Appendix 10

Environmental Noise Impact Assessment

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Proposed Residential Estate Development,
"Riveroaks", Ballina

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

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1.0 INTRODUCTION

This report is submitted in response to a request by Rayshield Pty Ltd, for an environmental noise impact assessment of a proposed residential and childcare centre development in Ballina.

Environmental noise logging was conducted, and through modelling, assessment of road traffic noise impacts upon proposed noise sensitive landuses were produced. Based upon these predicted levels, recommendations regarding acoustic treatment for control of road traffic noise have been provided.

A previous development application has been lodged at the site, with an acoustic assessment conducted by TTM Gold Coast Pty Ltd in December 2001 (attached in the Appendix to this report).

1.1 The Proposal

The proposal is to develop the following:

- 2[illegible]sidential lots across the subject site;
- A childcare centre to the south-eastern corner of the site;
- Sports fields to the southernmost portion of the site.

The Childcare Centre is likely to be accessed off the internal street network, as the Link Road is access controlled.

We are advised that the design level of the entire site is to be RL2.1, with the internal street network at RL 1.8. The Highway and Link Road are assumed to be at RL2.0m, with RL data for the Highway sourced from roundabout designs proposed by Ardill Payne & Partners (attached in the Appendix to this report).

As dwellings do not form part of this application, we have assessed at both ground level and at a likely second floor level, to take into account all possible development within the site.

Rayshield Pty Ltd have commissioned PMM Sydney Pty Ltd to prepare a project application to subdivide land described as Lots 1, 2, 3 and 5 on DP 1074242 and part Lot 269 on DP 755684 for the purpose of residential subdivision and development. The project seeks the Minister of Planning's project approval to subdivide land known as Riveroaks, Pacific Highway, Ballina into 236 residential lots that will potentially provide for up to 269 future dwellings. The project application seeks project approval for the subdivision of land, the provision of roads (including the Link Road), open space, recreational areas, allocated land for a childcare centre and associated infrastructure, including minor land recontouring for drainage purposes.

The subdivision will provide for the future development of a range of housing products, including Detached Homes, Duplexes, Courtyard Housing and Attached Villas. Lots will range in size from between 420 to 800 square meters. Residential lots will have direct access from the street or from access lanes as shown in the proposed plan of subdivision 20997-13I. It is proposed that future buildings will be subject to separate building approvals, however, to ensure a high quality architectural/built form, each proposed residential lot will include a covenant that will require future homes to be constructed in accordance with design guidelines.

The subdivision site will be accessed from the Pacific Highway via the proposed Link Road which is located partially Lot 2 DP 1074242 and Lot 269 DP 755684. The proposed intersection to the Highway is subject to a previous consent DA 2002/566 which was issued by Ballina Shire Council and is not included in this development application. DA 2002/566 approved a road corridor for the proposed Link Road. This application will only deal with the construction of that portion of the Link Road that exists within the aforementioned approved corridor within the deve[illegible]nt site. The details of DA 2002/566 are identified in section '1.4 Site Development History'.

It should be noted that subsequent to DA 2002/566, a further application was approved by Ballina Shire Council to create Lots 1, 2, 3 and 5 on DP 1074242 and Lot 269 on DP 755684. As part of this subdivision, land adjacent to the Pacific Highway was dedicated to the State for the construction of noise attention measures. The construction of the noise attenuation measures will not be included within this development application; however, details of the approved noise attention measures are included to demonstrate that noise impacts from the Highway have been addressed. In addition the Link Road corridor also incorporates noise attention measures to be constructed and those measures are subject to the Part 3A proposal.

The application will include the proposed minor land recontouring to facilitate stormwater drainage and flood management on Lot 2 DP 107424. While filling of Lots 1, 3 and 5 is subject to the previous Council consent DA 2002/566, the proposed drainage infrastructure will address the requirements of Council following finalisation of the Ballina Flood Study 2007. The land recontouring will result in a proposed 30-50 metre wide and approximately 0.8m deep drainage swale that divert storm and flood waters south of the proposed residential subdivision directly into North Creek Canal.

The proposal will seek the dedication of all roads, access lanes, open space, drainage infrastructure and public recreation areas to Ballina Shire Council. The application has sought to address Council's requirements with regard to landscaping, footpaths and road and drainage construction.

The project falls within the Coastal Zone of New South Wales and is required to respond to a range of environmental planning instruments and government policies that seek to protect, enhance and conserve the unique values and features associated with the New South Wales Coast.

The subdivision results in a high quality residential subdivision that maximises sustainable development outcomes through promoting walkability and connectivity to existing surrounding residential development, protects open space and encourages the future development of a range of housing types to enhance the development of distinct and vibrant coastal community.

1.2 Study Site Environs

The site is bounded by the Pacific Highway to the north and north-east, with the proposed Link Road to the eastern boundary.

The Department of Planning has requested an acoustic report to address potential noise impacts and proposed noise mitigation measures for road traffic noise in their letter dated 30/04/[illegible] (DoP reference MP 06_0118). Part 10 of the DoP request relates to noise issues, and is as follows:

> "**10.1** Address potential noise impacts, in particular road traffic noise, for future residents and appropriate mitigation measures"

Attachment 3 of the letter "*State Government technical and policy guidelines*" cites the following standards and guidelines in relation to noise:

- *Environmental criteria for road traffic noise* (EPA, 1999);
- *Acoustics – Road traffic noise intrusion – Building siting and construction* (Standards Australia, 1989, AS3671 – 1989).

2.0 EQUIPMENT

The following equipment was used to record existing noise levels in the locale:

TTM Logger Measurement
The following equipment was used in recording road traffic noise impacts in 2001:

- Rion NC 73 Calibrator;
- ARL EL315 Type II Environmental Noise Logger.

CRG Logger Measurement
The following equipment was used in recording ambient noise levels proximate to the BP Ballina service station across the Highway to the south (at the corner of Southern Cross Drive and the Highway) in 2007:

- Rion NC 73 Calibrator;
- Rion NL-21 Environmental Noise Logger.

3.0 MEASUREMENT PROCEDURE

3.1 Ambient Noise Measurement

TTM Logger Measurement
A logger was located on the subject site (refer to Sketch No. 1 in the appendix to this report), and set to record L_x[1] noise statistics in 15 minute blocks, continually between 11.00 a.m. Friday 13/07/01, to 11.30 am Monday 16/07/01.

The operation of the sound level measuring equipment was field calibrated before and after the measurement session and was found to be within 0.2 dB of the reference signal. All instrumentation used in the assessment held current calibration certificate from a certified NATA calibration laboratory. The measurement was conducted generally in accordance with Australian Standard AS2702 - 1984 '*Acoustics - Methods for the measurement of road traffic noise*'.

Weather conditions during the survey were generally fine, with a temperature range of 6 to 25˚ C.

CRG Logger Measurement
A logger was located on the southern boundary of the BP service station across the Highway from the site (refer to Sketch No. 1 in the appendix to this report), and set to record L_x noise statistics in 15 minute blocks, continually between 3.00 p.m. Thursday 14/09/06, to midday Sunday 17/09/06.

The operation of the sound level measuring equipment was field calibrated before and after the measurement session and was found to be within 0.1 dB of the reference signal. All instrumentation used in the assessment held current calibration certificate from a certified NATA calibration laboratory. The measurement was conducted generally in accordance with Australian Standard AS2702 - 1984 '*Acoustics - Methods for the measurement of road traffic noise*'.

Weather conditions during the survey were generally fine, with a temperature range of 8 to 25˚ C.

[1] L_x Is the generic term for level exceedance statistics, i.e. L_{10}

4.0 NOISE CRITERIA

4.1 Road Traffic Noise

Road noise intruding from external road network
Assessment of potential noise impacts resulting from the increase in road traffic volumes are required to be conducted as per the New South Wales EPA "*Environmental Criteria for Road traffic Noise*", which provides noise limit criteria for residential developments and schools. As the Pacific Highway is deemed a Freeway / Arterial road, the following criteria (re: Table 1, part 2, page 6 of the EPA document), applies to the proposed residential component, with the future Link Road being assessed as per Table 1, part 1, page 6:

TYPE OF DEVELOPMENT	CRITERIA		
	DAY (7 am–10 pm) dB(A)	NIGHT (10 pm–7 am) dB(A)	WHERE CRITERIA ARE ALREADY EXCEEDED
1. New freeway or arterial road corridor	$L_{Aeq(15hr)}$55	$L_{Aeq(9hr)}$50	The new road should be designed so as not to increase existing noise levels by more than 0.5 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In some instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.
2. New residential land use developments affected by freeway/arterial traffic noise	$L_{Aeq(15hr)}$55	$L_{Aeq(9hr)}$50	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria via judicious design and construction of the development. Locations, internal layouts, building materials and construction should be chosen so as to minimise noise impacts.

Table 1: Extract from the New South Wales EPA document "*Environmental Criteria for Road traffic Noise*" relating to residential development adjoining freeways or arterial routes.

Further to the above outdoor criteria, Councils typically accept that for developments that cannot achieve the outdoor criteria at all facades (e.g. at top floor level, above the relative level of the acoustic barriers), indoor criteria taken from AS/NZS 2107:2000 *'Acoustics – Recommended Design Sound Level and Reverberation Times for Building Interiors'* is applied. The noise levels applicable to residential uses in the Standard are as follows:

Type of Occupancy / Activity	**Recommended Design Sound Level, L_{Aeq}, dB(A)**	
7. RESIDENTIAL BUILDINGS	Satisfactory	Maximum
Houses and apartments near major roads –		
Living areas	35	45
Sleeping areas	30	40
Work areas	35	45
Apartment common areas (e.g. foyer, lift lobby)	45	55

Table 2: Extract from Australian Standard AS/NZS 2107:2000 *'Acoustics – Recommended Design Sound Level and Reverberation Times for Building Interiors'*

It is noted that AS/NZS 2107:2000 *'Acoustics – Recommended Design Sound Level and Reverberation Times for Building Interiors'* links directly with *Acoustics – Road traffic noise intrusion – Building siting and construction* (Standards Australia, 1989, AS3671 – 1989) which is cited in the "*State Government technical and policy guidelines*".

The following criteria applies to the proposed Childcare Centre, taking into account the impacts of the future Link Road (the Highway is not assessed, as there is sufficient separation to the Childcare Centre) (re: Table 2, rows 1 and 5, page 10 of the EPA document):

SENSITIVE LAND USE	CRITERIA		
	DAY 7 am–10 pm dB(A)	NIGHT 10 pm–7 am dB(A)	NOISE MITIGATION MEASURES
1. Proposed school classrooms (For existing schools see Technical Note x)	$L_{Aeq(1h)}$ 40 (internal)	-	To achieve internal noise criteria in the short term, the most practicable mitigation measures are often related to building or façade treatments. In the medium to longer term, strategies such as regulation of exhaust noise from in-service vehicles, limitations on exhaust brake use, and restricting access for sensitive areas or during sensitive times to low noise vehicles can be applied to mitigate noise impacts across the road system. Other measures include improved planning, design and construction of sensitive land use developments; reduced new vehicle emission standards; greater use of public transport; and alternative methods of freight haulage. These medium- to long-term strategies apply equally to mitigating internal and external noise levels. Where existing levels of traffic noise exceed the criteria, all feasible and reasonable noise control measures should be evaluated and applied. Where this has been done and the internal or external criteria (as appropriate) cannot be achieved, the proposed road or land use development should be designed so as not to increase existing road traffic noise levels by more than 0.5 dB(A) for new roads and 2 dB(A) for redeveloped roads or land use development with potential to create additional traffic.
2. Hospital wards	$L_{Aeq(1h)}$ 35 (internal)	$L_{Aeq(1h)}$ 35 (internal)	
3. Places of worship	$L_{Aeq(1h)}$ 40 (internal)	$L_{Aeq(1h)}$ 40 (internal)	
4. Active recreation (for example, golf courses)	Collector and local roads: $L_{Aeq(1h)}$ 60 Freeway/ arterial roads: $L_{Aeq(15h)}$ 60	-	
5. Passive recreation and school playgrounds	Collector and local roads: $L_{Aeq(1h)}$ 55 Freeway/ arterial roads: $L_{Aeq(15h)}$ 55	-	

Table 3: Extract from the New South Wales EPA document "*Environmental Criteria for Road traffic Noise*" relating to Childcare Centre development adjoining roadways.

Road noise from additional traffic generated by proposed development

The following criteria applies to the extra traffic generated by the proposed development (re: Table 2, row 7, page 7 of the EPA document):

7. Land use developments with potential to create additional traffic on existing freeways/arterials	$L_{eq(15hr)}$ 60	$L_{eq(9hr)}$ 55	Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.

Table 4: Extract from the New South Wales EPA document "*Environmental Criteria for Road traffic Noise*" relating to landuses generating extra road traffic on public roadways.

5.0 RESULTS & CALCULATIONS

5.1 Measured Levels Logger Survey

TTM Report Data
The following ambient noise levels were recorded by TTM in 2001 at the onsite logger location (approximately 22m from the Highway):

Noise Descriptor	Time Period	Measured Level dB(A)
Road Traffic Noise Level $L_{A\ eq\ 15\ hr}$	7:00am to 10:00pm	62
Road Traffic Noise Level $L_{A\ eq\ 9\ hr}$	10:00pm to 7:00am	59

Table 5: Ambient noise levels recorded by TTM at onsite logger location in 2001

CRG Data
The following ambient noise levels were recorded by CRG in 2006 at the BP Ballina logger location (approximately 15m from the Highway, with a reduced angle of view):

Noise Descriptor	Time Period	Measured Level dB(A)
Road Traffic Noise Level $L_{A\ eq\ 15\ hr}$	7:00am to 10:00pm	65
Road Traffic Noise Level $L_{A\ eq\ 9\ hr}$	10:00pm to 7:00am	63
Road Traffic Noise Level $L_{A\ eq\ 24\ hr}$	Full 24 hour period	65

Table 6: Ambient noise levels recorded by CRG at BP Ballina logger location in 2006

It is noted that the difference between the day and night Leq levels in the two sets of data are within 1 dB of each other, and are deemed as a reliable indicator of the difference in noise levels between the day and night periods.

5.2 Existing and Predicted Traffic Volumes

The Roads and Traffic Authority's publication "Traffic volume data for the Hunter and Northern Regions 2004" indicates a volume of 12,627 vpd. CRG Traffic Engineers estimate a current volume of 13,800 vpd.

Pacific Highway
2004: 12,674 vpd, 6% heavy vehicles;
2007: 13,800vpd, 6% heavy vehicles;
2007: 13,800vpd, 6% heavy vehicles;
2018: 15,500vpd, 6% heavy vehicles;
2025: 16,500vpd, 6% heavy vehicles (re: Ballina Shire Road Network model);

The Year 2025 volumes assume that the Ballina Bypass has been completed, with the year 2018 volume being an interpolation of the data from year 2007 and year 2025.

Link Road
Traffic volumes used in this report are taken from the approved TTM report, who cite Eppell Olsen & Partners Traffic Engineers as the source for traffic volumes on the Link Road.

2010: 9,750vpd, 9% heavy vehicles.
2018: 10,600vpd, 9% heavy vehicles.

The year 2018 traffic volume on the Link Road was based upon the assumption of a 2.9% growth rate on the Link Road from year 2010 data (which is the growth rate on the Highway between 2004 and 2007).

It should be noted that the heavy vehicle percentage is assumed, and is viewed as conservative.

5.3 Existing and Predicted Road Traffic Noise Levels

To verify the road traffic noise prediction model (a package called "PEN3D", which is based upon the CoRTN methodology), the model was set to reflect conditions at the TTM logger location to the south of the subject site. The model was found to be within 0.7 dB of the measured noise level, which is within the ± 2dB margin allowed under the CoRTN methodology.

It should be noted that we have assumed that the lots fronting both the main roads e.g. the Highway and Link Road (e.g. Lots 12 – 19, 28 – 30, 35 – 59, 164 – 173, 198 – 200 and 225 – 231) have the building located towards the main road side of the block, with a private external open space located on the far side of the building from the road (refer to Sketch No. 4 in the Appendix of this report). This design takes advantage of acoustical screening effects of the future building on the Lots, and reduces the required height of the noise barrier.

The receiver locations for the predicted impacts are as follows:

- Ground floor level, façade facing roadway;
- First floor level, façade facing roadway;
- Outdoor private open space at ground level (screened to the roadway by the dwelling for Lots 12 – 19, 28 – 30, 35 – 59, 164 – 173, 198 – 200 and 225 – 231).

The predicted $L_{Aeq,15hr}$ and $L_{Aeq,9hr}$ noise levels at the 3 assessment locations on all Lots are as follows (for calculation sheets of this component of the assessment, refer to the attached sheets in the Appendix to this report).

Receiver	2.5m High Acoustic Barrier: Predicted 2018 Traffic Noise Levels: Façade Corrected, dB(A)					
	Ground Floor Level Façade		First Floor Level Façade		Ground Level Recreation Area	
	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$
Lot 1	53	50	55	52	53	50
Lot 2	52	49	53	50	52	49
Lot 3	52	49	53	50	51	48
Lot 4	51	48	52	49	51	48
Lot 5	51	48	52	49	50	47
Lot 6	51	48	52	49	50	47
Lot 7	51	48	52	49	50	47
Lot 8	51	48	52	49	51	48
Lot 9	52	49	54	51	51	48
Lot 10	52	49	54	51	51	48
Lot 11	52	49	54	51	51	48
Lot 12	57	54	67	64	51	48
Lot 13	57	54	67	64	51	48
Lot 14	57	54	67	64	51	48
Lot 15	57	54	67	64	51	48
Lot 16	57	54	66	63	52	49
Lot 17	57	54	66	63	51	48
Lot 18	57	54	66	63	52	49
Lot 19	57	54	66	63	52	49
Lot 20	53	50	55	52	52	49
Lot 21	52	49	54	51	52	49
Lot 22	52	49	53	50	51	48
Lot 23	52	49	53	50	51	48
Lot 24	52	49	53	50	51	48
Lot 25	52	49	54	51	52	49
Lot 26	53	50	55	52	52	49
Lot 27	53	50	55	52	52	49
Lot 28	55	52	58	55	52	49
Lot 29	58	55	67	64	53	50
Lot 30	56	53	59	56	53	50
Lot 31	53	50	56	53	53	50
Lot 32	53	50	55	52	53	50
Lot 33	53	50	55	52	53	50
Lot 34	53	50	55	52	52	49
Lot 35	54	51	56	53	53	50
Lot 36	54	51	57	54	53	50
Lot 37	54	51	57	54	53	50
Lot 38	55	52	57	54	53	50
Lot 39	56	53	60	57	53	50
Lot 40	59	56	67	64	53	50
Lot 41	58	55	64	61	53	50
Lot 42	57	54	64	61	52	49
Lot 43	57	54	64	61	52	49
Lot 44	57	54	64	61	52	49
Lot 45	57	54	64	61	52	49
Lot 46	57	54	64	61	51	48
Lot 47	57	54	64	61	51	48
Lot 48	57	54	64	61	51	48
Lot 49	57	54	64	61	51	48
Lot 50	57	54	64	61	51	48
Lot 51	57	54	64	61	51	48
Lot 52	57	54	64	61	51	48
Lot 53	57	54	64	61	51	48
Lot 54	57	54	65	62	51	48
Lot 55	57	54	64	61	51	48
Lot 56	57	54	64	61	51	48
Lot 57	56	53	64	61	51	48
Lot 58	57	54	64	61	51	48
Lot 59	57	54	64	61	51	48
Lot 60	53	50	55	52	52	49

Receiver	2.5m High Acoustic Barrier: Predicted 2018 Traffic Noise Levels: Façade Corrected, dB(A)					
	Ground Floor Level Façade		First Floor Level Façade		Ground Level Recreation Area	
	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$
Lot 61	52	49	53	50	52	49
Lot 62	52	49	53	50	51	48
Lot 63	51	48	52	49	50	47
Lot 64	51	48	52	49	50	47
Lot 65	51	48	52	49	50	47
Lot 66	50	47	51	48	50	47
Lot 67	50	47	51	48	50	47
Lot 68	50	47	51	48	50	47
Lot 69	50	47	51	48	49	46
Lot 70	50	47	51	48	49	46
Lot 71	50	47	51	48	49	46
Lot 72	49	46	50	47	49	46
Lot 73	49	46	50	47	49	46
Lot 74	50	47	51	48	49	46
Lot 75	50	47	51	48	50	47
Lot 76	50	47	51	48	50	47
Lot 77	50	47	51	48	50	47
Lot 78	51	48	52	49	50	47
Lot 79	52	49	53	50	51	48
Lot 80	52	49	53	50	52	49
Lot 81	53	50	55	52	52	49
Lot 82	52	49	55	52	52	49
Lot 83	52	49	53	50	51	48
Lot 84	51	48	53	50	51	48
Lot 85	51	48	52	49	51	48
Lot 86	51	48	52	49	50	47
Lot 87	50	47	51	48	50	47
Lot 88	50	47	51	48	50	47
Lot 89	50	47	51	48	50	47
Lot 90	49	46	50	47	49	46
Lot 91	49	46	50	47	49	46
Lot 92	49	46	50	47	49	46
Lot 93	49	46	50	47	48	45
Lot 94	48	45	49	46	48	45
Lot 95	48	45	49	46	48	45
Lot 96	48	45	49	46	48	45
Lot 97	48	45	49	46	48	45
Lot 98	49	46	50	47	49	46
Lot 99	49	46	50	47	49	46
Lot 100	49	46	50	47	49	46
Lot 101	50	47	51	48	50	47
Lot 102	50	47	51	48	50	47
Lot 103	51	48	52	49	50	47
Lot 104	51	48	52	49	51	48
Lot 105	51	48	53	50	51	48
Lot 106	52	49	53	50	51	48
Lot 107	52	49	54	51	52	49
Lot 108	52	49	54	51	52	49
Lot 109	51	48	53	50	51	48
Lot 110	51	48	52	49	51	48
Lot 111	50	47	51	48	50	47
Lot 112	50	47	51	48	49	46
Lot 113	49	46	50	47	49	46
Lot 114	49	46	50	47	49	46
Lot 115	49	46	50	47	49	46
Lot 116	49	46	50	47	49	46
Lot 117	49	46	49	46	48	45
Lot 118	48	45	49	46	48	45
Lot 119	48	45	49	46	48	45
Lot 120	48	45	49	46	48	45

Receiver	2.5m High Acoustic Barrier: Predicted 2018 Traffic Noise Levels: Façade Corrected, dB(A)					
	Ground Floor Level Façade		First Floor Level Façade		Ground Level Recreation Area	
	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$
Lot 121	48	45	49	46	48	45
Lot 122	48	45	49	46	48	45
Lot 123	48	45	49	46	48	45
Lot 124	48	45	49	46	48	45
Lot 125	49	46	50	47	48	45
Lot 126	49	46	50	47	49	46
Lot 127	49	46	50	47	49	46
Lot 128	49	46	50	47	49	46
Lot 129	50	47	51	48	49	46
Lot 130	50	47	51	48	50	47
Lot 131	51	48	52	49	51	48
Lot 132	51	48	53	50	51	48
Lot 133	52	49	55	52	52	49
Lot 134	52	49	55	52	52	49
Lot 135	51	48	53	50	51	48
Lot 136	51	48	52	49	51	48
Lot 137	50	47	51	48	50	47
Lot 138	50	47	51	48	50	47
Lot 139	50	47	51	48	50	47
Lot 140	49	46	51	48	49	46
Lot 141	49	46	50	47	49	46
Lot 142	49	46	50	47	49	46
Lot 143	49	46	50	47	48	45
Lot 144	48	45	49	46	48	45
Lot 145	48	45	49	46	48	45
Lot 146	48	45	49	46	48	45
Lot 147	48	45	49	46	48	45
Lot 148	48	45	49	46	48	45
Lot 149	48	45	49	46	48	45
Lot 150	48	45	49	46	48	45
Lot 151	49	46	50	47	48	45
Lot 152	49	46	50	47	49	46
Lot 153	49	46	50	47	49	46
Lot 154	50	47	51	48	49	46
Lot 155	50	47	51	48	50	47
Lot 156	50	47	52	49	50	47
Lot 157	51	48	53	50	51	48
Lot 158	51	48	53	50	51	48
Lot 159	51	48	53	50	51	48
Lot 160	52	49	56	53	52	49
Lot 161	52	49	55	52	51	48
Lot 162	52	49	55	52	51	48
Lot 163	52	49	55	52	51	48
Lot 164	57	54	63	60	51	48
Lot 165	56	53	63	60	50	47
Lot 166	56	53	62	59	50	47
Lot 167	56	53	62	59	50	47
Lot 168	56	53	62	59	50	47
Lot 169	56	53	63	60	51	48
Lot 170	56	53	63	60	51	48
Lot 171	57	54	63	60	51	48
Lot 172	56	53	63	60	51	48
Lot 173	55	52	61	58	51	48
Lot 174	52	49	57	54	50	47
Lot 175	51	48	56	53	51	48
Lot 176	51	48	53	50	51	48
Lot 177	51	48	53	50	51	48
Lot 178	51	48	52	49	50	47
Lot 179	50	47	52	49	50	47
Lot 180	50	47	51	48	50	47

Receiver	2.5m High Acoustic Barrier: Predicted 2018 Traffic Noise Levels: Façade Corrected, dB(A)					
	Ground Floor Level Façade		First Floor Level Façade		Ground Level Recreation Area	
	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$	$L_{Aeq\ 15\ hr}$	$L_{Aeq\ 9hr}$
Lot 181	49	46	50	47	49	46
Lot 182	49	46	50	47	49	46
Lot 183	48	45	50	47	48	45
Lot 184	48	45	49	46	48	45
Lot 185	48	45	49	46	48	45
Lot 186	48	45	50	47	48	45
Lot 187	49	46	50	47	48	45
Lot 188	49	46	50	47	49	46
Lot 189	49	46	51	48	49	46
Lot 190	49	46	50	47	49	46
Lot 191	50	47	52	49	50	47
Lot 192	50	47	52	49	50	47
Lot 193	51	48	52	49	50	47
Lot 194	51	48	53	50	51	48
Lot 195	51	48	53	50	51	48
Lot 196	51	48	55	52	51	48
Lot 197	53	50	58	55	50	47
Lot 198	54	51	60	57	51	48
Lot 199	56	53	63	60	52	49
Lot 200	55	52	61	58	50	47
Lot 201	52	49	58	55	50	47
Lot 202	51	48	55	52	49	46
Lot 203	51	48	54	51	51	48
Lot 204	51	48	53	50	51	48
Lot 205	51	48	53	50	51	48
Lot 206	51	48	52	49	51	48
Lot 207	51	48	52	49	50	47
Lot 208	50	47	51	48	50	47
Lot 209	50	47	51	48	50	47
Lot 210	49	46	51	48	49	46
Lot 211	49	46	50	47	49	46
Lot 212	49	46	50	47	49	46
Lot 213	48	45	50	47	48	45
Lot 214	49	46	50	47	48	45
Lot 215	49	46	50	47	49	46
Lot 216	49	46	51	48	49	46
Lot 217	50	47	51	48	49	46
Lot 218	50	47	52	49	49	46
Lot 219	51	48	52	49	50	47
Lot 220	51	48	53	50	50	47
Lot 221	51	48	53	50	51	48
Lot 222	51	48	53	50	51	48
Lot 223	52	49	54	51	51	48
Lot 224	52	49	56	53	51	48
Lot 225	55	52	61	58	49	46
Lot 226	55	52	61	58	51	48
Lot 227	55	52	62	59	50	47
Lot 228	56	53	62	59	50	47
Lot 229	56	53	63	60	50	47
Lot 230	56	53	64	61	50	47
Lot 231	57	54	65	62	52	49
Lot 232	53	50	56	53	52	49
Lot 233	52	49	55	52	52	49
Lot 234	53	50	55	52	52	49
Lot 235	52	49	54	51	52	49
Lot 236	52	49	53	50	51	48
Childcare	49	46	N/A	N/A	49	46
Open space	N/A	N/A	N/A	N/A	50	47

Further to the above, the proposed development is predicted to generate 2,275 extra vehicle movements per day on the external road network (this is based upon the Carter Rytenskild Group Traffic Engineering report for this application).

Assuming that all of the site generated traffic use the Highway, the increase in existing road traffic noise levels is predicted to be 0.6dB. Assuming that all of the site generated traffic use the Link Road, the increase in existing road traffic noise levels is predicted to be 0.9dB. These increases are well below the allowable 2 dB rise, as specified under the *Environmental Criteria for Road Traffic Noise*). For calculation sheets of this component of the assessment, refer to the attached sheets in the Appendix to this report.

6.0 RECOMMENDED ACOUSTIC TREATMENTS

6.1 Indicative Acoustic Building Treatment for Control of Road Traffic Noise – Residential Component

Although buildings do not form part of this application, we have analysed a "typical" type dwelling that may be constructed on the noise affected Lots that require further acoustic attenuation (e.g. the Lots fronting the Highway / Link Road and top floor levels of lots setback from the roads– refer to Sketch No. 5 in the Appendix). As a guide, external building shell treatments to the future buildings on the worst affected Lots to achieve acceptable indoor noise levels are as follows (refer to the Appendix to this report for Rw calculation methodology):

Roveroaks	Building Component	Rw	Recommended Acoustic Treatment **Verify with supplier proposed element achieves required Rw**
Space			
Lots Fronting Highway			
Top Floor Level Bedroom	Window	27	6mm glass in a standard frame
Top Floor Level Bedroom	External Walls	35	Standard lightweight construction
Top Floor Level Bedroom	Roof/ceiling	34	Standard pitched roof construction
Ground Floor Level Living	Window	14	Standard construction
Ground Floor Level Living	Sliding door	19	Standard construction
Ground Floor Level Living	External Walls	24	Standard lightweight construction
Ground Floor Level Bedroom	Window	17	Standard construction
Ground Floor Level Bedroom	External Walls	25	Standard lightweight construction
Lots Fronting Link Road			
Top Floor Level Bedroom	Window	29	6.38mm laminate glass in an acoustic grade frame
Top Floor Level Bedroom	External Walls	37	Standard lightweight construction with fibreglass batts in wall void or standard masonry construction
Top Floor Level Bedroom	Roof/ceiling	36	Standard construction with R2 batts in ceiling void
Ground Floor Level Living	Window	14	Standard construction
Ground Floor Level Living	Sliding door	19	Standard construction
Ground Floor Level Living	External Walls	24	Standard lightweight construction
Ground Floor Level Bedroom	Window	17	Standard construction
Ground Floor Level Bedroom	External Walls	25	Standard lightweight construction
Lots Setback from Highway			
Top Floor Level Bedroom	Window	17	Standard construction
Top Floor Level Bedroom	External Walls	25	Standard lightweight construction
Top Floor Level Bedroom	Roof/ceiling	24	Standard pitched roof construction
Lots Setback from Link Road			
Top Floor Level Bedroom	Window	18	Standard construction
Top Floor Level Bedroom	External Walls	26	Standard lightweight construction
Top Floor Level Bedroom	Roof/ceiling	25	Standard pitched roof construction

Table 7: Indicative acoustic building treatments to a "typical" type dwelling for control of road traffic noise impacts

The basic principles to be applied to building design and orientation are as follows:

- Locate a terrace area on the screened side of the future building from the roadway (refer to Sketch No. 4 in the Appendix to this report for terrace location);
- Minimise openings facing the roadways;
- Non habitable spaces are best located on the side of the building facing the roadway;
- Provision for air conditioning or mechanical ventilation to allow occupants to close openings to mitigate road traffic noise intruding inside.

6.2 Acoustic Building Treatment for Control of Road Traffic Noise – Childcare Centre Component

We recommend that the future Childcare Centre be fully assessed for control of noise intrusion to comply with the indoor noise limit criteria of 40 dB(A) $L_{eq\ (1hr)}$ during building design.

6.3 Acoustic Barrier Treatment

We recommend that the acoustic barrier defined in Sketch No. 5 of the appendix be constructed at the site. This barrier may be either a fence type structure, or a combination of an earth mound and fencing.

7.0 DISCUSSION & CONCLUSIONS

The site is adjacent to the Pacific Highway and the proposed Link Road. Both of these major roadways have been assessed in accordance with the requirements of the "*Environmental Criteria for Road Traffic Noise*". It should be noted that we have recommended a barrier height of 2.5m, which is a balance between visual and acoustic impact.

All Lots will have a private external open space area that complies with the criterion, subject to the recommendation in this report being applied to the estate as a whole, and orientation of individual buildings within the road noise affected zone.

The worst affected facades of the worst affected Lots (e.g. the facades facing the road on Lots adjacent to the main road corridors) will be exposed to noise levels above the criteria at ground floor level (an exceedance of up to 2 dB at the Lots fronting the Highway and 3 dB at Lots fronting the Link Road), which we submit is acceptable, as the average person cannot detect less than a 3 dB shift in sound pressure level. To gain strict compliance at the most exposed facades at ground level, a barrier in excess of 3m would be required, which has implications in relation to urban design principles and visual impacts.

As a compromise between the visual impacts and urban planning principles and the requirements for noise intrusion control, we have specified a lower barrier height and recommendations for building orientation and construction.

We have assessed the potential for increased impacts from road traffic resulting from the development, and conclude that the development will increase noise levels by between 0.6 – 0.9 dB, which is below the noise criteria limit of 2 dB as specified in the "*Environmental Criteria for Road Traffic Noise*".

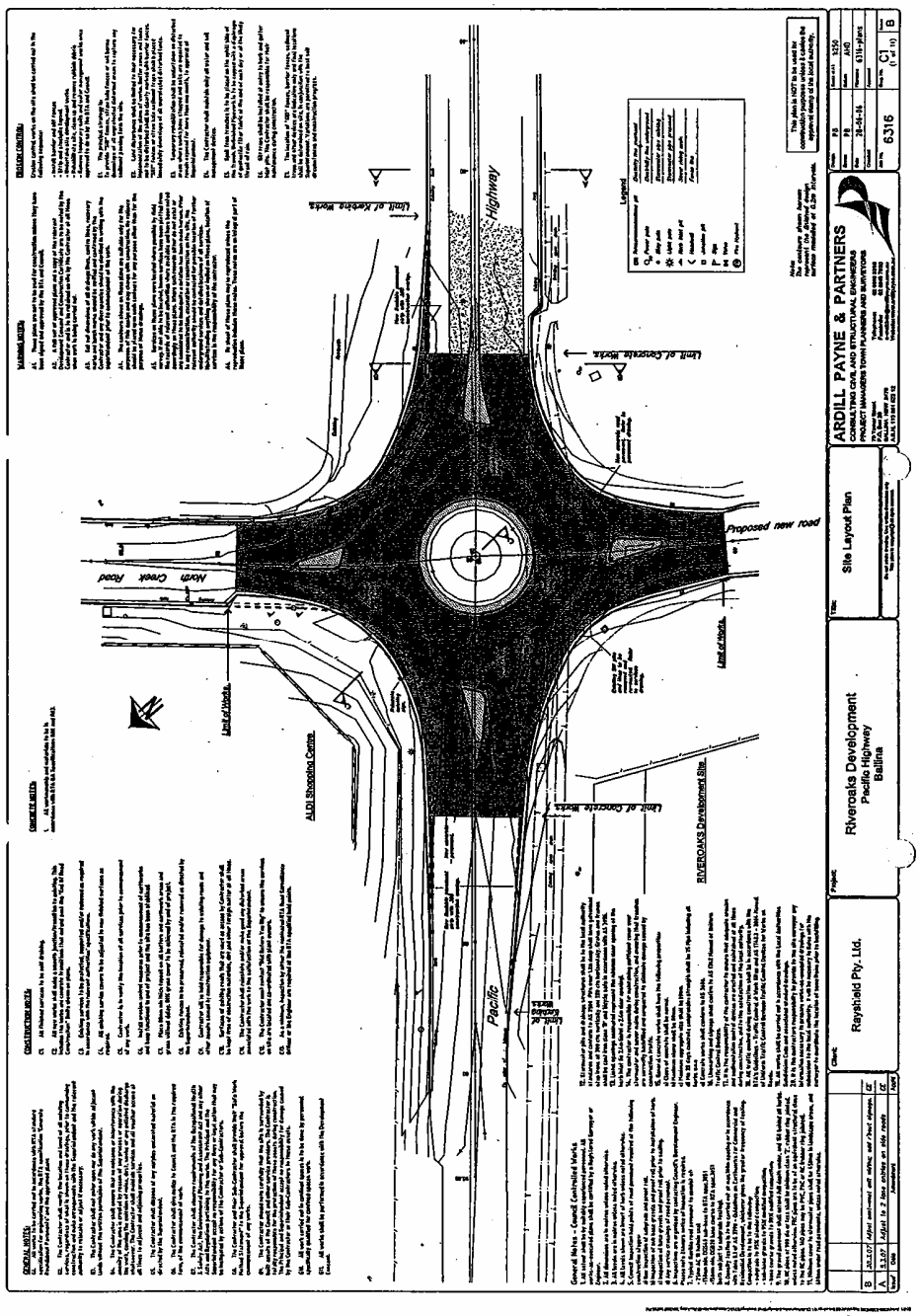
Report Compiled by:

JAY CARTER BSc
Director

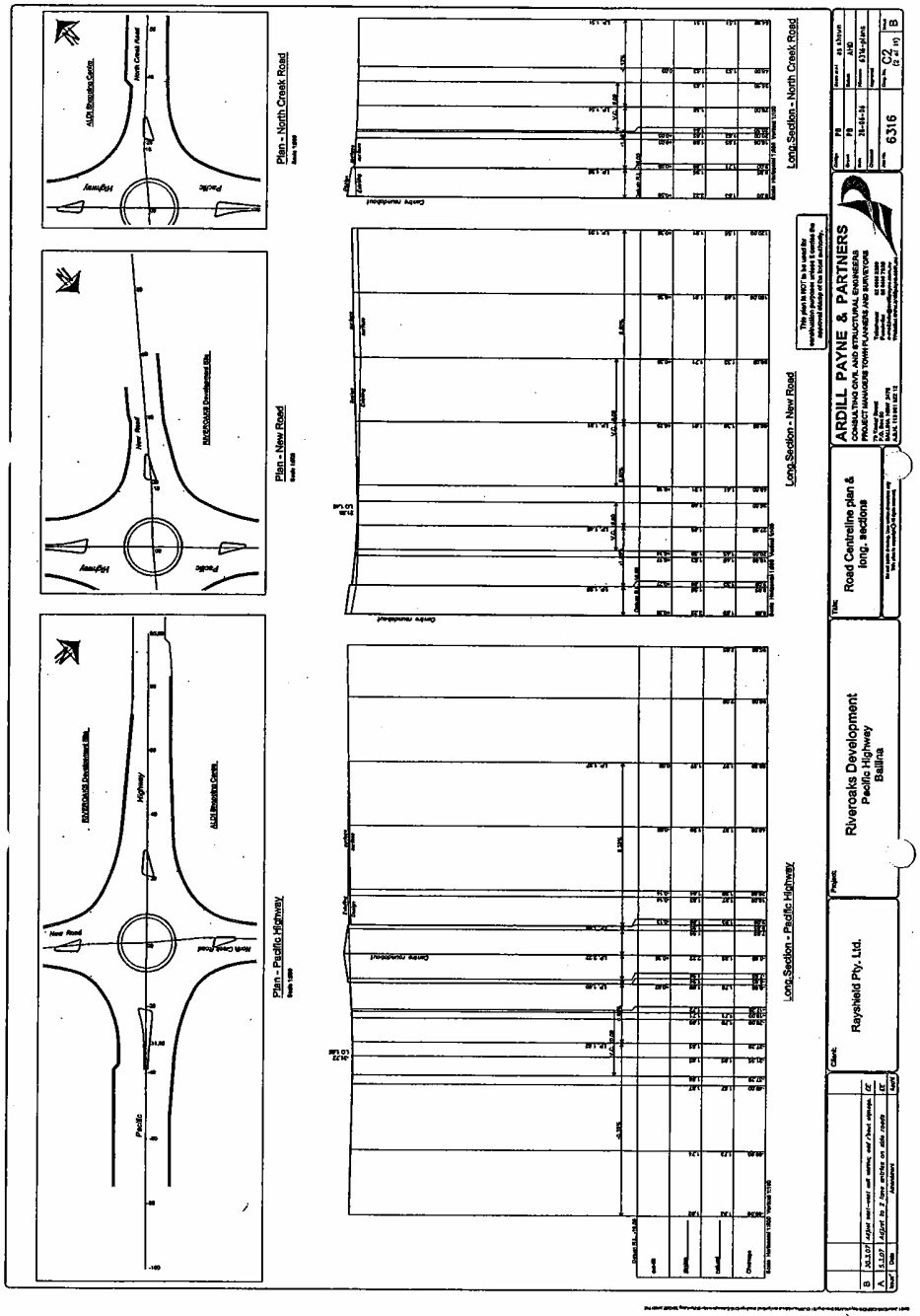
APPENDIX

Sketch No. 1: Subject Site Layout, Logger Location & Locale

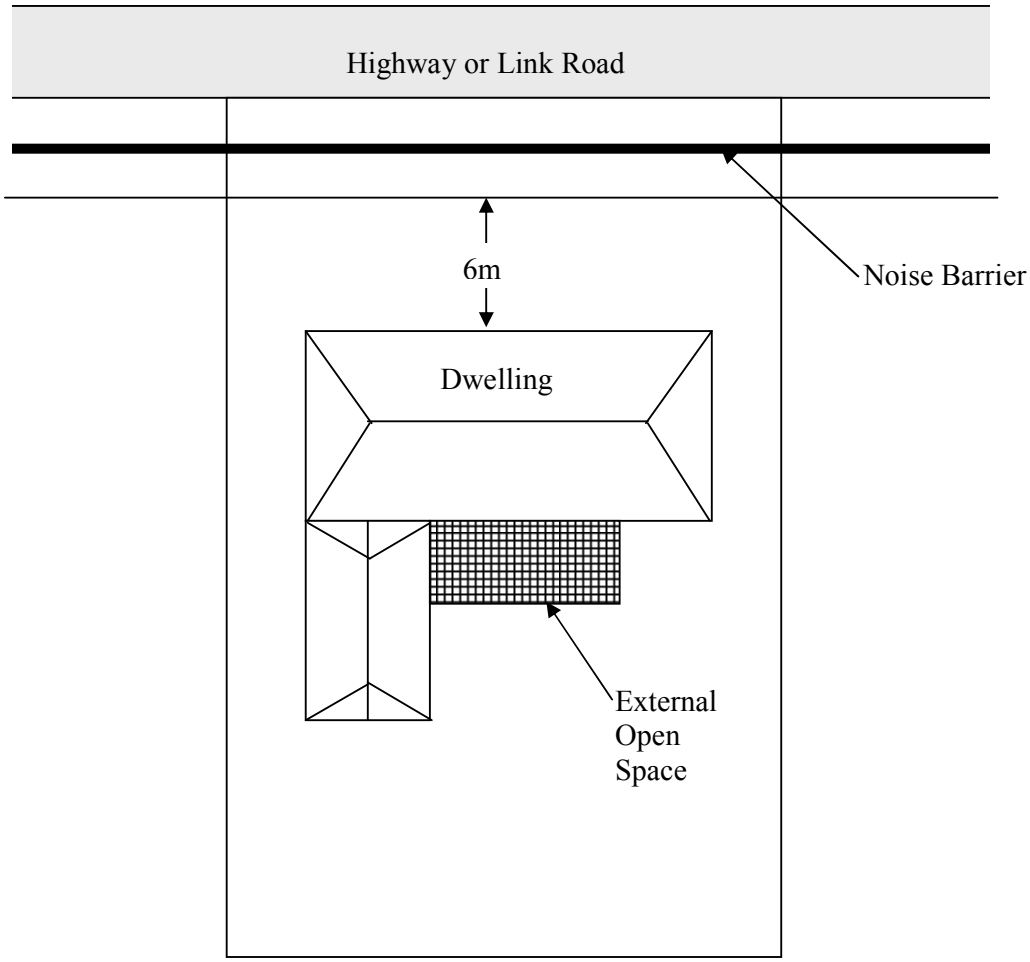
Sketch No. 2 Roundabout Layout and Levels



Sketch No. 3: Roundabout Layout and Levels



Sketch No. 4: Illustration Of Location Of Open Space Areas In Lots Adjacent To The Main Roads



Sketch No. 5: Recommended Acoustic Barriers & Noise Affected Lots Requiring Building Acoustic Design

LEGEND

2.5m high acoustic barrier constructed of a material with a surface mass of greater than 11 kg/m^2. Typical material s include masonry, 7mm FC sheet, 19mm timber palings with 40% overlap, earth mounding, or a combination of the above. Barrier should be free of holes or gaps, with particular care taken at the ground/barrier junction.

Lots requiring building design and construction at ground and top floor levels in accordance with AS 3671 – 1989 '*Road traffic noise intrusion – Building siting and construction*'

Lots requiring building design and construction in accordance with AS 3671 at top floor levels only (if constructed).

POINT CALCULATIONS

Pen3D2000 V1.9.8.1
Project Code:07359a
Project Description:Noise assessment of Riveroaks, Ballina
File:Z:\ACOUSTICS\07359a Riveroaks Estate Ballina\07359_pen\07359_existing.PEN
File Description:Data file covering existing

Thursday 01 Nov, 2007 at 10:02:07

CoRTN Calculations

All road segments included. Segmentation angle: 10degrees. Road elevations apply.

Receptor	X Posn (m)	Y Posn (m)	Height (m)	L10(18hour) (dB(A))
monitor	283.1	882.8	1.3	65.7 free-field

POINT CALCULATIONS

Pen3D2000 V1.9.8.1
Project Code:07359a
Project Description:Noise assessment of Riveroaks, Ballina
File:Z:\ACOUSTICS\07359a Riveroaks Estate Ballina\07359_pen\07359_year 2018 recreation rev.PEN
File Description:Data file covering recreation revised

Thursday 01 Nov, 2007 at 08:58:11

CoRTN Calculations

All road segments included. Segmentation angle: 10degrees. Road elevations apply.

Receptor	X Posn (m)	Y Posn (m)	Height (m)	Leq(9hour) (dB(A))
1	423.9	546.2	1.8	49.6
2	412.0	536.9	1.8	48.9
3	404.0	527.0	1.8	48.6
4	395.3	516.6	1.8	48.0
5	387.8	506.1	1.8	47.6
6	373.9	534.6	1.8	48.1
7	357.6	543.0	1.8	47.9
8	335.4	553.2	1.8	48.1
9	353.9	578.9	1.8	49.1
10	377.7	567.5	1.8	48.8
11	393.4	560.0	1.8	48.8
12	449.6	583.3	1.8	53.9
13	433.5	591.3	1.8	54.1
14	421.0	597.1	1.8	54.0
15	407.4	603.0	1.8	54.1
16	388.1	609.5	1.8	53.7
17	370.8	619.7	1.8	54.1
18	353.0	628.9	1.8	54.3
19	335.5	635.1	1.8	53.9
20	314.1	607.0	1.8	49.6
21	305.4	595.0	1.8	49.3
22	295.6	580.4	1.8	48.9
23	287.6	568.1	1.8	48.5
24	259.3	582.7	1.8	48.9
25	266.2	593.2	1.8	49.1
26	275.5	609.0	1.8	49.7
27	286.1	620.7	1.8	50.4
28	298.0	637.2	1.8	52.0
29	308.7	652.7	1.8	54.9
30	254.1	661.2	1.8	53.0
31	240.2	633.6	1.8	50.4
32	230.1	622.7	1.8	49.9
33	222.7	614.4	1.8	49.9
34	214.5	602.0	1.8	49.7
35	185.8	615.4	1.8	50.7
36	193.4	628.9	1.8	51.0
37	200.7	640.2	1.8	51.2
38	211.4	651.0	1.8	51.5
39	225.1	673.6	1.8	52.7
40	187.9	703.9	1.8	55.7
41	177.5	691.5	1.8	54.7
42	170.8	680.0	1.8	54.2
43	161.1	663.8	1.8	53.9
44	140.6	632.9	1.8	53.6
45	131.4	617.3	1.8	53.7
46	124.9	606.0	1.8	53.7
47	116.3	592.0	1.8	53.7
48	106.5	576.5	1.8	53.8
49	95.4	557.9	1.8	53.7
50	86.8	542.7	1.8	53.7
51	77.9	527.0	1.8	53.6
52	67.0	512.2	1.8	53.8
53	57.9	497.3	1.8	53.7
54	47.7	482.2	1.8	53.8
55	39.0	465.1	1.8	53.6

Receptor	X Posn	Y Posn	Height	Leq(9hour)
56	30.1	450.7	1.8	53.6
57	21.9	434.4	1.8	53.4
58	12.5	419.6	1.8	53.5
59	1.3	400.6	1.8	53.6
60	158.6	573.6	1.8	49.7
61	180.9	562.8	1.8	49.1
62	195.0	558.0	1.8	48.8
63	219.0	519.3	1.8	47.9
64	229.6	535.6	1.8	47.8
65	258.8	523.4	1.8	47.6
66	273.5	513.2	1.8	47.3
67	291.2	505.5	1.8	47.2
68	308.9	499.8	1.8	47.1
69	324.8	491.5	1.8	46.9
70	337.2	485.2	1.8	46.8
71	348.8	479.7	1.8	46.7
72	326.4	459.4	1.8	46.2
73	309.2	467.5	1.8	46.4
74	294.3	475.5	1.8	46.6
75	277.3	483.7	1.8	46.8
76	261.4	492.4	1.8	47.1
77	245.1	499.3	1.8	47.1
78	209.2	503.6	1.8	47.7
79	176.0	528.0	1.8	48.5
80	162.9	533.7	1.8	48.9
81	140.0	543.9	1.8	49.5
82	112.8	499.8	1.8	49.3
83	132.4	491.8	1.8	48.6
84	146.1	486.7	1.8	48.4
85	158.5	480.4	1.8	48.0
86	170.7	474.3	1.8	47.7
87	186.8	467.9	1.8	47.2
88	203.9	459.2	1.8	47.1
89	194.3	443.3	1.8	46.8
90	247.2	434.4	1.8	46.3
91	265.5	429.6	1.8	46.3
92	282.1	422.4	1.8	45.9
93	296.9	413.5	1.8	45.6
94	313.4	404.3	1.8	45.4
95	305.1	387.3	1.8	45.2
96	296.5	372.5	1.8	45.2
97	282.2	381.7	1.8	45.4
98	267.2	392.3	1.8	45.7
99	250.3	398.8	1.8	45.9
100	232.6	411.2	1.8	46.1
101	182.9	422.3	1.8	46.7
102	167.2	433.0	1.8	47.2
103	151.4	440.9	1.8	47.5
104	137.7	446.9	1.8	47.9
105	125.0	452.7	1.8	48.1
106	112.6	459.8	1.8	48.6
107	94.6	469.0	1.8	49.2
108	67.6	426.1	1.8	49.3
109	91.5	417.1	1.8	48.3
110	105.5	411.6	1.8	47.9
111	134.3	379.1	1.8	47.2
112	141.9	392.4	1.8	47.2
113	171.3	379.2	1.8	46.4
114	188.2	371.3	1.8	46.1
115	206.3	365.9	1.8	45.9
116	222.5	358.2	1.8	45.7
117	238.0	348.7	1.8	45.5
118	250.3	344.2	1.8	45.3
119	264.0	337.9	1.8	45.1
120	276.1	331.0	1.8	44.9
121	268.6	314.4	1.8	44.8
122	260.1	298.7	1.8	44.8
123	247.5	304.9	1.8	45.0
124	234.3	310.8	1.8	45.2
125	217.9	319.4	1.8	45.5

Receptor	X Posn	Y Posn	Height	Leq(9hour)
126	203.1	327.7	1.8	45.7
127	185.9	335.0	1.8	46.0
128	169.5	342.7	1.8	46.2
129	154.5	350.9	1.8	46.5
130	124.1	361.5	1.8	47.2
131	88.3	382.8	1.8	47.9
132	73.7	387.8	1.8	48.4
133	50.6	398.2	1.8	49.3
134	27.1	350.9	1.8	49.3
135	52.7	342.2	1.8	48.4
136	65.6	337.8	1.8	48.0
137	96.8	300.7	1.8	47.2
138	103.4	318.7	1.8	47.1
139	131.0	307.5	1.8	46.7
140	148.0	299.9	1.8	46.4
141	165.2	290.8	1.8	46.0
142	182.5	283.5	1.8	45.8
143	198.1	275.6	1.8	45.5
144	214.2	267.6	1.8	45.2
145	227.0	260.3	1.8	45.0
146	241.0	254.8	1.8	44.9
147	236.9	236.8	1.8	44.8
148	231.8	220.5	1.8	44.9
149	219.9	233.2	1.8	45.1
150	206.1	238.6	1.8	45.3
151	189.6	246.9	1.8	45.6
152	172.5	253.6	1.8	45.8
153	156.1	259.8	1.8	46.1
154	139.2	269.4	1.8	46.5
155	122.9	276.1	1.8	46.8
156	92.4	282.5	1.8	47.2
157	50.3	310.0	1.8	48.2
158	43.6	294.0	1.8	48.3
159	39.4	276.5	1.8	48.3
160	9.0	279.0	1.8	49.4
161	13.1	300.2	1.8	49.3
162	17.9	312.6	1.8	49.2
163	21.9	327.4	1.8	49.2
164	-7.9	379.7	1.8	53.5
165	-11.4	365.4	1.8	53.1
166	-14.9	352.2	1.8	52.9
167	-19.8	337.2	1.8	52.9
168	-24.8	319.3	1.8	52.9
169	-32.7	300.4	1.8	53.4
170	-34.2	279.9	1.8	53.2
171	-36.2	262.4	1.8	53.5
172	-33.9	239.7	1.8	53.3
173	-22.7	217.3	1.8	51.9
174	0.9	217.3	1.8	49.2
175	18.5	218.6	1.8	48.4
176	35.8	219.2	1.8	48.2
177	53.2	219.2	1.8	47.9
178	73.0	220.2	1.8	47.6
179	90.1	221.0	1.8	47.3
180	109.4	223.3	1.8	47.0
181	156.3	204.5	1.8	46.1
182	185.4	187.9	1.8	45.6
183	199.7	181.3	1.8	45.3
184	217.7	172.1	1.8	45.0
185	211.4	155.3	1.8	45.2
186	206.4	139.2	1.8	45.3
187	190.6	147.2	1.8	45.6
188	174.3	156.9	1.8	45.9
189	145.5	166.1	1.8	46.4
190	150.2	185.5	1.8	46.3
191	105.1	206.1	1.8	47.2
192	100.6	184.6	1.8	47.4
193	81.5	197.3	1.8	47.6
194	62.8	196.0	1.8	47.9
195	44.7	195.0	1.8	48.2

Receptor	X Posn	Y Posn	Height	Leq(9hour)
196	28.2	196.1	1.8	48.2
197	9.7	185.6	1.8	49.5
198	-6.3	183.7	1.8	51.1
199	-26.6	185.2	1.8	53.2
200	3.1	139.2	1.8	51.8
201	24.3	139.2	1.8	49.0
202	43.0	140.3	1.8	48.1
203	61.6	144.4	1.8	48.0
204	78.4	140.5	1.8	47.9
205	91.5	135.5	1.8	47.9
206	103.5	131.4	1.8	47.8
207	115.8	122.2	1.8	47.5
208	131.7	115.1	1.8	47.0
209	147.3	104.9	1.8	46.7
210	162.8	98.8	1.8	46.4
211	180.5	90.2	1.8	46.0
212	193.2	83.6	1.8	45.8
213	206.3	81.8	1.8	45.4
214	207.2	53.4	1.8	45.5
215	191.0	55.4	1.8	45.9
216	176.6	59.3	1.8	46.3
217	161.5	66.9	1.8	46.6
218	144.6	74.9	1.8	47.1
219	127.8	81.9	1.8	47.5
220	111.9	89.7	1.8	47.9
221	95.5	98.3	1.8	48.3
222	80.2	105.6	1.8	48.4
223	64.0	111.1	1.8	48.6
224	45.9	113.5	1.8	49.0
225	9.8	120.6	1.8	51.8
226	11.4	101.7	1.8	52.1
227	13.0	84.6	1.8	52.4
228	14.5	66.2	1.8	52.6
229	14.6	47.7	1.8	52.9
230	14.7	31.9	1.8	53.2
231	14.3	12.9	1.8	53.5
232	58.0	38.7	1.8	49.7
233	59.6	68.7	1.8	49.2
234	78.4	33.2	1.8	49.8
235	83.9	56.5	1.8	49.1
236	107.1	34.9	1.8	48.7
1	435.8	534.8	1.5	49.6
2	427.6	524.3	1.5	48.8
3	419.0	514.7	1.5	48.2
4	411.1	505.3	1.5	47.6
5	404.5	494.6	1.5	47.2
6	367.8	510.9	1.5	47.3
7	349.7	518.0	1.5	47.3
8	332.4	527.1	1.5	47.5
9	347.2	553.5	1.5	47.9
10	367.4	544.7	1.5	48.0
11	384.8	536.3	1.5	48.1
12	450.3	567.7	1.5	47.6
13	431.2	575.8	1.5	47.6
14	419.7	582.0	1.5	47.7
15	407.0	587.1	1.5	47.5
16	389.3	593.3	1.5	48.9
17	369.9	604.2	1.5	48.3
18	353.1	614.0	1.5	48.7
19	333.8	619.2	1.5	48.9
20	312.7	599.0	1.5	49.1
21	301.1	586.0	1.5	48.7
22	292.7	572.8	1.5	48.4
23	281.4	557.0	1.5	48.1
24	274.1	561.6	1.5	48.1
25	285.5	578.3	1.5	48.6
26	294.8	591.0	1.5	49.0
27	305.1	606.6	1.5	49.2
28	313.6	620.2	1.5	48.9
29	315.8	637.5	1.5	50.3
30	263.8	638.4	1.5	49.7

Receptor	X Posn	Y Posn	Height	Leq(9hour)
31	240.2	633.6	1.5	50.1
32	228.2	620.3	1.5	49.8
33	219.7	609.9	1.5	49.7
34	209.5	592.4	1.5	49.2
35	203.4	597.8	1.5	49.7
36	214.7	612.9	1.5	49.9
37	221.9	624.9	1.5	50.0
38	230.8	638.6	1.5	50.1
39	240.6	654.3	1.5	50.1
40	197.7	691.7	1.5	50.3
41	187.9	677.4	1.5	50.2
42	181.2	666.6	1.5	49.4
43	172.2	651.2	1.5	49.1
44	152.0	625.2	1.5	48.6
45	144.9	611.3	1.5	48.6
46	137.3	600.2	1.5	48.1
47	130.8	585.6	1.5	48.4
48	121.4	568.6	1.5	48.2
49	109.2	551.3	1.5	48.2
50	99.3	535.4	1.5	47.6
51	90.6	520.6	1.5	47.7
52	81.2	508.5	1.5	47.7
53	70.4	492.1	1.5	47.8
54	62.4	475.0	1.5	47.9
55	51.7	459.6	1.5	47.6
56	44.5	442.8	1.5	47.9
57	35.0	428.0	1.5	47.6
58	26.5	413.2	1.5	48.2
59	16.7	396.0	1.5	47.8
60	168.4	553.9	1.5	49.0
61	175.0	542.1	1.5	48.7
62	184.9	537.4	1.5	48.4
63	240.4	505.9	1.5	47.1
64	250.8	520.8	1.5	47.4
65	254.5	503.7	1.5	47.1
66	270.4	494.8	1.5	47.0
67	286.9	486.6	1.5	46.6
68	303.4	478.7	1.5	46.5
69	317.3	471.6	1.5	46.4
70	329.6	465.8	1.5	46.1
71	341.7	459.7	1.5	46.0
72	333.8	456.0	1.5	46.0
73	316.3	464.8	1.5	46.2
74	300.5	472.7	1.5	46.4
75	285.3	479.9	1.5	46.6
76	267.8	487.5	1.5	46.9
77	252.4	495.8	1.5	47.1
78	231.7	487.7	1.5	47.0
79	188.2	523.9	1.5	48.0
80	169.0	533.3	1.5	48.6
81	153.6	541.4	1.5	48.9
82	116.3	482.0	1.5	48.7
83	127.9	474.0	1.5	48.2
84	139.7	467.2	1.5	48.1
85	154.0	462.6	1.5	47.7
86	168.7	455.0	1.5	47.3
87	182.0	448.5	1.5	46.8
88	204.0	451.1	1.5	46.9
89	193.1	437.6	1.5	46.6
90	251.5	423.0	1.5	46.1
91	263.7	411.0	1.5	45.8
92	277.5	402.3	1.5	45.6
93	293.7	393.2	1.5	45.3
94	311.0	399.8	1.5	45.2
95	303.9	383.3	1.5	45.1
96	296.0	367.9	1.5	45.0
97	290.0	388.2	1.5	45.2
98	275.3	395.1	1.5	45.5
99	258.8	403.0	1.5	45.7
100	241.8	410.4	1.5	45.8

Receptor	X Posn	Y Posn	Height	Leq(9hour)
101	182.1	417.5	1.5	46.5
102	179.0	439.6	1.5	46.8
103	162.9	448.3	1.5	47.3
104	148.0	454.7	1.5	47.7
105	136.0	461.1	1.5	48.0
106	123.2	467.0	1.5	48.2
107	107.7	476.0	1.5	48.8
108	77.3	413.3	1.5	48.5
109	90.4	403.4	1.5	48.0
110	106.3	396.3	1.5	47.6
111	156.3	368.0	1.5	46.6
112	164.3	381.8	1.5	46.4
113	173.4	365.0	1.5	46.2
114	188.3	355.9	1.5	45.9
115	204.3	348.3	1.5	45.8
116	218.8	340.2	1.5	45.5
117	234.5	332.8	1.5	45.3
118	247.6	327.1	1.5	45.1
119	260.8	321.5	1.5	44.9
120	275.8	324.7	1.5	44.7
121	269.3	310.4	1.5	44.7
122	258.9	292.6	1.5	44.7
123	257.5	313.5	1.5	44.8
124	245.6	320.3	1.5	45.1
125	231.3	326.2	1.5	45.3
126	214.7	334.8	1.5	45.5
127	195.7	342.3	1.5	45.9
128	180.9	350.7	1.5	46.0
129	166.8	357.6	1.5	46.2
130	145.3	360.6	1.5	46.7
131	103.5	387.3	1.5	47.5
132	86.3	396.7	1.5	48.0
133	68.3	403.4	1.5	48.6
134	35.6	334.7	1.5	48.6
135	51.5	326.4	1.5	48.1
136	70.5	318.0	1.5	47.6
137	119.5	291.3	1.5	46.7
138	119.2	306.9	1.5	46.8
139	134.6	288.2	1.5	46.5
140	150.0	280.1	1.5	46.1
141	165.2	272.1	1.5	45.9
142	181.8	263.1	1.5	45.6
143	199.6	255.8	1.5	45.3
144	213.3	248.5	1.5	45.1
145	225.3	243.7	1.5	44.9
146	239.9	246.4	1.5	44.7
147	235.6	229.8	1.5	44.8
148	230.7	213.6	1.5	44.7
149	223.7	233.3	1.5	44.9
150	210.8	238.8	1.5	45.1
151	197.8	246.7	1.5	45.3
152	180.7	253.6	1.5	45.6
153	164.7	261.4	1.5	45.9
154	147.4	270.1	1.5	46.2
155	129.9	278.0	1.5	46.6
156	113.3	272.3	1.5	46.8
157	52.8	312.3	1.5	48.0
158	45.5	290.2	1.5	48.0
159	39.1	271.2	1.5	48.2
160	28.1	275.9	1.5	48.5
161	37.0	292.8	1.5	48.3
162	41.8	304.0	1.5	48.1
163	44.6	318.4	1.5	48.2
164	7.3	376.3	1.5	48.2
165	2.9	363.5	1.5	47.4
166	-0.0	348.5	1.5	47.3
167	-4.6	334.0	1.5	47.1
168	-8.9	317.3	1.5	47.2
169	-16.1	300.1	1.5	48.3
170	-19.1	282.3	1.5	48.2

Receptor	X Posn	Y Posn	Height	Leq(9hour)
171	-19.6	263.8	1.5	48.0
172	-19.2	242.7	1.5	48.2
173	-9.5	232.0	1.5	48.1
174	9.4	234.4	1.5	47.4
175	26.0	219.0	1.5	48.1
176	43.7	218.6	1.5	47.9
177	60.6	217.8	1.5	47.5
178	78.9	217.7	1.5	47.4
179	96.3	218.5	1.5	47.1
180	112.9	225.1	1.5	46.8
181	177.5	194.2	1.5	45.6
182	185.0	172.9	1.5	45.5
183	201.1	165.6	1.5	45.2
184	217.6	168.0	1.5	44.9
185	212.9	152.2	1.5	45.0
186	206.7	134.5	1.5	45.1
187	198.6	156.6	1.5	45.2
188	182.9	164.0	1.5	45.6
189	167.8	157.4	1.5	45.8
190	171.8	174.9	1.5	45.7
191	108.6	205.8	1.5	47.0
192	103.0	186.2	1.5	47.2
193	89.9	210.2	1.5	47.2
194	70.0	208.9	1.5	47.6
195	50.1	208.5	1.5	47.8
196	33.8	208.1	1.5	48.1
197	18.8	189.4	1.5	46.9
198	2.7	188.6	1.5	47.9
199	-16.7	189.8	1.5	49.3
200	17.0	151.2	1.5	47.4
201	33.1	155.5	1.5	46.5
202	52.3	154.1	1.5	45.8
203	65.4	140.7	1.5	47.8
204	79.7	136.1	1.5	47.7
205	90.5	129.9	1.5	47.8
206	102.2	123.1	1.5	47.7
207	115.9	117.7	1.5	47.3
208	132.5	108.7	1.5	46.8
209	149.0	100.4	1.5	46.5
210	165.2	93.0	1.5	46.2
211	182.0	86.7	1.5	45.8
212	195.0	79.3	1.5	45.5
213	205.8	76.0	1.5	45.2
214	209.5	56.0	1.5	45.2
215	198.1	66.6	1.5	45.5
216	187.5	72.4	1.5	45.7
217	173.5	79.2	1.5	46.0
218	156.0	87.6	1.5	46.4
219	141.3	94.5	1.5	46.8
220	123.9	101.8	1.5	47.1
221	110.1	109.6	1.5	47.5
222	92.5	116.7	1.5	47.9
223	73.2	123.0	1.5	48.1
224	51.8	125.8	1.5	48.4
225	25.9	122.5	1.5	46.3
226	28.3	105.8	1.5	47.6
227	28.7	87.1	1.5	46.5
228	29.5	68.8	1.5	46.5
229	31.0	50.5	1.5	47.2
230	31.1	31.2	1.5	47.2
231	32.3	14.9	1.5	48.7
232	72.0	44.1	1.5	49.4
233	79.7	65.6	1.5	48.9
234	91.9	38.2	1.5	48.9
235	92.2	46.8	1.5	48.9
236	109.8	41.3	1.5	48.2
childcare	346.3	446.4	1.8	45.9
childcare	351.0	453.0	1.5	45.9
open space	166.3	16.3	1.5	46.5

Receptor	X Posn (m)	Y Posn (m)	Height (m)	Leq(9hour) (dB(A))
1	423.9	546.2	4.6	51.8
2	412.0	536.9	4.6	50.4
3	404.0	527.0	4.6	50.0
4	395.3	516.6	4.6	49.3
5	387.8	506.1	4.6	48.8
6	373.9	534.6	4.6	49.4
7	357.6	543.0	4.6	49.2
8	335.4	553.2	4.6	49.3
9	353.9	578.9	4.6	50.9
10	377.7	567.5	4.6	50.6
11	393.4	560.0	4.6	50.8
12	449.6	583.3	4.6	63.6
13	433.5	591.3	4.6	63.9
14	421.0	597.1	4.6	63.6
15	407.4	603.0	4.6	63.6
16	388.1	609.5	4.6	62.8
17	370.8	619.7	4.6	63.2
18	353.0	628.9	4.6	63.4
19	335.5	635.1	4.6	62.8
20	314.1	607.0	4.6	51.9
21	305.4	595.0	4.6	51.1
22	295.6	580.4	4.6	50.3
23	287.6	568.1	4.6	49.8
24	259.3	582.7	4.6	50.4
25	266.2	593.2	4.6	50.8
26	275.5	609.0	4.6	51.5
27	286.1	620.7	4.6	52.4
28	298.0	637.2	4.6	55.0
29	308.7	652.7	4.6	64.2
30	254.1	661.2	4.6	56.3
31	240.2	633.6	4.6	53.0
32	230.1	622.7	4.6	52.3
33	222.7	614.4	4.6	52.1
34	214.5	602.0	4.6	51.6
35	185.8	615.4	4.6	53.0
36	193.4	628.9	4.6	53.5
37	200.7	640.2	4.6	53.9
38	211.4	651.0	4.6	54.3
39	225.1	673.6	4.6	56.9
40	187.9	703.9	4.6	63.7
41	177.5	691.5	4.6	61.4
42	170.8	680.0	4.6	60.9
43	161.1	663.8	4.6	60.7
44	140.6	632.9	4.6	61.0
45	131.4	617.3	4.6	61.0
46	124.9	606.0	4.6	61.0
47	116.3	592.0	4.6	61.1
48	106.5	576.5	4.6	61.3
49	95.4	557.9	4.6	61.3
50	86.8	542.7	4.6	61.2
51	77.9	527.0	4.6	61.0
52	67.0	512.2	4.6	61.4
53	57.9	497.3	4.6	61.4
54	47.7	482.2	4.6	61.5
55	39.0	465.1	4.6	61.2
56	30.1	450.7	4.6	61.2
57	21.9	434.4	4.6	60.8
58	12.5	419.6	4.6	60.9
59	1.3	400.6	4.6	60.9
60	158.6	573.6	4.6	52.0
61	180.9	562.8	4.6	50.4
62	195.0	558.0	4.6	50.4
63	219.0	519.3	4.6	49.0
64	229.6	535.6	4.6	49.2
65	258.8	523.4	4.6	48.7
66	273.5	513.2	4.6	48.4
67	291.2	505.5	4.6	48.4
68	308.9	499.8	4.6	48.2

Receptor	X Posn	Y Posn	Height	Leq(9hour)
69	324.8	491.5	4.6	48.0
70	337.2	485.2	4.6	47.8
71	348.8	479.7	4.6	47.7
72	326.4	459.4	4.6	47.2
73	309.2	467.5	4.6	47.4
74	294.3	475.5	4.6	47.6
75	277.3	483.7	4.6	47.9
76	261.4	492.4	4.6	48.2
77	245.1	499.3	4.6	48.3
78	209.2	503.6	4.6	48.9
79	176.0	528.0	4.6	49.9
80	162.9	533.7	4.6	50.4
81	140.0	543.9	4.6	51.7
82	112.8	499.8	4.6	51.5
83	132.4	491.8	4.6	50.2
84	146.1	486.7	4.6	49.8
85	158.5	480.4	4.6	49.3
86	170.7	474.3	4.6	48.9
87	186.8	467.9	4.6	48.4
88	203.9	459.2	4.6	48.2
89	194.3	443.3	4.6	47.9
90	247.2	434.4	4.6	47.3
91	265.5	429.6	4.6	47.1
92	282.1	422.4	4.6	46.9
93	296.9	413.5	4.6	46.6
94	313.4	404.3	4.6	46.3
95	305.1	387.3	4.6	46.2
96	296.5	372.5	4.6	46.1
97	282.2	381.7	4.6	46.3
98	267.2	392.3	4.6	46.5
99	250.3	398.8	4.6	46.8
100	232.6	411.2	4.6	47.2
101	182.9	422.3	4.6	47.8
102	167.2	433.0	4.6	48.3
103	151.4	440.9	4.6	48.8
104	137.7	446.9	4.6	49.3
105	125.0	452.7	4.6	49.5
106	112.6	459.8	4.6	50.1
107	94.6	469.0	4.6	51.3
108	67.6	426.1	4.6	51.4
109	91.5	417.1	4.6	49.8
110	105.5	411.6	4.6	49.3
111	134.3	379.1	4.6	48.4
112	141.9	392.4	4.6	48.3
113	171.3	379.2	4.6	47.4
114	188.2	371.3	4.6	47.1
115	206.3	365.9	4.6	47.0
116	222.5	358.2	4.6	46.7
117	238.0	348.7	4.6	46.4
118	250.3	344.2	4.6	46.1
119	264.0	337.9	4.6	45.9
120	276.1	331.0	4.6	45.8
121	268.6	314.4	4.6	45.7
122	260.1	298.7	4.6	45.7
123	247.5	304.9	4.6	45.9
124	234.3	310.8	4.6	46.2
125	217.9	319.4	4.6	46.5
126	203.1	327.7	4.6	46.7
127	185.9	335.0	4.6	46.9
128	169.5	342.7	4.6	47.2
129	154.5	350.9	4.6	47.6
130	124.1	361.5	4.6	48.4
131	88.3	382.8	4.6	49.3
132	73.7	387.8	4.6	49.8
133	50.6	398.2	4.6	51.5
134	27.1	350.9	4.6	51.8
135	52.7	342.2	4.6	50.0
136	65.6	337.8	4.6	49.4
137	96.8	300.7	4.6	48.4
138	103.4	318.7	4.6	48.4

Receptor	X Posn	Y Posn	Height	Leq(9hour)
139	131.0	307.5	4.6	47.8
140	148.0	299.9	4.6	47.5
141	165.2	290.8	4.6	47.0
142	182.5	283.5	4.6	46.8
143	198.1	275.6	4.6	46.5
144	214.2	267.6	4.6	46.2
145	227.0	260.3	4.6	46.0
146	241.0	254.8	4.6	45.8
147	236.9	236.8	4.6	45.8
148	231.8	220.5	4.6	45.9
149	219.9	233.2	4.6	46.1
150	206.1	238.6	4.6	46.3
151	189.6	246.9	4.6	46.6
152	172.5	253.6	4.6	46.9
153	156.1	259.8	4.6	47.1
154	139.2	269.4	4.6	47.6
155	122.9	276.1	4.6	47.9
156	92.4	282.5	4.6	48.5
157	50.3	310.0	4.6	49.7
158	43.6	294.0	4.6	49.9
159	39.4	276.5	4.6	50.0
160	9.0	279.0	4.6	52.5
161	13.1	300.2	4.6	52.0
162	17.9	312.6	4.6	51.8
163	21.9	327.4	4.6	51.6
164	-7.9	379.7	4.6	60.4
165	-11.4	365.4	4.6	59.8
166	-14.9	352.2	4.6	59.3
167	-19.8	337.2	4.6	59.2
168	-24.8	319.3	4.6	59.2
169	-32.7	300.4	4.6	60.1
170	-34.2	279.9	4.6	60.0
171	-36.2	262.4	4.6	60.2
172	-33.9	239.7	4.6	59.9
173	-22.7	217.3	4.6	58.4
174	0.9	217.3	4.6	54.1
175	18.5	218.6	4.6	52.5
176	35.8	219.2	4.6	50.4
177	53.2	219.2	4.6	49.7
178	73.0	220.2	4.6	49.3
179	90.1	221.0	4.6	48.8
180	109.4	223.3	4.6	48.3
181	156.3	204.5	4.6	47.2
182	185.4	187.9	4.6	46.7
183	199.7	181.3	4.6	46.5
184	217.7	172.1	4.6	46.2
185	211.4	155.3	4.6	46.4
186	206.4	139.2	4.6	46.5
187	190.6	147.2	4.6	46.8
188	174.3	156.9	4.6	47.1
189	145.5	166.1	4.6	47.7
190	150.2	185.5	4.6	47.4
191	105.1	206.1	4.6	48.5
192	100.6	184.6	4.6	48.9
193	81.5	197.3	4.6	49.3
194	62.8	196.0	4.6	50.0
195	44.7	195.0	4.6	50.4
196	28.2	196.1	4.6	51.7
197	9.7	185.6	4.6	54.8
198	-6.3	183.7	4.6	57.0
199	-26.6	185.2	4.6	60.3
200	3.1	139.2	4.6	57.8
201	24.3	139.2	4.6	54.8
202	43.0	140.3	4.6	52.0
203	61.6	144.4	4.6	50.9
204	78.4	140.5	4.6	50.1
205	91.5	135.5	4.6	49.6
206	103.5	131.4	4.6	49.4
207	115.8	122.2	4.6	49.0
208	131.7	115.1	4.6	48.4

Receptor	X Posn	Y Posn	Height	Leq(9hour)
209	147.3	104.9	4.6	48.1
210	162.8	98.8	4.6	47.8
211	180.5	90.2	4.6	47.4
212	193.2	83.6	4.6	47.1
213	206.3	81.8	4.6	46.8
214	207.2	53.4	4.6	46.9
215	191.0	55.4	4.6	47.4
216	176.6	59.3	4.6	47.8
217	161.5	66.9	4.6	48.1
218	144.6	74.9	4.6	48.6
219	127.8	81.9	4.6	49.0
220	111.9	89.7	4.6	49.5
221	95.5	98.3	4.6	50.1
222	80.2	105.6	4.6	50.4
223	64.0	111.1	4.6	51.4
224	45.9	113.5	4.6	52.7
225	9.8	120.6	4.6	57.7
226	11.4	101.7	4.6	58.3
227	13.0	84.6	4.6	58.7
228	14.5	66.2	4.6	59.3
229	14.6	47.7	4.6	60.0
230	14.7	31.9	4.6	60.7
231	14.3	12.9	4.6	61.5
232	58.0	38.7	4.6	53.3
233	59.6	68.7	4.6	52.4
234	78.4	33.2	4.6	52.1
235	83.9	56.5	4.6	51.2
236	107.1	34.9	4.6	50.4

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Traffic increase model

Segment		Abbrev	Leq	Seg Group	Group Total
1	Highway current volume	predev	65.9		
2	Highway with site generated traffic	postde	66.5		

INPUT DATA	Seg 1 predev	Seg 2 postde
Total Flow (veh/18h)	15500	17775
Heavy Vehicles (%)	6	6
SPEED:		
Average (km/h)	60	60
Origin (Zone or Est)	Z	Z
Road RL (m)	2	2
Road Gradient (%)	1	1
ROAD SURFACE:		
Surface Type (B,C,P)	b	b
Texture Depth (mm)	1	1
Dist Road-Rec (m)	15	15
Absorbing Ground (%)	75	75
Av Prop Ht (m)	1.2	1.2
Angle View (deg)	180	180
SPECIAL ADJUSTMENT?		
Value (±dBA)		
Comment		
BARRIERS ?		
1:Dist Road-Barr (m)		
Barrier RL (m)		
Description		
2:Dist Road-Barr (m)		
Barrier RL (m)		
Description		
3:Dist Road-Barr (m)		
Barrier RL (m)		
Description		
REFLECTORS ONLY ?		
Refl Angle View (deg)		
COMBINED REFL/BARR?		
Reflector RL (m)		
Reflector Tilt (deg)		
DistanceBetween (m)		
Either on Embankment?		

Ground RL at Receiver:	2.1
Height of Receiver above ground:	1.8
Road Surface Corrections supplied by:	CRTN
Building Facade at Receiver:	Yes
User's overall adjustment to CRTN:	0.0
Leq factor: 24hr:	-3.5

CORRECTIONS		Seg 1 predev	Seg 2 postde
Total Flow 18h	(Ch3)	67.5	68.1
Low Flow 18h	(Ch12)	0.0	0.0
Heavy Vehicles	(Ch4)	0.0	0.0
{SpChange,km/h}	(Ch5)	-0.9	-0.9
Road Gradient	(Ch6)	0.3	0.3
Road Surface	(CRTN)	-1.0	-1.0
Dist Road-Rec	(Ch7)	-1.4	-1.4
{h,metres}	(Ch7)	1.4	1.4
Av Prop Ht	(Ch8)	-2.0	-2.0
Angle View	(Ch10)	0.0	0.0
Special	(User)	0.0	0.0
BARRIERS			
Barrier Absent	(Ch8)		
1:Pot Barr Corr	(Ch9)		
{PathDiff,metres}	(P21)		
Description			
2:Pot Barr Corr	(Ch9)		
{PathDiff,metres}	(P21)		
Description			
3:Pot Barr Corr	(Ch9)		
{PathDiff,metres}	(P21)		
Description			
Barr Multiple Effect			
Barr Numbers			
Pot Barr Corr	(P35)		
REFLECTORS			
Refl Angle of View	(P26)		
COMBINED REFL/BARR			
Correction	(P36)		
{Y}	(P36)		
{W}	(P36)		
{Alpha}	(P36)		
{Delta1}	(P36)		
{Delta2}	(Ch13)		
{Delta3}	(Ch13)		
{Delta4}	(Ch14)		
{Delta5}	(Ch15)		

Building facade at receiver: +2.5
User's overall adjust to CRTN: 0
Leq factor: 24hr = -3.5

Traffic increase model LINK ROAD

Segment		Abbrev	Leq	Seg Group	Group Total
1	LINK ROAD volume without development	predev	63.9		
2	LINK ROAD with site generated traffic	postde	64.8		

INPUT DATA	Seg 1 predev	Seg 2 postde
Total Flow (veh/18h)	9750	12025
Heavy Vehicles (%)	6	6
SPEED:		
Average (km/h)	60	60
Origin (Zone or Est)	Z	Z
Road RL (m)	2	2
Road Gradient (%)	1	1
ROAD SURFACE:		
Surface Type (B,C,P)	b	b
Texture Depth (mm)	1	1
Dist Road-Rec (m)	15	15
Absorbing Ground (%)	75	75
Av Prop Ht (m)	1.2	1.2
Angle View (deg)	180	180
SPECIAL ADJUSTMENT?		
Value (±dBA)		
Comment		
BARRIERS ?		
1:Dist Road-Barr (m)		
Barrier RL (m)		
Description		
2:Dist Road-Barr (m)		
Barrier RL (m)		
Description		
3:Dist Road-Barr (m)		
Barrier RL (m)		
Description		
REFLECTORS ONLY ?		
Refl Angle View (deg)		
COMBINED REFL/BARR?		
Reflector RL (m)		
Reflector Tilt (deg)		
DistanceBetween (m)		
Either on Embankment?		

Ground RL at Receiver:	2.1
Height of Receiver above ground:	1.8
Road Surface Corrections supplied by:	CRTN
Building Facade at Receiver:	Yes
User's overall adjustment to CRTN:	0.0
Leq factor: 24hr:	-3.5

CORRECTIONS		Seg 1 predev	Seg 2 postde
Total Flow 18h	(Ch3)	65.5	66.4
Low Flow 18h	(Ch12)	0.0	0.0
Heavy Vehicles	(Ch4)	0.0	0.0
{SpChange,km/h}	(Ch5)	-0.9	-0.9
Road Gradient	(Ch6)	0.3	0.3
Road Surface	(CRTN)	-1.0	-1.0
Dist Road-Rec	(Ch7)	-1.4	-1.4
{h,metres}	(Ch7)	1.4	1.4
Av Prop Ht	(Ch8)	-2.0	-2.0
Angle View	(Ch10)	0.0	0.0
Special	(User)	0.0	0.0
BARRIERS			
Barrier Absent	(Ch8)		
1:Pot Barr Corr	(Ch9)		
{PathDiff,metres}	(P21)		
Description			
2:Pot Barr Corr	(Ch9)		
{PathDiff,metres}	(P21)		
Description			
3:Pot Barr Corr	(Ch9)		
{PathDiff,metres}	(P21)		
Description			
Barr Multiple Effect			
Barr Numbers			
Pot Barr Corr	(P35)		
REFLECTORS			
Refl Angle of View	(P26)		
COMBINED REFL/BARR			
Correction	(P36)		
{Y}	(P36)		
{W}	(P36)		
{Alpha}	(P36)		
{Delta1}	(P36)		
{Delta2}	(Ch13)		
{Delta3}	(Ch13)		
{Delta4}	(Ch14)		
{Delta5}	(Ch15)		

Building facade at receiver: +2.5
User's overall adjust to CRTN: 0
Leq factor: 24hr = -3.5

Typical Dwelling											
Rw Calculations to AS3671											
Space	**Building Component**	**Impact**	**Criteria**	**TNR**	**Element Area**	**Floor Area**	**Height**	**RT60**	**C**	**TNA**	**Rw**
Bedrooms		**dB(A)**	**dB(A)**	**dB(A)**	**(m2)**	**(m2)**	**(m)**	**(s)**			
Top Floor Level Bedroom	Window	62.0	40	22.0	2.24	11.50	2.20	0.50	3	21.01	**27**
Top Floor Level Bedroom	External Walls	62.0	40	22.0	13.80	11.50	2.20	0.50	3	28.91	**35**
Top Floor Level Bedroom	Roof/ceiling	62.0	40	22.0	11.50	11.50	2.20	0.50	3	28.12	**34**
Ground Floor Level Living	Window	57.0	45	12.0	2.24	35.00	2.20	0.70	3	7.64	**14**
Ground Floor Level Living	Sliding door	57.0	45	12.0	6.93	35.00	2.20	0.70	3	12.55	**19**
Ground Floor Level Living	External Walls	57.0	45	12.0	22.03	35.00	2.20	0.70	3	17.57	**24**
Ground Floor Level Bedroom	Window	54.0	40	14.0	2.24	11.50	2.20	0.50	2	11.25	**17**
Ground Floor Level Bedroom	External Walls	54.0	40	14.0	13.80	11.50	2.20	0.50	2	19.15	**25**
Top Floor Level Bedroom	Window	64.0	40	24.0	2.24	11.50	2.20	0.50	3	23.01	**29**
Top Floor Level Bedroom	External Walls	64.0	40	24.0	13.80	11.50	2.20	0.50	3	30.91	**37**
Top Floor Level Bedroom	Roof/ceiling	64.0	40	24.0	11.50	11.50	2.20	0.50	3	30.12	**36**
Ground Floor Level Living	Window	57.0	45	12.0	2.24	35.00	2.20	0.70	3	7.64	**14**
Ground Floor Level Living	Sliding door	57.0	45	12.0	6.93	35.00	2.20	0.70	3	12.55	**19**
Ground Floor Level Living	External Walls	57.0	45	12.0	22.03	35.00	2.20	0.70	3	17.57	**24**
Ground Floor Level Bedroom	Window	54.0	40	14.0	2.24	11.50	2.20	0.50	2	11.25	**17**
Ground Floor Level Bedroom	External Walls	54.0	40	14.0	13.80	11.50	2.20	0.50	2	19.15	**25**
Space	**Building Component**	**Impact**	**Criteria**	**TNR**	**Element Area**	**Floor Area**	**Height**	**RT60**	**C**	**TNA**	**Rw**
Bedrooms		**dB(A)**	**dB(A)**	**dB(A)**	**(m2)**	**(m2)**	**(m)**	**(s)**			
Top Floor Level Bedroom	Window	52.0	40	12.0	2.24	11.50	2.20	0.50	3	11.01	**17**
Top Floor Level Bedroom	External Walls	52.0	40	12.0	13.80	11.50	2.20	0.50	3	18.91	**25**
Top Floor Level Bedroom	Roof/ceiling	52.0	40	12.0	11.50	11.50	2.20	0.50	3	18.12	**24**
Top Floor Level Bedroom	Window	53.0	40	13.0	2.24	11.50	2.20	0.50	3	12.01	**18**
Top Floor Level Bedroom	External Walls	53.0	40	13.0	13.80	11.50	2.20	0.50	3	19.91	**26**
Top Floor Level Bedroom	Roof/ceiling	53.0	40	13.0	11.50	11.50	2.20	0.50	3	19.12	**25**
	Model ssumptions										
	Living areas on ground floor level;										
	Bedrooms on top floor level;										
	Bedrooms 11.5m2 floor area;										
	Bedroom external shell have a window, walls and roof (e.g. 3 building components);										
	Lightweight wall construction, tile or steel roof.										

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Proposed Residential Development
Pacific Highway, Ballina

ROAD TRAFFIC NOISE IMPACT REPORT

Prepared for

Natuna Pty Ltd & D. Cook

06 December 2001
ttmref: 4440 report

1.0 INTRODUCTION

This report is in response to a request by Ardill Payne & Partners Pty Ltd on behalf of Natuna Pty Ltd and D. Cook for a road traffic impact assessment of a proposed subdivision located adjacent to the Pacific Highway, Ballina. This report forms part of an application for a Material Change of Use under the Ballina Shire Council Town Plan.

On-site noise logging was conducted, and through modelling, predictions of future road noise impacts in the year 2011 were produced. Based upon these predicted levels, recommendations regarding acoustic treatments have been specified.

1.1 The Proposal

The proposal is for a residential subdivision of a parcel of land currently used for stock grazing. The site is relatively flat, with the Highway approximately 300mm above average relative level of the site.

An arterial road is proposed that truncates the site, and connects with the Pacific Highway.

2.0 EQUIPMENT

The following equipment was used to record existing road traffic noise impacting onto the site:

- Rion NC 73 Calibrator;
- ARL Environmental Noise Logger.

3.0 MEASUREMENT PROCEDURE

A logger was located at a free-field position onsite, with the microphone approximately 1.3m above ground level, and a direct line of sight to the Highway (approximately 22m away).

The logger was set to record noise statistics in 2 minute blocks continually between 11:00am Friday 13/07/01, to 11:300am Monday 16/07/01. The statistical interval was chosen to provide detailed data, and to allow application of AS/NZS 2107:2000 *'Acoustics – Recommended Design Sound Level and Reverberation Times for Building Interiors'*.

Road traffic noise levels were conducted generally in accordance with Australian Standard AS2702 - 1984 '*Acoustics - Methods for the measurement of road traffic noise*'.

The operation of the sound level measuring equipment was field calibrated before and after the measurement session and was found to be within 0.2dB of the reference signal. All instrumentation used in this assessment hold current calibration certificate from a certified NATA calibration laboratory.

Weather conditions during the survey were generally fine, with a temperature range of 6 to 25 C.

4.0 NOISE CRITERIA

Noise limit criteria applicable to the site is pursuant to the "*Environmental criteria for road traffic noise*", published by the New South Wales Environmental Protection Authority. Two parts of the Policy apply to the application as follows:

TYPE OF DEVELOPMENT	CRITERIA		
	DAY (7am - 10pm) dB(A)	NIGHT (10pm – 7am) dB(A)	WHERE CRITERIA ARE ALREADY EXCEEDED
1. New freeway or arterial road corridor	$L_{Aeq(15hr)}$[1] 55	$L_{Aeq(9hr)}$[2] 50	The new road should be designed so as not to increase existing noise levels by more than 0.5dB. Where feasible and reasonable, noise levels should be reduced to meet the noise criteria. In some instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.
2. New residential land use developments affected by freeway/arterial traffic noise	$L_{Aeq(15hr)}$ 55	$L_{Aeq(9hr)}$ 50	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria via judicious design and construction of the development. Locations, internal layouts, building materials and construction should be chosen so as to minimise noise impacts.

Table 1: Road traffic noise criteria applicable to the proposed development.
(After NSW EPA "*Environmental criteria for road traffic noise*")

Section 1 of Table 1 applies to the proposed arterial roadway as it impacts onto future dwellings, and Section 2 applies to the Pacific Highway noise impacting onto future dwellings.

[1] The $L_{Aeq(15hr)}$ level, represents the 'average' level between 7am to 10pm, and is often used to describe continuous daytime road traffic noise.

[2] The $L_{Aeq(9hr)}$ level, represents the 'average' level between 10pm to 7am, and is often used to describe continuous night time road traffic noise.

We recommend ensuring that road traffic noise levels inside dwellings comply with AS/NZS 2107:2000 *'Acoustics – Recommended Design Sound Level and Reverberation Times for Building Interiors'* if external noise criteria cannot be achieved. These levels are presented in Table 2 below.

Type of Occupancy / Activity	Recommended Design Sound Level, L_{Aeq} dB(A)	
7. RESIDENTIAL BUILDINGS	Satisfactory	Maximum
Houses and apartments near major roads –		
Living areas	35	45
Sleeping areas	30	40
Work areas	35	45
Apartment common areas (e.g. foyer, lift lobby)	45	55

Table 2: Internal noise limits for residential dwellings from Australian/New Zealand Standard AS/NZS 2107:2000 *'Acoustics - Recommended design sound levels and reverberation times for building interiors'.*

5.0 RESULTS & CALCULATIONS

5.1 Measured Levels – Ambient Noise

Table 3 below presents measured traffic noise levels measured over a concatenated 24 hour period at the logger measurement location on Friday 13/0, and Monday 16/07/01. The $L_{10,18hr}$ noise level was measured close to 65 dB(A). Graphical presentation of the measured road traffic noise levels is presented in the appendix to this report.

Road Traffic Noise Descriptor	Time Period	Measured Level dB(A)
$L_{A10,18hr}$	6:00am to 12:00pm	64
$L_{Aeq(15hr)}$	7:00am to 10:00pm	62
$L_{Aeq(9hr)}$	10:00pm to 7:00am	59

Table 3: Free-field measured road traffic noise levels at proposed site.

5.2 Modelled Noise Levels – Existing Situation

5.2.1 Pacific Highway

Road traffic noise predictions were conducted using "Tnoise", a CoRTN based model produced by Main Roads Western Australia. To verify the road traffic noise prediction model, the $L_{A10,18hr}$ traffic noise levels were calculated and compared to the measured noise levels. The model input variables and results are presented at the rear of this report.

The model reflecting the existing $L_{A10,18hr}$ noise level, at 22m (e.g. at the logger location) from the edge of the Pacific Highway, is 1.3 dB below the measured $L_{A10,18hr}$ level of 65 dB, hence the model is corrected by -1.3 dB to equal the measured levels. This 1.3 dB correction is within the acceptable tolerance defined in the CoRTN methodology.

5.2.2 Existing and Future Traffic Flows – Pacific Highway

The existing and future traffic flows for the Pacific Highway were obtained from the Ballina Shire Council. Predicted traffic flows are based upon projections for the year 2010 and are as follows:

Existing Traffic Flow: 8,000 vehicles per 24 hour

Predicted Traffic Flow: 15,000 vehicles per 24 hour

5.2.3 Future Traffic Flows – Proposed Arterial Road

The future traffic flows for the proposed arterial road were obtained from Eppell Olsen & Partners Traffic Engineers. Predicted traffic flows are based upon projections for the year 2010 and are as follows:

Predicted Traffic Flow: 9,750 vehicles per 24 hour period

5.3 Modelled Noise Levels – Year 2010

5.3.1 Pacific Highway

Based upon the future increases in traffic flow along the Pacific Highway, the Tnoise model predicts an ultimate road traffic noise impact of close to 65 dB $L_{A10,18hr}$ at 1m from the most likely location of a dwelling façade at the nearest point to the Highway, following installation of a 2.4m high acoustic barrier (for barrier location, refer to Sketch No. 1, attached).

This predicted $L_{A10,18hr}$ level represents future road traffic noise levels which can be applied to the measured L_{Aeq} levels to produce the following ultimate levels:

Daytime: 62 dB $L_{Aeq(15hr)}$
Night time: 59 dB $L_{Aeq(9hr)}$

5.3.2 Proposed Arterial Road

Based upon the predicted traffic flow along the proposed arterial road, the Tnoise model predicts an ultimate road traffic noise impact of close to 59 dB $L_{A10,18hr}$ at 1m from the most likely location of a dwelling façade at the nearest point to the arterial roadway, following installation of a 2.4m high acoustic barrier (for barrier location, refer to Sketch No. 1, attached).

To predict an ultimate L_{Aeq} level, we can apply the typical difference between L10 and Leq of - 2 dB (daytime), and – 5 dB (night time) to the future $L_{A10,18hr}$ to produce the following ultimate levels at 1m from the most likely location of a dwelling façade at the nearest point to the arterial roadway:

Daytime: 57 dB $L_{Aeq(15hr)}$
Night time: 54 dB $L_{Aeq(9hr)}$

6.0 RECOMMENDED ACOUSTIC TREATMENTS

We recommend construction of acoustic barriers as detailed in Sketch No. 1, attached. Given the external noise levels are above the EPA criteria following installation of the proposed acoustic barrier, we recommend ensuring that building location, layout, materials and construction be chosen so as to minimise noise impacts inside any future residential dwellings in the affected zone defined in Sketch No. 2, attached.

As the development is only a subdivision at this stage, we are unable to provide detailed acoustic treatments, but recommend the following basic principles to be applied to buildings in the affected zone:

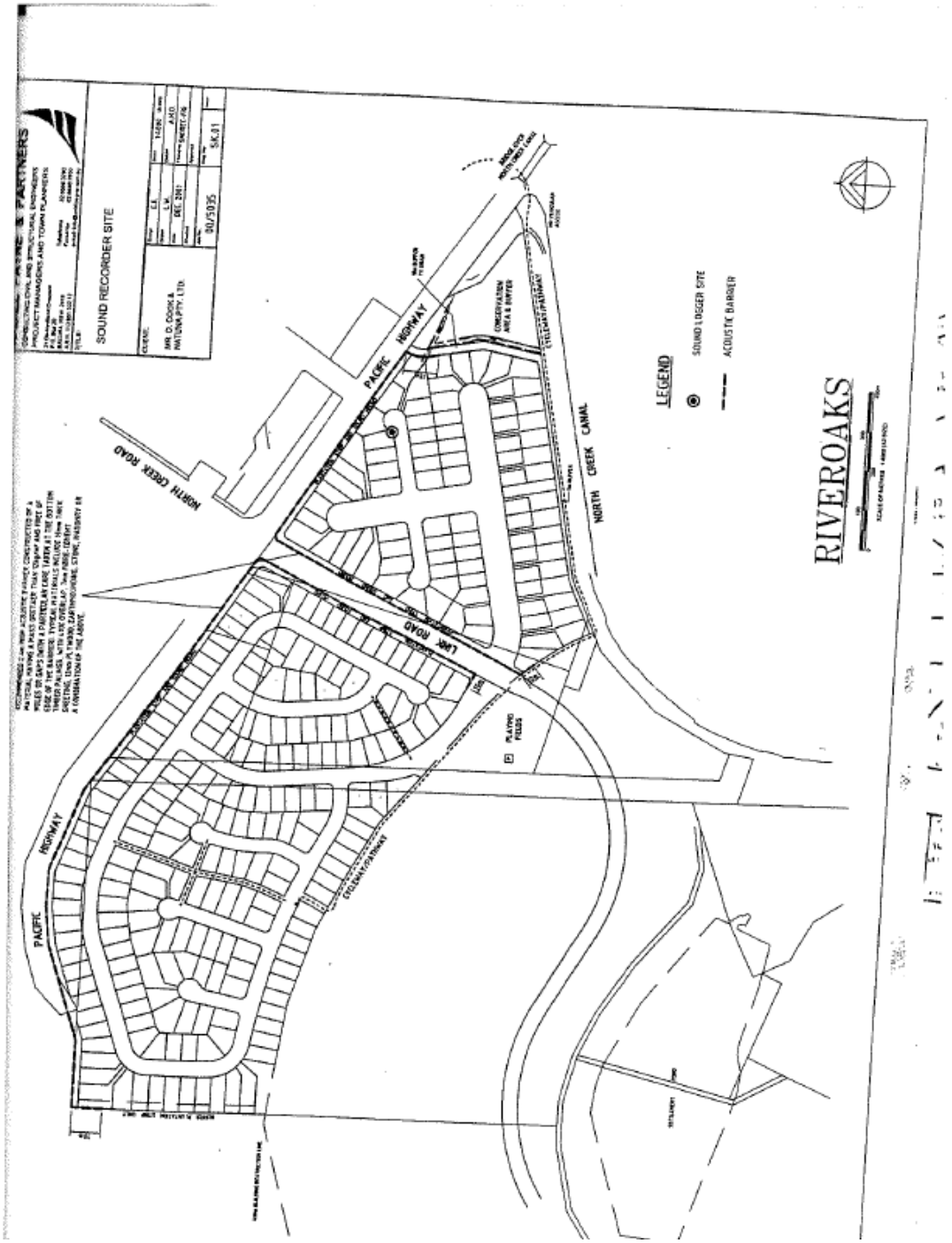
- Habitable spaces be located such that they are screened from the roadway by non-habitable spaces;
- Construction materials should be selected to reduce noise intruding inside the buildings;
- Provision for air conditioning or mechanical ventilation, as windows need to be closed to exclude noise;
- Minimisation of windows facing roadway.

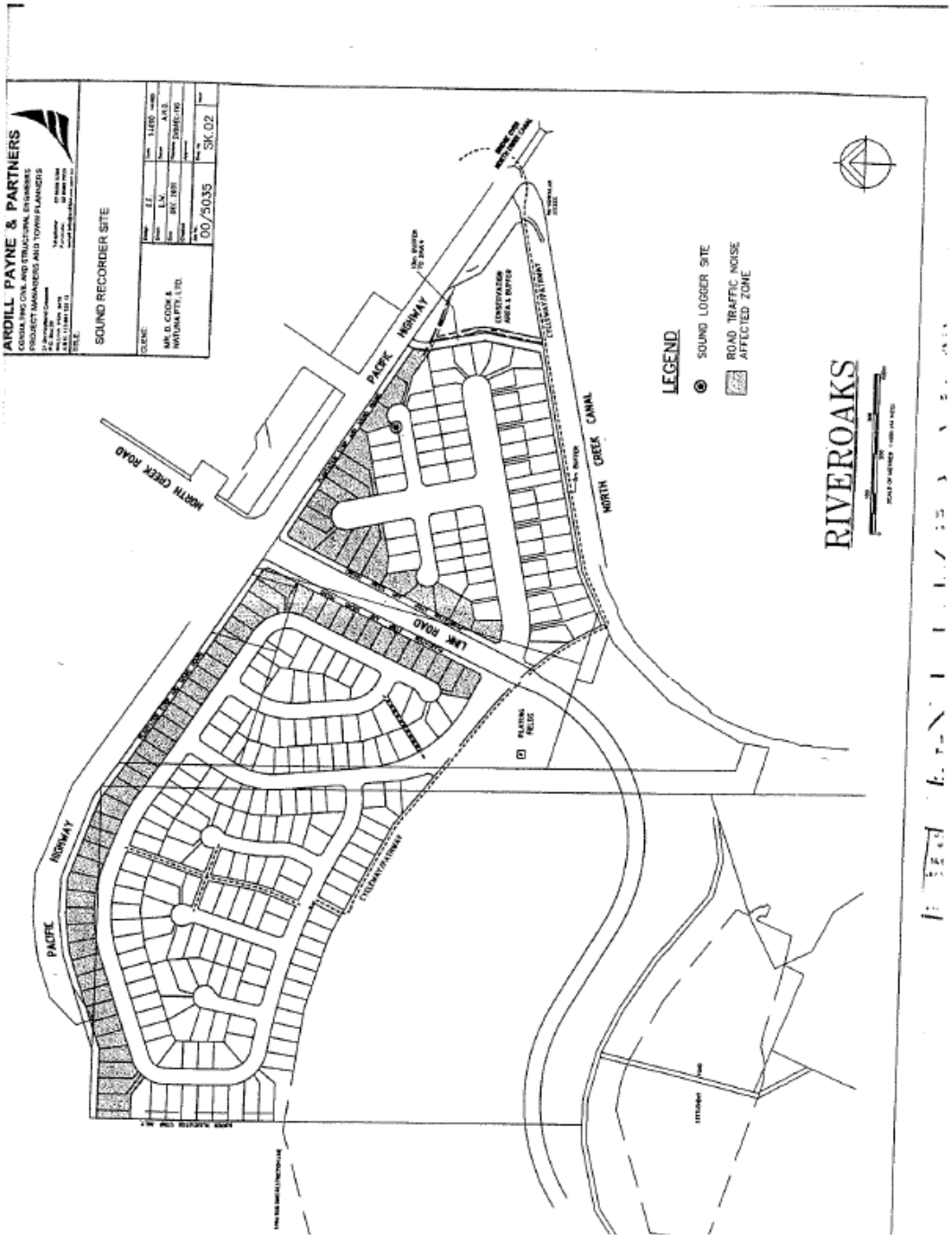
Specific building treatments may be determined by using the calculation methods detailed in Australian Standard AS3671 1989 *'Road Traffic Noise Intrusion – Building Siting and Construction'* when house plans are drafted. We recommend designing to internal noise levels defined in Australian/New Zealand Standard AS/NZS 2107:2000 *'Acoustics - Recommended design sound levels and reverberation times for building interiors'*.

A typical house would require the approximate building element sound reduction ratings (termed STC (Sound Transmission Class), or Rw (Weighted Sound Reduction Index) presented below. Please note that these are based upon a typical house, and that for building elements larger than typical sizes (i.e. floor to ceiling windows), a higher sound reduction may be required, and specialist advice should be sought.

Typical Building Elements	Typical Minimum Acoustic Treatment
Eastern Facades Facing Pacific Highway	
Bedroom Windows	**Rw 27:** 6.38mm laminated glass in commercial grade frames
Bedroom Roof/Ceiling	**Rw 37:** Pitched roof clad with tiles, or 0.5mm corrugated galvanised iron or 6mm corrugated cellulose-cement over 2 layers of 10mm plasterboard (re: AS3671)
External Walls	**Rw 39:** Masonry, or 9mm FC sheeting externally, 2 layers 10mm plasterboard internally **Rw 19:** Standard construction
Living/Dining Windows & Sliding Doors	**Rw 37:** Pitched roof clad with tiles, or 0.5mm corrugated galvanised iron or 6mm corrugated cellulose-cement over 2 layers of 10mm plasterboard (re: AS3671)
Living/Dining Roof/Ceiling	**or** Refer to attached CSR Roof/Ceilings construction sheet
External Walls Living/Dining	**Rw 35:** Standard Construction **Provision for air conditioning or mechanical ventilation should be provided**
Southern Facades Facing Proposed Arterial Roadway	
Bedroom Windows	**Rw 26:** 6.38mm laminated glass in commercial grade frames
Bedroom Roof/Ceiling	**Rw 31:** Standard construction
Living/Dining Windows & Sliding Doors	**Rw 18:** Standard construction
Living/Dining External Walls	**Rw 36:** Standard construction with 75mm thick 38kg/m³ fibreglass in wall cavity
Living/Dining Roof/Ceiling/Walls	**Rw 29:** Standard construction
	Provision for air conditioning or mechanical ventilation should be provided

Table 3: Weighted sound reduction indices for typical lowset housing constructed in affected zone defined in Sketch No. 2.


SOUND RECORDER SITE
RIVEROAKS
PACIFIC HIGHWAY
NORTH CREEK ROAD
LAKE ROAD
NORTH CREEK CANAL
LEGEND
SOUND LOGGER SITE
ACOUSTIC BARRIER
CONSERVATION AREA & BUFFER
PLAYING FIELDS


ARDILL PAYNE & PARTNERS
SOUND RECORDER SITE
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PACIFIC HIGHWAY
NORTH CREEK ROAD
LINK ROAD
NORTH CREEK CANAL
CONSERVATION AREA & BUFFER
FOOTPATH/CYCLEWAY
LEGEND
SOUND LOGGER SITE
ROAD TRAFFIC NOISE AFFECTED ZONE
RIVEROAKS

7.0 DISCUSSION & CONCLUSIONS

We have recommended 2.4m high acoustic barriers along both the Pacific Highway and the proposed arterial road. It should be noted that the need for barriers along the arterial are only necessary when the arterial is fully functional. We have limited the barrier to 2.4m in height, for aesthetic and amenity reasons, as barriers higher than 2.4m will start to create a 'canyon' effect along the arterial road, and will reduce breezes coming from the south-east.

Based upon ultimate traffic flows supplied by the Ballina Shire Council, the site will be exposed to road traffic noise levels above criteria defined in the NSW EPA "*Environmental criteria for road traffic noise*". We have specified an acoustic barrier that will reduce traffic noise and will be visually acceptable, and have also provided some basic principles to consider at the design stage of future dwellings.

It is noted that the EPA Road Traffic Noise Criteria states that noise levels from roads should be reduced to meet the criteria where feasible and reasonable. Our barrier design is considered reasonable when visual amenity issues, shadowing, and blocking of natural breezes are considered. It is noted that to gain total compliance with the criteria, a barrier approximately 6m high along the Pacific Highway, and 4m high along the arterial road would be required.

Our recommendations provide a solution balancing control of future road traffic noise impacts with other amenity issues associated with construction of roadside barriers.

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