Development Application Acoustic Report

Proposed Wahroonga Adventist School Development

Prepared for
Stanton Dahl Architects

13th March, 2013

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1 Introduction

1.1 Proposed Development

This study was undertaken as a part of State Significant Development Application for submission to the Department of Planning and Infrastructure for the new Wahroonga Adventist School (WAS). The proposed development is shown in Figure 1.

An acoustic assessment of the proposed Wahroonga Adventist School (WAS) has been carried out in accordance with current NSW planning guidelines and development application requirements for acoustics.

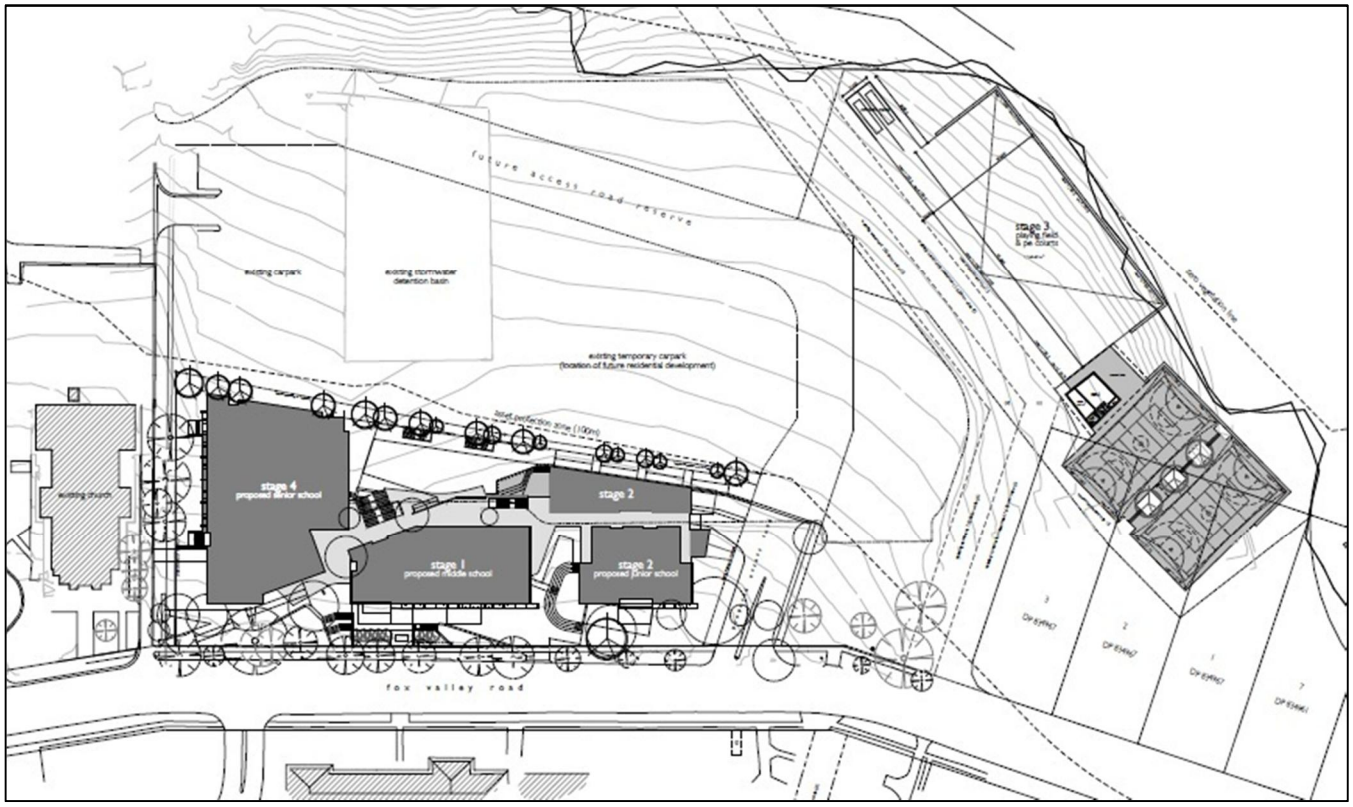

Figure 1: Proposed Wahroonga Adventist School.

The existing school is to be relocated to the proposed site has been an education provider to the Adventist Community for many years. Development of the Wahroonga Estate has been subject to separate development applications for the Sydney Adventist Hospital, Residential and other related sites on the Wahroonga Estate. The proposed development of the school is a State Significant Project, which is planned to occur in stages with completion due in 2023.

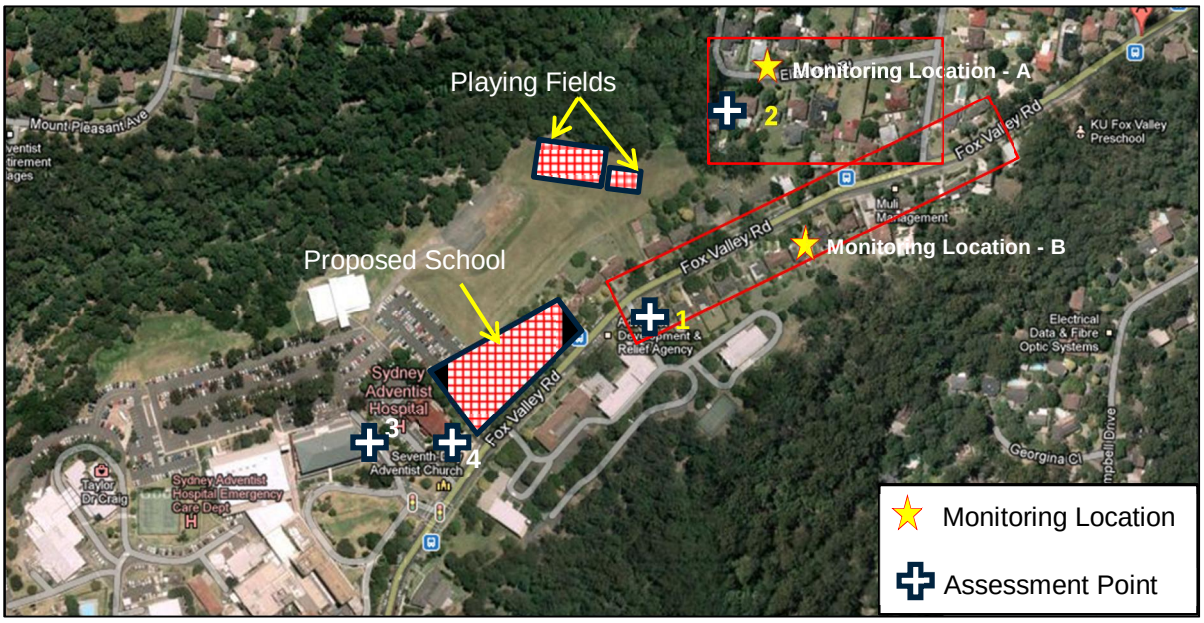

Figure 2: Proposed school and nearest affected receivers.

The school will be developed in 4 main stages, with a total capacity of 57 staff and 800 students, as follows:

- Stage 1 – Middle School: consisting of design and technology, special education areas, science laboratories and general learning and study areas.
- Stage 2 – Junior School, consisting of kindergarten and preparatory learning spaces, primary school, out of hours school care (OOSH).
- Stage 3 – Sports Fields located on the northern boundary of the site, consisting of playing fields and courts.
- Stage 4 – Senior School consisting of classrooms, board rooms, administration and reception areas, and canteen, library and storage areas. The second floor consists of a multi-purpose hall with provision for approximately 900 persons. This area will used for school assemblies and indoor sporting activities.
- Basement Level Car park with parking provision for 124 vehicles. Access to the car park will be provided by a proposed access road, located on the northern side off Fox Valley Road.

1.2 Proposed Usage Hours of Operation

Following consultations with the project team, the following proposed hours for the use of the school facilities, outside school hours is summarised as follows:

School Facilities:

- Piano Room (Ground Floor, Stage 2) - weekdays up to 8pm;
- Music Practice Rooms (2nd Floor, Stage 2) - weekdays up to 8pm;
- After hours school care (OOSH) - Ground Floor, Stage 2 - Monday to Thursday 7am to 6pm, Friday 7am to 8pm;
- Hall (2nd Floor, Stage 4) - 2 times per week night use for sporting competition and Friday night use. All day Saturday use from morning to evening, to be used as church facility:

  Occasional school productions and award nights up to 10:30pm

  Occasional Open Days all day Sunday;
- Food Tech (2nd Floor, Stage 4) - Friday night use, All day Saturday use from morning to evening (ie; used as church facility)
- Occasional school productions and award nights up to 10:30pm. Occasional Open Days all day Sunday;

- Library and Adjacent GLAs (Ground Floor and 1st Floor, Stage 4) - weekdays to 6pm Friday night use All day Saturday use from morning to evening (ie; used as church facility). Occasional school productions and award nights up to 10:30pm and occasional open days all day Sunday.

Sports Fields:

- After hours (under lights) use generally will be infrequent;
- Periodic afternoon use for training with lights used in winter months, with no spectator crowds;
- Occasional daytime Sunday use for school fetes or functions.

1.3 Acoustic Issues

From an acoustic perspective, the following aspects of the development have been identified:

- Site noise emissions from school activities and main assembly hall;
- Site noise emissions from traffic inside the proposed car park;
- Road traffic noise generation;
- Mechanical plant noise emissions;
- Sporting noise from the proposed sports fields;
- Construction noise and vibration impacts.

The following noise sensitive receiver zones and relative distances are presented below in Table 1.

Table 1: Approximate distances to noise sensitive receiver zones to proposed school and sporting fields.

Receiver Zone	Sporting Fields, m	School, m
Location 1 – Residences, Elizabeth Street, Wahroonga	80	180
Location 2 – Residences, Fox Valley Road, Wahroonga	84	135
Location 3 – Wahroonga Adventist Hospital	250	70
Location 4 – Wahroonga Adventist Church	210	30

2 Acoustic Criteria

2.1 NSW Department of Planning and Infrastructure

In relation to the Development, the Director General's Requirements under Section 78A 8A of the Environmental Planning and Assessment Act and Schedule 2 of the Environmental Planning and Assessment Regulation 2000, the following requirements for the overall development of the site required the following:

'6. Noise

Identify and provide a quantitative assessment of the main noise generating sources and activities at all stages of construction and any noise sources during operation. Outline measures to minimize and mitigate the potential noise impacts on surrounding occupiers of land.

Relevant Policies and Guidelines:

- *NSW Industrial Noise Policy (EPA)*
- *Interim Construction Noise Policy (DECC)'*

2.2 Ku-ring-gai Council

DCP48 section 26 relates to general noise guidelines, ie noise emission from the site should be designed to 5dB(A) above background noise at the site boundary and this is similar to the NSW Industrial Noise Policy (INP) criteria.

Given the current site conditions and hospital precinct, we consider the Industrial Noise Policy is a more suitable to assess noise impact to the adjoining hospital and has therefore been adopted in this acoustic assessment. The NSW INP acoustic criteria in Section **Error! Reference source not found.** of this report.

2.3 Protection of the Environment Operations Act 1997

Under the NSW Protection of the Environment Operations Act (POEO), the proposed development is not classified as a 'scheduled premises'. As a consequence, under the Act the local council is the regulatory authority having responsibility for the management associated with the development.

Under the POEO, the NSW Office of Environment and Heritage (OEH) has the responsibility to issue policy statements to set out criteria and methods of management for noise within the state.

The EPA has issued such policy documents addressing both stationary or industrial noise sources, as well as road traffic. In the absence of specific noise criteria applicable within the shire, Council is expected to invoke the policy guidelines of the OEH.

The focus of offensive noise relevant to this assessment should be noise above normal school operations are identified as "offensive". This was confirmed by recent Land and Environment Court findings discussed in (Tonin 2010) which determined that:

"All noise that emanates from the normal activities at a school is not offensive. The focus … should be that element of the noise above normal school hours which is identified as offensive…' (Tonin 2010[1]).

For the purposes of this assessment, we have focused our assessment on noise generating activities, which have the potential to occur outside the standard operating hours of the school.

2.4 NSW Industrial Noise Policy

In the absence of specific noise design criteria applicable to council, the Office of Environment and Heritage OEHs Industrial Noise Policy (INP) is the appropriate guiding document setting out an assessment methodology applicable to environmental noise impact assessment for the development proposal.

In assessing the noise impacts from industrial sources the INP requires the consideration of two separate criteria in developing the project specific criteria. These are the intrusiveness criteria and the amenity criteria. The application of these criteria are summarised below.

[1] Tonin R. (2010) What is offensive noise? A case study in NSW. Acoustics Australia Vol 38 April No.1, 31-33.

2.4.1 Intrusiveness Criteria

The Intrusiveness Criteria is used to evaluate the extent to which a noise intrudes above the background, particularly where the receiver is a dwelling. The INP considers that the L_{eq}, 15 minute level associate with a broad-band industrial noise source may be up to 5 dB(A) above the rating background noise level (L_{A90}) at a residential receiver without being considered offensive.

The rating background noise level is similar to the 10th percentile background L_{A90} however uses a different sampling technique to determine the value.

Where a noise source contains certain characteristics, such as tonality, intermittency, impulsiveness, irregularity or low-frequency dominance, correction factors may need to be applied to the noise annoyance criteria to determine the project specific criteria.

2.4.2 Amenity Criteria

The OEH INP also considers that there is a community expectation for a certain level of environmental noise amenity, depending on the type of area in which the noise sensitive receiver is located. The Industrial Noise Policy provides a table of recommended L_{Aeq} noise levels that, subject to the type of area and time of day, are considered desirable.

Depending on the level of existing industrial or commercial noise, these desirable levels are adjusted so as to require progressively more stringent amenity compliance levels. The objective of this approach is to prevent the background noise level from continually increasing as a result of each progressive new development.

For an 'Urban' amenity area, the INP proposes that the L_{eq} noise emission level should not exceed the following acceptable noise emission levels:

- Daytime (7am to 6pm): 60 dB(A);
- Evening (6pm to 10pm): 50 dB(A);
- Night (10pm to 7am): 45 dB(A).
- Places of Worship – Internal 40 dB(A);
- Hospital Wards – Noisiest 1 hour period:
  - Internal 35 dB(A);
  - External 50 dB(A).

2.5 Construction Noise Criteria

The NSW Office of Environment and Heritage provides guidance for assessing construction noise impacts in the document “Interim Construction Noise Guideline” dated July 2009.

Generally, noise impact mitigation measures are determined by the timing and duration of the noise emissions and the perceived impact of the noise above existing background noise levels.

Based on the quantitative assessment method, the applicable noise criteria is summarised in Table 2.

Table 2: NSW OEH Construction Noise Criteria, dB(A).

Time of Day	Management Level, $L_{eq\ (15min)}$	How to apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL+10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. ▪ Where noise is above this level, the relevant authority (consent, determining, regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) 2. If the community is prepared to accept longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(A)	▪ A strong justification would typically be required for work outside the recommended standard hours ▪ The proponent should apply all feasible and reasonable work practices to meet the noise affected level ▪ Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community ▪ For guidance on negotiating agreements see Section 7.2.2 (NSW OEH Interim Construction Noise Guideline)

2.5.1 Construction Vibration

Vibration from construction activities can impact on the amenity of the occupants of adjacent dwellings or buildings to the construction works and can commonly be summarised in two categories:

- Effect on human comfort; and
- Structural damage to buildings.

2.5.2 Human Comfort

Vibration criteria is not covered in the NSW OEH Interim Construction Noise Guideline, however the document "Assessing Vibration: A Technical Guide" issued by the NSW OEH outlines vibration limits in relation to human comfort. Criteria in this Guideline are based on the British Standard BS6472-1992, "Evaluation of human exposure to vibration in buildings (1-80Hz).

The guideline gives recommendations regarding the preferred and maximum allowable vibration levels in three axes for human comfort in building interiors.

An excerpt from the guideline, allowable levels specified for 1 – 80 Hz is shown in Table 3.

Table 3: Allowable vibration acceleration levels (1-80 Hz).

Location	Assessment Period	Preferred values		Maximum values	
		z axis	x and y axes	z axis	x and y axes
Continuous Vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Workshops	Day or night time	0.04	0.029	0.080	0.058
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.010	0.0071	0.020	0.014
Workshops	Day or night time	0.64	0.46	1.28	0.92

2.5.3 Effect on Structures

The potential for damage during the construction phase is considered against the limits given within German Standard DIN 4150 part 3. Table 4 presents guide values for vibration velocity limits for a typical dwelling.

Table 4: Transient Vibration Values ppv (mm/s)

Line	Type of Structure	Peak component particle velocity (mm/s) in frequency range of predominant pulse		
		1 - 10Hz	10 - 50Hz	50 - 100Hz
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that because of their particular sensitivity to vibration cannot be classified under lines 1 and 2 and are of great intrinsic value	3	3 to 8	8 to 10

2.6 Sporting Activities

Given the Wahroonga Adventist School proposes to undertake periodic sporting activities which do not generate industrial noise; we recommend that an alternative criterion be applied for these activities.

The Environmental Noise Management Manual (ENMM) while no longer supported by the Office of Environment and Heritage (OEH) contains many useful guidelines for the operation of specific activities. In relation to sporting activities, the ENMM states:

'Chapter 159 Lawful Sporting Activities

Athletic Sporting Events

Athletic Sporting Events involve crowds gathering to participate in or watch sporting competitions such as tennis, football and BMX races. The primary sources of noise from such events are public address systems and crowd noise including arrival and departure.

The control of noise from public address systems is described in Chapter 56.

The extent to which athletic sporting activities cause noise in residential areas can be minimised firstly by appropriate planning of the venue site. Thereafter, control usually is most equitably and effectively achieved by regulation of the frequency and duration of events.

The following criteria should be considered as guidelines only and variations may be made according to local conditions.

Time Restrictions

- *When no offensive noise occurs, athletic sporting events should be restricted to:*
- *7am to 6pm any weekday*
- *8am to 6pm Saturdays and Sundays*
- *6pm to 10pm two nights per week excluding Sundays, or Public Holidays*

Where no offensive noise is likely to be caused, restrictions are not applicable.

The number of nights per week could be extended to all nights except Sunday if the intrusive noise level (L_{A10} for the activity measured over 15 minutes at the affected receiver) does not exceed the background (L_{A90}) noise level by more than 5 dB(A) for new events or 10 dB(A) for existing activities.

- *No impulsive or intermittent correction shall be applied to the measured levels.*
- *The abovementioned hours may be extended to 11pm provided intrusive noise does not exceed the background noise level. This applies to new and existing activities.*
- *Noise should be inaudible between 11pm and 8am*
- *Noise means noise form the sport itself and the associated activities including the use of sound reproduction equipment*
- *Participants should be encouraged by the management to leave the premises quickly and quietly at night to lessen the likelihood of noise complaints. '*

3 Noise Monitoring

To determine appropriate criteria for the proposed development, ambient noise monitoring was conducted on the site from Friday 7th December, 2012 to Friday 14th December, 2012 shown in Figure 1, at Monitoring Location A and Monitoring Location B.

Ambient noise was measured using Acoustic Research Laboratories EL-215 Environmental Noise Loggers. All instruments were calibrated before and after use using a 94dB(A), 1 kHz calibration tone, with no significant drift occurring over the monitoring period. The level of drift over the monitoring period was determined to be less than 0.2 dB(A) on all noise loggers.

The measurement locations, shown in Figure 2, were selected with the following objectives in mind:

- Monitoring Location A – at 11 Elizabeth Street. This site was primarily chosen due to the proximity of the proposed sports fields to residences in Elizabeth Street. Main noise sources were local street traffic, birds, insects and vegetation/wind noise.

  For the purposes of this assessment, we have assessed to the nearest affected dwelling – 'Location 1'.

- Monitoring Location B – 130 Fox Valley Road. This site was selected as being representative of residential areas along Fox Valley Road. Main noise sources were traffic movements along Fox Valley Road. As construction noise was audible residences closer to the school, this location was chosen as it was not adversely unaffected by construction noise.

  For the purposes of this assessment, we have assessed to the nearest affected dwelling – 'Location 2'.

- 'Location 3' relates to the Wahroonga Adventist Church while 'Location 4' relates to the Sydney Adventist Hospital. The relevance locations are discussed further in Section 4.

Following a comparison of background noise levels against those recorded on the logger during the same time periods, we are satisfied that this location is both consistent and representative of the ambient noise environment to residential areas to the south and west of the site.

The results of the site monitoring at Location A and Location B are presented below in Figure 3 and Figure **4**, respectively.

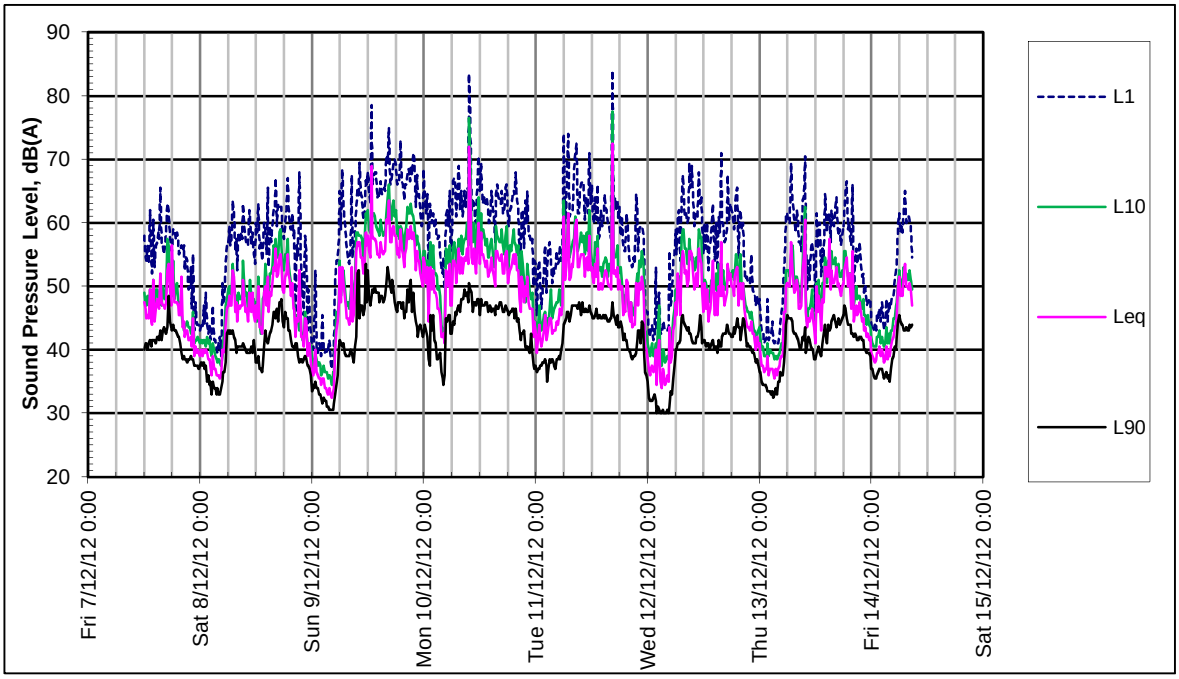

Figure 3: Ambient noise, Monitoring Location A, 11 Elizabeth Street, Wahroonga.

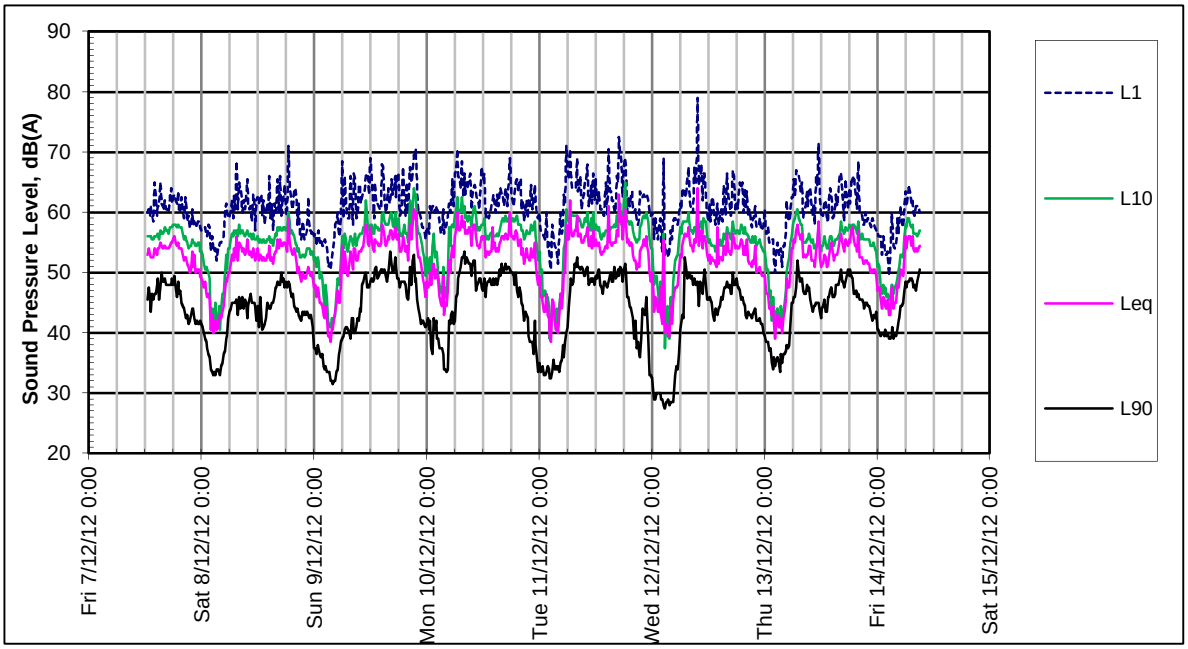

Figure 4: Ambient noise Monitoring Location B - 130 Fox Valley Road, Wahroonga.

Following analysis of the noise logger data, the following noise parameters relevant to establishing project specific criteria for the site are presented below in Table 5.

Table 5: Noise monitoring summary, dB (A).

Measurement Position	Period	RBL, L_{90}	Ambient Noise Level L_{eq}
Elizabeth Street Residences	Day (0700-1800)	41	56
	Evening (1800-2200)	41	52
	Night (2200-0700)	39	48
Fox Valley Road Residences	Day (0700-1800)	49	58
	Evening (1800-2200)	47	44
	Night (2200-0700)	39	41

4 Acceptable Noise Levels

4.1 NSW Industrial Noise Policy (INP)

4.1.1 Intrusiveness Criteria

Following determination of the rating background level from the noise logger data, the Intrusiveness criteria for is summarised below in Table 6. The intrusiveness criterion applies to residential areas at Location 1 and Location 2 only.

Table 6: Intrusiveness Criteria, $L_{eq\ 15\text{-}minute}$ dB(A)

Time of Day	RBL	Intrusiveness Criteria
Location 1 – Elizabeth Street		
Day (0700-1800)	41	46
Evening (1800-2200)	41	46
Night (2200-0700)	34	39
Location 2 – Fox Valley Road		
Day (0700-1800)	44	49
Evening (1800-2200)	42	47
Night (2200-0700)	34	39

4.1.2 Amenity Criteria

For Location 1 and Location 2 an 'Urban area, the INP proposes that the L_{eq} noise emission level should not exceed 60 dB(A) in the daytime (7 am to 6 pm), 50 dB(A) in the evening (6 pm to 10 pm) and 45 dB(A) during the night (10 pm to 7 am).

For Location 3 (Adventist Church) which is classified as a place of worship, the INP proposes that internal noise criteria are to achieve a 40 dB(A) internal noise level. For Location 4 (Adventist Hospital) the INP proposes external and internal noise levels of 50 and 35 dB(A) respectively.

For the purposes of this assessment we have calculated external noise level at the nearest affected boundary. As a guide, the difference between the internal noise level and external noise level is typically 10-15 dB with windows open to achieve adequate ventilation conditions.

Table 7: NSW INP Amenity Criteria, $L_{eq,}$ dB(A).

Time of Day	Amenity
Location 1 – Elizabeth Street Residences	
Day (0700-1800)	58
Evening (1800-2200)	42
Night (2200-0700)	38
Location 2 – Fox Valley Road Residences	
Day (0700-1800)	58
Evening (1800-2200)	44
Night (2200-0700)	41
Location 3 – Wahroonga Adventist Church	
Day (0700-1800)	40 (internal)*
Evening (1800-2200)	40 (internal)*
Night (2200-0700)	40 (internal)*
Location 4 – Sydney Adventist Hospital	
Day (0700-1800)	35 (internal) 50 (external)
Evening (1800-2200)	35 (internal) 50 (external)
Night (2200-0700)	35 (internal) 50 (external)

* As a guide, the difference between the internal noise level and external noise level is typically 10dB with windows open for adequate ventilation. For the Church we have calculated noise levels to achieve 50 dB(A) externally.

4.1.3 NSW INP Project Specific Design Criteria

The project specific criteria for the development are determined as the most stringent of the intrusiveness and amenity criteria. These criteria relevant to the proposed school are summarised below in Table 8.

Table 8: NSW INP Project Specific Criteria, $L_{eq,}$ dB(A)

Time of Day	Location 1- Elizabeth Street Residences	Location 2 - Fox Valley Road Residences	Location 3 - Wahroonga Adventist Church	Location 4 – Sydney Adventist Hospital
Day (0700-1800)	46	49	40*	50
Evening (1800-2200)	42	44	40*	50
Night (2200-0700)	38	39	40*	50

* As a guide, the difference between the internal noise level and external noise level is typically 10dB with windows open for adequate ventilation. For the Adventist Church we have calculated noise levels to achieve 50 dB(A) externally.

4.2 NSW ENCM Sleep Disturbance Criteria

In relation to sleep disturbance from occasional noisy events, the NSW Environmental Noise Control Manual (ENCM) provides useful guidelines regarding design criteria relevant to the control of sleep disturbance.

This document is officially withdrawn from circulation, however has not been replaced by alternative guiding documents in a number of areas, with wake-up effects being one.

The ENCM recommends that the night period L_{A1} noise level at a dwelling, due to external noise events, should not exceed the background L_{A90} by more than 15dB(A). As outlined in Section 1.2, proposed activities to take place to 10.30pm are occasional award nights and school production in the hall.

These criteria summarised in below in Table 9.

Table 9: NSW – Night-time Sleep Disturbance Criteria, $L_{1,\ 15\ minute}$ dB(A).

Location	RBL, L_{90} (2200-0700)	Sleep Disturbance Criteria, L_1
Location 1 – Elizabeth Street Residences	39	54
Location 2 – Fox Valley Road Residences	34	49

4.3 Construction Noise Criteria

Standard hours for construction noise are outlined in the NSW Construction Noise Policy. Typical plant items and predicted construction noise impacts are discussed further in Section 5 and 6 of this report. 'Table 3' of the policy also lists construction noise criteria for places of worship and hospital wards and operating centres. These criteria are summarised below in Table 10.

Table 10: Criteria for standard hours during construction, $L_{eq,\ 15minute}$, dB(A)

Location	RBL, L_{90}	Criteria
Standard Hours 'Daytime': Monday to Friday 7am to 6pm; Saturday 8am to 1pm		
Location 1 – Elizabeth Street Residences	46	56
Location 2 – Fox Valley Road Residences	49	59
Location 3 – Wahroonga Adventist Church	N/A	55*
Location 4 – Sydney Adventist Hospital	N/A	55*

4.4 Sporting Activities

The proposed criteria for the sporting fields is summarised below in Table 11. At this stage, we have classified the sports fields as a new sporting event, as sporting activity is currently not taking place on the site. This would require activity from sporting operations to comply with 'background + 5 dB(A)'. The application of the Sporting Activity criteria is discussed further in Section 6 of this report.

Table 11: Sports fields noise criteria, $L_{10, 15minute}$, dB (A)

Location	RBL, L_{90}	Criteria, L_{10}
Evening Period (1800 to 2200) – New Sporting Events		
Location 1 – Elizabeth Street Residences	41	46
Location 2 – Fox Valley Road Residences	42	47

4.5 NSW OEH Road Noise Policy

The NSW OEH provides consolidated criteria and guidelines on appropriate design objectives for road traffic noise and is published in the document "NSW Road Noise Policy (RNP)". Under this policy document, the OEH proposes the use of the L_{eq} for the assessment of significance of changes to road traffic noise.

The policy provides assessment criteria for residential land uses for Day and Night time criteria. In order to assess relative increases in road traffic noise, the most common method of prediction of road traffic noise is the CORTN (Calculation of Road Traffic Noise) procedure originally developed in the United Kingdom.

Using the CORTN algorithms for freely flowing road traffic, the L_{eq} noise level generated by traffic movement may be calculated from the following general relationship:

$L_{eq} = 10 \text{ Log } (N) + K$

Where:

- N is the traffic flow volume;
- K is a site constant.

The site constant (K) is calculated from the actual site conditions, including distance from the road edge, the speed of traffic flow, and any site-specific factors such as shielding by fences etc.

Providing the site factors remain constant, as is the case with changes that do not alter the roadway itself, it is possible to calculate the change to road traffic noise levels as:

L_{eq} change = 10 log (N2/N1)

Where:

- N1 is the initial traffic flow;
- N2 is the future traffic flow.

More relevantly, it is proposed by the INP that changes to land use, or the redevelopment of local roads, should be planned so that an increase to the existing L_{eq} resulting from the changed traffic patterns should be less than 2dB(A).

It is important to note that the road traffic noise criteria recommended by the OEH refer to vehicles on public roads.

For the purpose of this report, the design criteria adopted for assessment of environmental noise impact from all vehicular activities is to:

- Maintain, or if possible reduce, existing noise exposure levels to nearby dwelling areas;
- Where increased levels are anticipated, ensure the changes to road traffic noise do not exceed an increase of 2dB(A).

5 Noise Impact Assessment

5.1 Site Noise Impacts

5.1.1 After hours School Activity

To model the effects of school activity, such as classrooms in evening, the following worst case assumptions were made:

- Typical Block work/Masonry construction;
- 25 persons in each classroom, with raised to staged voices, using a sound power level L_w=83dB(A);
- Typical mid-frequency reverberation times of 0.6 seconds;
- Half the Stage 1 and Stage 2 classrooms in use during the evening period;
- Windows closed, assuming 6mm glazing.

Predicted noise levels with windows closed are presented below in Table 12. As shown, noise emissions from the classrooms are predicted to comply with the criteria at all locations.

Table 12: Predicted classroom noise emissions with windows closed, $L_{eq,\ 15\ minute}$ dB(A).

Location	INP Criteria (Evening)	Predicted Noise Levels Windows Closed	Complies (Y/N)
Location 1 – Elizabeth Street Residences	42	18	Yes
Location 2 – Fox Valley Rd Residences	44	23	Yes
Location 3 – Wahroonga Adventist Church	50	25	Yes
Location 4 – Sydney Adventist Hospital	50	20	Yes

5.1.2 Mechanical Plant Noise

At stage of the development, plant equipment and selections have not been finalised. However based upon the current data, we would recommend that mechanical plant and equipment is designed, so that the limiting aggregate plant sound power level from the site does not exceed L_w=87 dB(A). Typical noise controls measures require to achieve the INP are outlined in Section 6 of this report.

5.1.3 Multi-purpose Hall Activity

As the Stage 4 Hall is proposed to be used at different times to the school, it has been assessed separately to the operation of the school. At the proposed hall has provision for approximately 900 persons have assumed the following inputs in assessing noise emissions from the hall. It should be noted that the proposed use of the hall into the night will require assessment to the night time criteria, which is more stringent criteria. The following assumptions about the hall are as follows:

- Masonry/Block work construction to walls;
- 6mm Glass entry doors closed during use;
- 900 persons inside the hall with a sound power level of L_w=111;
- Occupied mid frequency reverberation times of 1.0 to 1.5 seconds;

Predicted noise emissions from the hall are presented below in Table 13. As shown noise emissions exceed at the adjoining church. We would anticipate that this issue would simply be addressed by closing all doors

during noisy activity from the hall. Provided church services do not take place at the same time and that the church will also utilise the hall for many of its activities.

All doors to the hall should remain closed during use, particularly into the night, to minimise the potential for sleep disturbance. Recommendations regarding the use of the hall are further discussed in Section 6.

Table 13: Predicted Hall Noise Emissions with doors open, $L_{eq\ 15\ minute}$ dB(A).

Location	INP Criteria Night	Predicted Noise Levels Doors Closed	Complies (Y/N)
Location 1 – Elizabeth Street Residences	38	19	Yes
Location 2 – Fox Valley Road Residences	39	22	Yes
Location 3 – Wahroonga Adventist Church	50	37	Yes
Location 4 – Sydney Adventist Hospital	50	27	Yes

5.1.4 Sporting Activities

To determine the impacts of sporting activity, predicted noise levels were assessed from previous measurements of court type sports, which involve participants and crowd shouting, use of referee of whistles and crowd applause.

For the purposes of this assessment a sound power level of 102 dB(A) for each sports field was used. This is based upon previous measurements for sporting activity. For a typical worst case scenario, we have assumed all three facilities operating simultaneously, into the evening period.

Predicted noise levels are presented below in Table 14. As shown predicted noise levels from all sports fields in operation was predicted to exceed the criteria. Based upon these results, we anticipate less intensive use of the sports fields will still result exceedances for both day and evening periods.

Acoustic treatment options to these sports fields will be required. Noise mitigation measures to reduce noise from the proposed sports fields, is discussed further in Section 6.

Table 14: Predicted noise emissions from sporting activity, $L_{10,\ 15\ minute}$ dB(A).

Location	ENCM Evening Criteria 'RBL+5' for a new sporting event	Predicted Noise Levels	Complies (Y/N)
Location 1 – Elizabeth Street Residences	46	**60**	No
Location 2 – Fox Valley Road Residences	47	**59**	No

5.1.5 Car park Noise

For the purposes of this assessment we have assumed the following aspects of the operational car park. As we are assuming the car park may be used during night time use of the hall beyond 10pm, we have assessed full use of the car park at night.

To determine the impact of the car park on the nearest sensitive receivers, the following assumptions were applied:

- Cars entering the car park from Fox Valley Road and descending the car park ramp, using a sound power level of Lw=89 dB(A);
- Cars exiting the car park, ascending the car park ramp and exiting via Fox Valley Road, using a sound power level of Lw = 92 dB(A);
- Assumed 31 vehicle trips, or 25% of the proposed 124 new car spaces in 15-minutes;
- Typical event duration of 10 seconds for each car movement;
- We have assumed building shielding of -10 dB(A) from intervening structures to Locations 3 and 4;

Predicted typical worst case noise levels from the proposed car park is shown in Table 15. As shown, noise levels from cars entering/leaving the car park are predicted to exceed the noise criteria by 12 dB(A). Proposed treatments and management measures to the car park are presented in Section 6 of this report.

Table 15: Predicted car park noise at the site entry, $L_{eq,\ 15\ minute}$, dB(A).

Location	INP Criteria Night Period	Predicted Noise Levels	Complies (Y/N)
Location 1 – Elizabeth Street Residences	38	47-49	N
Location 2 – Fox Valley Road Residences	39	49-51	N
Location 3 – Wahroonga Adventist Church	50	36*-38*	Y
Location 4 – Sydney Adventist Hospital	50	34*-36*	Y

'* Assumed building shielding of -10 dB(A).

5.2 Traffic Noise Impacts

5.2.1 Road Traffic Report Key Findings

A road traffic assessment report for this project has been prepared by Transport and Traffic Planning Associates and is based on the current development proposal site layout. Based on a review undertaken by Cardno, the key acoustic related findings of the report are outlined below.

- Fox Valley Road is a Regional Road and collector route connecting Pacific Highway and The Comenarra Parkway.
- Existing Annual Average Daily Traffic (AADT) for the two collector roads are (inclusive of current Adventist Primary School operations):
    - The Comenarra Parkway (South of Fox Valley Road): 14,137
    - The Comenarra Parkway (North of Fox Valley Road): 19,319
    - Fox Valley Road (North of The Comenarra Parkway): 16,535
- In relation to car spaces, the proposed development will provide a total of 124 car spaces.
- Based on the assessment of the road network in the area around the proposed development, vehicle entry/ exit will be via Fox Valley Road.
- The traffic survey undertaken in 2012 on Fox Valley Road yielded peak hourly traffic movements shown in Table 16.

Table 16: Summary of existing 2012 peak hour traffic flows (vtph).

Road	Morning Peak Hour	Evening Peak Hour
Fox Valley Road – north side of intersection	1,511	1,442

To determine the additional traffic generated onto the existing road network, the following calculation assumed that all traffic from the proposed site car park will utilise Fox Valley Road, or 124 vehicle trips in 1 hour.

Following analysis using the CoRTN Methodology outlined in Section 4.5, the following predicted change in noise levels to the road traffic network in summarised below in Table 17. As shown the predicted acceptable change to Fox Valley Road is determined to be within acceptable limits (i.e. 2 dB(A), and the development will not result in any significant change in road traffic noise.

The Transport and Traffic Planning Associates report states that the existing bus network is currently under-utilised and is capable of servicing additional bus trips.

Table 17: Predicted relative increases in traffic noise level, dB(A).

Road	Existing Vehicle (vtph)	Additional (vtph)	Predicted Change $L_{eq, 1hr}$
Fox Valley Road – north side of intersection	1442 to 1511	124	+0.4

5.3 Construction Noise Impacts

At this stage the proposed construction works staging has not been finalised. Based upon similar projects of this type, we anticipate the following stages are anticipated during construction, summarised below in Table 18.

Table 18: Estimated Construction Stages.

Construction Stage	Estimated General Activities
Site Establishment:	Minor site earthworks to create a building pad, construction of a retaining wall, storm water and other hydraulic services.
Earthworks:	Bulk earthworks including topsoil stripping, excavation of below grade car park, construction of batters and landscaping Removal of spoil and increased heavy vehicle movements are expected
Building Construction:	Delivery of construction materials and other consumables, mobile cranes/ hoists, formwork, erection of scaffolding, power tools, internal fit out works.

Based on the estimated general construction activities, the estimated type and quantity of plant is summarised in Table 19.

Table 19: Estimated construction plant.

Construction Activity	Equipment Type	Quantity
Site establishment	30t Excavator	1
	Bobcat	1
	Tree Shredder and truck	1
Bulk excavation	30t Excavator	2
	5t Excavator	1
	Haulage trucks	2
	Concrete pump	1
	Piling rig	1
Building construction	Delivery trucks	2
	Mobile cranes	2
	Hand tools	Not known

Table 20 provides a summary of typical sound power levels for the anticipated construction equipment, based on previous projects, published data and with reference to the Australian Standard AS2436-2010 "Guide to Noise Control on Construction, Maintenance and Demolition Sites".

Table 20: Estimated construction plant items and associated sound power levels, L_{eq}

Equipment	Sound Power Level per Item, dB(A)	Estimated Quantity	Total Sound Power Level, L_{A10} dB(A)
30t Excavators (for bulk excavation)	108	2	111
5t Excavators (for detailed excavation)	102	1	102
Trucks	106	2	109
Impact Piling Rig	124	1	124
Cranes and hoists	110	2	113
Concrete pump trucks	106	1	106
Tree shredder (including truck)	118	1	118

Predicted construction noise levels based upon typical plant items are presented below in Table 21. As shown worst case unmitigated construction noise levels at the residential areas, hospital and church are predicted to exceed the construction noise criteria outlined in Table 10. This will require the provision of best practice noise mitigation measures to reduce construction activity to acceptable levels. These mitigation measures are discussed in Section 6 of this report.

Table 21: Predicted worst-case construction noise levels $L_{eq,\ 15\ minute}$ dB(A).

Construction Activity	Equipment Type	Operating distances, m		
		30m	100m	200m
Site establishment	30t Excavator	69	59	53
	Bobcat	64	54	48
	Tree shredder and truck	76	66	60
Bulk excavation	30t Excavator	69	59	53
	5t Excavator	60	50	44
	Haulage trucks	67	57	51
	Concrete pump	64	54	48
	Impact Piling rig	82	72	66
Building construction	Delivery trucks	64	54	48
	Mobile cranes	71	61	55

6 Discussion

A noise impact assessment was conducted for the proposed new Wahroonga Adventist School. As outlined this assessment was based upon offensive noise activities, which have the potential to occur outside standard operating hours for the school.

Noise emissions from the classrooms were determined to comply with the project specific criteria during the evening period with windows closed.

At the time of writing, information regarding proposed mechanical plant items was not known, however it is anticipated that the use of best practice engineering measures to attenuate noise from mechanical plant. At this stage we would nominate that mechanical plant and equipment from the site does not exceed a limiting aggregate sound power level of L_w=87 dB(A) would be sufficient to achieve the NSW INP criteria at the assessment locations. Recommended practice engineering measures to achieve the limiting aggregate sound power level include:

- The application of acoustic silencers;
- Barrier screening and enclosures to rooftop plant;
- Location of noisy plant away from the affected boundaries;
- Use of screening and shielding for rooftop plant items;
- Preferential selection of “quiet” option plant and equipment.

It should be noted that the majority of plant and equipment will be on the rooftop. Some iteration of plant items, plant location and acoustic treatments is anticipated in the detailed design phase of the project.

The proposed use of the hall for use outside school hours was predicted to have minimal noise impacts on the surrounding community, provided the doors to the facility remain closed during use, and particularly during events which occur into the night.

Based upon current traffic information, predicted changes in traffic noise, projected vehicle movements on Fox Valley Road are predicted to be largely negligible.

For construction noise activity most typical plant items and activities associated with proposed works are anticipated to exceed the NSW Construction Noise criteria and will require best practice measures, as outlined in Australian Standards 2436-2010. Best practice construction noise mitigation measures should include:

- The selection screw piling, in lieu of percussive piling;
- Scheduling noisier activities for less sensitive periods;
- Erection of site hoardings;
- Distance attenuation (or safe operating distances);

The use of the on-site car park was predicted to exceed the criteria by up to 12 dB(A) at night. To reduce noise emissions from cars entering and leaving the car park, noise control measures such as absorptive treatments to the car park entry ramp are recommended, to reduce reverberant noise emissions inside the car park. However it would be difficult to screen the car park from these affected residences in Fox Valley Road. As an alternative, the strictly limiting number of cars accessing/exiting the car park could be limited to reduce noise levels at night.

The use of the sports fields was predicted to exceed the adopted noise criteria for sporting events in the evening by up to 14 dB(A). This suggests optimal operation of the sports fields will have a significant noise impact on the surrounding residences. To treat noise emissions using engineering measures only, it is anticipated that fencing or noise walls, with a nominal height of 3.0m is required to achieve the evening noise criteria. This will have some practical limitations, particularly for the open playing field, as the erection of noise barriers or noise walls around this field would have space limitations to the adjoining field.

Acoustic rated acrylic vinyl, such as 'Acoustifence' (Rw28) or similar material could be applied around the netball courts, but this would not be practical for the open sports field, which would require earthworks berms (or similar) to be applied to at least 3-sides of the playing fields. Due to the constraints of the property, we understand from our discussions with Stanton Dahl, that the consideration of noise attenuating barriers will be difficult, may not be feasible or reasonable, particularly for the open playing fields.

Based upon the adopted criteria, a new sporting event 'L_{90} + 5 dB(A)' is based upon the sports fields being classified under the criteria as a 'new sporting event', as it is currently not conducted on the site. However, given the established presence of the Adventist Community on the Wahroonga Estate, consideration should be given to relaxation of the criteria to a new 'existing sporting event or L_{90} + 10 dB(A)'. This process may require some liaison between relevant stakeholders, to determine community attitudes and sensitivity to evening sports field noise, before adopting a relaxation of the criteria. Based upon preliminary calculations, a relaxation of the noise criteria to a 'existing sporting event', is estimated to reduce barrier/fencing by approximately 1m in height.

It is also recommended that a noise management plan for the operation of the sports fields is considered, as a part of an overall management plan for the site. A noise management plan will place emphasis on the proponent to manage their own sports field noise, rather than relying upon the provision of large noise attenuating structures. Noise management measures recommended include:

- Encouragement orderly planning of the venue/site by regulating the frequency of noisy events;
- Minimise or limit the use of referee's whistles, use of public address systems;
- Encourage supervision of sporting by teachers/staff during the use of the playing fields;
- Encourage patrons to leave the sporting fields in a quick and quiet manner to reduce the likelihood of neighbourhood complaints;
- Limit the use of the fields during the evening period to one court/field as opposed to all 3 courts/fields will result noise emission reductions of approximately 5dB(A).

At this stage, these recommendations are in-principle and further detailed design of the sports fields and stake holder liaison will be required to determine the appropriate list of noise mitigation measures to minimise offensive noise impacts on the community.

7 Conclusion

A noise impact assessment was conducted for the proposed Wahroonga Adventist School. The assessment was conducted addressing offensive noise. The findings of the study have determined that the operation of the sports fields will have a significant noise impact on surrounding residences and will require a range of measures to reduce sporting field noise on the local community. Engineering measures alone, particularly to the open playing fields may not be feasible or reasonable and alternative measures, such as relaxation of the criteria and noise management measures will also need to be considered to reduce the requirement for barriers.

Noise impacts from the proposed car park are predicted to exceed the project specific criteria and mitigation measures will be required to reduce these impacts. Extra-curricular use of the classrooms and hall were determined to comply with the project specific criteria into the night period. We anticipate that these issues will be addressed during the detailed design phase of the project, and should form part of an overall management plan for the site, to minimise the impacts of after-hours activities on the neighbouring community.

8 Glossary

Ambient Sound: Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far.

Background Sound Level: The average of the lower levels of the ambient sound. The background sound levels are commonly deemed to be the L90 when statistically based measurements are used. In the case of a noise complaint, the background sound level is measured in the absence of the noise alleged to be offending.

Decibel, dB: A unit of acoustic measurement. Measurements of power, pressure and intensity may be expressed in dB relative to standard reference levels.

dB(A): A unit of acoustic measurement electronically weighted to approximate the sensitivity of human hearing to sound frequency.

$D_{nT,w}$: Weighted standardised level difference: Noise reduction, weighted in the same manner as STC ratings but over a slightly different frequency range. Basically the same measurement as was previously termed NIC, but allows for the fact that most occupied domestic rooms have a reverberation time (RT) of about 0.5 seconds. (Field measurements are 'standardised' to this value). Higher values mean higher sound isolation performance, or the higher the number the quieter it the outcome will be.

D_w: Weighted level difference: Noise reduction, weighted in the same manner as STC ratings but over a slightly different frequency range. Basically the same measurement as was previously termed NIC. Higher values mean higher sound isolation performance, or the higher the number the quieter it the outcome will be.

L_{eq}: Equivalent continuous sound pressure level. The sound pressure level of a continuous steady sound that has the same sound energy as the actual time-varying sound.

L_{AeqT}: The A-weighted value of the L_{eq}, also specifying a measurement time interval T. Where T is omitted, the time interval is undefined.

Noise Rating Number: A single number ascribed to a prescribed set of measured octave band sound pressure levels. The number ascribed is the greatest of the set of octave band noise rating numbers (q.v.) calculated from the measured set of octave band sound pressure levels.

R_w : Weighted Sound Reduction Index of a partition separating two enclosed spaces: a single number evaluation of its ability to attenuate sound passing between the two spaces, obtained under laboratory test conditions. R_w takes into account the sound transmission loss in each band of a specified set of one-third octave bands. Similar to STC. Defined in AS 1276.

R'_w Weighted Apparent Sound reduction Index. The equivalent parameter to R_w but obtained under field test conditions. Similar to FSTC. Defined in AS 1276.

Sound Pressure Level, Lp, dB of a sound: 20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure of 20 microPascals. Sound pressure level is measured using a microphone and a sound level meter, varies with distance from the source and is affected by the environment. The term "noise level" generally refers to the measured sound pressure level.