CLANCY CATHOLIC COLLEGE
WEST HOXTON

Acoustic Assessment for Development Application

Issued

March 2016

acoustic studio

abn	76 106 325 982
address	Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel	(+61) 2 9557 6421
fax	(+61) 2 9557 6423
email	mail@acousticstudio.com.au

Contact for this Report

Peter Griffiths
peter.griffiths@acousticstudio.com.au

acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
fax (+61) 2 9557 6423
email mail@acousticstudio.com.au

Proj & Code	Clancy Catholic College, West Hoxton	FTP-2468
Doc Title	Acoustic Assessment for Development Application	
Ref	20160210.FTP2468.0002.Rep.RevD.docx	
Date	March 2016	Revision: D
Author(s)	Laura Lapena & Peter Griffiths	

Circulation	**Organisation**	**Location**	**Delivered Via**
Michelle Teutenberg	Fulton Trotter Architects	Sydney	e-mail
Ben McFadden	Fulton Trotter Architects	Sydney	e-mail

Appendices	As listed in the Table of Contents

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This report takes into account the particular instructions and requirements of our Client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Table of Contents

Executive Summary

Clancy Catholic College is proposing the extension of some of its existing facilities, currently sited at 201 Carmichael Drive, West Hoxton.

A Development Application (DA) is to be submitted to Liverpool City Council for the new and refurbished components of the development. Fulton Trotter Architects (FTA) is the lead consultant and architect for the project.

The refurbishment of the existing premises involves a new Hall, a Gallery link building to connect the existing Lecture Theatre and new Hall buildings, new soundproofed music practice rooms within the existing Music buildings, new Fitness and Canteen blocks plus adjacent multi-purpose playing courts, and additions and extensions to the existing Theatre, Science, Administration, Library/Staff and TAS building.

Acoustic Studio has undertaken a noise impact assessment to determine if there will be any adverse noise impacts on the community and local residences or businesses as a result of the proposal, plus to provide a description of the acoustic and noise control measures that will be incorporated into the proposed design to control those noise impacts.

The key noise sources associated with the proposal likely to have an impact in surrounding residences and sensitive receivers are:

- New mechanical plant for the proposed buildings.
- Assemblies, sports events and performance activities in the new Hall, Gallery and adjacent new Entry Courtyards, particularly when live, amplified music is included as part of the activity.
- Vehicles movements in the car parks, including overflow car park areas during major events.
- Sports activities on the new multi-purpose playing courts.
- Noise impacts during construction.

In addition, we have considered any external noise sources that may impact on the proposed development, and provided a description of the acoustic and noise control measures required to control these noise impacts. The key external noise source that may impact on the proposed facilities is local traffic on Carmichael Drive and surrounding local streets and those are anticipated to have a minimal impact on the facility.

A summary of the DA noise assessment is outlined below:

Environmental noise from mechanical plant

Residential boundary noise criteria have been set, based on the measured existing background noise level:

- Day A maximum L_{Aeq} of 44 dB from mechanical plant noise.
- Evening A maximum L_{Aeq} of 42 dB from mechanical plant noise.

Noise controls will be incorporated within the mechanical services (including outdoor chiller and condenser units, exhaust fans, rooftop plant, etc.) to ensure that the cumulative noise output from the plant at the nearest affected receivers meets the above criteria. Details of recommended noise controls for mechanical plant are provided in Section 6.3 of this report.

Operational noise from new hall and refurbished theatre

The calculation and predicted boundary noise levels from activities and operation of the new hall and refurbished theatre show that the INP intrusive noise criteria will be met at the nearest residential boundaries under the worst-case scenario of simultaneous amplified music performances in the Hall and the Theatre.

No further noise control recommendations are required.

Patron noise from the new Entry Courtyard

The calculation and predicted boundary noise levels from patrons congregating and talking in the new Entry Courtyard show that the INP intrusive noise criteria will be met at the nearest residential boundaries, provided patrons are encouraged to enter the Gallery/Foyer area of the building, and large build-ups of patrons are discouraged in the Courtyard. It is recommended that this be included in the school's noise management plan.

No further noise control recommendations are required.

People noise from the Canteen Undercroft

The Undercroft is acoustically shielded from the nearest residential boundaries and the resulting noise levels will be significantly less than those produced by the activities within the hall and theatre. Noise from the undercroft will be inaudible at the nearest residential boundaries, and no further noise controls are required.

Carpark noise and increase in traffic noise due to the proposal

It is expected that in all cases the increases in noise level resulting from (a) local roads, (b) new car park areas, and (c) vehicle and drop-off points will be inaudible and insignificant, and that the design criteria of an increase of no more than 2 dB(A) will be met, as a consequence of the insignificant changes in traffic flows and vehicle numbers resulting from the proposed development.

Traffic noise associated with high vehicle flows pre and post events

Higher levels of vehicle flows can be expected in the 30 minute periods pre and post events as patrons arrive before and depart after an event.

The major potential impact will be on residences along Carmichael Drive as some vehicles travel along this road to reach the school car park.

The predicted short term traffic noise impact during the 30 minute pre and post event periods will be 39 dB(A), $L_{eq,15\ minutes}$, which complies with the INP maximum intrusive noise criterion of 42 $dBL_{eq,15\ minutes}$ for the evening period.

Traffic noise impact from playing courts/overflow parking and access road

The proposed playing courts (western side of the site) will be used when required for overflow parking for events at the Performing Arts Centre. A total of 56 overflow parking spaces will be provided for after school events.

The noise levels resulting from overflow car park operations on the proposed playing courts have been calculated at the boundary of the most affected residential receivers located to the west of the site (Dryander and Warby Avenues). Included in the assessment are the LAeq,15 minute noise levels resulting from a number of car park activities including vehicle doors closing, vehicle engines starting, vehicles accelerating, vehicles moving slowly, and patrons talking and laughing as they exit or enter the car park.

The predicted short term traffic noise impact during the 30 minute pre and post event periods will be 37 dB(A), $L_{eq,15\ minutes}$, which complies with the INP maximum intrusive noise criterion of 42 $dBL_{eq,15\ minutes}$ for the evening period.

Sports activity noise on the new playing courts

A daytime criterion for noise from the playing courts has been set at a maximum $L_{eq,15\ minutes}$ of 49 dB(A), based on the measured existing daytime background sound level (L_{90} of 44 dB(A)).

Previous noise measurements of netball and basketball games in a school context have been used to establish the likely on-court noise level (a courtside measured level of 55 $dBL_{Aeq,15\ minutes}$ at 5.5 m).

Based on this noise source, and taking distance attenuation into account, the predicted noise level at the nearest residential boundary in Warby Avenue is 34 dB(A).

Applying an impulsive noise character adjustment of 5 dB to this level results in an assessment level of 39 dB(A) at the nearest residential boundary.

This is less than the acceptance criterion of 49 dB(A) and no further noise controls are considered necessary for the multi-purpose playing courts.

Cumulative noise assessment

Cumulative noise assessments have been carried out on three scenarios that are likely to occur with multiple noise sources occurring simultaneously. In all cases the cumulative noise levels at the nearest residential boundaries comply with the INP maximum intrusive noise criterion of 42 $dBL_{eq,15\ minutes}$ for the evening period.

Noise impacts during construction

Potential construction noise and vibration impacts on the surrounding community have been presented in this report and recommendations based on relevant guidelines are provided.

1 Introduction

Clancy Catholic College is proposing extensions to its existing facilities, currently sited at 201 Carmichael Drive, West Hoxton.

Acoustic Studio Pty Ltd has been engaged to carry out a noise impact assessment for the Project and to prepare an acoustic report for submission with the Development Application (DA). The Catholic Education Office is the Client, Fulton Trotter Architects (FTA) is the Architect and JHA is the building services consultant.

We understand that FTA has completed a master plan for the College that included alterations and additions to the existing buildings on the site as well as a number of new buildings and outdoor areas intended to address a shortfall in teaching and learning spaces currently at the College.

An environmental noise assessment has been carried out for the Proposal, and is detailed in this report along with the findings and recommendations. This noise assessment has been prepared as part of the Development Application (DA) to be submitted to Liverpool City Council for the proposed Facility.

The new and upgraded facilities proposed under this DA are not expected to change out-of-school-hours activities, nor will they change the school hours of operation or increment the number of students and / or staff.

The objectives of this assessment are to:

- Identify noise sensitive receivers that will potentially be affected by the operation of the proposed refurbished and new buildings.
- Carry out noise surveys to determine existing ambient and background noise levels at the nearest noise sensitive receivers that surround the site.
- Establish the appropriate noise assessment criteria in accordance with the relevant standards and guidelines.
- Determine whether the relevant criteria can be achieved based on proposed operations. Where applicable, provide recommendations for any necessary acoustic control measures that will need to be incorporated into the development or use in order to ensure compliance with the assessment criteria.

This acoustic assessment has been carried out in accordance with the relevant Australian Standards, Guidelines and the publications of the NSW Office of Heritage and Environment (OHE, formerly EPA).

2 Project Overview

2.1 Description of the Proposal

The Project will involve the following components:

- Construction of new buildings and major additions to existing buildings
  - New Hall & Gallery link building to existing Lecture Theatre (Block M, 1-storey).
  - Refurbishment of Lecture Theatre (Block G, 1-storey).
  - New Visual Arts / Fitness building (Block L, 2-storey).
  - New Canteen building (Block N, 2-storey).
- Minor additions and extensions to existing buildings
  - Addition of three soundproofed music practice rooms within the Music building (within Block C second storey).
  - Extension to the Administration building to create larger entry foyer (Block A, 1-storey).
  - Extension for new science lab and GLA within the Science building (Block B, 2-storey).
  - Enclosure of existing balcony in the Staff/Library building to create larger staff lounge (Block H, 1-storey).
  - Extension to the TAS Building to external existing classroom (Block F, 1 storey addition).
- Creation of new outdoor areas
  - Entry courtyards to the Gallery link building (Block M).
  - Under-croft gathering area adjacent to Canteen building (Block N).
  - Playing courts to the west of the Visual Arts / Fitness building (Block L).

A site plan of the proposed development highlighting all new and refurbished building plus new outdoor proposed areas is shown in Figure 1 below.

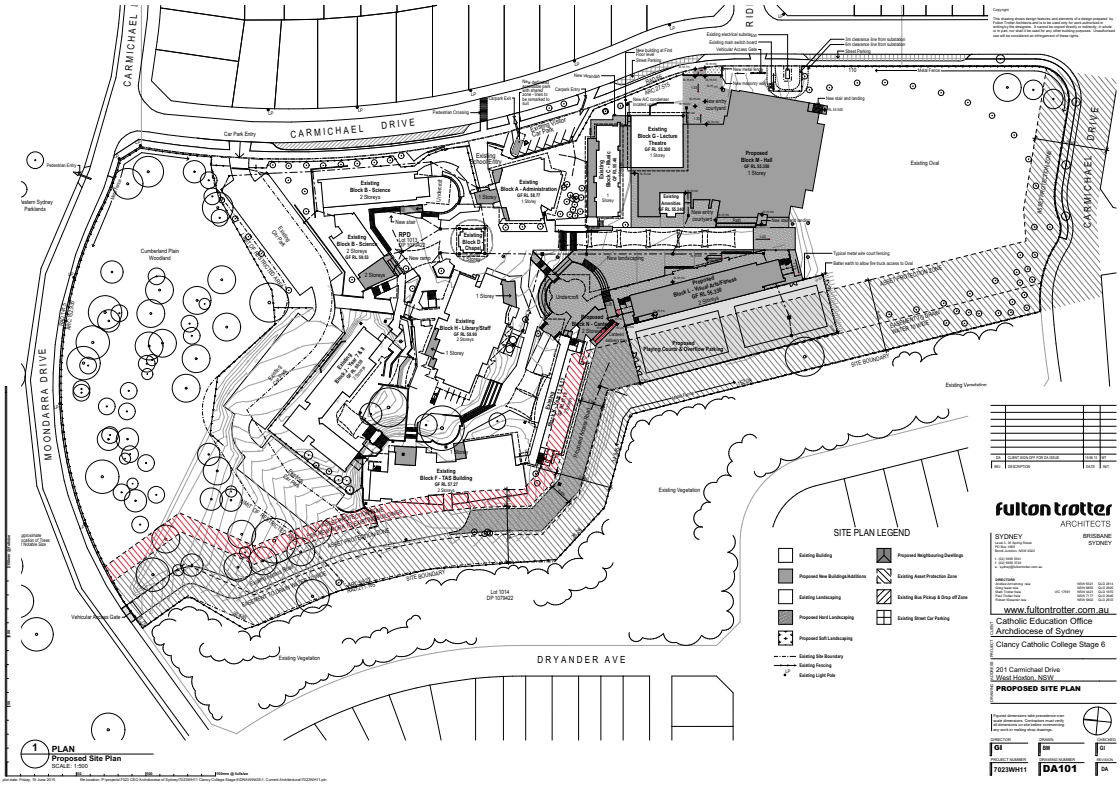


Figure 1: Site plan of proposed development

The preliminary plan drawings for the proposed new buildings are shown below in Figures 2 to 5 below as follows:

- Hall & Gallery – Block M (Figure 2)
- Lecture Theatre – Block G (Figures 2 and 3)
- Visual Arts / Fitness building – Block L (Figure 4)
- Canteen – Block N (Figure 5)

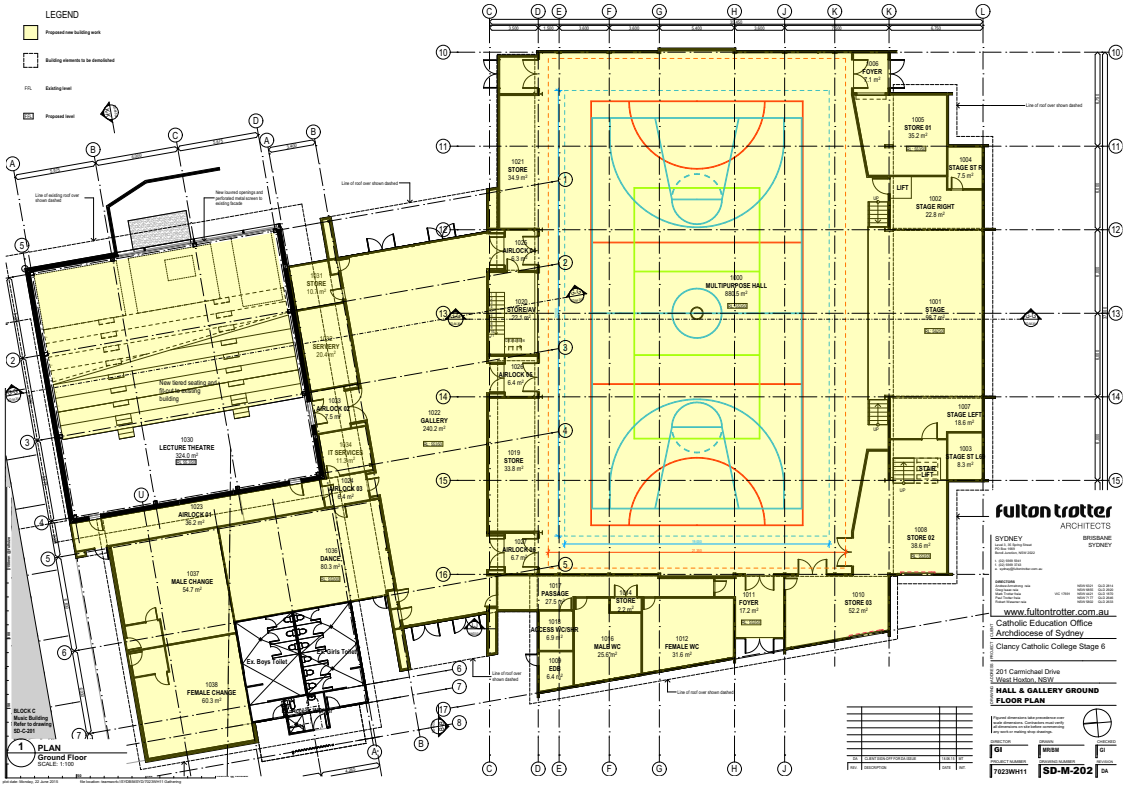


Figure 2: Plan of proposed development – Hall, Gallery and Performing Arts buildings (Ground Floor).

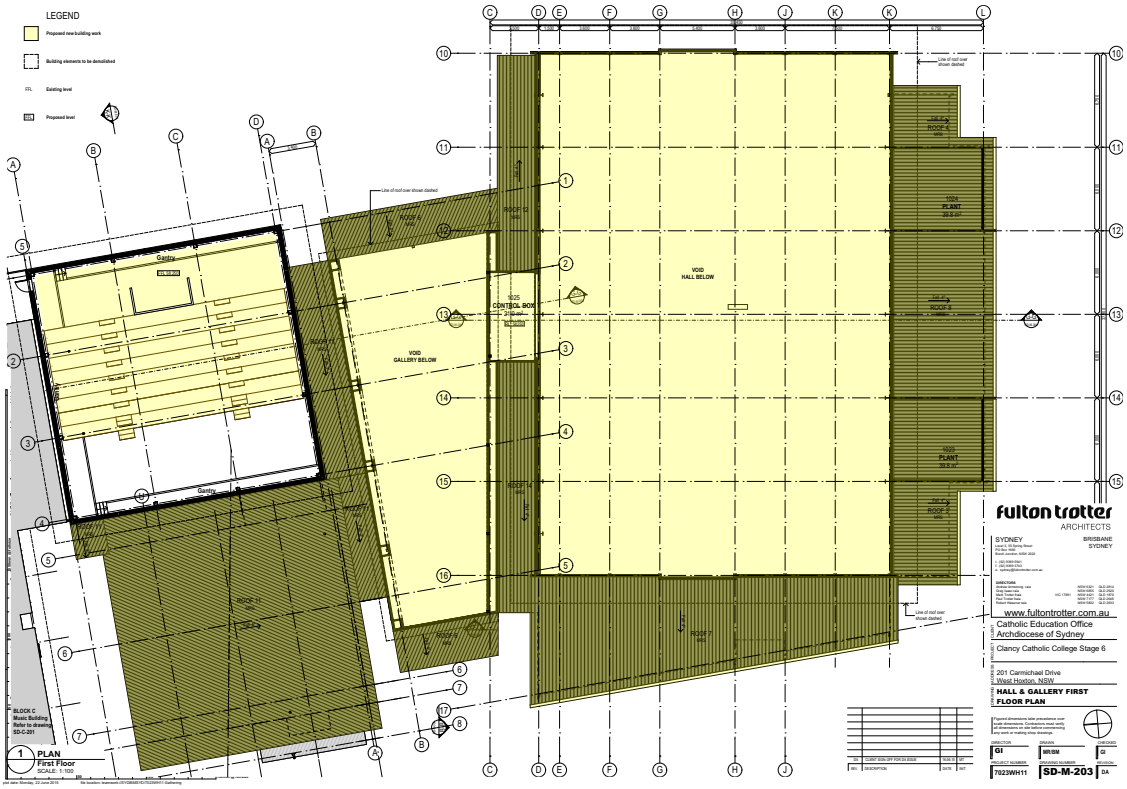


Figure 3: Plan of proposed development – Performing Arts and Music buildings (First Floor)

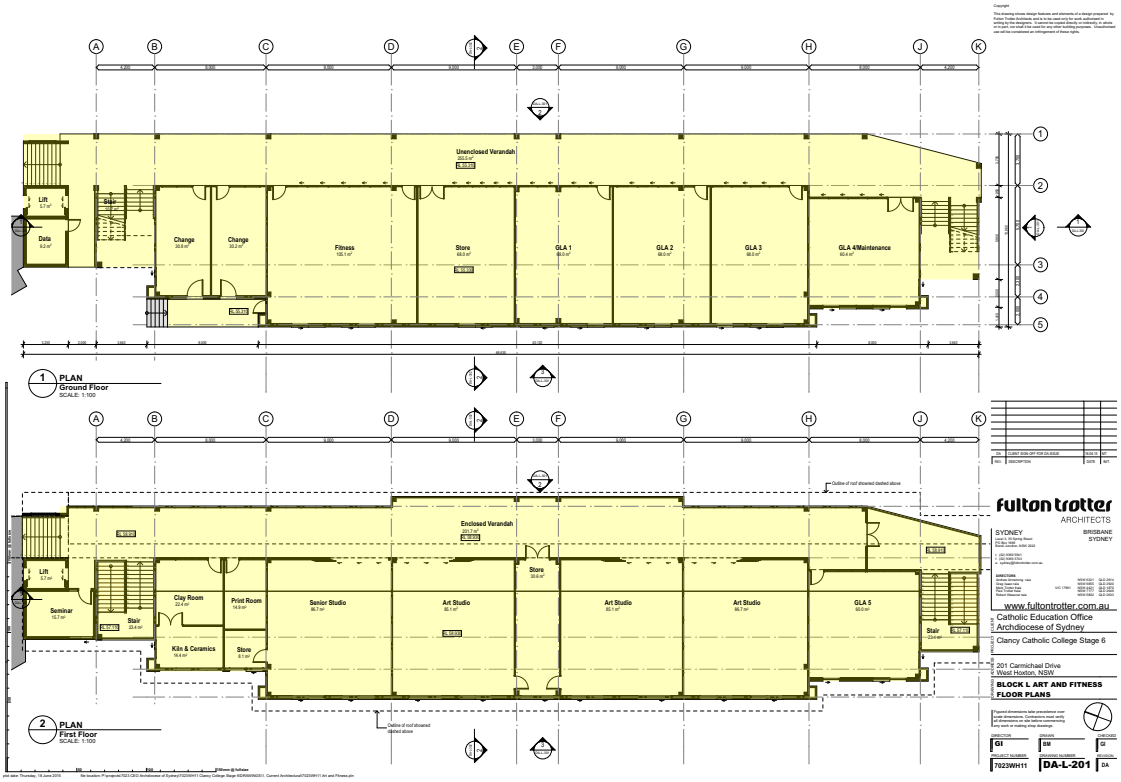


Figure 4: Plan of proposed development – Visual Arts / Fitness building (Ground and First Floor)

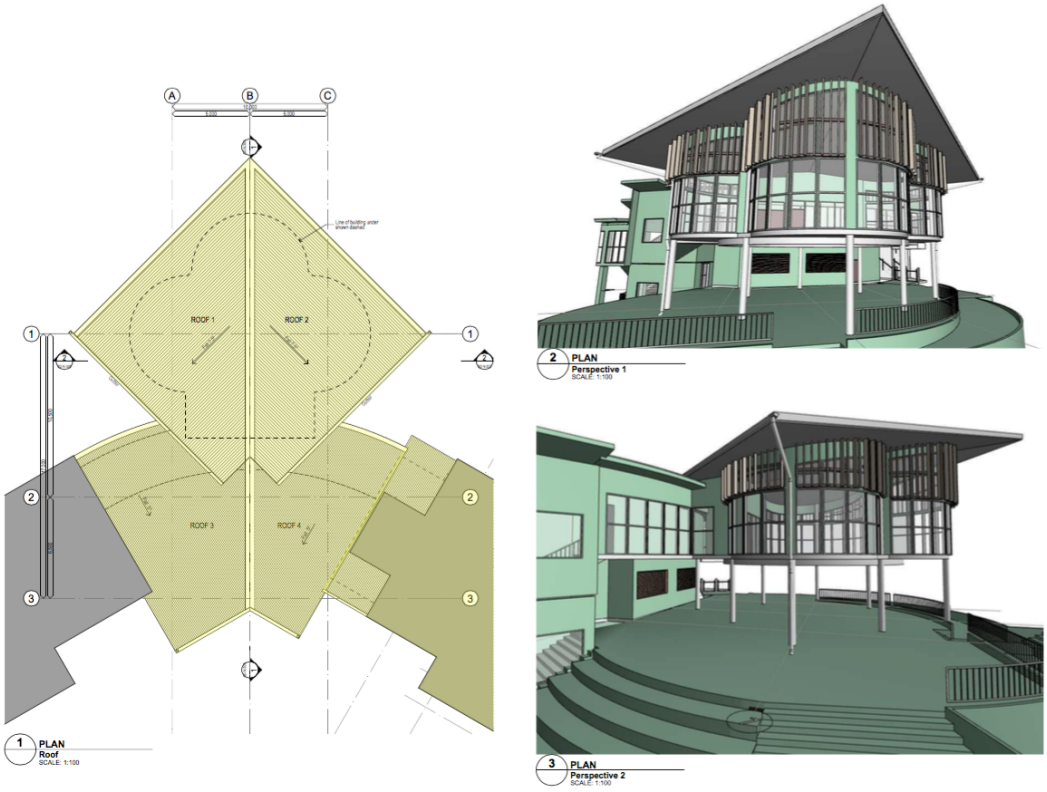


Figure 5: Proposed Canteen and adjacent under-croft area

2.2 The site and the surrounding area

The Clancy Catholic College site is an elongated and irregular-shaped plot located at 201 Carmichael Drive, West Hoxton.

The site is located within a suburban residential environment characterised by low to medium levels of activity throughout the day and decreasing noise levels in the evening and night. Figure 6 below shows the location of the College site within the context of the surrounding area.

Figure 6: Clancy Catholic College site, in the context of the surrounding area, and noise monitoring locations.

The nearest receivers to the proposed site are as follows:

- Residential receivers
  - 1 and 2-storey houses located to the east of the site across Carmichael Drive and Riddell Street.
  - 1 and 2-storey houses located to the east of the site across Dryander and Warby Avenues.
- Educational receivers
  - Montessori long day care centre located to the east of the site across Carmichael Drive.

Traffic noise sources impacting on the development include:

- Intermittent local traffic on local roads.
- Distant semi-continuous traffic from Cowpasture Road to the east of the site, approximately 500 to 900 metres from the site.

Noise impacts from traffic on local roads on the proposed facility are expected to be low (refer Section 4.2 for details). Therefore, it is anticipated traffic will have a minimal impact on the Project and its impacts are not assessed from herein.

2.3 Activities and operating hours

The proposed development will not change the operating hours of the school.

The Clancy Catholic College is open and in use during school opening hours, during the private school term. Hours are generally as follows:

- School hours on Monday, Wednesday, Thursday and Friday are from 8:35 am to 2:55 pm, on school term weekdays.
- School hours on Tuesday are from 8:35 am to 2:30pm, on school term weekdays.
- Administrative office hours are 8 am to 4 pm on weekdays.

Further to the above, the College will hold eighteen (18) events per year as listed below, including approximate numbers of attendants and their expected timeframes:

	Number of Visitors	*Times*
Welcome to New Parents	400	7 – 8 pm
Year 11 Assessment Information Night	320	7 – 8 pm
Year 10 Information Night	400	7 – 9 pm
Open Day	700 – 800	11 am – 2 pm
Stage 6 Parent/Teacher Interviews	620	3.30 – 8.30 pm
Mothers Day Mass	1400	11 am – 12.30 pm
Stage 4 & 5 Parent/Teacher Interviews	700	12.00 – 8.30 pm
Stage 4 & 5 Parent/Teacher Interviews	300	3.30 – 8.30 pm
Year 11 2016 Subject Information Night	400	7 – 8 pm
Year 7 2016 Information Night	400	7 – 9 pm
Year 12 Parent/Teacher Interviews	200	3.30 – 8.30 pm
Year 9 2016 Subject Selection Information Night	300	7 – 8 pm
HSC 2016 Assessment Information Night	300	7 – 8 pm
Arts & Culture Night	450 – 500	6.30 – 9.30 pm
Special Education Awards Night	70	7 – 8 pm
HSC Drama Night	20	7 – 8 pm
HSC Music Night	20	7 – 8 pm
Father's Day Breakfast	200	7.30 – 9 am

2.4 The building structure – Theatre, Hall and Gallery Building

Recognising the proximity of the Theatre, Hall and Gallery Building to the residential neighbours along the eastern boundary, the following construction is proposed for the building:

- The Theatre
    - Existing external masonry walls (cavity brick) – acoustically rated at R_w 50.
    - Metal deck roof with a plasterboard ceiling, acoustically rated at minimum R_w 45.
- The Hall
    - New steel and concrete framed building with external metal cladding and CFC panels. Internal timber lining (12 mm thick) over minimum 200 mm cavity with insulation in the cavity, acoustically rated at minimum R_w 45.
    - Metal deck roof with a plasterboard ceiling, acoustically rated at minimum R_w 45.
- The Gallery
    - New link building between existing Theatre structure and the new Hall. Steel framed structure with external glazed façade to the north (facing the nearest residential areas, acoustically rated at minimum R_w 30.
    - Metal deck roof with a plasterboard ceiling, acoustically rated at minimum R_w 45.

3 The Key Acoustic Issues

The key design considerations for the Project in regards to noise environmental impacts are as follows:

- The impact of mechanical noise generated by mechanical plant to be installed around the site, associated either with the proposed new buildings – particularly the new Hall plant – or additions / alterations to existing buildings.

  The mechanical plant noise impact assessment has been presented in Section 6.

- The impact of operational noise generated by 'noisy' activities to be undertaken within some of the proposed buildings and outdoor areas as follows:

  - Hall and Gallery (Block M) – performances, sports events, functions, service of food and drinks and patron noise.
  - Theatre (Block G) – dance and music classes, performance art.
  - Canteen (Block N) – occasional formal assemblies in under-croft area.
  - Outdoor Playing Courts – sports activities, overflow parking for large events.

  The operational noise impact assessment is presented in Section 7.

  Noise impacts relating to activities occurring in a number of indoor areas that are sound insulated from outdoors – new soundproofed music practice rooms in Block C, Visual Arts / Fitness building, extensions to the Administration, Science and Library / Staff buildings – will have a negligible noise impact on surrounding residential receivers. No further assessment is required for these activities.

- The potential impact of traffic noise from any increase in traffic volumes on local roads plus the potential impact of additional car park noise due to the car parks proposed as part of the Proposal.

  The traffic and car park noise impact assessment is been presented in Section 8.

- The potential impact of noise from sports activities on the new playing courts is presented in Section 9.

- A cumulative noise impact is presented in Section 10.

- The impact of noise and vibration generated during the construction stages of the Project.

  Section 11 of this report establishes construction noise and vibration criteria. Once the structural design and construction methodology is progressed, a detailed assessment of construction noise and vibration impacts should be prepared by the contractor in accordance with the EPA *Interim Construction Noise Guideline* (2009) and associated references such as the EPA *Assessing Vibration* (2006).

4 Existing Noise Environment

4.1 General survey information

Noise surveys have been carried out at the site and its surrounds to determine the pre-existing ambient and background noise levels representative of the nearest receivers, and to identify / quantify noise levels from sources with potential to impact on the site.

Both attended and unattended noise monitoring has been carried out during the noise surveys.

Instrumentation used for the surveys included:

- Brüel & Kjær Hand-held Analyser Type 2250, Serial Number 2832406.
- RTA Technology Environmental Noise Logger Type 02, Serial Number RTA02#038.

The calibration of the equipment was checked before and after the surveys and no significant variation in levels occurred. A windshield was used to protect the microphone of both the analyser and the logger.

Jorge Reverter and Anthony Cano of Acoustic Studio Pty Ltd carried out the noise surveys.

Short-term attended measurements were carried out on two occasions to validate logged data for the daytime and early night-time period. Attended measurement surveys were carried out on the following days:

- Friday 24th April 2015 between 11:00 am and 11:30 am, and
- Tuesday 28th April 2015 between 10:00 pm and 10:30 pm.

The attended measurement locations are shown in Figure 6 in Section 2.2.

Long-term unattended noise monitoring was conducted at the proposed development site as shown in Figure 6. The logger position was selected as secured location to determine the pre-existing traffic, ambient and background noise levels around the subject site and at the nearest sensitive receivers.

Unattended noise logging was carried out on the following days:

- From Friday 24th April to Friday 1st May 2015, and
- From Thursday 7th to Monday 11th May 2015.

The unattended logger location is shown in Figure 6 in Section 2.2.

4.2 Short-term noise monitoring results

Ambient and background noise measurements were carried around the site to validate the long-term logged data. Measurement results from short-term ambient and background noise monitoring are provided in Tables 1 and 2 below.

Location	Time	Measured ambient sound level ($L_{eq,15min}$), dB re 20 µPa									
		Overall dB(A)	Octave band centre frequency, Hz								
			31.5	63	125	250	500	1k	2k	4k	8k
S1 – Carmichael Dr corner Riddell St	24/4/15 11:23am	**54**	55	56	50	48	48	49	47	47	35
	28/4/15 10:07pm	**48**	55	58	51	45	42	44	41	34	23
S2 – 10 Warby Avenue	24/4/15 11:14am	**54**	54	56	53	52	51	49	47	42	25
	28/4/15 10:19pm	**42**	49	55	52	43	39	37	30	29	17

Table 1: Measured ambient noise levels ($L_{eq,15min}$) around the Clancy Catholic College site

Location	Time	Measured background sound level ($L_{90,15min}$), dB re 20 µPa									
		Overall dB(A)	Octave band centre frequency, Hz								
			31.5	63	125	250	500	1k	2k	4k	8k
S1 – Carmichael Dr corner Riddell St	24/4/15 11:23am	**46**	43	44	41	38	36	36	33	29	18
	28/4/15 10:07pm	**40**	47	51	46	39	35	35	29	20	12
S2 – 10 Warby Avenue	24/4/15 11:14am	**44**	44	47	39	34	33	32	31	32	15
	28/4/15 10:19pm	**40**	46	53	48	39	36	34	25	18	13

Table 2: Measured background noise levels ($L_{90,15min}$) around the Clancy Catholic College site

From our observations on-site, we note the following:

- Ambient and background noise levels during the daytime are dominated by occasional local traffic and other intermittent noises sources such as school children within the College, and environmental noise sources such as birds, etc.

  NOTE: Traffic noise from Cowpasture Road was not audible at the time of the daytime attended survey.

- Ambient and background noise levels during the night-time are dominated by distant low-level traffic noise from Cowpasture Road and noise from environmental noise sources.

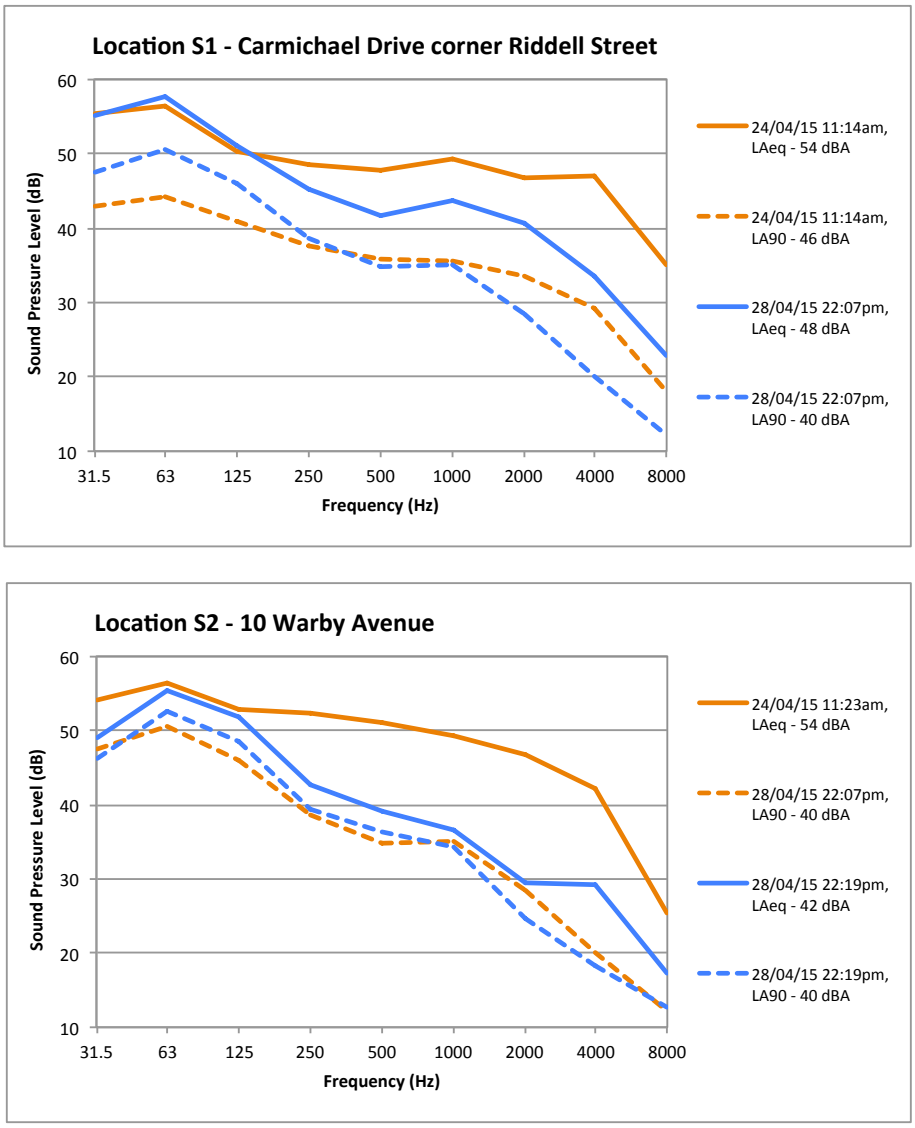


Figure 7: Measured spectrums of ambient and background noise levels at locations around the site

4.3 Long-term noise monitoring results

A noise logger was installed in the Clancy Catholic College site. The logger was located near the southeast boundary of the site, near the location of the proposed new Hall (Block M). This location was chosen as (a) a secure place to leave the unattended noise logger, and (b) representative of the ambient and background noise levels at the nearest residential boundaries to the site. The long-term noise monitoring locations are shown in Figure 6 in Section 2.2.

The detailed results of the long term noise monitoring at the logger location (L1) are shown graphically in Appendix A.

Weather patterns were monitored during the survey period and were typically calm and dry during the unattended noise survey. Graphs in Appendix A show highlighted in grey the times where logged data was likely affected by rain and / or wind. Data affected by rain and / or wind has not been included in our derivation of the noise assessment criteria in accordance with accepted practice.

The logged data shows the background and ambient noise levels of the area. The recorded background noise levels have been used to establish a limiting criteria for noise emitted from the proposed development.

The background noise level is defined as the noise level exceeded 90% of the time, and is designated as the L_{90}. The ambient noise level impacting on the buildings is referred to as the equivalent continuous sound level (L_{eq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

The background sound levels have been established in general accordance with the methodology described in the NSW INP, i.e. the 10^{th} percentile background sound level for each period for each day of the ambient noise survey. The median of these levels is then presented as the background sound level for each assessment period. These background noise levels are shown in Table 3 below together with the L_{Aeq} ambient noise levels measured for each period.

As required by the INP methodology, any data likely to be affected by rain, wind or other extraneous noises has been excluded from the calculations.

Location	L_{90} Background Noise Levels, dB(A)			Leq Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
L1 – Clancy Catholic College (south-eastern side of site)	39	37	31	56	52	47

Table 3: Long-term background and ambient noise levels measured around the Project site

From observations during our site visits, it is noted that both ambient and background noise levels around the site are currently dominated by intermittent traffic noise on local roads, natural noises such as birds, and also distant traffic low-level noise from Cowpasture Road at night.

5 Relevant Standards and Guidelines

5.1 Operational noise

The following standards and guidelines are considered relevant to the project and have been referenced in developing the project noise criteria:

- Liverpool City Council Development Control Plan (DCP) and Local Environment Plan (LEP) 2018.
- Protection of the Environmental Operations (POEO) Act 1997.
- Environmental Planning and Assessment (EP&A) Act 1979.
- NSW Industrial Noise Policy (INP) 2000.

The following documents have been referenced to derive noise criteria where not explicitly provided in the local and state planning documents listed above.

- Office of Liquor, Gaming and Racing (OLGR) standard noise conditions.

We note that the noise definitions and conditions provided by the Liverpool Council DCP, LEP and POEO are generally focused around a subjective assessment.

Acoustic Studio recommends determining suitable objective criteria for assessing offensive noise, for noise emissions from mechanical plant and the Facility operations (sound systems, students and staff). Compliance with the criteria described in Sections 6.1 and 7.1 of this report, in accordance with NSW INP, OLGR and NSW RNP (NSW Road Noise Policy) documents and guidelines will ensure that the general noise conditions applicable to the Proposal will be met.

5.2 Construction noise and vibration

This acoustic report does not examine in detail the potential impacts from construction noise and vibration on sensitive receivers. The Contractor should prepare a full construction noise and vibration impact assessment once the likely construction methods are developed.

The primary references are:

- EPA Interim Construction Noise Guideline (2009)
- EPA Assessing Vibration – a technical guideline (2006)

6 Mechanical Plant Noise Impact

6.1 Environmental noise limits

6.1.1 New South Wales Industrial Noise Policy (INP)

The NSW INP is specifically aimed at assessing noise from industrial noise sources, including plant, scheduled under the Protection of the Environment Operations Act 1997.

It is noted that the Policy is designed for large and complex industrial sources. It is also typically applied to fixed facilities, commercial premises and individual industrial sources such as heating, ventilating and air conditioning (HVAC) equipment. It provides guidance on the methodology for determining limiting noise criteria designed for external noise emissions typically associated with mechanical plant as follows:

- Identifies any beneficial or adverse noise impacts that might result in the surrounding community.
- Describes any noise mitigation measures and strategies that will be necessary to protect the acoustic amenity of the area.
- Describes the methods by which compliance with the acoustic criteria can be determined after the facility is operational.

The INP document sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the project specific noise levels.

Based on the existing noise levels from the unattended noise monitoring, Table 4 presents the environmental noise limits for the Proposal at surrounding residential and educational property boundaries. Details of measured levels on-site and the process to obtain the project specific noise levels are provided in Appendix B.

The operating times of the plant associated with the Proposal will be consistent with the school operational hours as presented in Section 2.3. That is, generally up to 4 pm and up to 9:30 pm on occasional events. Therefore, the night period is not considered in this assessment.

Type of Receiver	Period	Noise Criteria (L_{Aeq})
Residential – Suburban (external)	Day	44
	Evening	42
School classroom (internal)	Noisiest 1-hr period, when in use	35

Table 4 : Summary of noise criteria for mechanical plant INP noise assessment

6.2 Location and description of major mechanical plant noise sources

Plant associated with the operation of the Proposal should be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers. In particular, externally located plant (such as that proposed for the Hall rooftop plant), air intake and discharge louvres in the external walls of buildings, roof mounted and roof discharging extract and exhaust fans (e.g. toilet exhausts, kitchen exhausts, fume cupboard and laboratory exhausts), and externally located chiller or condenser units will require acoustic attenuation measures.

At the time of the submission of this report for the DA stage of the project (June 2015), final plant selections had not been made, and a detailed noise assessment of the mechanical plant could not be carried out. Since that time, the mechanical services design has progressed, and the following plant associated with (a) the Theatre, Hall and Gallery Building, and (b) the extension to the existing Block B – Science has been identified as the noise sources most likely to potentially impact the neighbouring residences.

The location of this plant is shown below in Figure 8 and described in Table 5.

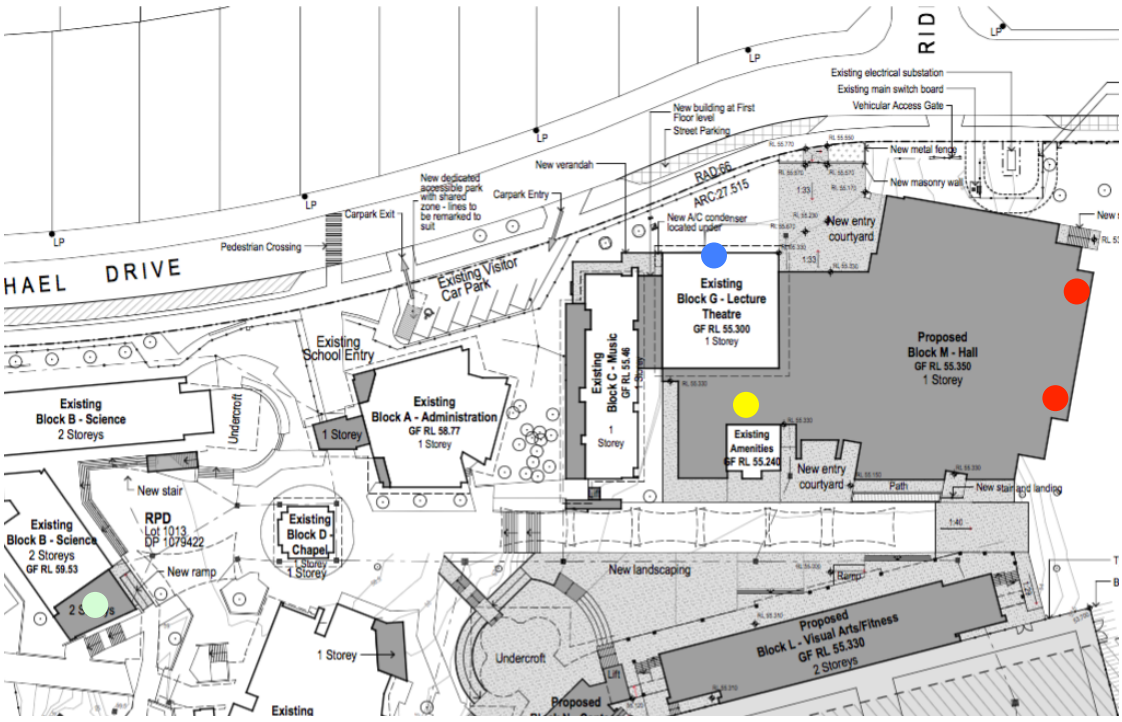


Figure 8: Location of external mechanical plant (refer Table 5 below for description of plant)

Building	Plant location and type	Model nominated in mechanical documentation	Distance to nearest residential boundary (m)	Radiated sound power level, dB(A) re 10^{-12} W
Block M - Hall	Rooftop package air conditioning unit	Temperzone OPA960RKTB	40	85
Block M - Hall	Rooftop package air conditioning unit	Temperzone OPA960RKTB	55	85
Block M - Gallery	Rooftop package air conditioning unit	Temperzone OPA370RKTB	52	81
Block G - plant room below Theatre - louvres in northern facade	Theatre fan coil units (2x)	Daikin 250MAVE	30	67
	Outside air fan	Fantech SCD564HP	30	84
Block B - Science	Laboratory exhaust fan located internally, discharging via flue to external	Laboratory exhaust fan	60	73

Table 5 : Mechanical plant used in this noise assessment

Noise source justification: Manufacturer's data

Noise controls have be identified where required, and incorporated within the mechanical services design to ensure that the cumulative noise output from plant at the nearest affected receivers is within the allowable limits. These noise controls are summarised below in Section 6.3.

6.3 Noise control recommendations for mechanical plant

6.3.1 Block M – Hall: Rooftop package air conditioning unit #1 (Temperzone OPA960RKTB)

Maximum sound power level	85 dB(A)
Minimum distance from residential boundary	40 m
Location	Rooftop plant deck of Hall
Noise control	Acoustic screening by building form (300 mm above top of unit) plus acoustic louvres around plant deck

6.3.2 Block M – Hall: Rooftop package air conditioning unit #2 (Temperzone OPA960RKTB)

Maximum sound power level	85 dB(A)
Minimum distance from residential boundary	55 m
Location	Rooftop plant deck of Hall
Noise control	Acoustic screening by building form (300 mm above top of unit) plus acoustic louvres around plant deck

6.3.3 Block M – Gallery: Rooftop package air conditioning unit (Temperzone OPA370RKTB)

Maximum sound power level	81 dB(A)
Minimum distance from residential boundary	52 m
Location	Rooftop plant deck of Theatre
Noise control	Acoustic screening by building form (300 mm above top of unit)

6.3.4 Block G - plant room below Theatre - louvres in northern façade – Theatre fan coil units (2x) (Daikin 250MAVE)

Maximum sound power level	67 dB(A) per unit
Minimum distance from residential boundary	30 m (from plant room louvres)
Location	Plant room below Theatre
Noise control	Not required

6.3.5 Block G - plant room below Theatre - louvres in northern façade – outside air fan (Fantech SCD564HP)

Maximum sound power level	84 dB(A)
Minimum distance from residential boundary	30 m (from plant room louvres)
Location	Plant room below Theatre
Noise control	Internal duct lining between air intake and fan (minimum 5 m)

6.3.6 Block B - Science – laboratory exhaust fan flue

Maximum sound power level	73 dB(A)
Minimum distance from residential boundary	60 m (from plant room louvres)
Location	Flue discharging via new roof
Noise control	Not required.

6.4 Predicted noise levels from mechanical services

The overall noise levels from the major mechanical plant noise sources at the nearest residential receivers is calculated below in Sections 6.4.1 to 6.4.3. This calculation takes into account the distance of the plant to the receiver locations (Table 5) and the corresponding distance attenuation, the sound power level of each plant item (Table 5), the attenuation provided by building shielding, and other recommended noise controls.

The receiver locations used for assessment are shown below in Figure 9.

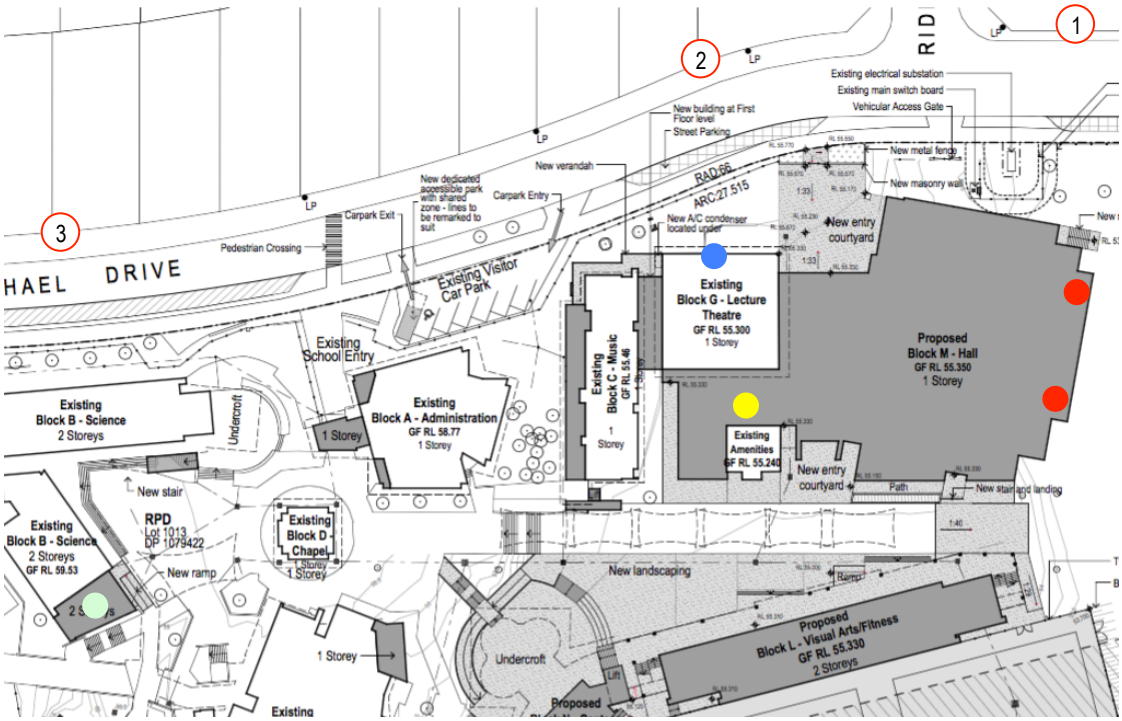


Figure 9: Location of assessment receiver locations 1, 2 and 3.

6.4.1 Assessment receiver Location 1

Plant	SWL, dB(A) re 10^{-12} watts	Distance, m	Attenuation, dB			Noise level at assessment receiver location, dB re 20 µPa
			Distance	Building/ Barrier Shielding *	Other noise controls	
Block M – Hall Rooftop package air conditioning unit #1	85	40	32	14	-	31
Block M – Hall Rooftop package air conditioning unit #1	85	55	35	14	-	28
Block M – Gallery Rooftop package air conditioning unit	81	75	38	14	-	21
Block G - plant room below Theatre – Theatre fan coil units (2x)	67	65	36	-	-	23
Block G - plant room below Theatre – outside air fan	84	65	36	-	20 **	20
Block B Science – laboratory exhaust fan flue	73	170	45	-	-	20
			Total noise level from mechanical services, dB(A)			**34**

Table 6: Calculation of mechanical plant noise at Location 1

* Building shielding attenuation calculated from shielding provided by building form around plant location.

** Attenuation provided by ductwork internal linings and ductwork geometry between fan and external louvres in building façade.

6.4.2 Assessment receiver Location 2

Plant	SWL, dB(A) re 10^{-12} watts	Distance, m	Attenuation, dB			Noise level at assessment receiver location, dB re 20 µPa
			Distance	Building/ Barrier Shielding *	Other noise controls	
Block M – Hall Rooftop package air conditioning unit #1	85	65	36	14	-	27
Block M – Hall Rooftop package air conditioning unit #1	85	75	38	14	-	25
Block M – Gallery Rooftop package air conditioning unit	81	52	34	14	-	25
Block G - plant room below Theatre – Theatre fan coil units (2x)	67	30	30	-	-	29
Block G - plant room below Theatre – outside air fan	84	30	30	-	20 **	23
Block B Science – laboratory exhaust fan flue	73	120	42	-	-	23
			Total noise level from mechanical services, dB(A)			**34**

Table 7: Calculation of mechanical plant noise at Location 2

* Building shielding attenuation calculated from shielding provided by building form around plant location.

** Attenuation provided by ductwork internal linings and ductwork geometry between fan and external louvres in building façade.

6.4.3 Assessment receiver Location 3

Plant	SWL, dB(A) re 10^{-12} watts	Distance, m	Attenuation, dB			Noise level at assessment receiver location, dB re 20 µPa
			Distance	Building/ Barrier Shielding *	Other noise controls	
Block M – Hall Rooftop package air conditioning unit #1	85	155	44	14	-	19
Block M – Hall Rooftop package air conditioning unit #1	85	155	44	14	-	19
Block M – Gallery Rooftop package air conditioning unit	81	110	41	14	-	18
Block G - plant room below Theatre – Theatre fan coil units (2x)	67	100	40	-	-	19
Block G - plant room below Theatre – outside air fan	84	100	40	-	20 **	16
Block B Science – laboratory exhaust fan flue	73	60	36	-	-	29
			Total noise level from mechanical services, dB(A)			**31**

Table 8: Calculation of mechanical plant noise at Location 3

* Building shielding attenuation calculated from shielding provided by building form around plant location.

** Attenuation provided by ductwork internal linings and ductwork geometry between fan and external louvres in building façade.

At all assessment receiver locations, the predicted noise level from mechanical services plant is less than the INP noise criteria of 44 dB(A) daytime, and 42 dB(A) evening.

7 Noise Impact Assessment from Operations

We have been advised that the following activities represent the "worst-case" scenarios likely to have the highest noise impacts at the nearest residential boundaries:

- Hall (Block M) – performances, sports events and functions including amplified music.
- Theatre (Block G) – dance and music classes and performance art including amplified music.
- Gallery (Block M) –service of food and drinks and patron noise.
- Canteen (Block N) – occasional formal assemblies in undercroft area including patron noise.

These activities have been used as the basis of the operational noise assessment.

7.1 Operational noise criteria

Council has requested that the NSW Industrial Noise Policy (INP) be used to assess the potential for intrusive noise generated from the Hall and Theatre. In addition, Council has requested that the criteria derived from the INP methodology are used to assess cumulative noise impacts of all appropriate noise sources.

Accordingly, this noise impact assessment for intrusive noise generated from the Hall and Theatre has adopted the intrusive noise criteria previously established with the INP methodology for the nearest residential boundaries (refer Table 4 of this report), notably:

- A maximum $L_{Aeq,15\ minutes}$ of 44 dB daytime, and
- A maximum $L_{Aeq,15\ minutes}$ of 42 dB evening.

Aspects to note regarding the application of the above are:

- A 15-minute measurement period has been adopted for the INP limits.
- The existing background noise level has been determined in accordance with the NSW Industrial Noise Policy (INP) 2000. The Day and Evening background noise levels are used to determine environmental noise criteria in accordance with the proposal hours of operation of the School.

7.2 Noise assessment of performance activities – the Hall and Theatre

Simultaneous performances in the Hall and Theatre have been assumed. The worst-case scenario is based on amplified music in both venues.

7.2.1 Activity sound levels

The activity sound levels used in this assessment are shown below in Table 9. They include amplified music (in both the Hall & Theatre) and noise from patrons gathered inside the Gallery.

The activity sound levels and spectra reported below represent typical reverberant sound levels measured by Acoustic Studio in school halls and theatres similar to that proposed in this project. It is considered that these activity sound levels and associated spectra accurately represent the internal sound levels generated by the worst case activity – amplified music.

Activity	Reverberant sound level, L_{eq}, dB re 20µPa									
	Overall dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Amplified music (in each of both the Hall and theTheatre)	95	66	69	87	93	93	91	84	78	68
Patrons talking in Gallery (intermission)	70	41	44	62	68	68	66	59	53	43

Table 9: Activity noise levels

Noise source justification: Measured levels in similar facilities

These levels represent typical reverberant L_{eq} sound levels that could be reasonably expected within the spaces.

7.2.2 Sensitive receivers

The nearest residences are those located along Carmichael Drive, as shown in Figure 9 of this report.

7.2.3 Activity noise assessment of the Theatre, Hall and Gallery

The L_{eq} levels have been calculated at the nearest residential boundary assessment locations for amplified music performances in the Theatre and Hall, and the noise levels generated by patrons in the Gallery. These calculations were carried out in octave bands, but are presented below in terms of overall dB(A) for clarity. Note that only Locations 1 and 2 are shown as these represent the worst case. Location 3 is located further from the Performing Arts Centre, and the activity sound levels at Location 3 will be less than those at Locations 1 and 2.

Distance attenuation and building envelope attenuation have been taken into account.

Location 1

Noise from Theatre activities

Reverberant sound level in Theatre from amplified music	95 dB, $L_{Aeq,15\ minutes}$
Building envelope attenuation from roof structure	R_w 45 (refer Section 2.4)
Building envelope attenuation from wall structure	R_w 50 (refer Section 2.4)
Distance attenuation to Location 1 (60 m)	36 dB
Resultant maximum sound level from Theatre activities	*27 dB, $L_{Aeq,15\ minutes}$*

Noise from Hall activities

Reverberant sound level in Hall from amplified music	95 dB, $L_{Aeq,15\ minutes}$
Building envelope attenuation from roof structure	R_w 45 (refer Section 2.4)
Building envelope attenuation from wall structure	R_w 45 (refer Section 2.4)
Distance attenuation to Location 1 (35 m)	31 dB
Resultant maximum sound level from Hall activities	*37 dB, $L_{Aeq,15\ minutes}$*

Noise from Gallery activities

Reverberant sound level in Gallery from patrons	70 dB, $L_{Aeq,15\ minutes}$
Building envelope attenuation from roof structure	R_w 45 (refer Section 2.4)
Building envelope attenuation from wall structure	R_w 30 (refer Section 2.4)
Distance attenuation to Location 1 (60 m)	36 dB
Resultant maximum sound level from Gallery activities	*16 dB, $L_{Aeq,15\ minutes}$*

Location 2

Noise from Theatre activities

Reverberant sound level in Theatre from amplified music	95 dB, $L_{Aeq,15\ minutes}$
Building envelope attenuation from roof structure	R_w 45 (refer Section 2.4)
Building envelope attenuation from wall structure	R_w 50 (refer Section 2.4)
Distance attenuation to Location 1 (35 m)	31 dB
Resultant maximum sound level from Theatre activities	*32 dB, $L_{Aeq,15\ minutes}$*

Noise from Hall activities

Reverberant sound level in Hall from amplified music	95 dB, $L_{Aeq,15\ minutes}$
Building envelope attenuation from roof structure	R_w 45 (refer Section 2.4)
Building envelope attenuation from wall structure	R_w 45 (refer Section 2.4)
Distance attenuation to Location 1 (60 m)	36 dB
Resultant maximum sound level from Hall activities	*32 dB, $L_{Aeq,15\ minutes}$*

Noise from Gallery activities

Reverberant sound level in Gallery from patrons	70 dB, $L_{Aeq,15\ minutes}$
Building envelope attenuation from roof structure	R_w 45 (refer Section 2.4)
Building envelope attenuation from wall structure	R_w 30 (refer Section 2.4)
Distance attenuation to Location 1 (40 m)	32 dB
Resultant maximum sound level from Gallery activities	*20 dB, $L_{Aeq,15\ minutes}$*

7.2.4 Noise assessment results

The predicted boundary noise levels above show that the INP noise criteria of 44 $L_{Aeq,15\ minutes}$ (day) and 42 $L_{Aeq,15\ minutes}$ (night) will be met at the nearest residential boundary from activity noise generated in the each of the Theatre, Hall and Gallery.

Note that a cumulative noise assessment is carried out in Section 10 of this report.

7.3 Noise assessment of patron noise in the new Entry Courtyard

Patrons of the Performing Arts Centre will enter the building via a new Entry Courtyard located on the eastern side. This courtyard will lead into the Gallery, which serves as a foyer to both the Theatre and the Hall.

The Entry Courtyard is approximately 300 m^2 in area. We have been advised that the maximum capacity for this area can be established by assuming a maximum of 1 person / 2.2 m^2. On this basis the maximum capacity of the Entry Courtyard is 136 people.

The Gallery is designed to attract patrons into the interior of the space, rather than to have patrons congregating within the Entry Courtyard, and therefore it is not anticipated that the Courtyard will regularly serve at its maximum capacity.

The noise levels that may be generated by patrons in the Entry Courtyard have been calculated for a range of occupancy levels:

- 100% occupied – approximately 136 patrons (anticipated as an unlikely occurrence)
- 67% occupancy – approximately 91 patrons
- 33% occupancy – approximately 68 patrons

It is reasonable to assume that not all patrons in the courtyard will be talking simultaneously. We have assumed that up to 1 in 3 people will be talking at the same time. This assumption is commonly used when assessing patron noise from large groups of people.

Furthermore, we have assumed that approximately 50% of the patrons will be male and 50% female.

Sound levels of males and females talking have been established with reference to "The Audio System Designer Technical Reference, published by Klark Teknik, as follows:

- Normal male vocal effort 58 dB, L_{Aeq} at 1 m
- Normal female vocal effort 55 dB, L_{Aeq} at 1 m

Table 10 below summarises the predicted noise levels from patrons in the Entry Courtyard at the occupancy levels discussed above. The assessment location is the nearest residential boundary, approximately 32 m from the Entry Courtyard.

Courtyard occupancy	Total number of patrons	Assumed number of patrons talking simultaneously (1 in 3 patrons)	Predicted noise level at nearest residential boundary (32 m), L_{Aeq}
100%	136	45	43 dB(A)
67%	91	30	42 dB(A)
33%	45	15	38 dB(A)

Table 10: Predicted noise levels from patrons in new Entry Courtyard, at nearest residential boundary (Location 2).

The predicted boundary noise levels above show that the INP noise criteria of 44 dB$L_{Aeq,15\ minutes}$ (day) and 42 $L_{Aeq,15\ minutes}$ (night) will be met at the nearest residential boundary from patron noise generated in the new Entry Courtyard when the Courtyard is 67 and 33% occupied. We have been advised that these occupancy rates represent the most likely operating scenario, as patrons are expected to enter the Gallery / Foyer space rather than congregate externally.

However, the INP noise criteria of 42 $L_{Aeq,15\ minutes}$ (night) would be exceeded should 100% of the patrons congregate in the Courtyard. This is considered highly unlikely to occur.

Patrons should be encouraged to enter the Gallery/Foyer area of the building, and large build-ups of patrons should be discouraged in the Courtyard area. It is recommended that this be included in the school's noise management plan.

Note that a cumulative noise assessment is carried out in Section 10 of this report.

7.4 Noise assessment of visitor noise from the Canteen Undercroft

Occasional assemblies are proposed for the Canteen Undercroft.

The Undercroft is acoustically shielded from the nearest residential boundaries and the resulting noise levels are expected to be significantly less than those produced by the activities within the Hall and Theatre. It is anticipated that the noise from the Undercroft will be inaudible at the nearest residential boundaries, and that consequently no further noise controls are required.

8 Traffic and Car Park Noise Assessment

8.1 General traffic noise impact

It is understood that the proposed development will not result in any changes to the student and staff numbers, beyond normal year-to-year variations.

Furthermore, it is understood that the events that will be accommodated with the proposed buildings of this development (the Hall, the Theatre, etc.) already take place within the School, and no change in people numbers is planned.

Therefore it is not anticipated that there will be any significant change in traffic flows on the nearby roads as a result of the development, from either normal day-to-day school operations, or from any special events related to this development.

Similarly, it is assumed that the changes in vehicle movements at the existing vehicle access and drop off points will experience no significant change.

The appropriate noise criteria for traffic noise on (a) local roads, (b) new car park areas, and (c) vehicle and drop-off points, is a maximum increase in existing traffic noise levels (L_{Aeq}) from traffic arising from the development ≤ 2 dB(A).

It is expected that in all cases the increases in noise level resulting from (a) local roads, (b) new car park areas, and (c) vehicle and drop-off points will be inaudible and insignificant, and that the design criteria of an increase of no more than 2 dB(A) will be met, as a consequence of the insignificant changes in traffic flows and vehicle numbers resulting from the proposed development.

8.2 Traffic noise associated with high vehicle flows pre and post events

The DA traffic assessment states that the total parking capacity is 291, made up as follows:

- 78 time restricted parking spaces available on-street on non-residential street parking.
- 33 spaces available at night, but signposted “No Parking” and “No Stopping” during the school arrival and departure periods.
- 180 spaces available 0n-site after school hours.

The DCP parking requirement for an Entertainment Facility is 234 spaces (1 space per 6 seats for 1400 seats). The DA traffic assessment states that generally a multi-purpose hall such as Clancy would not be expected to generate this demand, except for a night concert / play when the Hall and Theatre would be filled to capacity. Therefore, a total of 234 vehicles has been assumed for this assessment.

For the purposes of this assessment we have assumed the following:

- 56 cars will use the overflow car park/playing courts
- 90 cars (50% of the 180 cars using the school car park) will approach the car park entry from Moondarra Drive.
- 90 cars (50% of the 180 cars using the school car park) will approach the car park entry along Carmichael Drive.
- For an after school event, the arrival period will occur over 30 minutes, and similarly the departure period will occur over 30 minutes (worst case 9:30 to 10 pm).

This means that the potentially affected residences along Carmichael Drive will be impacted by 45 cars travelling along the street over a 15 minute period.

Refer Table 11 below, showing the Sound Exposure Level of a vehicle moving slowly is 55 to 60 dB(A) at 7m. This equates to an $L_{Aeq,15\ minutes}$ of 42 dB(A) at 7 m during the 30 minute pre and post event periods.

Taking distance attenuation (- 3 dB) into account to the residences on the eastern side of Carmichael Drive, the short term traffic noise impact during the 30 minute pre and post event periods will be 39 dB(A), $L_{eq,15\ minutes}$, which complies with the INP maximum intrusive noise criterion of 42 $dBL_{eq,15\ minutes}$ for the evening period.

8.3 Traffic noise impact from playing courts/overflow parking and access road

The proposed playing courts (western side of the site) will be used when required for overflow parking for events at the Performing Arts Centre. A total of 56 overflow parking spaces will be provided for after school events.

Nearest residential receivers

The nearest receivers to the proposed access road and playing courts/overflow car park are as follows:

- Residential receivers located 50m to the west of the road, across existing vegetation, and fronting Dryander Avenue.
- Residential receivers located 50m to the west of the playing courts/overflow car park, across existing vegetation, and fronting Warby Avenue.

Hours of operation

The playing courts/overflow car park and the proposed access road are expected to operate for after school events in the Performing Arts Centre, such as the Arts and Culture Night, on selected evenings from 6 pm to 9:30 pm.

The potential impact of noise generated by vehicle movements within the car park and driveways, other vehicle operational noise (i.e. door opening and closing, engine starting) and patron noise (i.e. people talking in the car park) is addressed as part of this access road and car park noise assessment.

Car park activities and nature of noise sources

The potential noise sources associated with the proposed car park operations will be:

- Noise generated by vehicle movements within the car park and on the access road (i.e. vehicles moving slowly).
- Other vehicle operational noises (i.e. doors and closing, engines starting).
- Patron noise (i.e. people talking in the car park).

Acoustic Studio has compiled the noise level data in Table 11 below for the noise sources / car park activities assumed for the proposed car park.

Noise Source / Car park activities	Noise Levels at 7 metres, in dB(A)
	SEL[2]
Vehicle door closing	60
Vehicle engine starting	65
Vehicle accelerating	65
Vehicle moving slowly	55
Patrons talking and laughing	55

Notes

1. *Sound exposure level (SEL) is the total noise energy produced from a single noise event. SEL is a useful metric to describe the amount of noise from transient events, such as an individual car pass-by, regardless of its duration. SEL is related to L_{AeqT} by the following equation:*

   $L_{Aeq,15\ minutes}$ *= SEL + [10 x log (number of events/15 minutes x 60 seconds)]*

Table 11 : Noise levels for vehicles and patrons associated with the proposed car park activities

The noise levels resulting from overflow car park operations on the proposed playing courts have been calculated at the boundary of the most affected residential receivers located to the west of the site, as described above.

The calculation takes into account distance attenuation of 17 dB (from 7m to 50m).

As a worst-case scenario the following assumptions have been made in regards to the car park noise assessment:

- Overflow car park operating during an evening event at the Performing Arts Centre.

- Vehicles using the overflow car park arriving between 5:30 pm and 6:30 pm and departing between 9:30 pm and 10 pm.
- Vehicle movements within the overflow car park limited to 28 movements per 15-minute period (i.e. one half of total capacity).
- Overflow car park activities/operations are those described above and vehicle and patrons using the car park are evenly distributed in the overflow car park and driveways area.

The results of the operational noise assessment are shown in Table 12 below.

Assessment Location	Noise Levels at property boundary, $dBL_{Aeq,15min}$	Evening (6pm to 10pm)	
		Criteria, $dBL_{Aeq,15min}$	Complies?
Dryander Avenue	**37**	42	Yes
Warby Avenue	**37**	42	Yes

Table 12: Overflow car park operational noise assessment during an event at the Performing Arts Centre (evening period)

9 New Playing Courts

The new multipurpose playing courts will be used for a variety of ball games such as tennis, basketball and netball, as well as general physical education (PE) lessons. The highest noise levels resulting from the use of the court are anticipated to be during netball and basketball games.

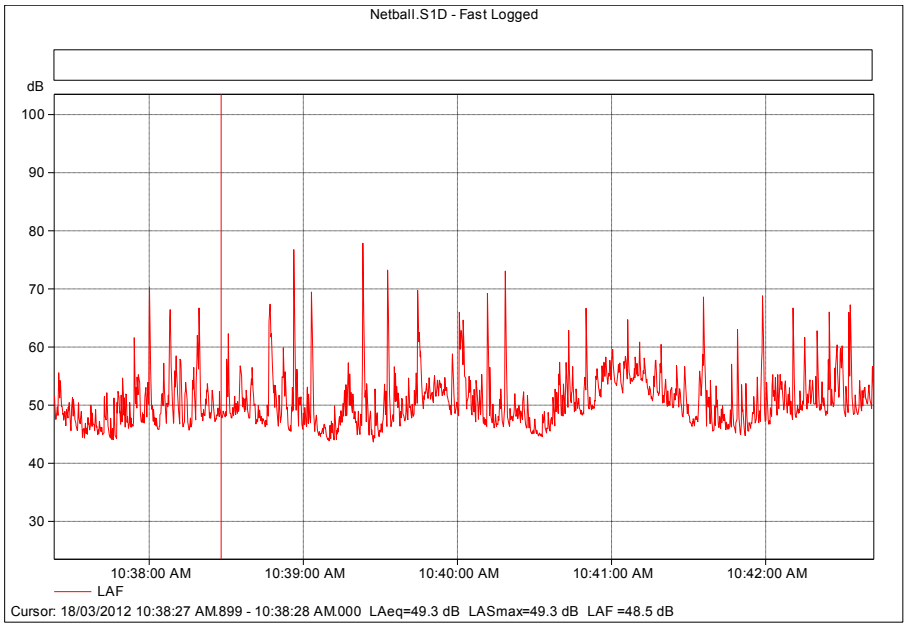
The nearest residential properties are located to the west of the courts (approximately 60 m from the nearest court). These properties represent the most likely affected properties.

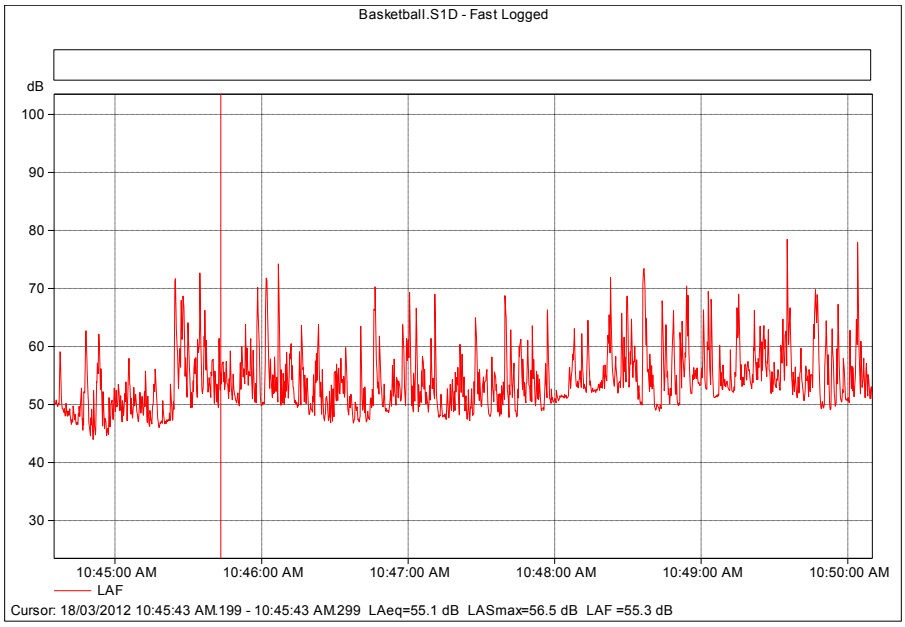
It is considered that an appropriate external noise criterion for noise from the multipurpose court is as follows:

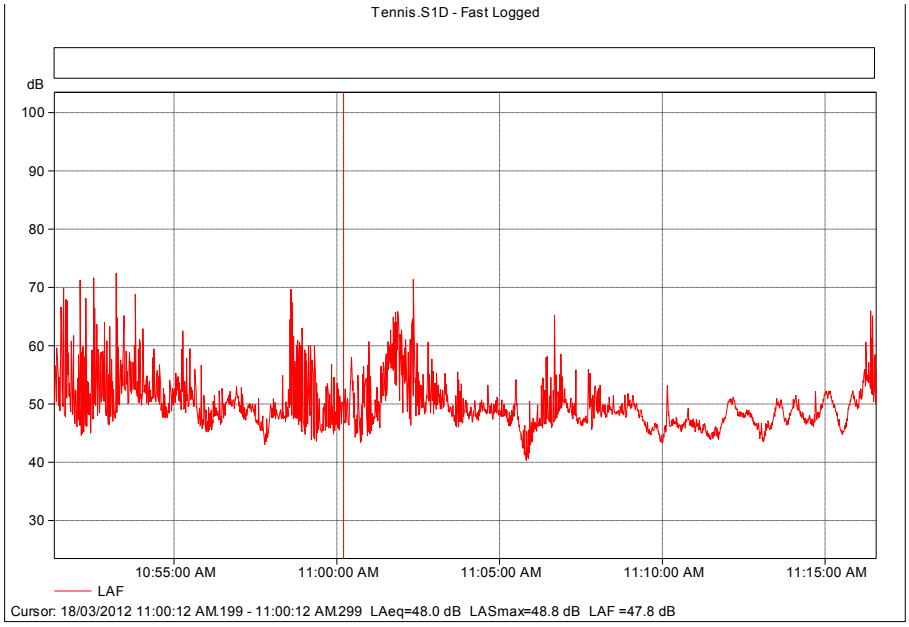
Noise levels from the multipurpose court shall not exceed the background (L_{A90}) level by more than 5 dB(A) when measured at the most affected point on or within any residential property.

Background noise level surveys have established an L_{90} of 44 dB(A) at the nearest residential boundaries in Warby Avenue. Therefore, the external noise criterion for noise from the multipurpose court is a maximum $L_{Aeq,15\ minutes}$ of 49 dB(A) at the most affected point on or within any residential property.

Acoustic Studio has previously carried out noise assessments of basketball and netball games on open air playing courts in similar, supervised school environments. Information on file of court side noise level measurements carried out during a netball game by Steven Cooper of The Acoustic Group shows the output of these measurements as follows:







The highest measured L_{Aeq} of these samples is 55 dB(A) and this has been used in this assessment as the input noise data for typical ball games on the proposed playing courts.

Based on these noise level measurements, source data for this project has been established as an $L_{Aeq,\ 15\ minutes}$ of 55 dB(A) at 5.5 m. This level represents the level that would typically exist in a supervised school environment. This supervision and control is reflected in the Noise Management Plan to be issued for the overall proposal.

Taking into account distance attenuation of 21 dB over a distance of 60 m, the resulting noise level at the nearest residential boundary in Warby Avenue (from noise from the playing courts) will be 34 dB(A).

Council has also stated that an adjustment for impulsive noise is to be included in the noise assessment of the playing courts. The INP defines an impulsive noise as one in which the difference in A-weighted maximum noise levels between fast response and impulse response in greater than 2 dB. If this is the case, the adjustment is the difference in measured levels, up to a maximum of 5 dB.

Other noise surveys carried out by Acoustic Studio of the noise levels generated during adult competitive basketball games have shown that the difference in A-weighted maximum noise levels between fast response and impulse response is typically 5 dB. We consider that this is likely to represent the worst case, given the differences in play between adult competitive basketball players and basketball games within a school context. Notwithstanding this, we have used this dB difference to establish the impulsive noise adjustment required by Council.

On this basis the impulsive noise adjustment is 5 dB, making the assessment noise level from the playing courts 39 dB(A), $L_{eq,15\ minutes}$.

This is less than the acceptance criterion of 49 dB(A) and no further noise controls are considered necessary for the multi-purpose playing courts.

10 Cumulative Noise Impact

Council has requested a cumulative noise impact be carried out to assess multiple noise sources generating noise simultaneously. As an example, Council has nominated events in the Hall, the Theatre, mechanical plant equipment, the entry courtyard, and increased traffic as noise sources that will likely all contribute to the noise generated from an event.

We have considered three possible event scenarios in order to assess potential cumulative noise impact. These scenarios are summarised below in Table 13.

Noise source	Scenario 1	Scenario 2	Scenario 3
Event in Hall	Yes	Yes	No
Event in Theatre	Yes	No	No
Patrons in Gallery	No	Yes	Yes
Patrons in Entry Courtyard	No	Yes	Yes
Mechanical Plant	Yes	Yes	Yes
Increased traffic along Carmichael Drive	No	No	Yes

Table 13: Noise scenarios for cumulative noise assessment

The basis of these scenarios is as follows:

Scenario 1 – Simultaneous events in Hall and Theatre

- Simultaneous events in the Hall and the Theatre.
- No patrons in the Gallery or Entry Courtyard (all patrons in the Theatre or Hall).
- All mechanical plant operating.
- No increased traffic from event patrons during event (increased traffic occurs pre and post event.

Scenario 2 – Single event in Hall or Theatre, and interval for second event

- An event in the Hall OR the Theatre.
- Patrons in the Gallery and Entry Courtyard, before, or during interval of a second event.
- All mechanical plant operating.

- No increased traffic from event patrons during event (increased traffic occurs pre and post event.

Scenario 3 – Pre and Post event periods with maximum capacity

- No events in the Hall or the Theatre.
- No patrons in the Gallery or Entry Courtyard (all patrons in the Theatre or Hall).
- All mechanical plant operating.
- Increased traffic from event patrons - occurring pre and post event.

The predicted noise levels for these scenarios at the nearest residential boundaries (Assessment Locations 1 and 2) are shown below.

10.1Assessment Location 1

10.1.1 Scenario 1

Noise source	Included in Scenario 1 assessment	Noise level at Location 1 boundary, $dBL_{Aeq,15\ minutes}$
Event in Hall	Yes	37
Event in Theatre	Yes	27
Patrons in Gallery	No	-
Patrons in Entry Courtyard (33% occupancy)	No	-
Mechanical Plant	Yes	34
Increased Traffic	No	-
Total cumulative noise level at Location 1, Scenario 1		**39**

Table 14: Cumulative noise assessment for Location 1, Scenario 1

10.1.2 Scenario 2

Noise source	Included in Scenario 2 assessment	Noise level at Location 1 boundary, $dBL_{Aeq,15\ minutes}$
Event in Hall	Yes	37
Event in Theatre	No	-
Patrons in Gallery	Yes	16
Patrons in Entry Courtyard (33% occupancy)	Yes	38
Mechanical Plant	Yes	34
Increased Traffic	No	-
Total cumulative noise level at Location 1, Scenario 2		**41**

Table 15: Cumulative noise assessment for Location 1, Scenario 2

10.1.3 Scenario 3

Noise source	Included in Scenario 3 assessment	Noise level at Location 1 boundary, $dBL_{Aeq,15\ minutes}$
Event in Hall	No	-
Event in Theatre	No	-
Patrons in Gallery	Yes	16
Patrons in Entry Courtyard (33% occupancy)	Yes	38
Mechanical Plant	Yes	34
Increased Traffic	Yes	39
Total cumulative noise level at Location 1, Scenario 3		**42**

Table 16: Cumulative noise assessment for Location 1, Scenario 2

10.2Assessment Location 2

10.2.1 Scenario 1

Noise source	Included in Scenario 1 assessment	Noise level at Location 2 boundary, $L_{Aeq,15\ minutes}$
Event in Hall	Yes	32
Event in Theatre	Yes	32
Patrons in Gallery	No	-
Patrons in Entry Courtyard (33% occupancy)	No	-
Mechanical Plant	Yes	34
Increased Traffic	No	-
Total cumulative noise level at Location 2, Scenario 1		**38**

Table 17: Cumulative noise assessment for Location 2, Scenario 1

10.2.2 Scenario 2

Noise source	Included in Scenario 2 assessment	Noise level at Location 2 boundary, $L_{Aeq,15\ minutes}$
Event in Hall	Yes	32
Event in Theatre	No	-
Patrons in Gallery	Yes	20
Patrons in Entry Courtyard (33% occupancy)	Yes	38
Mechanical Plant	Yes	34
Increased Traffic	No	-
Total cumulative noise level at Location 2, Scenario 2		**40**

Table 18: Cumulative noise assessment for Location 2, Scenario 2

10.2.3 Scenario 3

Noise source	Included in Scenario 3 assessment	Noise level at Location 2 boundary, $dBL_{Aeq,15\ minutes}$
Event in Hall	No	-
Event in Theatre	No	-
Patrons in Gallery	Yes	20
Patrons in Entry Courtyard (33% occupancy)	Yes	38
Mechanical Plant	Yes	34
Increased Traffic	Yes	39
Total cumulative noise level at Location 1, Scenario 3		**42**

Table 16: Cumulative noise assessment for Location 2, Scenario 2

The predicted cumulative noise impacts for typical event scenarios range from 38 to 42 $dBL_{Aeq,15\ minutes}$, which complies with the INP maximum intrusive noise criterion of 42 $dBL_{Aeq,15\ minutes}$ for the evening period.

11 Noise and Vibration Impacts During Construction

Control of noise and vibration levels generated during the construction will be necessary. Currently the project is at a preliminary design stage and the detailed construction program is not yet defined. This section of the report provides general recommendations only and indicates best noise and vibration control practices to be observed during the construction period.

11.1Construction noise sensitive receivers

The nearest noise sensitive receivers to the development have been listed in Section 2.2 and are also shown in Figure 6.

11.2Construction noise management

11.2.1 Control elements

As a general rule, prevention should be applied as universal work practice at any time of day, but especially if any construction works are to be undertaken at critical times outside normal daytime / weekday periods.

It is noted that the reduction of the noise at the source and the control of transmission path between the construction site and the receiver are the preferred options for noise minimisation.

Providing treatments at the affected residences or other sensitive land uses should only be at a last resort.

Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
    - Use quieter methods.
    - Use quieter equipment.
    - Operate plant in a quiet and effective manner.
    - Maintain equipment regularly.
- On site noise management
    - Strategically locate equipment and plant.
    - Avoid the use of reversing alarms or provide for alternative systems.
    - Maximise shielding in the form of existing structures or temporary barriers.

- Schedule the construction of barriers and structures so they can be used as early as possible.

- Consultation, notification and complaints handling
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
  - Schedule activities to minimise noise impacts.
  - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
  - Keep truck drivers informed of designated routes, parking locations and delivery hours.

11.2.2 Working hours

Working hours shall be limited at least to those set out as recommended standard hours of work in the EPA's "Interim Construction Noise Guideline" as follows:

- Monday to Friday — 7 am to 6 pm
- Saturday — 8 am to 1 pm
- Sundays and Public Holidays — No excavation or construction work

The project construction hours will be in accordance with the DA conditions issued by Liverpool City Council.

11.2.3 Noise criteria / site operational noise level limits

The noise criteria and operational levels presented in this section are for guidance only and do not form part of any legal obligation on the part of the project proponent. However, compliance with these criteria/limits is considered best practice.

At nearest residential dwellings

The EPA in its "Interim Construction Noise Guideline" suggests construction noise management levels that may minimise the likelihood of annoyance being caused to noise sensitive residential receptors. These are as follows:

- Within recommended standard hours.

The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background level by more than 10 dB(A). This noise level represents the point above which there may be some community reaction to noise.

However, in the case of a highly noise affected area, the construction noise level at the most exposed boundary of any affected residential receiver when the construction site is in operation should not exceed 75 dB(A). This level represents the point above which there may be strong community reaction to noise.

- Outside recommended standard hours.

  The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background level by more than 5 dB(A).

  It is noted that a strong justification would be required for works outside the recommended standard hours.

Other sensitive land uses

EPA's "Interim Construction Noise Guideline" also suggests construction noise management levels for other sensitive land uses that are applicable to the Montessori Long Day Care Centre located near the Project site. These levels are as follows:

- Industrial premises: $L_{Aeq,15min}$ 45 dB(A) (internal)

11.2.4 Ground-borne noise criteria

Apart from the external construction noise management levels presented above, the EPA guideline also recommends internal ground-borne noise maximum levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise. The ground-borne noise levels presented below are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- Evening: $L_{Aeq,15min}$ 40 dB(A) (internal)
- Night: $L_{Aeq,15min}$ 35 dB(A) (internal)

The internal noise levels are to be assessed at the centre of the most affected habitable room. It is noted that a strong justification would be required for works outside the recommended standard hours.

11.2.5 Vibration criteria

Vibration criteria for human comfort in nearby occupied premises would primarily be derived in accordance with EPA *Assessing Vibration – a technical guideline* (2006), which describes a dose-based acceptable vibration level. This again requires an understanding of

how long any vibration-generating equipment would be used. Preferred vibration dose values are:

- For residences – 0.2 $m/s^{1.75}$ during the day and 0.13 $m/s^{1.75}$ during the night.
- For schools and other educations institutions – 0.4 $m/s^{1.75}$ during the day.

12 Summary and Conclusions

A noise assessment has been carried out for the extensions and new buildings proposed for Clancy Catholic College, West Hoxton.

The assessment methodology used in this study is aimed at protecting the acoustic amenity of the neighbouring residents from the following noise types and sources:

- Noise from activities and operations of the new Hall and the refurbished Theatre and associated spaces.
- Noise from special events held at the facilities, including the outdoor gathering of patrons in the Entry Courtyard.
- Noise from general mechanical plant and air-conditioning equipment.
- Noise from games activities from the multi-purpose playing courts.
- Noise from traffic associated with the development, including vehicle access and drop-off points, and car parks.

Ambient noise monitoring has been carried out at the nearest residential boundaries to establish typical daytime and night-time octave band frequency spectra of the existing background noise levels. Noise criteria have been established from these measured levels.

Source noise levels and spectra for the typical operational scenarios of the new development have been established.

In summary:

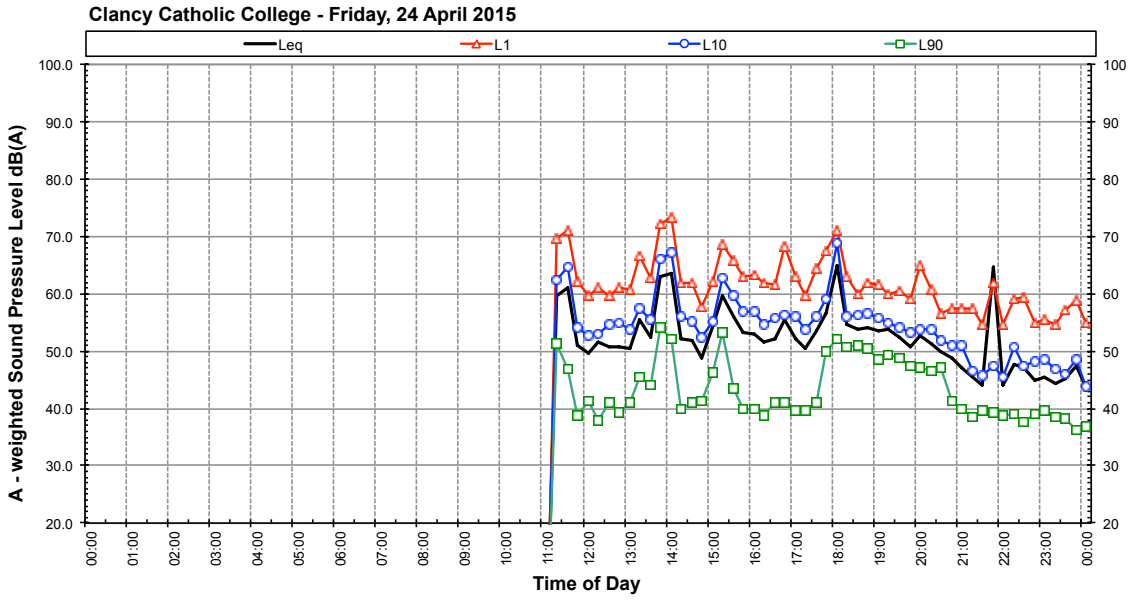
- The design and construction of the new Hall and refurbished Theatre will result in noise from the proposed activity scenarios being less than the noise limiting criteria (and inaudible) at the nearest residential boundaries, provided the building constructions meet the following minimum acoustic ratings:
    - Theatre wall construction – minimum R_w 50
    - Theatre roof/ceiling construction – minimum R_w 45
    - Multipurpose Hall wall construction – minimum R_w 45
    - Multipurpose Hall roof/ceiling construction – minimum R_w 45
    - Gallery glazed façade construction - minimum R_w 30
    - Gallery glazed roof/ceiling construction - minimum R_w 45

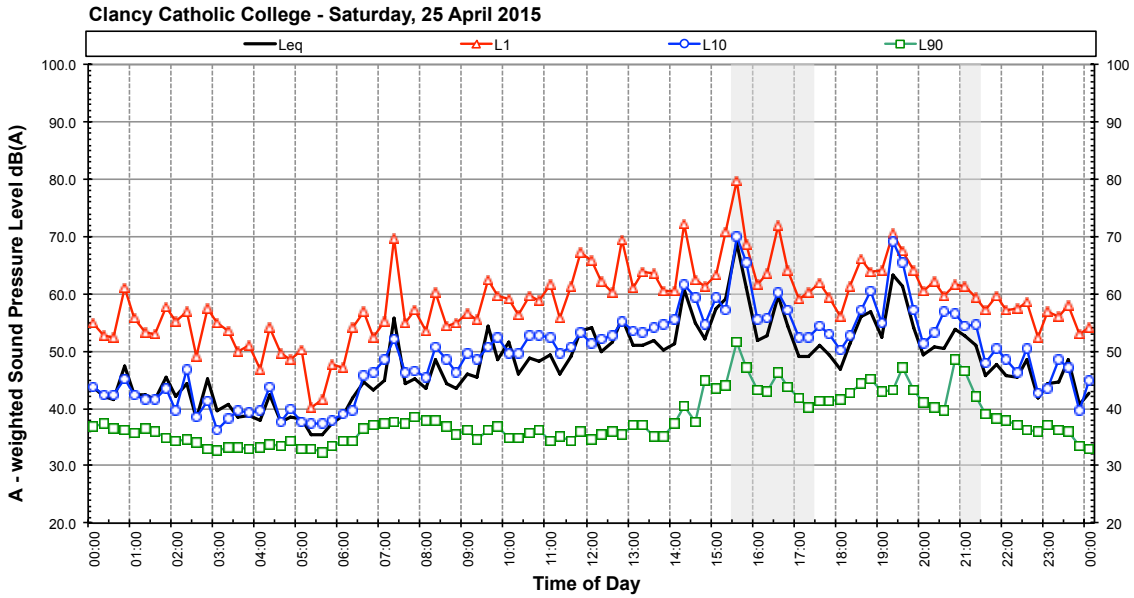
- The design and construction of the new buildings will ensure that noise from general internal classroom teaching activities will meet the noise limiting criteria.
- There will be no significant increase in noise from general external playground activities.
- Noise controls and appropriate attenuation measures have been included in the selection and design of all mechanical plant and air-conditioning equipment to ensure that the noise limiting criteria are met. Details of these noise controls are provided in Section 6.3 of this report.
- Noise from games activities on the multi-purpose playing courts will be less than the acceptance criterion, will be insignificant and generally inaudible compared with existing daytime background sound levels. An impulsive noise adjustment has been applied to the noise level calculated from games on the playing courts in accordance with the INP methodology, and the resultant assessment shows that no further noise controls are required.
- There will be no significant increase in noise from traffic associated with the development, including vehicle access and drop-off points, and new car parking areas.
- Cumulative noise assessments have been carried out on three scenarios that are likely to occur with multiple noise sources occurring simultaneously. In all cases the cumulative noise levels at the nearest residential boundaries comply with the INP maximum intrusive noise criterion of 42 $dBL_{eq,15\ minutes}$ for the evening period.

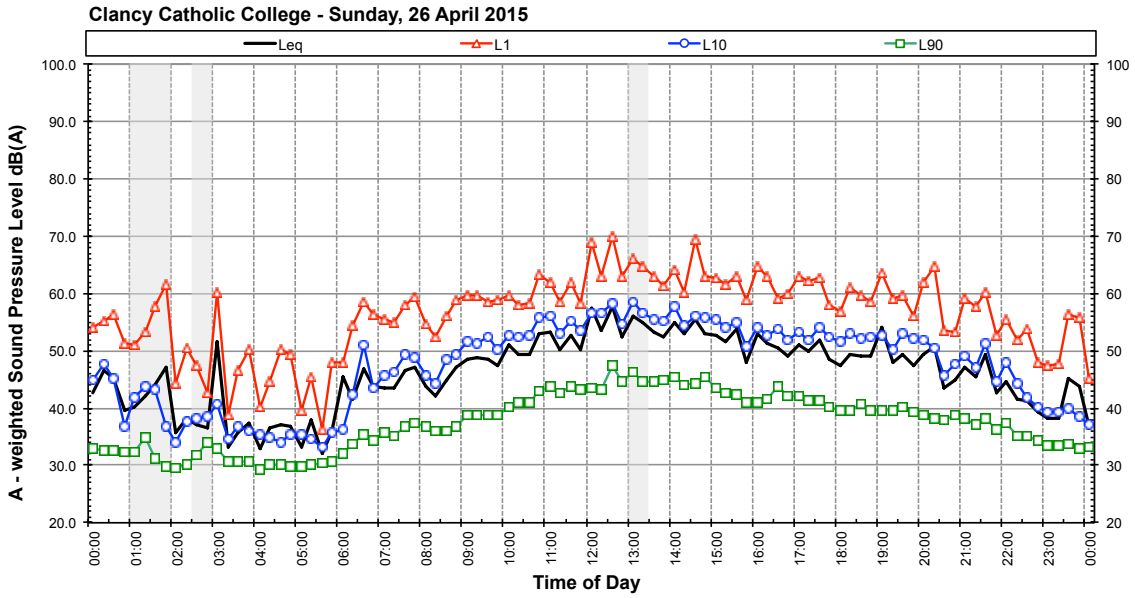
Potential construction noise and vibration impacts on the surrounding community have been presented in this report and recommendations based on relevant guidelines are provided.

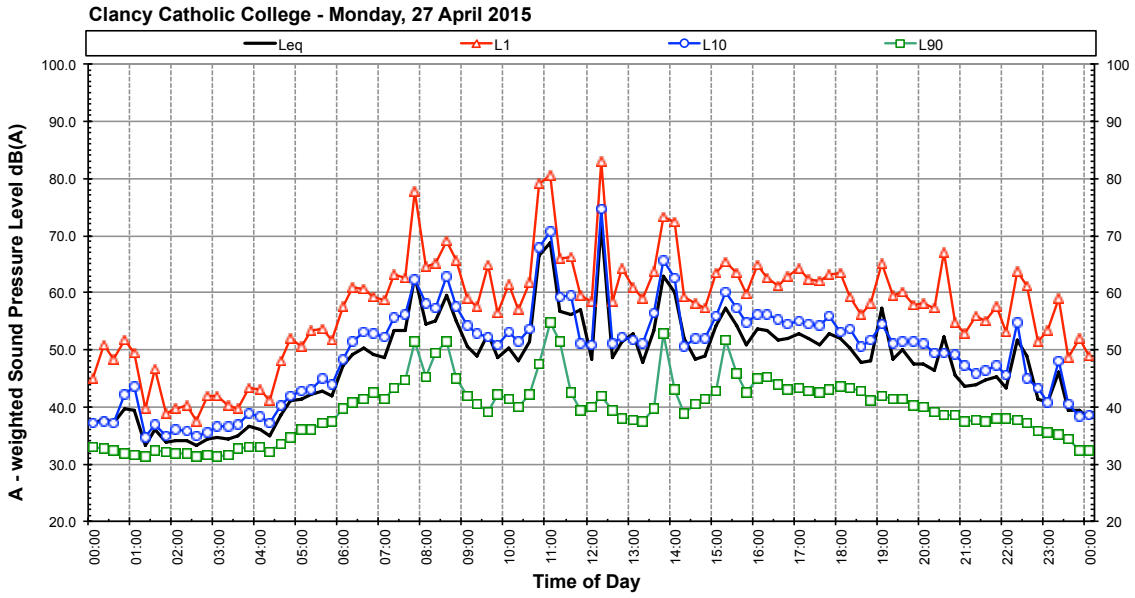
Appendices

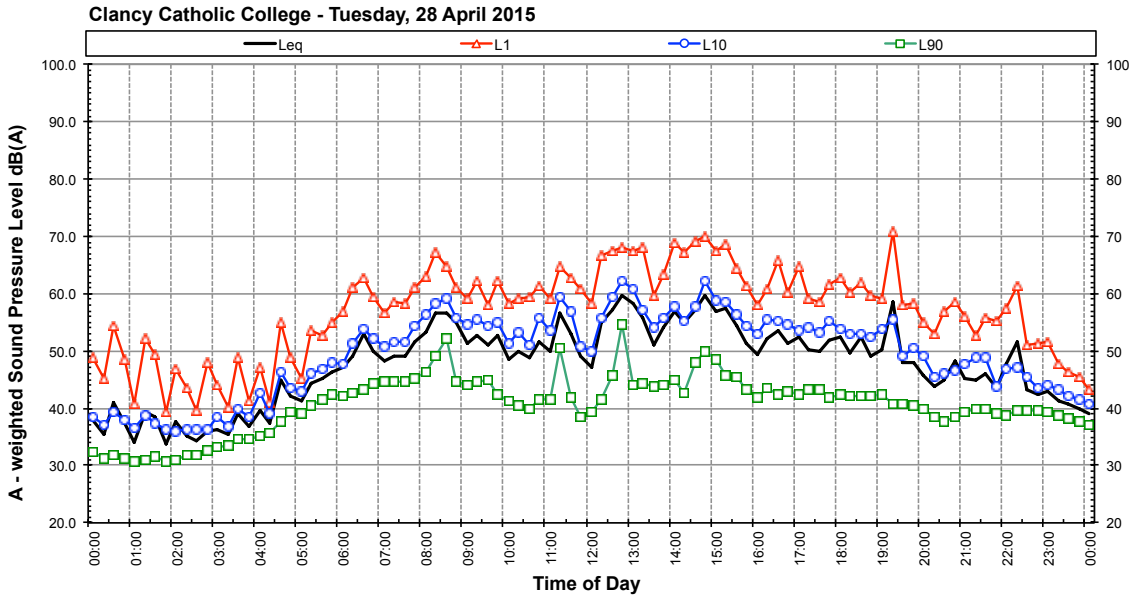
Appendix A : Long-term monitoring results

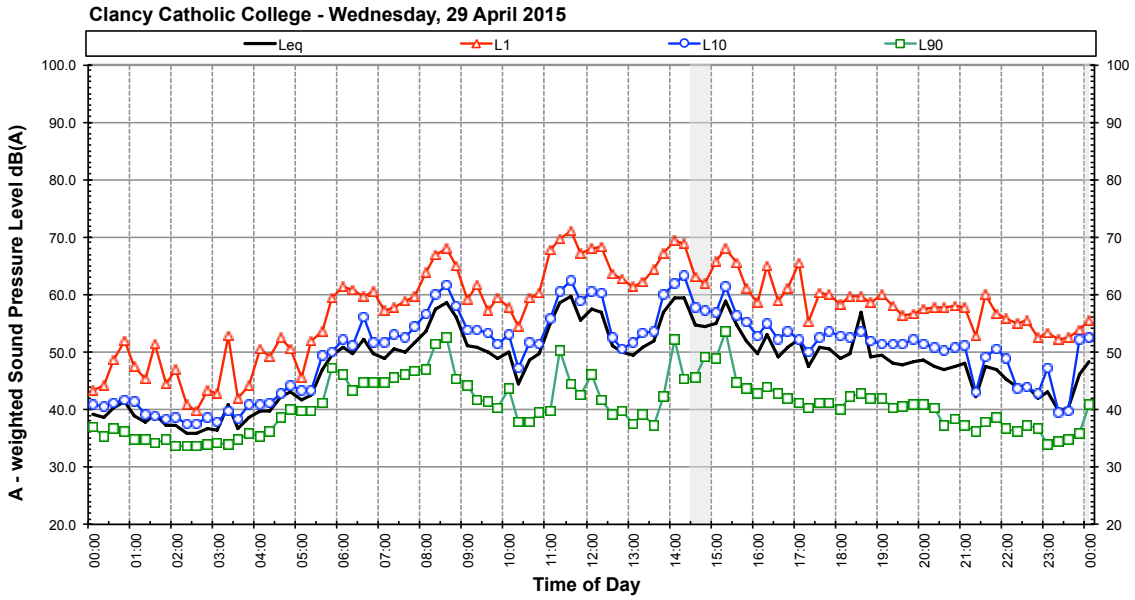


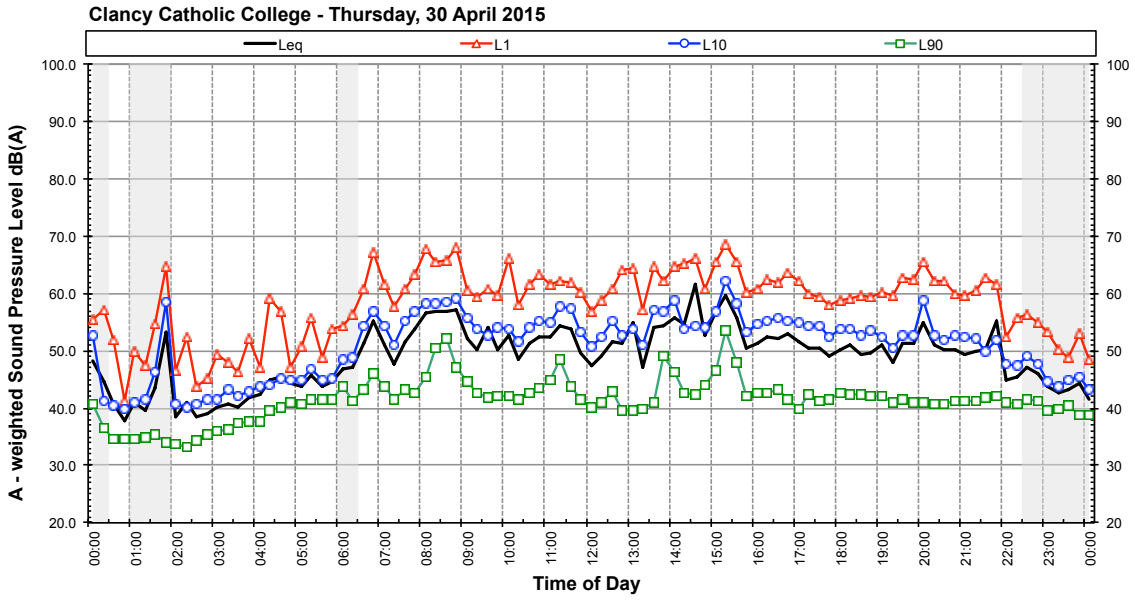


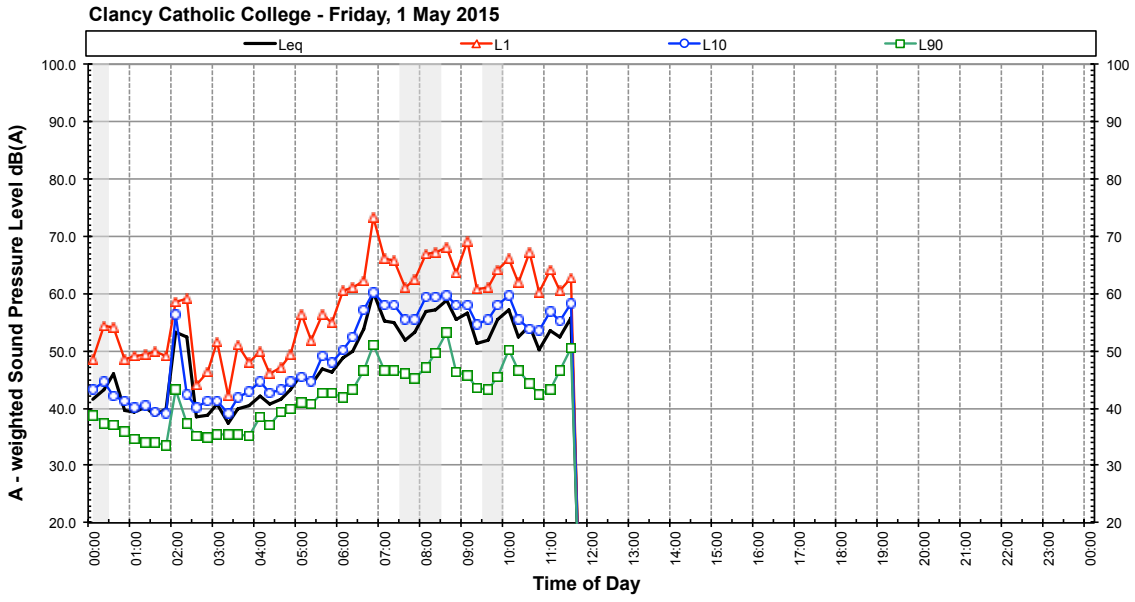

Clancy Catholic College - Sunday, 26 April 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

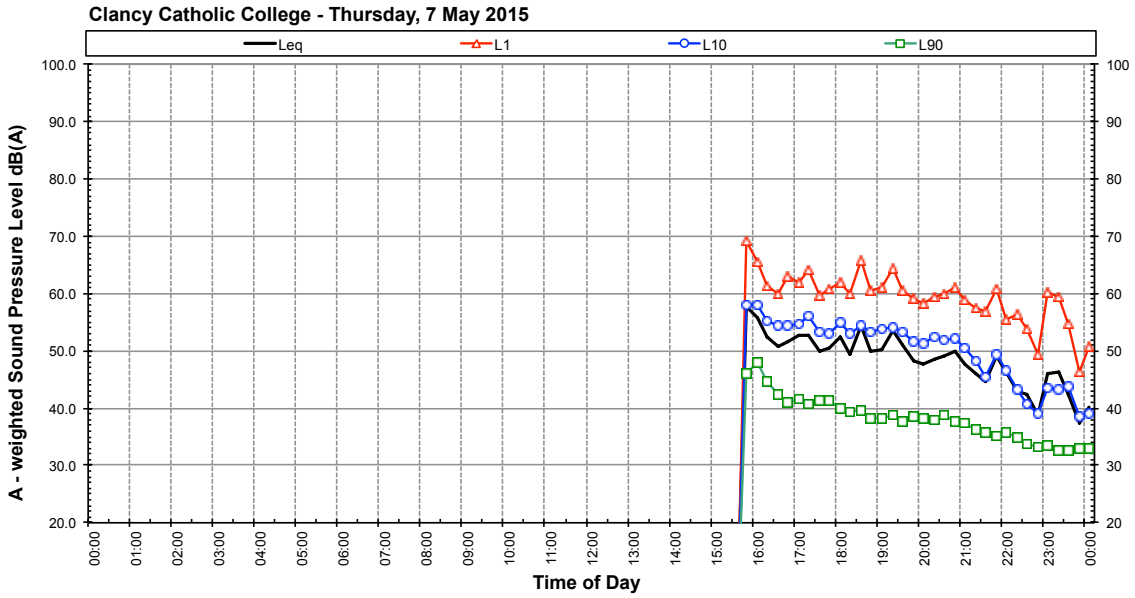

Clancy Catholic College - Monday, 27 April 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

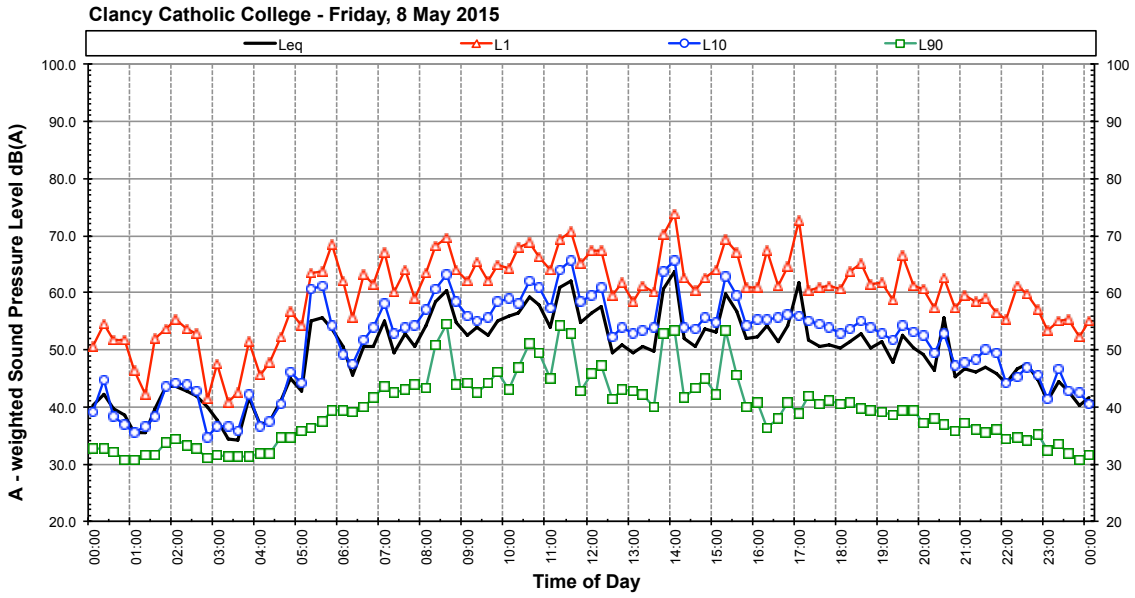

Clancy Catholic College - Tuesday, 28 April 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

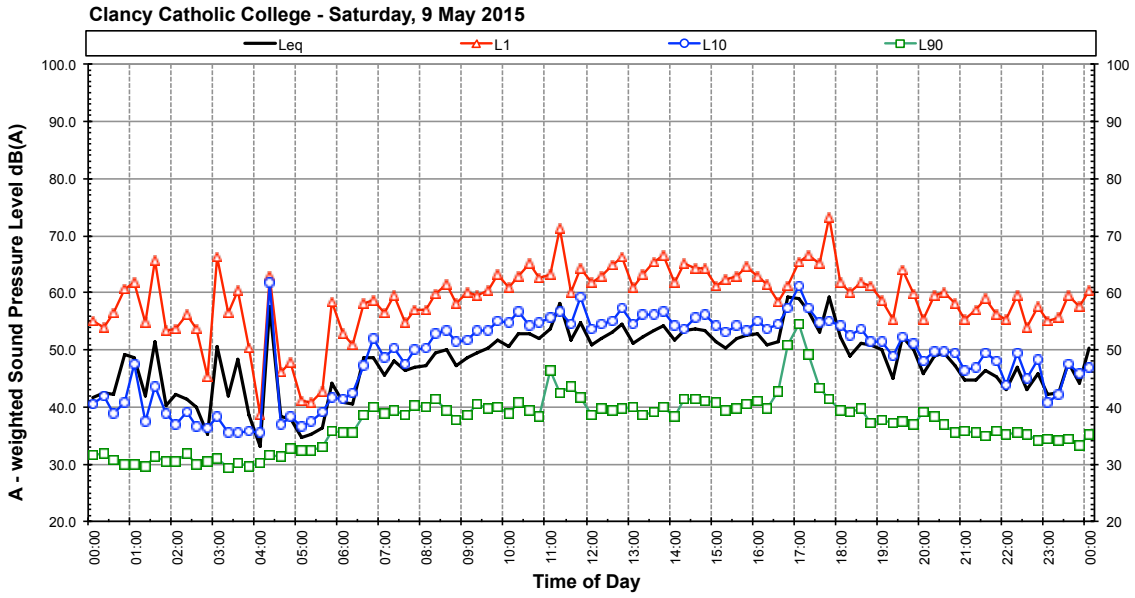

Clancy Catholic College - Wednesday, 29 April 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

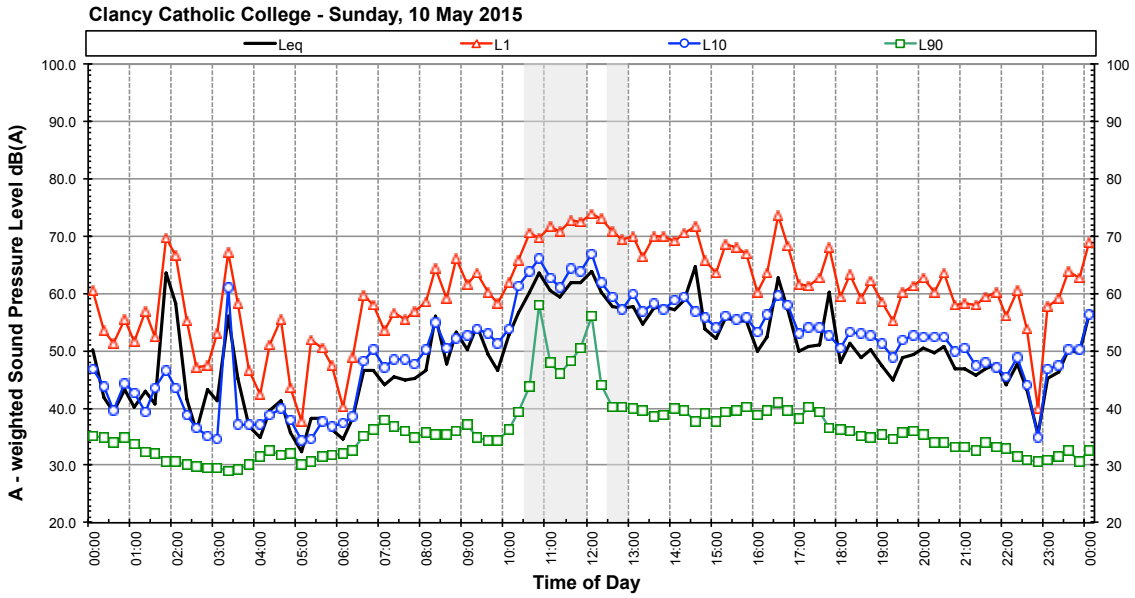

Clancy Catholic College - Thursday, 30 April 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

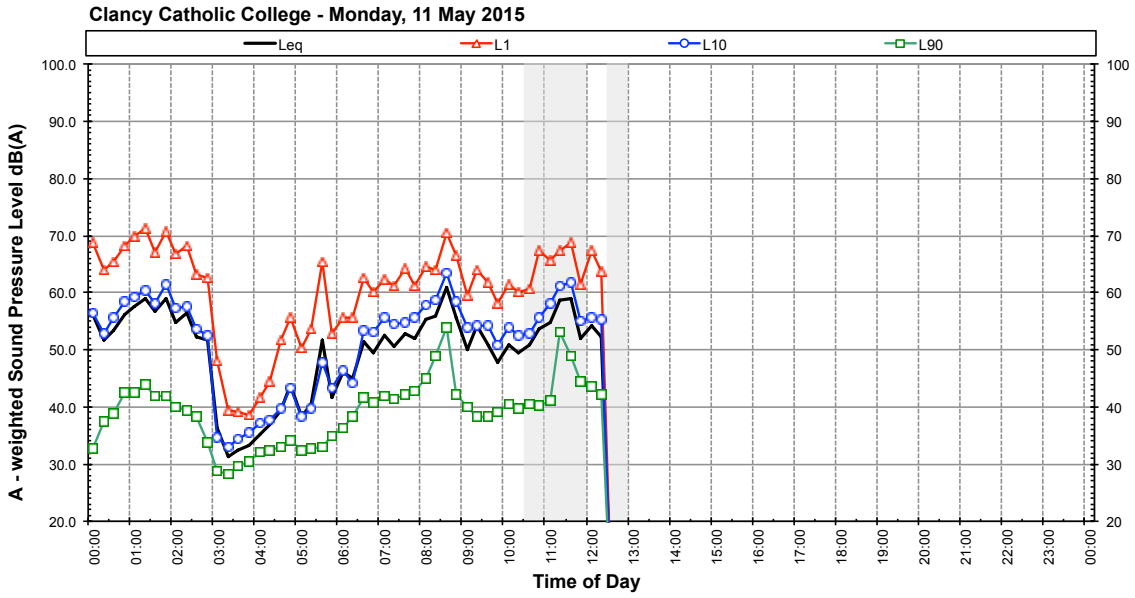

Clancy Catholic College - Friday, 1 May 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day


Clancy Catholic College - Thursday, 7 May 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day


Clancy Catholic College - Friday, 8 May 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day


Clancy Catholic College - Saturday, 9 May 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day


Clancy Catholic College - Sunday, 10 May 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day


Clancy Catholic College - Monday, 11 May 2015
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

Appendix B : Derivation of Environmental Noise Break-out Limits

The one of the sources of noise break-out from the Project site to the environment will be mechanical services plant.

The environmental noise impact of the proposed roof plant will be assessed in accordance with the NSW Industrial Noise Policy 2000 (NSW INP).

The NSW INP sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the project specific noise level.

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source should not be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured - if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project specific noise level

For the new roof plant, the more stringent of the intrusive and the amenity criteria sets the project specific noise level.

The derivation of the project specific noise levels is provided below.

B.1 Existing Background and Ambient Noise Levels

The rating background level (RBL) has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in NSW INP.

Three time periods are presented (consistent with the time of day classifications in the Policy):

- Day - 7 am to 6 pm
- Evening - 6 pm to 10 pm
- Night - 10 pm to 7 am

From the noise logged data presented in Appendix A, the calculated RBL's and measured ambient noise levels are shown below in Table B1.

Location	L_{90} Background Noise Levels, dB(A)			L_{eq} Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
L1 – Clancy Catholic College (south-eastern side of site)	39	37	31	56	52	47

Table B1: Long-term background and ambient noise levels measured around Clancy Catholic College

From observations during our site visits, it is noted that both ambient and background noise levels around the site are currently dominated by intermittent traffic noise on local roads, natural noises such as birds, and distant traffic noise from Cowpasture Road.

B.2 Determination of intrusiveness criterion

The intrusiveness criterion is defined as:

$$L_{Aeq,15\ minute} \leq \text{rating background level plus 5}$$

As a worst-case scenario, the intrusiveness criterion has been determined from the lowest RBL's presented in Table B1 for each period and from the short-term measurements presented in Section 4.2.

- Day Intrusiveness criterion of 39 + 5 = **44 dB(A)**
- Evening Intrusiveness criterion of 37 + 5 = **42 dB(A)**
- Night Intrusiveness criterion of 31 + 5 = **36 dB(A)**

B.3 Determination of amenity criterion

To limit continuing increases in noise levels, the maximum ambient noise levels within an area from industrial noise sources should not normally exceed the acceptable noise levels appropriate for the type of area (e.g. the acceptable noise level in a rural area would be less than that in an urban or industrial area).

Recommended L_{Aeq} noise levels from industrial noise sources within NSW INP

The Acceptable Noise Levels (ANLs) for each land use type under consideration (as detailed in Table 2.1 of the NSW Industrial Noise Policy) are given in Table B2 below.

The nearest residential receivers to the project are considered to be in a Noise Amenity Area characterised by the NSW Industrial Noise Policy as Suburban.

Type of Receiver	Period	Recommended $L_{Aeq, period}$ Noise Level (ANL)	
		Acceptable	Recommended Maximum
Residential – Suburban (external)	Day	55	60
	Evening	45	50
	Night	40	45
School classroom (internal)	Noisiest 1-hr period, when in use	35	40

Table B2 : Recommended L_{Aeq} noise levels from industrial noise sources at residential and educational receivers

For the purpose of this assessment, "Acceptable" noise levels as presented in the table above are to be adopted.

B.4 Project specific noise level

The Project Specific Noise Level is defined as the lower of the intrusiveness and the amenity criteria. On this basis, the Project Specific Noise Levels (PNLs) for plant associated with the Clancy Catholic College project are shown in Table B5 below (PNLs shown shaded in grey).

Type of Receiver	Period	Intrusiveness Criterion	Amenity Criterion
Residential – Suburban (external)	Day	44	55
	Evening	42	45
	Night	36	40
School classroom (internal)	Noisiest 1-hr period, when in use	N/A	35

Table B5 : Determination of NSW INP project specific noise levels for the Clancy Catholic College project