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REPORT No.: 001 R05 201009de

PROJECT: ABERCROMBIE PRECINCT REDEVELOPMENT PROJECT
NOISE IMPACT ASSESSMENT

CLIENT: University of Sydney
C/- DBL Property
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DATE: 2 April 2012

MARSHALL DAY ACOUSTICS

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DOCUMENT STATUS

Revision	Purpose	Date delivered	Reviewed by
-	Issued to client	18 November 2010	MB
01	Operational noise updated	3 December 2010	JBB
02	Operational noise updated	9 December 2010	JBB
03	Car parking numbers adjusted	7 March 2011	JBB
04	Revised concept plan	21 February 2012	IW
05	Updated construction hours	23 February 2012	SM
06	Revised basement plan	2 April 2012	IW

EXECUTIVE SUMMARY

Marshall Day Acoustics has conducted an assessment of the potential noise emissions associated with the proposed Abercrombie Precinct redevelopment to be located on the corner of Abercrombie Street and Codrington Street, Darlington, New South Wales.

Background noise monitoring was conducted between 5 November 2010 to 17 November 2010 inclusive.

Noise criteria have been derived in accordance with the requirements of the Office of Environment and Heritage's (OEH, formerly known as the DECCW) *Industrial Noise Policy* (INP), *Road Noise Policy* (RNP), *Noise Guide for Local Government* (NGLG) and RNP sleep disturbance criteria.

Noise emissions from car parking and truck access to the loading dock will comply with the INP project specific noise levels. Traffic noise levels on local roads are anticipated to be below the recommendations of the RNP.

During the concept stage of this proposed development, specific noise level criteria have been developed in accordance with current New South Wales policies and guidelines. In principal, noise levels are expected to be compliant with all relevant criteria. When the detailed design stage commences, comprehensive review and design of mechanical plant noise sources will be undertaken to ensure that any offsite noise propagation is compliant with relevant established criteria.

1.0 INTRODUCTION

Marshall Day Acoustics has been engaged to conduct a noise impact assessment for the proposed Abercrombie Precinct Redevelopment Project (APR). The APR involves the development of existing University land for the purposes of a new Economics and Business School on the Darlington campus. This assessment is to be submitted to the Department of Planning for approval of the Part 3A Major Project Application.

This report addresses the potential impact associated with the construction and operation of the development. An outline of the content is provided below:

- A description of the site and the surrounding area
- An assessment of the existing noise environment in accordance with the Office of Environment and Heritage's (OEH, formerly the DECCW) *Industrial Noise Policy* (INP) and determination of the project specific noise impact criteria
- A description of the site and its predicted noise impact when assessed in accordance with the INP
- A review of construction noise and vibration under guidance from the OEH's *Interim Construction Noise Guideline* (CNG) and *Assessing Vibration: a technical guideline*
- A discussion of the potential increase in traffic noise under guidance from the OEH's *Road Noise Policy* (RNP, formerly the DECCW's *Environmental Criteria for Road Traffic Noise*)
- An assessment of the potential for sleep disturbance in accordance with OEH's *Noise Guide for Local Government* (NGLG)
- An assessment of the State Environmental Planning Policy (Infrastructure) 2007 (SEPP Infrastructure 2007) requirements in relation to this development
- A discussion of noise and vibration mitigation measures for the construction and operational phases of the development.

It should be noted that the development stage is still in a concept form and therefore our assessment is largely qualitative and is intended to set benchmarks and provide guidance to assess and manage potential acoustic impacts brought about by the proposed development.

Acoustic terminology used throughout this report is defined in Appendix A.

2.0 DEVELOPMENT DESCRIPTION

The APR involves the redevelopment of the land bounded by Abercrombie Street, Codrington Street, Darlington Land and Darlington Public School. The proposed development is for the construction of a new six storey business school of approximately 27,518m^2 facing Codrington Street, a new 4 storey student accommodation building of approximately 6,800m^2 facing Abercrombie Street, a two level underground car park with 82 spaces and associated landscaping. It is anticipated mechanical services will be located in the basement and on the roof.

The site of the proposed development is bounded by Codrington Street to the East, Darlington Road to the North, Darlington Public School to the West and Abercrombie Street to the South. The subject site is zoned for use by the University. Refer Appendix B for zoning and site maps.

The southern and western rail corridors are located approximately 230m to the south of the development site. State Road 54 lies to the north of the site, at a minimum distance of approximately 120m.

The nearest receivers are residences located on the opposite side of Abercrombie Street to the South, residences located on Darlington Lane to the North, Darlington Public School to the West, and the University of Sydney Services Building on Codrington Street to the East.

The following receivers have been selected to be representative:

Receiver A	No. 120 Darlington Road, Darlington (representing the residential properties adjoining the site on Darlington Road, 7 of which are privately owned, the remaining owned by USYD).	facade of dwelling located approximately 16m from the northern facade of the proposed development
Receiver B	No. 422 Abercrombie Street, Darlington (representing the residential properties located to the south of the site on Abercrombie Street)	facade of dwelling located approximately 18m from the car park entrance of the proposed development
Receiver C	Darlington Public School	Directly to the West
Receiver D	USYD Services Building	Directly to the East

In addition, the proposed student accommodation building will be considered as part of our assessment (designated Receiver E).

Refer to Appendix B for site map indicating nearest noise sensitive receivers.

3.0 POTENTIAL NOISE AND VIBRATION IMPACTS

A number of potential noise and vibration impacts are associated with the construction and operational phases of the proposed development. Table 1 overleaf details these impacts and the relevant legislation or guideline applicable for the assessment of each.

Table 1
Potential noise and vibration impacts from the proposed development

Phase	Potential impact	Source of assessment criteria	Document status
Construction	Noise from construction activities including demolition	Interim Construction Noise Guideline	Interim guideline
	Vibration from construction activities including demolition	Assessing Vibration: a technical guideline	Guideline
Operation	Loading dock, deliveries and waste collection noise	Industrial Noise Policy	Guideline
	Car parking activity	Industrial Noise Policy	Guideline
	Mechanical services noise	Industrial Noise Policy	Guideline
	Late night car park activity	Noise Guide for Local Government Road Noise Policy	Guideline
	Traffic noise	Road Noise Policy	Guideline
	Outdoor activities*	Industrial Noise Policy	Guideline

*In the absence of any specific noise guideline for outdoor activities, these will be assessed under the INP.

In addition, SEPP Infrastructure 2007 requires the potential impact of the existing environment on the proposed development be considered. Table 2 details these impacts and the relevant legislation or guideline applicable for the assessment of each.

Table 2
Potential noise and vibration impacts on the proposed development

Potential impact	Source of assessment criteria	Document status
Rail noise and vibration	SEPP Infrastructure 2007	Policy
	DoP Development Near Rail Corridors & Busy Roads	Guideline
Road noise and vibration	SEPP Infrastructure 2007	Policy
	DoP Development Near Rail Corridors & Busy Roads	Guideline

4.0 ENVIRONMENTAL NOISE SURVEY

In order to perform a noise impact assessment in accordance with the INP, a survey of baseline noise levels is required at locations that represent the most affected noise sensitive receivers at times when maximum impact is likely to occur.

Baseline noise levels were recorded over the period commencing Friday 5 November 2010 to Wednesday 17 November 2010 inclusive. Noise loggers were set up on site near the boundaries of Darlington Lane (representative of Darlington Road residences) and Abercrombie Street (representative of Abercrombie Street residences, Darlington Public School and USYD). Noise levels were measured continuously over this period in 15 minute intervals.

In determining existing noise levels, any data affected by extraneous noise events in addition to rainfall has been excluded. On this basis, 161 measurements were excluded from the logger placed at Darlington Lane, and 103 measurements were excluded from the logger placed at Abercrombie Street. This represents approximately 10% of the total number of measurements.

In the INP, the background noise level is termed the Rating Background Level (RBL). The methodologies used to determine the long-term RBL and L_{Aeq} noise levels for each assessment period are from Tables 3.1 & 3.2 of the INP.

The survey results for the entire one week period are summarised in Appendix C. The RBL and L_{Aeq} levels for the day, evening and night-time period are summarised in Table 3 below.

Table 3
Industrial Noise Policy time periods and ambient noise levels

Period	Time period	RBL L_{A90} dB	L_{Aeq} dB
Darlington Lane			
Day	0700-1800hrs	44	56
Evening	1800-2200hrs	43	50
Night	2200-0700hrs	39	48
Abercrombie St			
Day	0700-1800hrs	45	59
Evening	1800-2200hrs	43	58
Night	2200-0700hrs	39	54
School-internal			
Day*	0700-1800hrs	35	49

*Based on noise logging data from Abercrombie Street and 10dB noise reduction through an open window.

The measured noise levels indicate a noise environment dominated by traffic noise.

5.0 ENVIRONMENTAL NOISE AND VIBRATION CRITERIA

The assessment of criteria has been divided into two zones as indicated in Figure 1 below. This is to distinguish between the two noise environments on the site as measured by our noise loggers.

The proposed student housing will front Abercrombie Street, and will be assessed with the Zone 2 criteria.

Figure 1 Development Zoning Plan

5.1 Construction noise

The CNG is the guideline for assessing noise associated with construction activities. The CNG sets out noise management levels above which there may be community reaction to construction noise. The management levels are applicable during the proposed construction working hours for the development are as follows:

- Monday to Friday, 7am to 7pm
- Saturday, 7am to 5pm
- No construction work to take place on Sundays or public holidays.

The noise management levels for residential receivers are derived from the Rating Background Level, as determined by the requirements of the INP, and adding 10dB. For other noise sensitive receivers, internal management noise levels from construction works are provided in the CNG. The construction noise management levels are provided in Table 4 overleaf.

Table 4
Construction noise management levels

Receiver	RBL L_{A90} dB	Management level $L_{Aeq,\ 15minutes,}$ dB
Receiver A	44	54
Receiver B	45	55
Receiver C*	NA	45
Receiver D*	NA	70

*Internal noise levels

In applying the management levels, the CNG requires that all feasible and reasonable work practices be employed. Refer Appendix D for construction noise management work practices. Where the management level is exceeded, all potentially impacted residents should be informed.

Where noise levels exceed 75dBA at residences, there may be a requirement for community consultation and negotiation. Further restrictions to construction hours may be necessary to provide respite periods.

5.2 Construction vibration

For the construction phase of this project, the potential effects of vibration can be generally categorised into the following:

1. Effects on people
2. Damage to building structures

The relevant criteria and guidelines are discussed below.

Effects on people

Assessing Vibration: a technical guideline provides guidance and recommendations for the assessment and evaluation of human response to vibration. These guidelines are based on BS 6472:1992 *Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*.

The guideline separates vibration into three categories for assessment:

- Continuous – uninterrupted for a defined period such as daytime or night-time
- Impulsive – Rapid build-up followed by a damped decay
- Intermittent – interrupted periods of continuous or repeated periods of impulsive vibration.

The *Assessing Vibration* guideline uses a vibration dose value (VDV) criteria to assess the severity of intermittent vibration, such as that experienced from construction activities including piling and rock breaking. It takes account of the number of vibration events over the assessment period and the frequency spectrum of the vibration measured. The VDV criterion is related to the probability of adverse comment or disturbance to building occupants. The preferred values indicate a low probability of adverse comment, and the maximum values indicate adverse comments may be expected.

The VDV criteria for a range of receiver types are provided in Table 5 below.

Table 5
Acceptable vibration dose values for intermittent vibration, m/s$^{1.75}$

Receiver type	Day-time[1]		Night-time[1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26
Offices, schools Educational institutions	0.40	0.80	0.40	0.80

Note 1: Day-time 7:00am to 10:00pm and night-time 10:00pm to 7:00am.

Damage to buildings

Guidance relevant to acceptable vibration at the foundation of buildings is contained within:

- German Standard DIN 4150 (1999) *Structural vibration Part3: Effect of vibration on structures*, and;
- British Standard BS 7385 (1993): *Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground-borne vibration*.

German Standard DIN 4150 Part 3 provides limits below which cosmetic damage to buildings is very unlikely to occur. These are provided in Table 6 below.

Table 6
Vibration limits according to DIN 4150, PPV mm/s

Building Class	Type of building	Maximum PPV vibration, mm/s
I	historical, ancient buildings, ruins and monuments	2
ii	buildings visibly damaged and cracked	4
iii	structurally sound buildings (technically in good order)	6
iv	industrial buildings, concrete buildings - generally without plaster	10-40

BS 7385 defines the following different classes of damage:

- Cosmetic – formation or extension of hairline cracks in plaster or mortar;
- Minor – formation of large cracks or loosening and falling of plaster or formation of cracks through bricks or blocks; and
- Major – damage to structural elements of the building.

BS 7385 states that there should typically be no cosmetic damage if intermittent vibration does not exceed 15mm/s at low frequencies rising to 20mm/s at 15Hz and 50mm/s at 40Hz and above. It is recommended that vibration from construction activities should be limited to the values provided in BS7385 and reproduced in Table 7 below.

Table 7
BS 7385 Construction vibration criteria for buildings, PPV mm/s

Construction	Limits for Transient Vibration	
	4 – 15 Hz	>15 Hz
Heavy or reinforced	50 mm/s	
Light (eg normal dwellings)	15 mm/s at 4 Hz rising to 20 mm/s at 15 Hz	20 mm/s at 15 Hz rising to 50 mm/s for 40 Hz and above

It should be noted that of the vibration criteria presented in Table 5 through to Table 7, the human response criteria in Table 5 are the most stringent. Compliance with the criteria for human response will result in compliance with criteria for vibration in buildings. Refer Appendix D for construction vibration management work practices.

5.3 Industrial Noise Policy

In NSW, the INP is the guideline for assessing noise emissions from industrial facilities and other developments with noise sources that may be considered to be industrial in nature. The INP sets out a procedure where an industrial facility can be assessed against a series of noise level criteria. In the INP, these criteria are called the *project specific noise levels* and are derived from an involved analysis of the ambient noise environment and zoning information. The *project specific noise levels* for this development are summarised below in Table 8 with the derivation set out in Appendix E.

Table 8
Project specific noise levels for Zone 1

Period	Intrusiveness Criteria $L_{Aeq,\ 15mins}$, dB	Amenity Criteria $L_{Aeq\ period}$, dB
Day	49	58
Evening	48	44
Night	44	38

Table 9
Project specific noise levels for Zone 2

Period	Project Specific Criteria
Residences	
Day	50dB $L_{Aeq, 15mins}$
Evening	48dB $L_{Aeq, 15mins}$
Night	44dB $L_{Aeq, 15mins}$
School Classroom-internal	
When in use	39dB $L_{Aeq, period}$
Commercial	
When in use	65dB $L_{Aeq, period}$

5.4 Road Noise Policy

The noise level criteria for increased traffic flow as a result of land-use development with the potential to create additional traffic are set by the RNP. Table 10 presents the traffic noise criteria for this development.

Table 10
Road traffic noise criteria

Type of Development	Criteria	
	Day 0700-2200hrs	Night 2200-0700hrs
Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hr)}$ 55dB	$L_{Aeq(1hr)}$ 50dB

Source: Table 3 OEH's RNP

In addition to the above criteria, the increased traffic associated with the development should not increase the existing noise levels by more than 2dBA.

5.5 Sleep Disturbance Criteria

OEH's Noise Guide for Local Government

In their *Noise Guide for Local Government* the OEH provide the following criteria as an example of a "screening test" to determine the potential for sleep arousal:

- The L_{A1} level of any specific noise source should not exceed the background noise level (L_{A90}) by more than 15dB when measured outside a bedroom window.

L_{A1} is defined as the noise level that is exceeded for 1% of the measurement time and is similar to, but numerically lower than L_{Amax}. The OEH has stated that it will accept analysis based on either L_{A1} or L_{Amax} descriptors.

In this instance, the criterion for sleep disturbance becomes 54dB L_{Amax} at the facade of the nearest affected residences for both Zone 1 and Zone 2.

Our assessment indicates that L_{Amax} levels will be exceeded at the façade of the nearest affected residences. When this occurs, the following assessment should be conducted.

OEH's INP

In their INP application notes dates 4th May 2006, the OEH have recognised that the above criteria are "*not ideal*". However, the OEH *"will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*"

The OEH recommends that detailed analysis address the extent to which sleep disturbance may occur. The use of the RNP by the OEH is recommended to review the extent of possible impacts.

The RNP suggests that potential sleep arousal from traffic should be assessed. The RNP has compared a number of sleep disturbance criteria and concluded the following:

- Maximum internal noise levels below 50-55dBA are unlikely to awaken people from sleep
- One or two noise events per night, with maximum internal noise levels of 65-70dBA, are not likely to affect health and well-being significantly.

Based on these findings, a noise level of 60-65dB LAmax outside an open bedroom window would be unlikely to cause awakening reactions (assuming that the façade of the residential building provides 10dB attenuation, which would be typical of a façade with partially open windows). Furthermore, one or two events with a noise level of 75-80dB LAmax outside an open bedroom window would be unlikely to affect health and well-being significantly.

6.0 CONSTRUCTION PHASE – NOISE AND VIBRATION IMPACT ASSESSMENT

The construction associated with the proposed development is estimated to take approximately 2 years including demolition of existing structures on site and works required for site preparation prior to the construction of buildings.

There are several sources associated with the construction phases of the development that have the potential to increase noise and vibration levels at the nearest sensitive receivers.

At this stage builders have not been engaged on this project. However, based on previous project experience, we anticipate the following activities and equipment are likely to be involved in the demolition, site preparation and construction work as provided in Table 11.

Table 11
Activities and equipment during construction

Phase	Activities	Equipment
Demolition	Demolition of existing structures including breaking concrete and brickwork	Excavator fitted with pneumatic breaker, concrete cutters, trucks, compressor
Site preparation	Digging of trenches, holes and foundations	Excavator, pneumatic breaker
	Removal of waste material from site	Tracked loaders, crane, trucks
	Piling	Rotary bored piling rig, concrete trucks, crane, drilling rig, trucks
Construction	Preparation, mixing and discharging of concrete	Concrete truck mixer, compressors, concrete pump
	Cutting/drilling through concrete	Concrete saw/drill
	Supply of air for use of power tools	Compressor
	Supply of site electricity	Generator
	Pumping water	Water pump
	Use of hand tools for cutting, drilling, assembly work	Electric saw, hammer, drills
	Moving material around site	Loader, crane
	Removal of waste material from site	Tracked loaders, crane, trucks

Noise and vibration levels for the construction phase are assessed below. Noise levels associated with each noise source are detailed in Appendix F.

6.1 Construction noise

Noise levels during construction have been calculated at the nearest noise sensitive locations during each phase. These noise levels have been predicted under guidance from *AS2436 – 1981: Guide to noise control on construction, maintenance and demolition sites*. We have assumed that all sources listed above will be working together for between 50 and 100% of the time over a 15 minute period.

It should be noted that the predicted noise levels are for those receivers closest to the construction activities.

Phase 1 – Demolition

We have presented data below for "worst case" situations where noise sources will be closest to the noise sensitive locations and also for the "average" situation, with noise sources located towards the centre of the site. The latter is likely to be representative of the long term noise emissions.

Table 12
Demolition noise at nearest receivers

Receiver	Assessment	Calculated level $L_{Aeq,\ 15minutes}$ dB	Management level $L_{Aeq,\ 15minutes}$ dB	Margin of excess $L_{Aeq,\ 15minutes}$ dB
Receiver A	"Worst-case"	78	54	+24
	"Average"	59		+5
Receiver B	"Worst-case"	72	55	+17
	"Average"	57		+2
Receiver C*	"Worst-case"	68	45	+13
	"Average"	47		+2
Receiver D*	"Worst-case"	62	70	-8
	"Average"	48		-22

*Internal noise level applies

The calculated levels for the "worst case" situation indicate that demolition noise sources are likely to be considerably above the derived management level, that is to say, when demolition noise sources will be closest to the residences and school and university receivers. Appropriate management of noise emissions will be required when demolition is occurring close to the site boundaries.

During the "average" assessment situation, which is with noise sources distributed across the site giving a long term average, the margin of excess above the derived criteria is up to 5 dBA.

The management levels will be exceeded for Receivers A, B and C and they should therefore be informed of the proposed construction activities. It is likely that community consultation and negotiation will be required with Receivers A and B during the demolition phase.

Phase 2 – Site preparation

As with the demolition phase, we have predicted noise levels for "worst case" and "average" situations.

Table 13
Site preparation noise at nearest receivers

Receiver	Assessment	Calculated level $L_{Aeq,\ 15minutes}$ dB	Management level $L_{Aeq,\ 15minutes}$ dB	Margin of excess $L_{Aeq,\ 15minutes}$ dB
Receiver A	"Worst-case"	82	54	+28
	"Average"	63		+9
Receiver B	"Worst-case"	76	55	+21
	"Average"	61		+6
Receiver C	"Worst-case"	72	45	+27
	"Average"	51		+6
Receiver D	"Worst-case"	66	70	-4
	"Average"	52		-18

The calculated levels indicate that site preparation activities, including excavation and shoring, have the potential to be significantly above the construction noise management levels when at their "worst case" assessment position. The long term noise levels are calculated to be 6 to 9dB above the derived criteria.

The management levels will be exceeded for Receivers A, B and C, therefore notification should be provided of the proposed construction activities. It is likely that community consultation and negotiation will be required with Receivers A and B during site preparation.

Phase 3 – Erection of structure and general construction

In the final and longest construction phase, a wide variety of construction plant will be utilised. Following initial site preparation and building erection, a significant proportion of the construction fit out work will occur within the proposed development and, as such, noise will be attenuated by the existing building envelope.

Table 14
General construction noise at nearest receivers

Receiver	Assessment	Calculated level $L_{Aeq, 15minutes}$ dB	Management level $L_{Aeq, 15minutes}$ dB	Margin of excess $L_{Aeq, 15minutes}$ dB
Receiver A	"Worst-case"	78	54	+24
	"Average"	58		+4
Receiver B	"Worst-case"	71	55	+16
	"Average"	56		+1
Receiver C	"Worst-case"	66	45	+21
	"Average"	47		+2
Receiver D	"Worst-case"	61	70	-9
	"Average"	48		-22

The calculated noise levels indicate that long term construction noise levels will likely exceed the noise management levels at the school and residences. Notification should be provided of the proposed construction activities. Community consultation and negotiation may be required at the start of this phase as noise levels may exceed 75dBA at Receiver A.

6.2 Construction vibration assessment

It is expected that the primary sources of vibration during the construction phase of the project will be those generated by hydraulic rock breaking and piling. The type of piling used in the construction will depend on the ground characteristics.

There are numerous factors that affect the reliable prediction of vibration levels that will be generated at nearby properties during construction activities, including:

- the ground characteristics which influence the interaction between the vibration source and the ground subject to the vibration
- the ground conditions, which influence the propagation of the energy away from the vibration source.

The reduction in vibration during transmission from the construction site to the nearest receivers and other potentially affected structures is therefore difficult to accurately predict.

In any case, the vibration dose value (VDV) criteria from the *Assessing Vibration* guideline, and reproduced in Table 5, Section 5.2, provide the limiting vibration criteria for the project.

7.0 OPERATIONAL PHASE – NOISE IMPACT ASSESSMENT

The potential noise impact associated with the operational phase of the development is assessed in the following sections.

There are several sources associated with the operation of the development that have potential to increase the noise levels at the nearest noise sensitive locations. For the purposes of this assessment, the following noise sources have been identified as having potential for noise disturbance:

- Car parking on site
- Loading dock activity
- Building services plant
- Outdoor activities
- Traffic noise levels on local roads.

The relevant guidelines have been applied to each of these which are discussed in turn below in Sections 7.1 through to Section 7.3. Noise levels associated with each noise source are detailed in Appendix F.

Noise and vibration sources that have the potential to impact on the proposed development such as road and rail are discussed in Section 7.4.

7.1 INP assessment

Car parking activity

The APR will include basement and ground level car parking for approximately 82 vehicles. The entry and exit to the car park will be located on Abercrombie Street. It is understood that access to the car park will be available to USYD staff and students 24 hours a day, 7 days a week. It is anticipated that most of the car parking activity will occur during the daytime period.

The car park will be fully enclosed; therefore the nearest noise sensitive receivers will be screened from vehicle noise within the car park. The main source of noise from car parking activity will occur from cars entering and exiting the car park.

In order to provide an indication of potential noise levels, we have calculated noise levels from cars entering and exiting the site based on the following assumptions:

Table 15
Car parking activity assumptions

Time period	Assumptions
Day	The car park will be full during the day 70% of car spaces will be occupied during the peak hour period, representing 17% of car spaces in the busiest 15 minute period
Evening	50% of car spaces will be occupied during the evening period It is expected 25% of car spaces will be occupied in the busiest 15 minute period of the evening
Night	30% of car spaces will be occupied during the evening period It is expected 5% of car spaces will be occupied in the busiest 15 minute period of the evening

Our results are presented in Table 16 through to Table 19 below.

Table 16
Receiver A calculated noise impact from car parking

	Intrusiveness Criteria $L_{Aeq,\ 15mins}$ dB			Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?	Predicted Level	Noise Limit	Compliance?
Day	<1	49	✓	<1	58	✓
Evening	<1	48	✓	<1	44	✓
Night	<1	44	✓	<1	38	✓

Table 17
Receiver B calculated noise impact from car parking

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	28	50	✓
Evening	30	48	✓
Night	24	44	✓

Table 18
Receivers C and D calculated noise impact from car parking

	Amenity Criteria $L_{Aeq\ period}$, dB		
Receiver	Predicted Level	Noise Limit	Compliance?
Receiver C*	15	39	✓
Receiver D*	<1	65	✓

*Internal noise level through an open window when in use

Table 19
Receiver E calculated noise impact from car parking

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	26	50	✓
Evening	28	48	✓
Night	22	44	✓

Truck access and loading dock activity

The loading dock is to be located at ground level in the car park. Trucks access the loading bay through the car park entrance on Abercrombie Street. All manoeuvring is to take place on site.

The number of vehicles and the proposed hours of delivery are yet to be finalised. However, it is envisaged that loading bay activity will be during the daytime period.

To provide an indication of anticipated noise levels from delivery vehicles, we have assumed there will be one delivery from a large truck every day. Our results are presented in Table 20 through to Table 23 overleaf.

Table 20
Receiver A calculated noise impact from truck access

	Intrusiveness Criteria $L_{Aeq,\ 15mins}$ dB			Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?	Predicted Level	Noise Limit	Compliance?
Day	<1	49	✓	<1	58	✓

Table 21
Receiver B calculated noise impact from truck access

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	38	50	✓

Table 22
Receivers C and D calculated noise impact from truck access

	Amenity Criteria $L_{Aeq\ period}$, dB		
Receiver	Predicted Level	Noise Limit	Compliance?
Receiver C*	27	39	✓
Receiver D*	<1	65	✓

*Internal noise level through an open window when in use

Table 23
Receiver E calculated noise impact from truck access

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	36	50	✓

Building services plant

Once a development of this nature becomes fully operational, a variety of electrical and mechanical plant will be required to service the building. Most of this plant will be capable of generating noise to some degree. Some of this plant may operate 24 hours a day, and hence has the potential to be most noticeable during quiet periods (i.e. overnight).

The general philosophy adopted in this type of development is to locate the building services plant within purpose built plant rooms in order to minimise noise emissions. Any opening required for ventilation will be orientated away from the nearest dwellings and provided with acoustic attenuators as required, to meet relevant noise criteria.

Proven noise control techniques will be employed to ensure that emissions from plant comply with the daytime, evening and night-time criteria at the nearest noise sensitive receivers.

It is envisaged that the following may be employed:

- duct mounted attenuators on the atmosphere side of all air handling plant;
- splitter attenuators or acoustic louvres providing free ventilation to internal plant areas;
- solid barriers screening any external plant;
- anti-vibration mounts on all reciprocating plant.

At this stage, the mechanical services for the APR have not been designed. Mechanical services will continue to be assessed as the design develops to ensure the appropriate noise control is applied to achieve compliance with INP noise criteria.

The use of standard acoustic treatments such as those described above will readily achieve the required attenuation to meet project specific criteria.

Outdoor activities

The APR will include landscaped rooftops which will be used for private study. It is expected that conversation may occur amongst small groups of people and this will occur at normal voice level.

We have calculated noise levels for on normal conversation on the rooftop which is expected to occur with private study use. The following assumptions have been made:

- normal voice conversation may take place continuously over a 15 minute period
- Conversation will take place over 50% of the day and evening periods
- Conversation will take place over 5% of the night-time period.

Our results are presented in Table 24 through to Table 27.

Table 24
Receiver A calculated noise impact from private study

	Intrusiveness Criteria $L_{Aeq,\ 15mins}$ dB			Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?	Predicted Level	Noise Limit	Compliance?
Day	14	49	✓	<1	58	✓
Evening	14	48	✓	<1	44	✓
Night	14	44	✓	<1	38	✓

Table 25
Receiver B calculated noise impact from private study

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	<1	50	✓
Evening	<1	48	✓
Night	<1	44	✓

Table 26
Receivers C and D calculated noise impact from private study

	Amenity Criteria $L_{Aeq\ period}$, dB		
Receiver	Predicted Level	Noise Limit	Compliance?
Receiver C*	<1	39	✓
Receiver D*	<1	65	✓

*Internal noise level through an open window when in use

Table 27
Receiver E calculated noise impact from private study

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	<1	50	✓
Evening	<1	48	✓
Night	<1	44	✓

The calculated noise levels presented in Table 24 through to Table 27 indicated noise levels associated with normal voice conversation will comply with the criteria.

It will be the responsibility of USYD to manage the use of rooftop areas to ensure that noise emissions from the rooftop to the nearest noise sensitive receivers are minimised.

Cumulative noise levels

The INP requires that the cumulative impact of all noise sources associated with a development be assessed. This ensures that the contribution of each noise source to the overall noise emissions of a development do not compromise the amenity of receivers.

The cumulative noise levels have been calculated and are presented in the tables below and overleaf.

Table 28
Receiver A calculated cumulative noise impact

	Intrusiveness Criteria $L_{Aeq,\ 15mins}$ dB			Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?	Predicted Level	Noise Limit	Compliance?
Day	38	49	✓	38	58	✓
Evening	38	48	✓	38	44	✓
Night	38	44	✓	38	38	✓

Table 29
Receiver B calculated cumulative noise impact

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	41	50	✓
Evening	38	48	✓
Night	38	44	✓

Table 30
Receivers C and D calculated cumulative noise impact

	Amenity Criteria $L_{Aeq\ period}$, dB		
Receiver	Predicted Level	Noise Limit	Compliance?
Receiver C*	31	39	✓
Receiver D*	28	65	✓

*Internal noise level through an open window when in use

Table 31
Receiver E calculated cumulative noise impact

	Amenity Criteria $L_{Aeq\ period}$, dB		
Time period	Predicted Level	Noise Limit	Compliance?
Day	40	50	✓
Evening	38	48	✓
Night	38	44	✓

Based on the information to date, the cumulative noise levels will comply with the INP project specific noise levels. The cumulative impact of all noise sources will continue be assessed as the design develops.

7.2 Sleep disturbance assessment

To assess the potential for sleep disturbance, we have predicted car parking and outdoor activity maximum noise levels at the nearest affected receivers in Table 32 below.

Table 32
Sleep disturbance assessment

Noise source	Predicted Level L_{Amax} dB	
	Receiver A	Receiver B
Standard vehicle	34	62
"Modified" car (worst case)	43	70
Loud car stereo	29	56
Rowdy voice	49	64

The predicted maximum noise levels from car parking activity and rooftop activity on site range from 29dBA to 49dBA at Receiver A, complying with the RNP criteria of 65dB L_{Amax}..

At Receiver B, the predicted maximum noise levels from activity on site range from 56dBA to 70dBA, exceeding the RNP criteria by 5dB. The RNP criterion is exceeded by 5dB in the event that the said vehicle is used in a reckless manner at the car park entrance. It is recommended that a speedhump be installed inside the entry crossovers to the site in order to maintain low vehicle speeds. .

It should be noted that the character of the noise associated with the car parking will not be dissimilar to that from the existing road traffic on Abercrombie Street.

7.3 RNP assessment

In order to increase the traffic noise levels by greater than 2dB, the required increase in traffic volumes is greater than 65%. It is understood that the additional traffic volumes on nearby streets due to the proposed development are unlikely to be significant and will be below the 2dBA increase limit recommended by the RNP.

7.4 SEPP Infrastructure 2007

Rail noise and vibration

SEPP Infrastructure 2007 requires that the potential impact of rail noise and vibration be considered for developments, including educational institutions, which are located adjacent to a rail corridor.

In determining whether a development is at risk of potential noise and vibration impacts from rail, the following factors must be considered:

- Distance from rail corridor
- Line of sight to the rail corridor
- Type of trains using the rail corridor
- Speed of trains using the rail corridor.

The Department of Planning (DoP) document *Development near Rail Corridors & Busy Roads* provides the following graphs for determining the level of assessment required for developments adjacent to rail corridors.

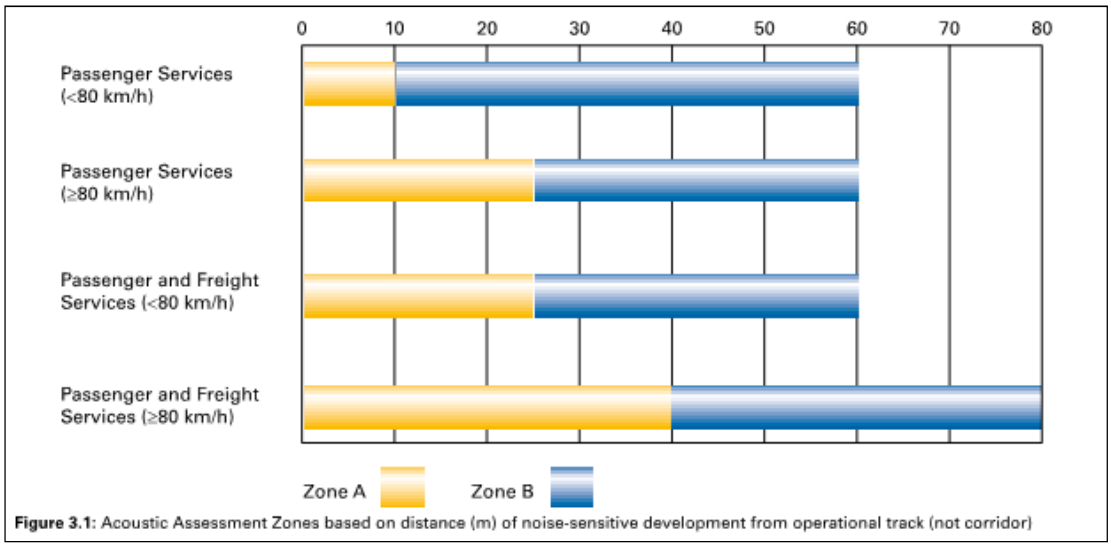

Figure 2: Rail noise assessment guide
Source: DoP *Development near Rail Corridors & Busy Roads*, Figure 3.1

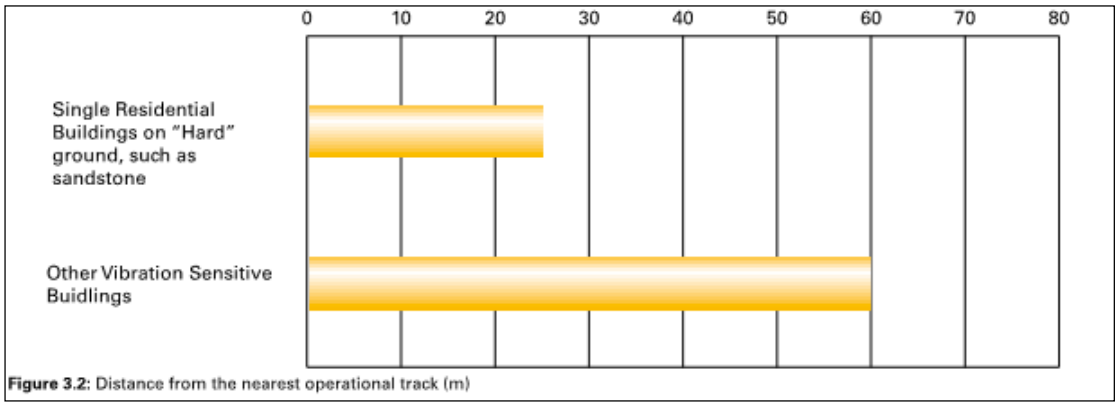

Figure 3: Rail vibration assessment guide
Source: DoP *Development near Rail Corridors & Busy Roads*, Figure 3.2

For developments located within Zone A, a full impact assessment is required. For developments located within Zone B (relevant to noise only), standard mitigation measures are available for single dwelling residences.

The APR is located approximately 230m north of the nearest rail corridor. Based on Figure 2 and Figure 3 above, an assessment of rail noise and vibration is not required.

Road noise and vibration

SEPP Infrastructure 2007 requires that the potential impact of road noise and vibration be considered for developments, including educational institutions, which are located adjacent to a busy road. A busy road is classified as a road that is a freeway, toll way, or transit way, or a road that has an annual average daily volume of more than 40,000 vehicles.

Based on the traffic volume data from the RTA, the roads adjacent to the proposed APR do not meet the requirement of a busy road classification. Therefore, an assessment of road noise and vibration is not required.

8.0 SUMMARY

- Marshall Day Acoustics has performed an acoustic assessment associated with the proposed Abercrombie Precinct Redevelopment located on the corner of Abercrombie and Codrington Streets, Darlington.
- The current noise environment is characterised by distant traffic noise.
- Noise associated with construction activities has been found to exceed the noise management level of the CNG. Community consultation will be required.
- Mechanical plant to be installed as part of the proposed development will be designed to minimise impacts on the nearest receivers and comply with the INP.
- Noise impacts from car parking and truck access to the loading dock will not exceed the INP project specific noise levels.
- Management of the rooftop will be required by the university to ensure the amenity of residences is not compromised.
- Noise from most activities on-site will not exceed the RNP sleep disturbance criterion. The inclusion of a speedhump is recommended at the car park entry to minimise noise associated with excessive vehicle speeds.
- Traffic noise levels on local roads are anticipated to be below the recommendations of the RNP.
- We have reviewed the SEPP Infrastructure 2007 and found the assessment of rail and road noise and vibration will not be required for this development.

Based on the above we conclude that the proposed development can be designed and constructed in order to control noise emissions to an appropriate level.

APPENDIX A

ACOUSTIC TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
L_{90}	Background noise levels are described in terms of the level exceeded for 90% of the measurement period (L_{90}). This is commonly referred to as the typical minimum level and is generally measured in dBA.
L_{10}	Non-continuous noise levels are described in terms of the level exceeded for 10% of the measurement period (L_{10}). This is commonly referred to as the typical maximum level and is generally measured in dBA.
L_{eq}	Continuous or semi-continuous noise levels are described in terms of the equivalent continuous sound level (L_{eq}). This is the constant sound level over a stated time period which is equivalent in total sound energy to the time-varying sound level measured over the same time period. This is commonly referred to as the average noise level and is generally measured in dBA.
dBA	Unit of overall noise level, in A-weighted decibels. The A-weighting approximates the average human response over the entire frequency range.
L_{max}	The maximum noise level (L_{max}) is defined as the highest noise level which occurs during any noise event occurring over a particular time period. This is generally measured in dBA.
L_{01}	Non-continuous noise levels can be described in terms of the level exceeded for 1% of the measurement period (L_{01}). For dog barks, we consider that this level would approximate to the average maximum of meter deflections.
Octave band	The noise level at a range of individual frequencies can be determined by dividing the frequency range (usually 63Hz to 4kHz) into 7 frequency bands called octave bands, with centre frequencies of 63Hz, 125Hz, 250Hz, 1kHz, 2kHz and 4kHz.
L_w	Sound power level. The measure of acoustic power radiated by a sound source.
SPL	Sound pressure level referenced to 20 micro Pascals, expressed in decibels. An increase of 10dB on average represents a doubling in the subjective loudness of a sound.