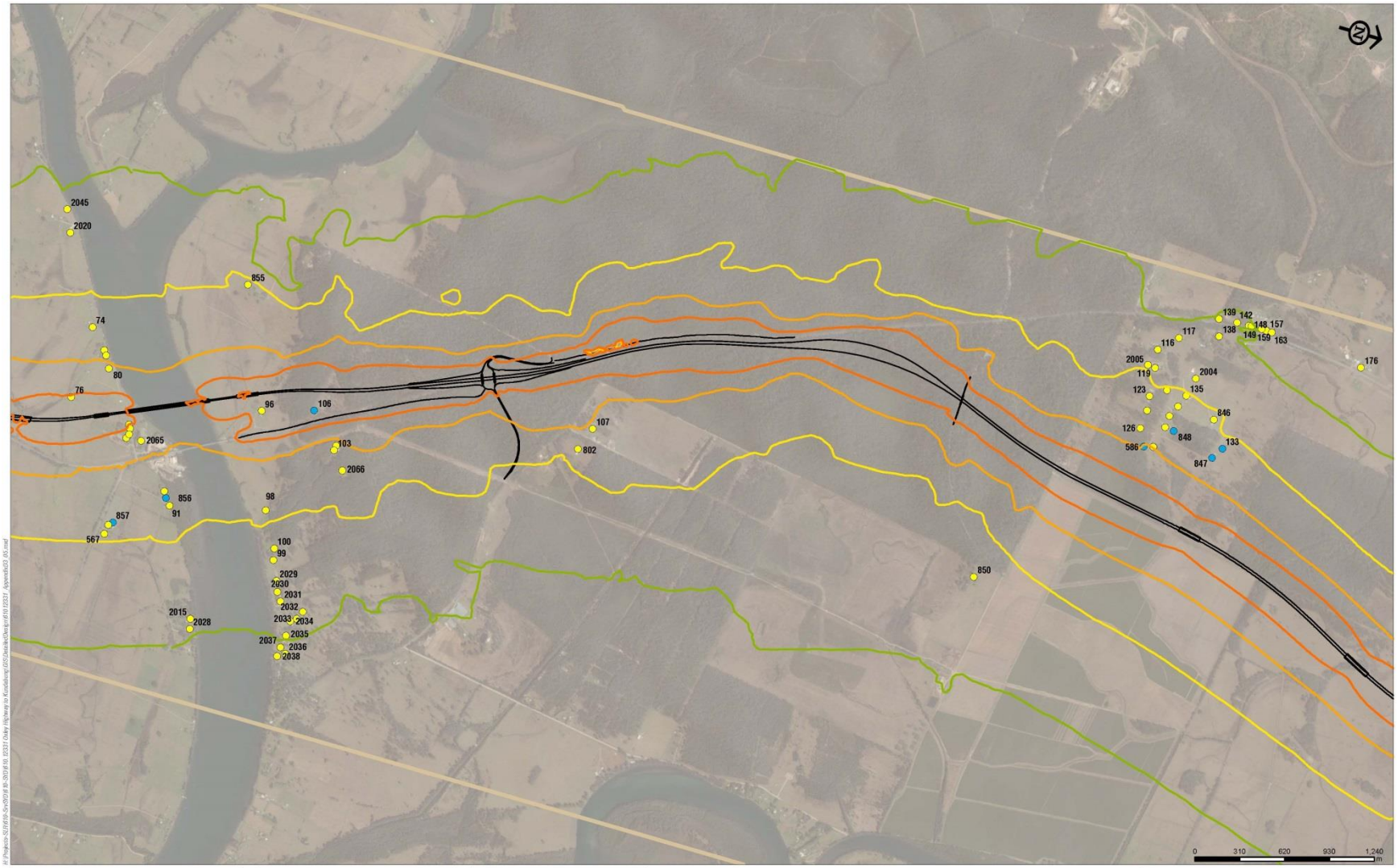
Lend Lease

Oxley Highway to Kundaberg

IFC Design
2026 $L_{Aeq(15hr)}$(Day)
Noise Contours

APPENDIX D3-1

Appendix D 2016 and 2026 Noise Contours



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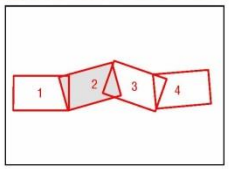


Noise Sensitive Receivers (Residences)
Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

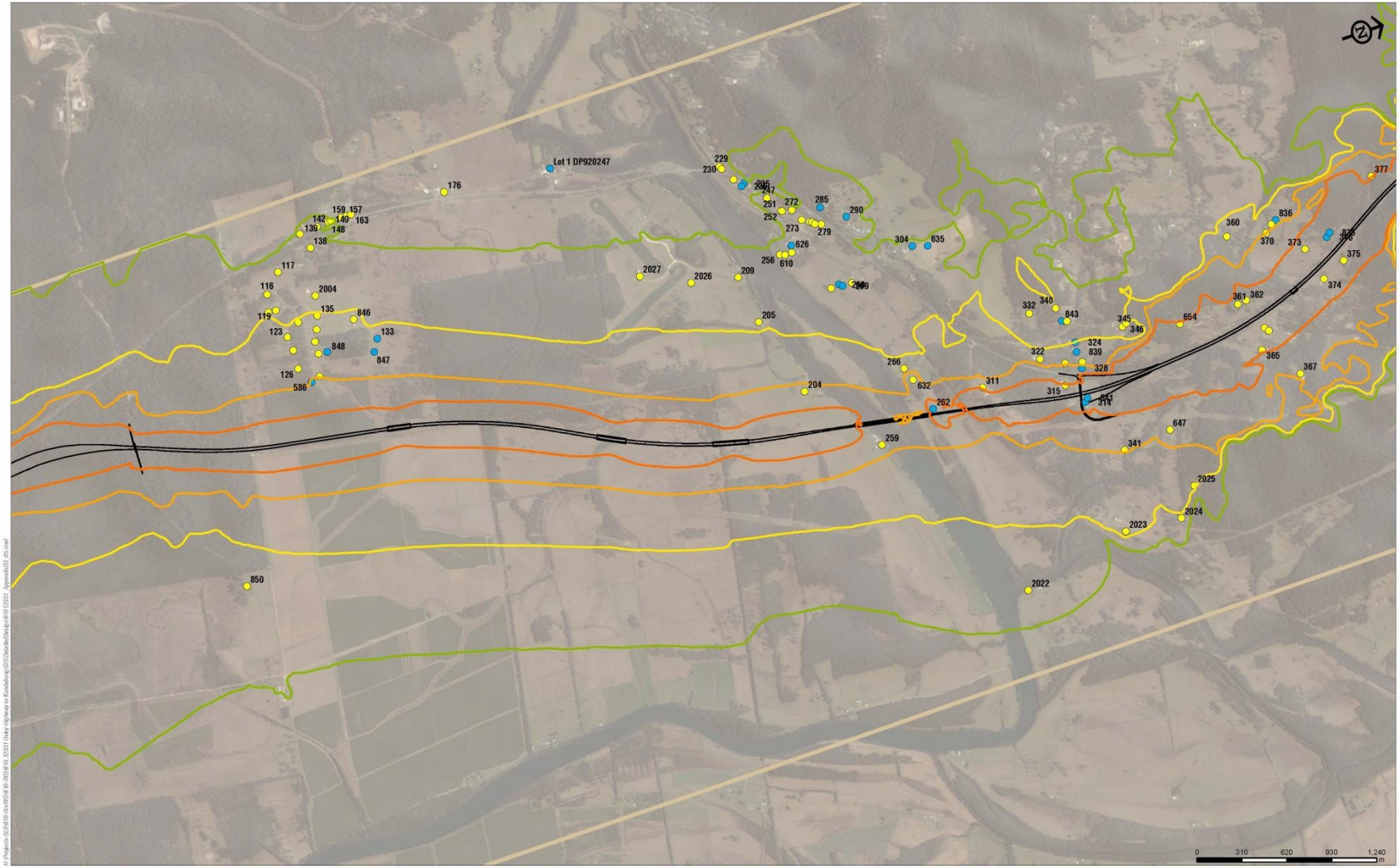
Lend Lease

Oxley Highway to Kundaberg

IFC Design
2026 $L_{Aeq(15hr)}$(Day)
Noise Contours

APPENDIX D3-2

Appendix D 2016 and 2026 Noise Contours



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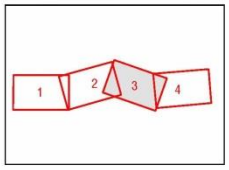

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Proposed Alignment
Noise Calculation Extent

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45 dBA
50 dBA
55 dBA
60 dBA

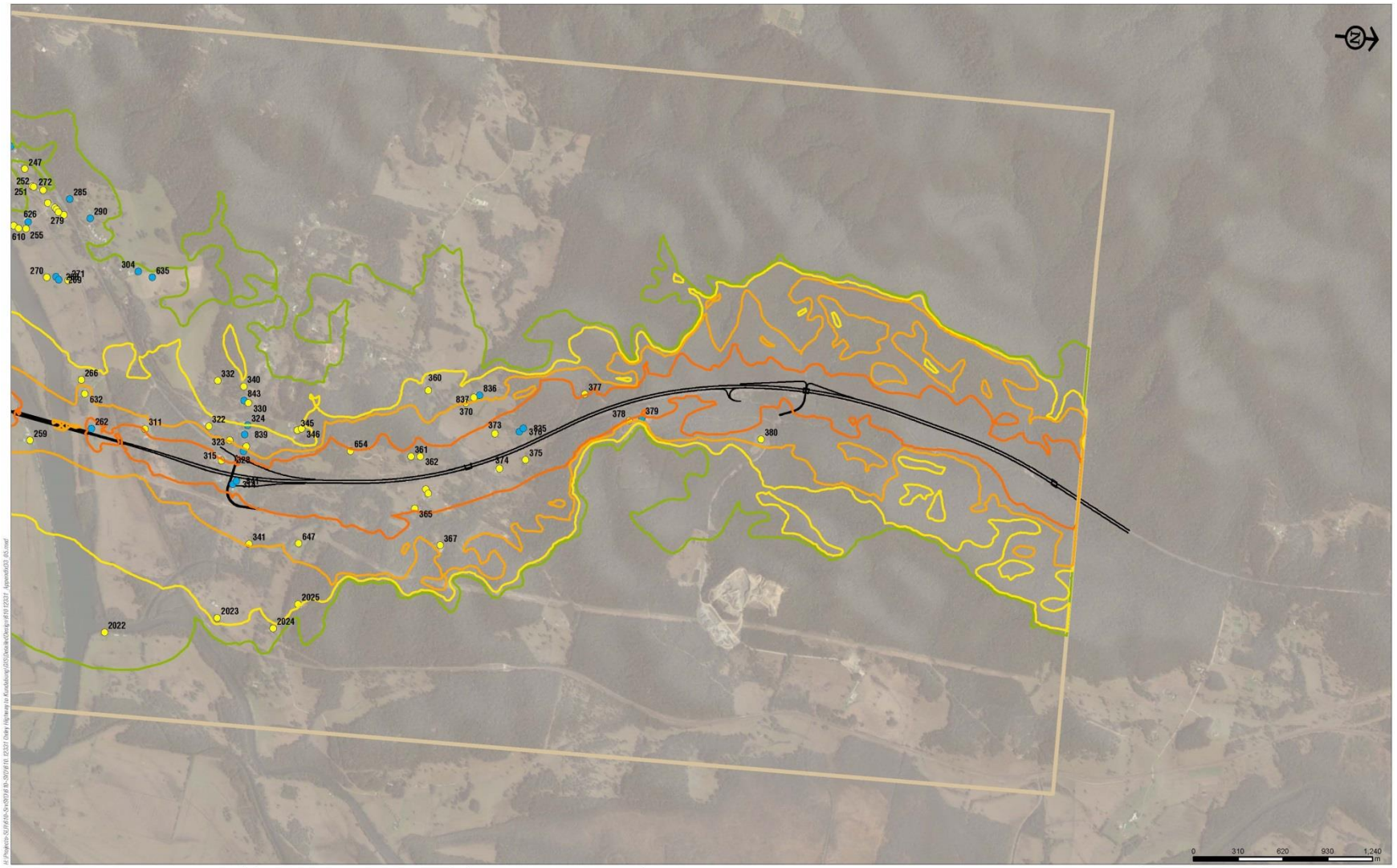
Lend Lease

Oxley Highway to Kundaberg

IFC Design
2026 $L_{Aeq(15hr)}$(Day)
Noise Contours

APPENDIX D3-3

Appendix D 2016 and 2026 Noise Contours



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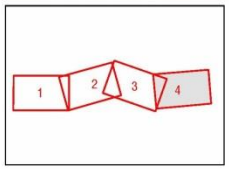

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50 dBA
55 dBA
60 dBA

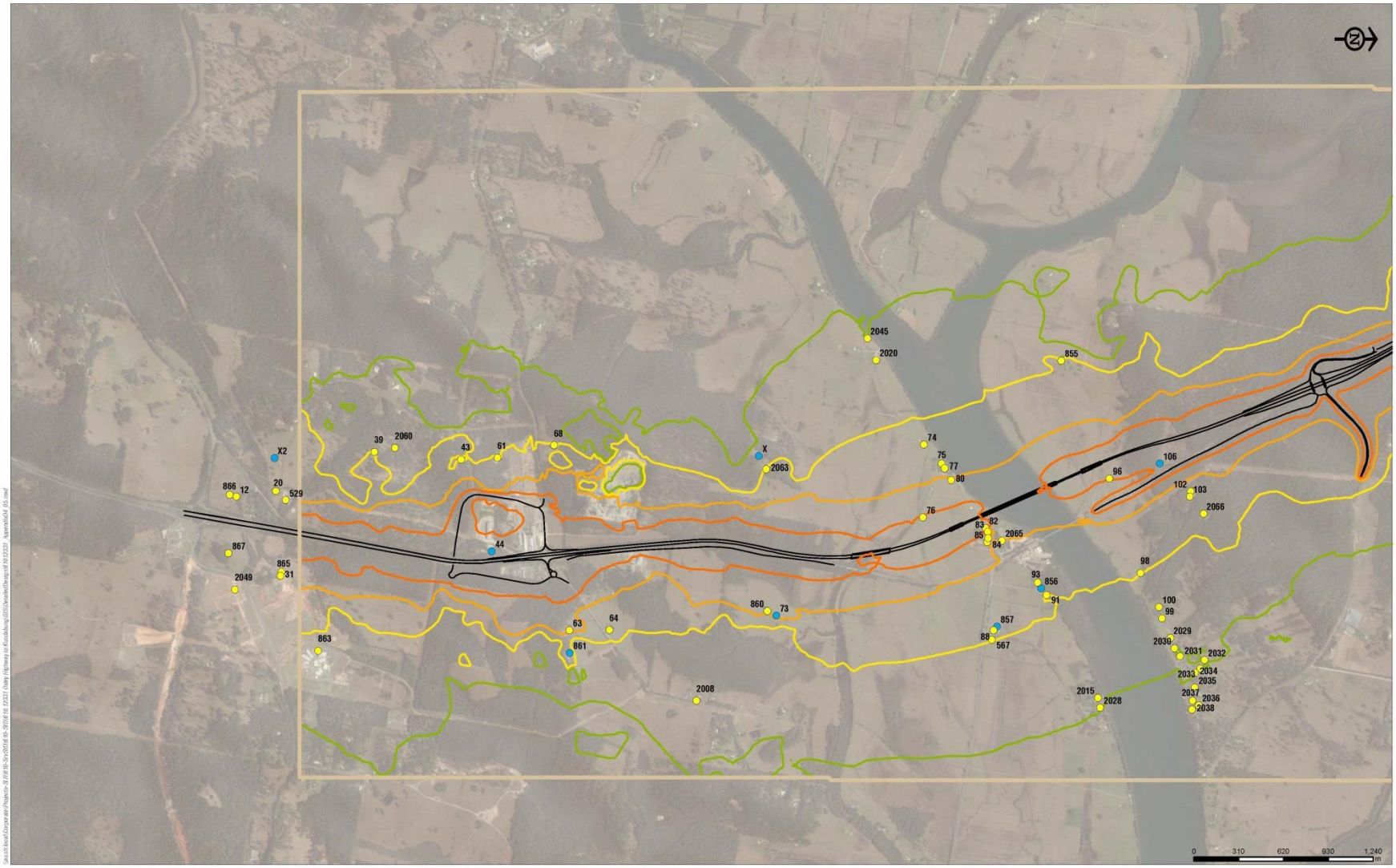
Lend Lease

Oxley Highway to Kundaberg

IFC Design
2026 $L_{Aeq(15hr)}$(Day)
Noise Contours

APPENDIX D3-4

Appendix D 2016 and 2026 Noise Contours



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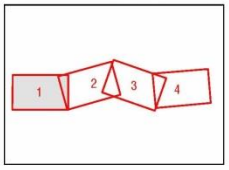

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Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

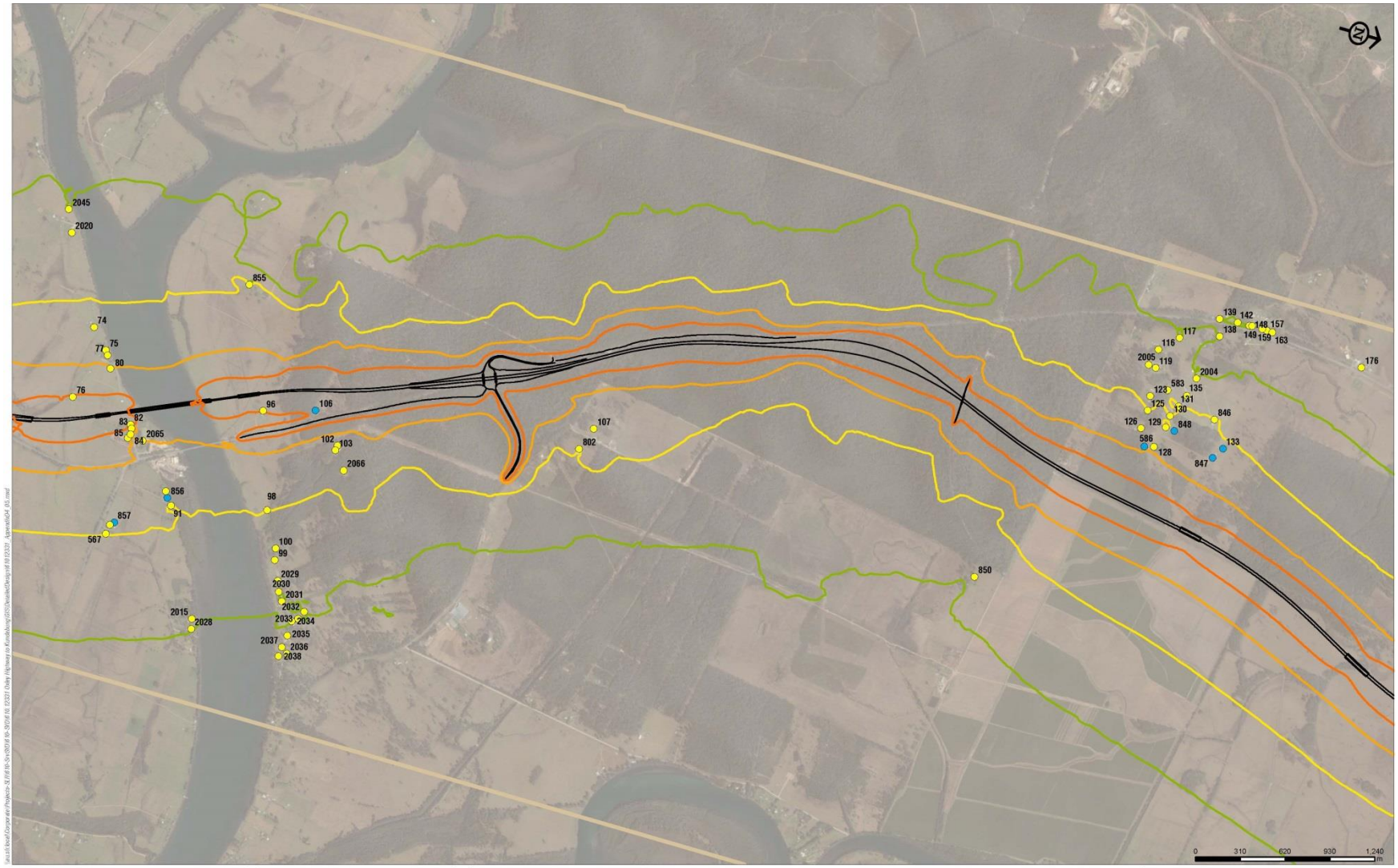
Lend Lease

Oxley Highway to Kundabung

IFC Design
2026 $L_{Aeq(9hr)}$ (Night)
Noise Contours

APPENDIX D4-1

Appendix D 2016 and 2026 Noise Contours



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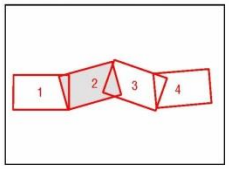

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Non Noise Sensitive Receivers (Garages, sheds etc.)
Proposed Alignment
Noise Calculation Extent

Façade Reflected Night Noise Contours
45 dBA
50 dBA
55 dBA
60 dBA

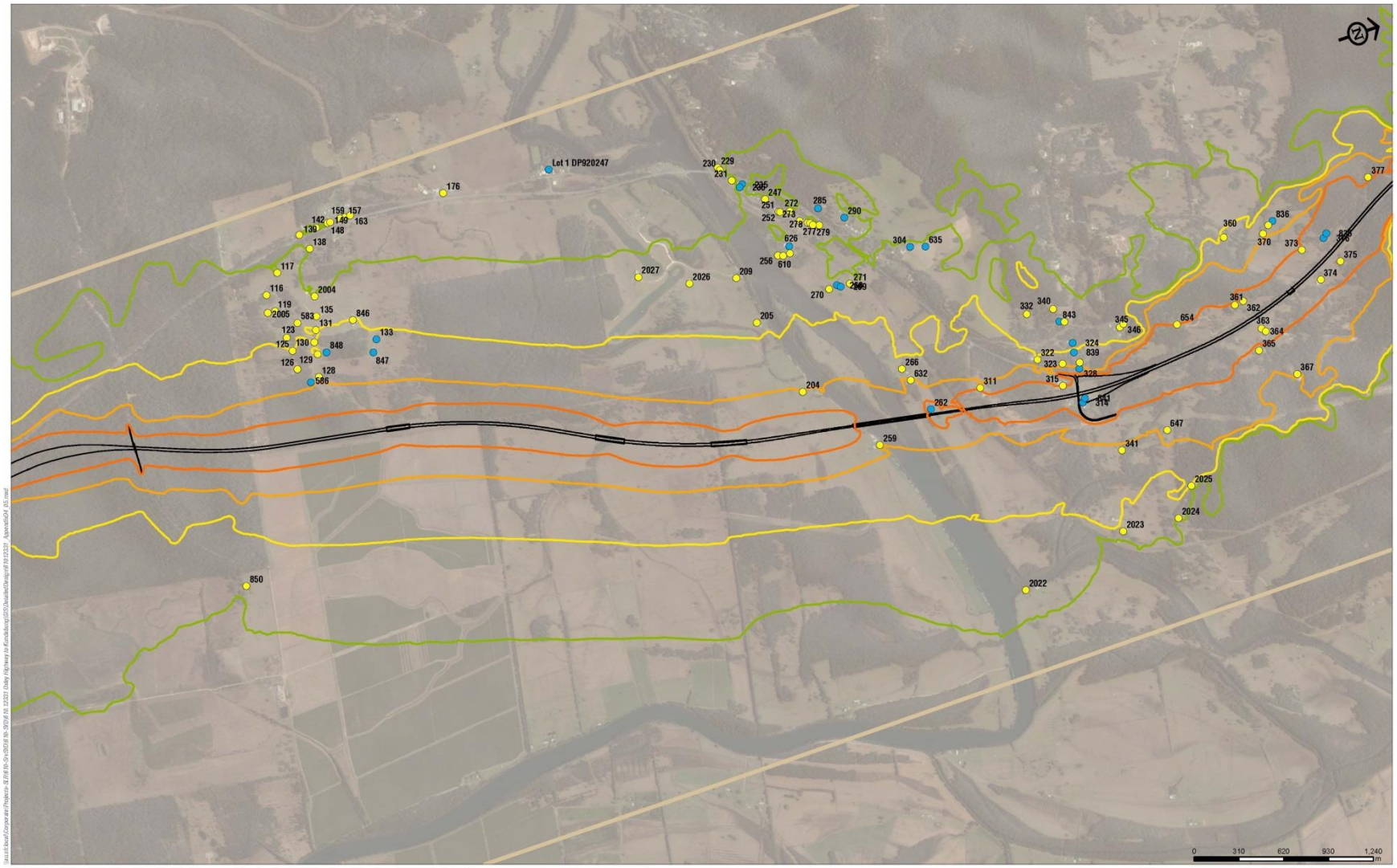
Lend Lease

Oxley Highway to Kundabung

IFC Design
2026 $L_{Aeq(9hr)}$ (Night)
Noise Contours

APPENDIX D4-2

Appendix D 2016 and 2026 Noise Contours



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1 2 3 4

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45 dBA
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55 dBA
60 dBA

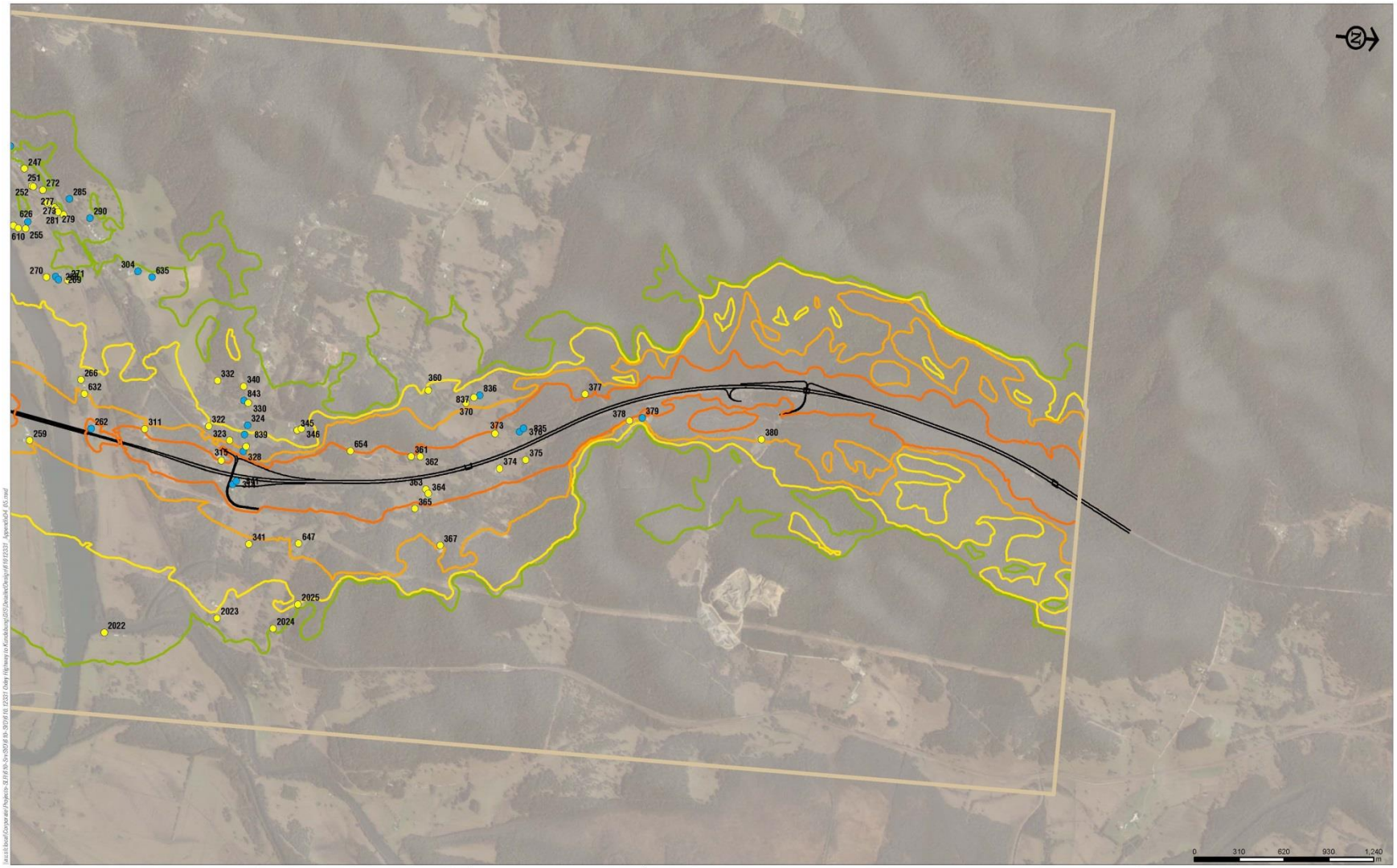
Lend Lease

Oxley Highway to Kundabung

IFC Design
2026 $L_{Aeq(9hr)}$ (Night)
Noise Contours

APPENDIX D4-3

Appendix D 2016 and 2026 Noise Contours



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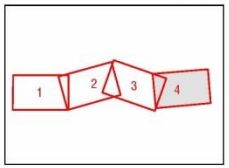

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Oxley Highway to Kundabung

IFC Design
2026 $L_{Aeq(9hr)}$ (Night)
Noise Contours

APPENDIX D4-4

Appendix D 2016 and 2026 Noise Contours

Appendix F ECRTN Assessment

Appendix F ECRTN Assessment

Appendix F ECRTN Assessment

NCA	Receiver ID	2016 Future Existing Noise Level[1,5]		Applicable ECRTN Criteria[2]		Detailed Design Noise Level (dBA)[3,5]				2026 Future Design "Exceedance" at Most Affected Facade (dBA)[4,5]			
						2016 Future		2026 Future Design		Daytime LAeq(15hr)		Night-time LAeq(9hr)	
		Daytime LAeq(15hr)	Night-time LAeq(9hr)	Daytime LAeq(15hr)	Night-time LAeq(9hr)	Daytime LAeq(15hr)	Night-time LAeq(9hr)	Daytime LAeq(15hr)	Night-time LAeq(9hr)	Exceedance [4] (dBA)	Acute?	Exceedance [4] (dBA)	Acute?
11	360	49	47	60	55	52	50	53	51		-		-
11	361	57	55	60	55	63	61	64	62	3.8	-	7.0	Yes
11	362	60	58	60	60	63	61	64	62	4.4	-	2.5	Yes
11	370	52	50	60	55	55	53	56	54		-		-
11	373	59	57	60	59	63	61	65	62	4.5	Yes	3.5	Yes
11	377	54	53	60	55	58	56	59	57		-	2.0	-
11	654	57	56	60	58	62	59	63	60	2.5	-	2.5	Yes
11	837	51	50	60	55	55	53	56	54		-		-
12	363	60	58	60	60	63	61	64	62	3.7	-	1.8	Yes
12	364	60	58	60	60	62	60	63	61	3.4	-	1.5	Yes
12	365	56	55	60	55	59	57	60	58		-	2.8	-
12	367	55	53	60	55	58	55	59	57		-	1.7	-
12	374	60	59	60	61	67	65	68	66	8.2	Yes	5.2	Yes
12	375	59	58	60	60	63	61	64	62	4.1	-	2.0	Yes
12	378	54	53	60	55	58	56	59	57		-	2.0	-
12	380	54	53	60	55	57	55	58	56		-	0.8	-
13	315	47	45	55	50	64	61	65	63	9.9	Yes	13.4	Yes
13	322	51	50	55	50	49	46	50	48		-		-
13	323	47	46	55	50	47	44	48	46		-		-
13	330	51	50	55	50	49	46	50	48		-		-
13	332	50	49	55	50	49	46	50	48		-		-
13	340	51	50	55	50	50	47	51	49		-		-
13	345	51	50	55	50	50	47	51	49		-		-
13	346	51	50	55	50	50	47	51	49		-		-
13	840	49	48	55	50	47	44	48	46		-		-
14	259	48	47	55	50	56	54	56	56	0.8	-	5.8	-
14	341	52	50	55	50	55	53	56	54	1.1	-	4.3	-
14	647	52	50	55	50	56	53	57	55	1.9	-	5.0	-
14	2022	45	43	55	50	47	45	48	47		-		-
14	2023	47	46	55	50	51	48	51	50		-		-
14	2024	47	45	55	50	49	46	50	48		-		-
14	2025	48	47	55	50	51	48	52	50		-		-
15	204	40	39	55	50	56	53	56	56	1.0	-	5.6	-
15	205	46	44	55	50	50	47	50	49		-		-
15	209	49	47	55	50	48	45	48	48		-		-
15	266	40	39	55	50	54	52	54	54		-	4.0	-
15	270	48	47	55	50	48	47	49	49		-		-
15	271	50	48	55	50	48	47	49	49		-		-
15	311	48	47	55	50	59	56	59	58	3.9	-	8.4	-
15	632	43	42	55	50	56	54	56	56	1.1	-	6.0	-
16	176	48	47	55	50	33	30	33	33		-		-
16	229	52	50	55	50	33	30	33	33		-		-
16	230	65	64	65.5	64.5	45	43	45	45		-		-
16	231	58	57	58.5	57.5	45	43	45	45		-		-
16	247	51	50	55	50	46	44	47	46		-		-
16	251	51	50	55	50	46	44	47	46		-		-
16	252	54	53	55	53.5	46	44	46	46		-		-
16	255	48	47	55	50	47	45	48	47		-		-
16	256	48	47	55	50	47	45	48	48		-		-
16	272	57	55	57.5	55.5	46	44	47	47		-		-
16	273	55	54	55	54.5	46	44	47	46		-		-
16	277	50	49	55	50	46	44	47	46		-		-
16	278	54	53	55	53.5	46	44	46	46		-		-
16	279	56	54	56.5	54.5	46	44	47	46		-		-
16	281	58	57	58.5	57.5	46	44	47	46		-		-
16	610	48	47	55	50	47	45	48	48		-		-
16	2026	45	43	55	50	48	45	48	47		-		-
16	2027	44	43	55	50	47	45	47	47		-		-
17	116	48	47	55	50	49	45	48	48		-		-
17	117	51	50	55	50	47	44	47	46		-		-
17	119	47	46	55	50	49	46	49	49		-		-
17	123	44	42	55	50	50	47	50	50		-		-
17	125	42	40	55	50	52	49	52	51		-	1.2	-
17	126	42	40	55	50	53	50	53	52		-	2.5	-
17	128	40	39	55	50	55	52	55	54		-	4.3	-
17	129	42	41	55	50	53	50	52	52		-	2.0	-
17	130	43	42	55	50	52	49	51	51		-	1.1	-
17	131	42	41	55	50	51	48	51	50		-		-
17	135	44	43	55	50	50	47	50	49		-		-
17	138	51	50	55	50	46	43	46	45		-		-
17	139	58	57	58.5	57.5	42	39	42	41		-		-
17	142	49	47	55	50	35	32	35	34		-		-
17	148	58	57	58.5	57.5	43	40	43	42		-		-
17	149	61	59	61.5	59.5	46	43	46	46		-		-
17	157	49	47	55	50	34	31	34	34		-		-
17	159	53	52	55	52.5	38	34	38	37		-		-
17	163	50	48	55	50	34	31	34	33		-		-
17	583	43	41	55	50	50	47	50	49		-		-
17	846	46	44	55	50	50	47	50	50		-		-
17	2004	45	43	55	50	48	45	48	47		-		-
17	2005	43	42	55	50	50	47	49	49		-		-
18	850	43	41	55	50	49	46	49	48		-		-
19	74	50	48	55	50	53	51	54	52		-	2.4	-
19	75	50	48	55	50	53	52	54	53		-	2.9	-
19	76	52	51	55	51.5	61	59	62	60	6.6	-	8.7	Yes
19	77	51	49	55	50	54	53	55	54	0.2	-	4.1	-
19	80	51	50	55	50	56	54	56	55	1.4	-	5.3	-
19	855	48	47	55	50	51	49	52	51		-	0.7	-
19	2020	46	44	55	50	48	46	49	47		-		-
19	2045	45	44	55	50	46	45	48	46		-		-
19	2063	49	47	55	50	51	49	51	50		-	0.5	-
20	82	48	46	55	50	61	60	62	61	7.0	-	11.1	Yes

Appendix F ECRTN Assessment

NCA	Receiver ID	2016 Future Existing Noise Level[1,5]		Applicable ECRTN Criteria[2]		Detailed Design Noise Level (dBA)[3,5]				2026 Future Design "Exceedance" at Most Affected Facade (dBA)[4,5]			
						2016 Future		2026 Future Design		Daytime LAeq(15hr)		Night-time LAeq(9hr)	
		Daytime LAeq(15hr)	Night-time LAeq(9hr)	Daytime LAeq(15hr)	Night-time LAeq(9hr)	Daytime LAeq(15hr)	Night-time LAeq(9hr)	Daytime LAeq(15hr)	Night-time LAeq(9hr)	Exceedance [4] (dBA)	Acute?	Exceedance [4] (dBA)	Acute?
20	83	57	55	57.5	55.5	60	59	61	60	3.9	-	4.9	Yes
20	84	53	51	55	51.5	58	56	59	58	3.7	-	6.2	-
20	85	51	50	55	50	56	55	57	56	2.4	-	6.3	-
20	88	52	50	55	50	50	49	51	50		-		-
20	91	51	50	55	50	49	47	50	48		-		-
20	93	54	52	55	52.5	50	49	51	50		-		-
20	96	51	49	55	50	62	60	62	61	7.1	-	10.8	Yes
20	98	51	49	55	50	51	48	51	50		-		-
20	99	51	49	55	50	49	47	50	49		-		-
20	100	52	50	55	50	50	48	51	49		-		-
20	102	53	51	55	51.5	52	49	53	51		-		-
20	103	49	48	55	50	50	47	50	49		-		-
20	107	52	50	55	50	54	50	54	52		-	2.4	-
20	567	52	51	55	51.5	51	49	52	51		-		-
20	802	53	51	60	55	54	51	55	53		-		-
20	860	55	54	60	55	58	55	58	57		-	1.7	-
20	2015	49	48	55	50	47	46	49	48		-		-
20	2028	49	47	55	50	46	46	48	47		-		-
20	2029	50	48	55	50	48	46	49	47		-		-
20	2030	49	47	55	50	46	45	48	46		-		-
20	2031	50	48	55	50	48	46	49	47		-		-
20	2032	49	47	55	50	47	45	48	46		-		-
20	2033	46	45	55	50	45	43	46	44		-		-
20	2034	34	32	55	50	47	45	48	46		-		-
20	2035	47	46	55	50	45	43	46	45		-		-
20	2036	45	43	55	50	43	41	44	43		-		-
20	2037	47	46	55	50	45	43	46	44		-		-
20	2038	47	45	55	50	44	43	46	44		-		-
20	2065	46	44	55	50	53	52	54	53		-	3.2	-
20	2066	50	49	55	50	51	48	52	50		-		-
21	12	56	55	60	55	60	58	61	59	0.7	-	4.5	-
21	20	55	54	60	55	58	57	59	58		-	2.9	-
21	39	47	46	60	55	50	49	51	50		-		-
21	43	47	46	55	50	52	50	52	51		-	1.0	-
21	61	47	46	55	50	53	52	54	53		-	2.6	-
21	63	53	52	60	55	57	56	57	57		-	1.7	-
21	68	46	45	55	50	52	51	52	51		-	1.1	-
21	529	54	54	60	55	59	57	60	58		-	3.0	-
21	866	56	55	60	55	59	58	60	59		-	3.8	-
21	2060	44	43	60	55	49	47	49	48		-		-
22	31	54	53	60	55	57	56	58	57		-	2.0	-
22	64	51	50	60	55	55	53	55	54		-		-
22	863	48	47	60	55	52	50	52	50		-		-
22	865	56	55	60	55	59	58	60	59		-	3.8	-
22	867	55	54	60	55	59	58	60	59		-	4.2	-
22	2008	47	46	60	55	49	48	49	48		-		-
22	2049	50	49	60	55	54	52	55	53		-		-

The 2016 Future Existing is the "baseline" scenario and is used to determine the existing road traffic noise level in the absence of the project, predicted at the year of opening. This scenario makes use of the existing alignment geometry.
The ECRTN criteria is determined from guidance in ECRTN/ENMM with the category based on SWTC Appendix 4 Tables 4.1 and 4.2.
Where the existing noise level is already above the ECRTN base criteria then the applicable criteria becomes the existing noise level plus the relevant allowance factor.

Note 3 The 2016 Future and 2026 Future Design noise levels are based on the IFC Design of the highway with all noise controls included in the modelling.

Note 4 Highest exceedance around the façades of the dweling over and above the Applicapable ECRTN criteria.

Note 5 Predicted noise levels are shown rounded to an integer, whereas the increases in future traffic noise are presented to one decimal place.

Appendix G Maximum Noise Level Assessment

Appendix G Maximum Noise Level Assessment

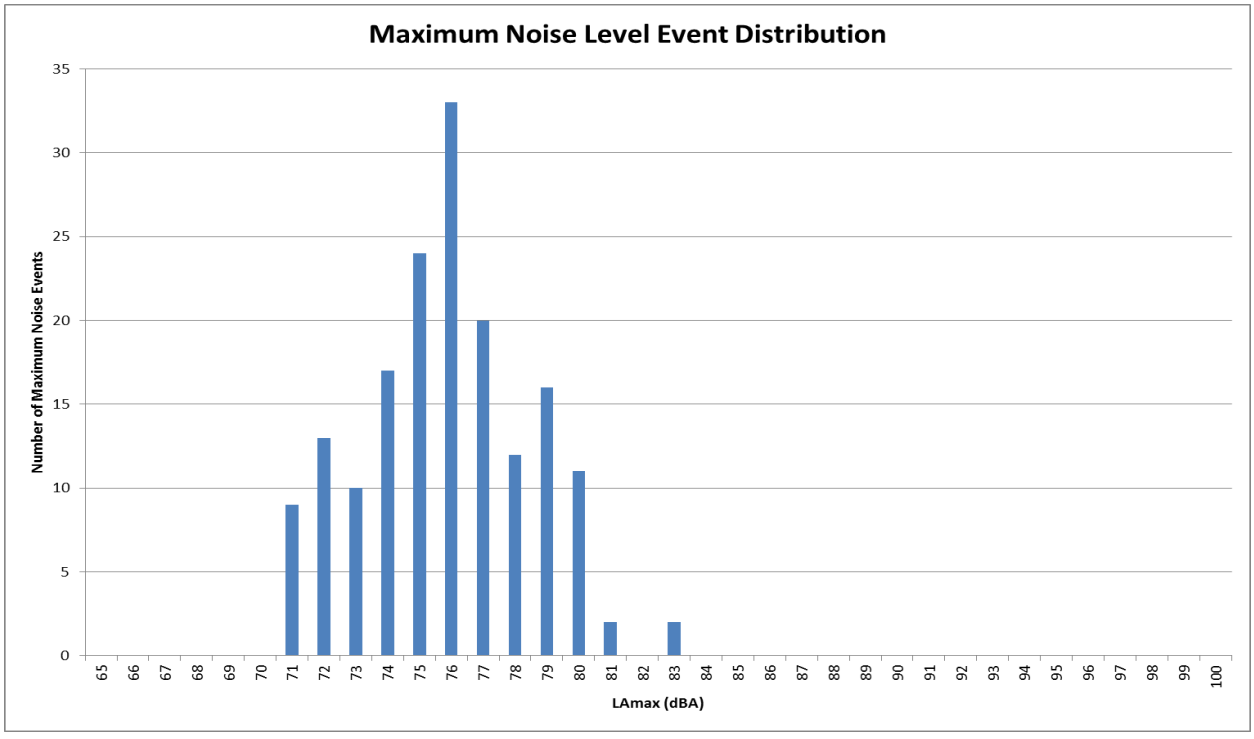
L5 – 8656 Pacific Highway, Telegraph Point

Table 1 L5 Maximum Noise Level Events

Monitoring Date	Number of Maximum Noise Events per Hour (LAmax Noise Levels (dBA))									
	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	22:00-23:00	23:00-00:00	Total/ (Range)
20-May-14	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	-	-	-
21-May-14	-	1 (80)	-	3 (79-81)	1 (80)	-	-	-	1 (83)	6 (79-83)
22-May-14	-	-	-	2 (80-81)	-	-	-	-	-	2 (80-81)
23-May-14	-	-	-	2 (80)	2 (79-80)	-	-	-	1 (83)	5 (79-83)
24-May-14	1 (79)	-	2 (79-80)	7 (76-78)	4 (78)	2 (79)	1 (79)	9 (76-77)	8 (76-79)	34 (76-80)
25-May-14	11 (75-77)	8 (74-76)	12 (71-74)	8 (71-72)	10 (71-74)	5 (72-74)	1 (79)	4 (78-79)	8 (77-79)	67 (71-79)
26-May-14	15 (75-78)	7 (74-80)	15 (74-75)	8 (75-77)	6 (75-77)	-	-	-	-	51 (74-80)
27-May-14	-	-	1 (80)	-	1 (80)	-	-	-	-	2 (80)
28-May-14	-	-	1 (79)	-	-	-	-	-	-	1 (79)
29-May-14	-	-	-	-	1 (79)	-	-	n/a[1]	n/a[1]	1 (79)

Note 1: This period was outside of the period of unattended noise logging.

Figure 2L5 Maximum Noise Level Event Distribution over Monitoring Period



END OF DOCUMENT

OPERATIONAL NOISE MANAGEMENT

NV01

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