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Mixed Use Development , Noise Impact Assessment

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DOCUMENT CONTROL REGISTER

Project Number	20150016.1
Project Name	Woolooware Bay Town Centre, Stage 4 Residential/Hotel
Document Title	Mixed Use Development , Noise Impact Assessment
Document Reference	20150016.1/2411A/R3/BW
Issue Type	Email
Attention To	Bluestone Property Solutions Pty Ltd Mr Julian Urquhart

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	7/01/2015	20150016.1/0701A/R0/BW	BW		BW
1	3/02/2016	20150016.1/0701A/R1/BW	BW		BW
2	13/09/2016	20150016.1/0701A/R2/BW	BW		BW
3	24/11/2016	20150016.1/2411A/R3/BW	BW		BW

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1 EXECUTIVE SUMMARY

This report details the noise and vibration assessment for impacts associated with the Woolooware Bay Town Centre, Stage 4 Residential/Hotel development as well as potential for noise impacts generated on the site impacting on surrounding areas (including built and natural environments).

The report details the assessment conducted into noise impacts which will potentially affect existing surrounding residence and future residence from the commercial/retail areas of the project, and includes:

1. Environmental noise impact on the future site, including surrounding traffic noise from surrounding roadways.

2. Traffic noise impact to surrounding residential properties from additional traffic numbers.

3. Building services noise to surrounding receivers.

4. The report also details the potential of noise impact from the proposed development to surrounding receivers including the built and natural environment (including neighbouring wet lands and Towra Point). The assessment includes noise generated on the site during the construction phase of the project as well as noise impact once the project is completed.

This report provides the results of Environmental Noise Study for the proposed Woolooware Bay Town Centre, Stage 4 Residential/Hotel project. Noise at the site has been measured and noise goals have been set in accordance with the requirements of the relevant statutory/regulatory authorities including Local Council and the Environmental Protection Authority (EPA) and the SEARS.

Determination of noise assessment criteria based on the EPA's Industrial Noise Policy and ECRTN have been determined based on both unattended and attended noise monitoring conducted at the proposed site.

Potential noise impacts generated from the proposed retail area of the development will be required to comply with the environmental noise level criteria detailed in this report (such as loading docks, carpark, plant and equipment etc).

For the residential and hotel components of the project has been developed to assess noise and vibration as required by Condition 8 of the Director Generals Requirements which follows:

> ***8. Noise and Vibration Assessment***
>
> *The EPA should address the issue of noise and vibration impacts and provide details of how these will be managed and ameliorated through the design of the building, in compliance with the relevant Australian Standards and the Departments Interim Guidelines for Development near Rail Corridors and Busy Roads.*

The report details the assessment conducted into existing noise impacts which will potentially affect future residence and includes:

1. Environmental noise within the vicinity of the site including traffic noise from surrounding road ways.

2. Noise from the operation of the sports ground to the residential tenancies to the west of the site.

2 INTRODUCTION

Acoustic Logic Consultancy Pty Ltd has been engaged to conduct an acoustic assessment for the purpose of assessing the potential impacts on the acoustic amenity of the proposed Woolooware Bay Town Centre, Stage 4 Residential/Hotel project for the potential impact of noise on surrounding receivers as part of the Section 75W. The noise sources investigated are as follows:

- Environmental noise impact on the future site, including surrounding traffic noise from surrounding roadways.
- Traffic noise impact to surrounding residential properties.
- Building services noise to surrounding receivers.
- The report also details the potential of noise impact from the proposed development to surrounding receivers including the built and natural environment (including neighbouring wet lands and Towra Point). The assessment includes noise generated on the site during the construction phase of the project as well as noise impact one the project is completed.
- Assess the potential for the environmental noise impact from surrounding noise sources, predominantly traffic noise, into the future residential and hotel tenancies within the project.

Unattended and attended noise monitoring was conducted in order to determine the existing environmental noise levels within the vicinity of the site.

The report will address noise generated from the retail elements of the development to surrounding properties. At this early stage no detailed design has been conducted for mechanical plant as is standard at Section 75W stage. This cursory study will set the goal assessment criteria applicable to the project based on EPA requirements, other council and relevant statutory/regulatory requirements.

2.1 SITE DESCRIPTION

Figure 1 below illustrates the location of the Cronulla Sharks Redevelopment site, and the location of noise monitoring and measurements. This report is relevant for the Woolooware Bay Town Centre, Stage 4 Residential/Hotel project component which is also identified in the figure below.

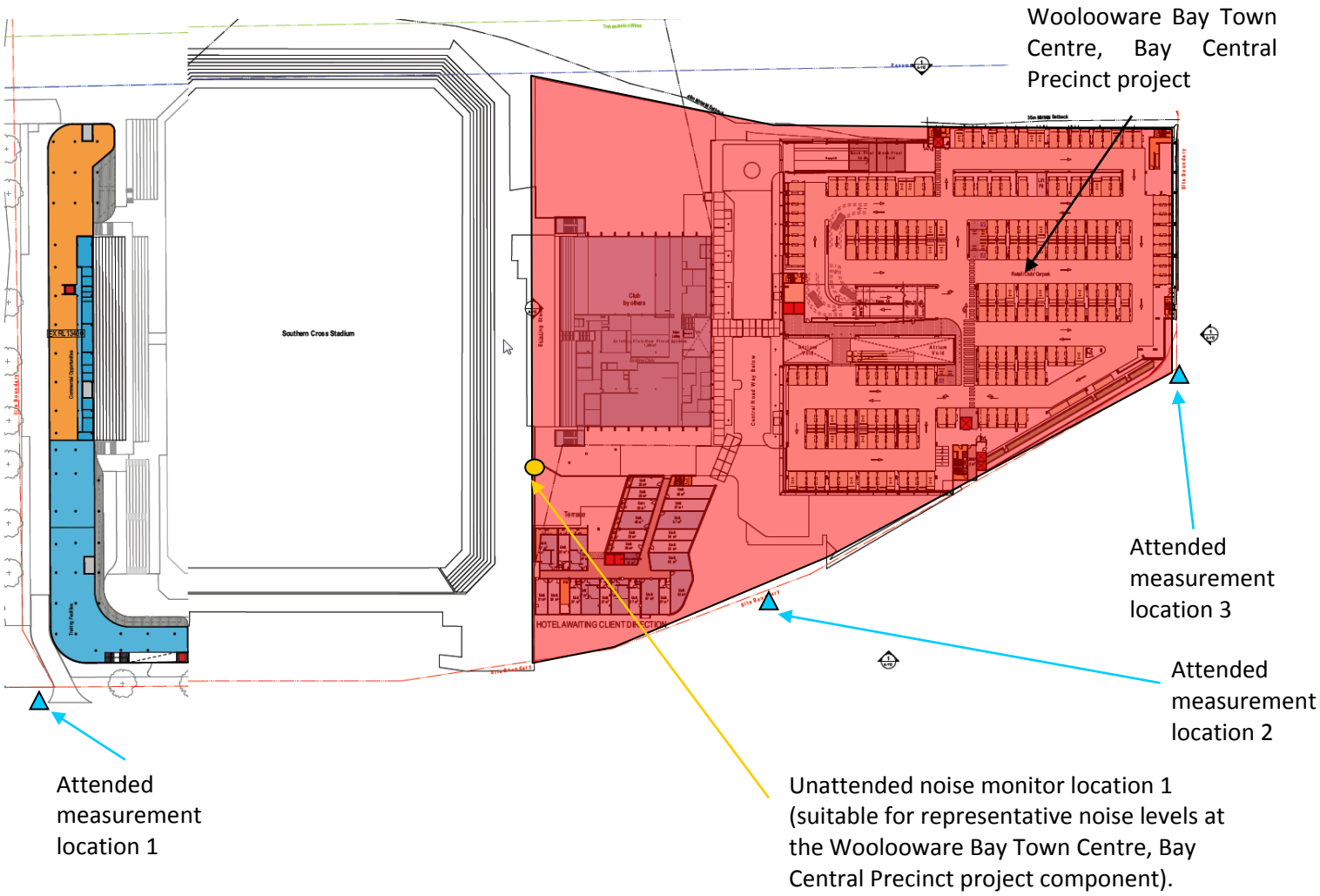


Figure 1 – Site Location and Measurement Positions

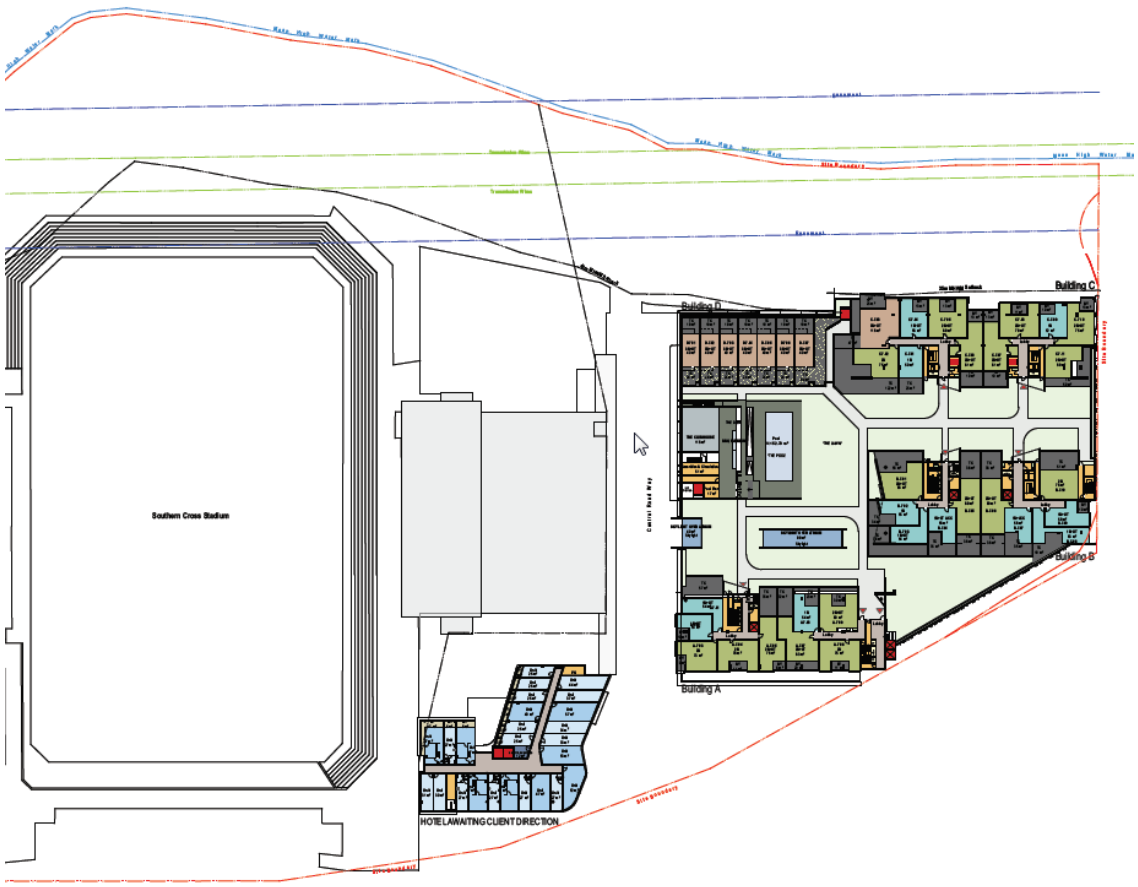


Figure 2 – Woolooware Bay Town Centre, Stage 4 Residential/Hotel project

The existing environmental noise sources affecting the site are as follows:

- Environmental noise predominantly from traffic noise from Captain Cook Drive to the south of the site which carries high volumes of traffic.

- Southern Cross Group Stadium to the east of the site. Games are typically conducted on sporting field every second weekend during the winter seasons of approximately March to September. Noise from Southern Cross Group Stadium is not considered further in this report as noise impact to the retail receivers will not impact the amenity of the project.

- Other surrounding boundaries are neighboured by existing parklands.

The environmental noise source outlined above has varying degrees of impact upon the proposed residential development which will be outlined in this report.

3 EXISTING ACOUSTIC ENVIRONMENT

Environmental noise impacting the site is a result of traffic noise from the surrounding perimeter roadways.

3.1 TOPOGRAPHY

The topography of the site and surrounding land of the proposed residential development is generally flat. The acoustic assessment has taken this topography into account.

4 ACOUSTIC SURVEY

As part of this assessment an acoustic survey of the proposed Woolooware Bay Town Centre - Stage 4 Residential/Hotel project site has been conducted.

The acoustic survey included attended and unattended noise logging which has previously been undertaken at the site and supplemented by attended noise measurements which are detailed in this section of the report.

4.1 ENVIRONMENTAL NOISE LEVELS

Environmental noise constantly varies in level, due to fluctuations in local noise sources including road traffic. Accordingly, a 15 minute measurement interval is normally utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters.

In the case of environmental noise three principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced by the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source depends on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the measurement period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of industrial noise.

4.2 ATTENDED NOISE MEASUREMENTS

Attended noise level measurements conducted as part of this assessment are detailed in this section of the report.

4.2.1 Measurement Equipment

Attended noise measurements were obtained using a CEL-593 Type 1 Sound Level Analyser, set to A-weighted fast response. The sound level meter was calibrated before and after the measurements using a RION NC-73 Sound Level Calibrator. No significant drift was recorded.

4.2.2 Measurement Period

Noise monitoring was conducted at the locations detailed in Figure 1 in Section 2 above during the following period:

1. Peak afternoon conditions between 4.30pm and 6pm on the 17th of January, 2013.

2. Supplementary noise level measurements were undertaken at the site between 4pm and 6pm on the 16th December 2014.

3. Additional attended measurements were conducted on the evening of the Friday 3rd June, 2011 during a period when a Cronulla home game was being conducted home game was being conducted with a Crowd of over 15,000 people.

4.3 UNATTENDED NOISE MONITORING

Unattended noise monitoring conducted as part of the master plan assessment which has been used as part of this investigation. The obtained noise logging results are detailed in this section of the report. The results of unattended noise logging are included in Appendix A.

4.3.1 Unattended Monitoring Period

Unattended noise monitoring was conducted at the site during the period of 10th to 20th June 2011 in order to measure the existing background and traffic noise levels at the site.

The noise level monitors were located at the following locations:

1. Location 1 – To the south east of the site facing Captain Cook Drive. This logger will be used for traffic noise levels and background noise levels at the site.

4.3.2 Monitoring Equipment

Unattended noise measurements were obtained using an Acoustic Research Laboratories Pty Ltd noise logger. The logger was programmed to store 15-minute statistical noise levels throughout the monitoring period. The noise monitors were calibrated at the beginning and the end of the measurement using a Rion NC-73 calibrator. No significant drift was detected. All measurements were taken on A-weighted fast response mode. Periods of adverse weather conditions during the during the measurement period have not be used in this assessment.

4.4 RESULTS OF THE ACOUSTIC SURVEY

An acoustic survey was undertaken at the proposed Woolooware Bay Town Centre, Stage 4 Residential/Hotel component in order to determine the existing acoustic environment. The unattended monitor results will be used to determine the variation between day, evening and night time noise levels.

Attended measurements will be compared with the unattended monitoring data during the same measurement period so that relative differences between the attended and unattended locations can be formed thereby providing a comprehensive study of existing noise levels around the proposed site.

4.4.1 Existing Background Noise Levels

Background noise levels during day time are dominated by general vehicular traffic movements. The NSW Environmental Protection Authority (EPA) Industrial Noise Policy (INP) details specific steps in determining the background noise level for assessment of the day, evening and night time periods. Table 1 summarises the background determined at the monitoring location, based on the guidelines set out in the INP and the results of unattended noise monitoring.

Table 1 – Measured Ambient Noise Levels

Location	Description	Day Noise Level 7am to 6pm (dB(A))	Evening Noise Level 6pm to 10pm (dB(A))	Night Noise Level 10pm to 7am (dB(A))
Location 1 – Noise Monitoring Location	Background $L_{90,15min}$	44	42	34

In addition to the background levels obtained at the unattended monitoring position presented above, attended noise monitoring was conducted at 2 locations around the perimeter of the subject site as detailed in Figure 1 of Section 1 above. The results of the attended noise measurements are presented in Table 2 below.

Table 2 – Measured Attended Environmental Noise Levels

Location	Time Period	Measured Noise level dB(A) $L_{eq\ (15\ min)}$
Location 1 – Captain Cook Drive Location 1	Peak Afternoon Period 3.30pm to 6pm	67
Location 2 – Captain Cook Drive Location 2	Peak Afternoon Period 3.30pm to 6pm	64
Location 3 – Captain Cook Drive Location 2	Peak Afternoon Period 4pm to 6pm	66
Location 4 – Stadium Noise level measurement location	7.45pm-8.30pm During game time	65

5 NOISE EMISSION LIMITS – NOISE GENERATED ON THE SITE

The Environmental Protection Authority (EPA) Industrial Noise Policy provides guidelines for assessing noise impacts from development sites. The recommended assessment objectives vary depending on the potentially affected receivers, the time of day, and the type of noise source. The EPA's Industrial Noise Policy has two requirements which both have to be complied with, namely an amenity criterion and an intrusiveness criterion. In addition, the EPA in its Environmental Noise Control Manual states that noise controls should be applied with the general intent to protect residences from sleep arousal.

For land use developments with the potential to create additional traffic on local roads the development should comply with the requirements detailed in the Environmental Criteria for Road Traffic Noise (ECRTN).

Noise level criterion detailed in this section of the report includes noise levels generated from both the retail and residential elements of the proposed redevelopment.

5.1 EPA INTRUSIVENESS CRITERION

The EPA guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5 dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.

5.2 EPA AMENITY CRITERION

The EPA guideline is intended to limit the absolute noise level from all industrial noise sources to a level that is consistent with the general environment.

The EPA's Industrial noise policy sets out acceptable noise levels for various localities. Table 2.1 on page 16 of the policy indicates 4 categories to distinguish different residential areas. They are rural, suburban, urban and urban/industrial interface.

Table 5 of the INP provides the recommended ambient noise levels for the suburban residential receivers for the day, evening and night periods. For the purposes of this condition:

- Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays;
- Evening is defined as the period from 6pm to 10pm; and
- Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

Table 3 – EPA Recommended Amenity Noise Levels

Type of Receiver	Time of day	Recommended Acceptable Noise Level dB(A) L_{eq}
Residential	Day	55
	Evening	45
	Night	40

5.3 SLEEP AROUSAL

To minimise the potential for sleep arousal the $L_{1\ (1\ minute)}$ noise level of any specific noise source does not exceed the background noise level (L_{90}) by more than 15 dB(A) outside a resident's bedroom window between the hours of 10pm and 7am. The L_1 noise level is the level exceeded for 1 per cent of the time and approximates the typical maximum noise level from a particular source. Where the typical repeatable existing L_1 levels exceed the above requirement then the existing L_1 levels form the basis for, sleep disturbance criteria.

5.4 SUMMARY OF ASSESSMENT CRITERIA FOR PROPOSED SITE

The EPA INP intrusiveness, amenity and sleep arousal criteria for this project have been determined using these guidelines and the noise monitoring results. These are summarised below. We note that the formulation of the assessment criteria has been based on the lowest ambient levels determined from all monitoring data.

5.4.1 Day Time Period

The following table sets out the measured L_{eq} amenity and L_{90} background noise levels, and the assessment criteria based on the suburban criteria. The day period applies between 7am and 6pm Monday to Saturday; and 8am to 6pm Sundays and public holidays.

Table 4 – Measured L_{eq} & L_{90} Noise Levels and Criteria - Daytime

Location	Measured L_{eq} Noise Level dB(A)	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}
Surrounding Residential Receivers	48	44	55	49

5.4.2 Evening Period

The following table sets out the measured L_{Aeq} and L_{90} background noise levels, and the assessment criteria based on the suburban criteria. The evening period applies between 6pm and 10pm.

Table 5 –Measured L_{eq} & L_{90} Noise Levels and Criteria - Evening Period

Location	Measured L_{eq} Noise Level dB(A)	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}
Surrounding Residential Receivers	45	42	45	47

5.4.3 Night Time Period

The night period (that is, between 10pm and 7am) is the period where noise emissions can have the most significant effect on residential amenity. In addition to the quasi-steady state criteria the L_1 noise emission level should not exceed the background noise level by more than 15 dB(A) to prevent sleep arousal from intermittent events. The night time period applies between 10pm and 7am.

Table 6 –Measured L_{eq} & L_{90} Noise Levels and Criteria - Night Time Period

Location	Measured L_{eq} Noise Level dB(A)	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}	Night time Sleep Disturbance dB(A) $L_{1\ (1\ Min)}$
Surrounding Residential Receivers	40	34	40	39	49

5.5 RESULTING NOISE LEVEL CRITERIA

The criteria for the various monitoring locations have been considered and assessed for the surrounding receivers. Table 7 below details the noise level criterion for properties surrounding the proposed development. In all cases, if a discrepancy in attended and unattended noise levels were obtained at two nearby locations within a residential grouping the more conservative noise level criterion has been adopted.

Table 7 – Noise Objectives for Surrounding Receivers

Location	Day time Noise Objective dB(A) L_{eq}	Evening Noise Objective dB(A) L_{eq}	Night time Noise Objective dB(A) L_{eq}	Noise Objective for Intermittent Activities dB(A) $L_{1\ (1\ Min)}$ (Background + 15 dB(A))
Surrounding Residential Receivers	53	45	40	55

Noise level criteria are to be applied to commercial traffic levels generated from vehicle movements on the site only, as presented by the Industrial Noise Policy. Noise levels generated from the movement of vehicles entering and exiting the site on ramps are generally required to comply with levels presented in the presented tables for surrounding receivers.

5.6 ASSESSMENT CRITERIA – ADDITIONAL TRAFFIC GENERATION

For land use developments with the potential to create additional traffic on local roads the development should comply with the requirements detailed in the EPA ECRTN. Criteria applicable to the development are detailed below. If existing noise levels exceed those in Table 8 a 2 dB increase in noise is allowed.

The proposed development includes the use of a carpark and future roadways to the north east and northwest of the site which will be assessed against the criteria detailed in the table below.

Table 8 - Criteria for Traffic Noise for New Developments

Time of day	Criteria for Acceptable Traffic Noise Level dB(A)
Day (7am to 10pm)	60 $L_{Aeq(1hr)}$ – Collector Road 55 $L_{Aeq(1hr)}$ – Local Road
Night (10pm to 7am)	55 $L_{Aeq(1hr)}$ – Collector Road 50 $L_{Aeq(1hr)}$ – Local Road

Note: the criteria above includes noise levels generated from both the residential and retail areas of the proposed redevelopment.

Attended and unattended traffic noise levels measurements were conducted at a number of locations surrounding the development including locations as detailed in the table below. The resulting noise levels have been used to generate the resulting noise level criterion for additional traffic movements which been used in this assessment.

Table 9 - Criteria for Traffic Generation

Location	Criteria for Acceptable Traffic Noise Level dB(A) $L_{eq\ (1hr)}$	
	Day (7am to 10pm)	Night (10pm to 7am)
Captain Cook Drive	66*	63

*Based on evening noise levels obtained at the site.
Note: Noise levels calculated to potentially worst affected residential facades from results of on site testing.

6 ADDITIONAL TRAFFIC NOISE GENERATION ASSESSMENT

The proposed development includes carparking within the retail/commercial areas of the project. The total number of carparking spaces within the proposed is approximately 770 retail spaces and 258 residential spaces.

Potential noise impacts from traffic movements generated by the development on public roads have been assessed for residents surrounding the site and future tenancies within the development, including the potential for noise impact generated from the proposed additional roadways on the perimeter of the site. The assessment is based on the maximum traffic flow periods using FHWA and CORTN traffic noise prediction models and noise level measurements conducted at the site and presented in this report.

6.1 ADDITIONAL TRAFFIC NOISE ON LOCAL STREETS

Traffic noise generated by the proposed development was assessed using current and predicted traffic numbers provided to this office for both the retail and residential areas of the project such that the overall site does not impact on surrounding receivers.

The predicted worst case noise increases on each of the streets surrounding the development are summarised in the following table. The assessment was conducted assuming up to a 75% renewal of car spaces during a worst case 1 hour during a peak morning or evening period within the future carpark areas.

The calculated potential noise from additional traffic movements from the site are displayed in the table below at the potentially worst affected residential receivers located at 1 Carabella Road to the west of the site.

Table 10 – Calculated Noise Associated with Traffic Generation

Roadway	Time Period	Current Traffic Noise Levels	Criteria for Acceptable Traffic Noise Level dB(A) $L_{eq\ (1hr)}$	Calculated Future Traffic Noise $L_{eq\ (1\ hr)}$	Compliance
Carabella Road	Day (7am to 10pm)	64	66	Approximately 0.2 dB(A) increase on existing noise levels	Yes
	Night (10pm to 7am)	61	63	Approximately 0.2 dB(A) increase on existing noise levels	Yes

Note: All calculations were conducted using FHWA and CORTN traffic modelling.

The investigation into noise associated with additional traffic movements revealed that any increased traffic flows will cause either no noise increase to existing roadways or compliance with INP criteria for increased traffic volumes on surrounding roadways and would not adversely impact on the acoustic amenity of surrounding residential receivers.

7 INTERNAL ENVIRONMENTAL ACOUSTIC OBJECTIVES

This section of the report details the assessment of potential environmental noise impact within the future residential and hotel areas of the development.

7.1 INTERNAL TRAFFIC NOISE OBJECTIVES

As the development is located adjacent to Captain Cook Drive internal noise levels from traffic noise will be assessed in conjunction with recommended maximum noise levels within the Australian Standard AS2107:2000 'Acoustics - Recommended design sound levels and reverberation times for building interiors' for developments nears major roads. AS/NZS 2107:2000 nominates the L_{eq} descriptor as the noise descriptor. The L_{eq} descriptor is commonly used and recognised as the most appropriate descriptor to assess external noise intrusion as it more closely corresponds with human perception of a changing noise environment; such as character of traffic noise. Based on the above, the following criteria will be applied for external noise intrusion.

Table 11 – Internal Traffic Noise Assessment Criteria

LOCATION	Required Internal Noise Levels / Time of Day	
	Day Time dB(A) $L_{eq\ (1hr)}$ (7am – 10pm)	Night Time dB(A) $L_{eq\ (1hr)}$ (10pm – 7am)
Bedrooms	45	40
Living rooms	45	N/A
Hotel Rooms	45	40

7.2 COMPLIANCE WITH INTERNAL NOISE LEVELS

Experience with similar projects indicates that compliance with internal noise level criteria detailed in this section of the report is both possible and practical. The external façade of the future development will be acoustically treated where necessary to ensure internal noise levels comply with specified noise levels.

Acoustic treatment will include the upgrading of glazing and other façade elements based on noise level measurements conducted at the site. Typically the required upgraded glazing for acoustics will include 6.38mm laminated or 10.38mm laminated glazing.

Masonry and other high mass elements of the façade will not require additional acoustic treatments. Light weight wall constructions will include acoustic insulation and the like to ensure internal noise level criteria are achieved.

7.3 INTERNAL SPORTS GROUND NOISE LEVELS

Internal noise levels within the future residential development as a result of sporting events conducted within Southern Cross Group Stadium to the east of the site will be assessed in conjunction within the recommended maximum noise levels within the Australian Standard AS2107:2000 'Acoustics - Recommended design sound levels and reverberation times for building interiors' for developments near minor roads. AS/NZS 2107:2000 nominates the L_{eq} descriptor as the noise descriptor. The L_{eq} descriptor is commonly used and recognised as the most appropriate descriptor to assess external noise intrusion as it more closely corresponds with human perception of a changing noise environment; such as character of traffic noise. Based on the above, the following criteria will be applied for external noise intrusion.

Table 12 – Internal Sports Ground Noise Assessment Criteria

LOCATION	Required Internal Noise Levels / Time of Day	
	Day Time dB(A) $L_{eq\ (1hr)}$ (7am – 10pm)	Night Time dB(A) $L_{eq\ (1hr)}$ (10pm – 7am)
Bedrooms	40	35
Living rooms	40	N/A
Hotel Rooms	40	35

7.4 COMPLIANCE WITH INTERNAL NOISE LEVELS

Experience with similar projects indicates that compliance with internal noise level criteria detailed in this section of the report is both possible and practical. The external façade of the future development will be acoustically treated where necessary to ensure internal noise levels comply with specified noise levels.

Acoustic treatment will include the upgrading of glazing and other façade elements based on noise level measurements conducted at the site. Typically the required upgraded glazing for acoustics will include 6.38mm laminated or 10.38mm laminated glazing.

Masonry and other high mass elements of the façade will not require additional acoustic treatments. Light weight wall constructions will include acoustic insulation and the like to ensure internal noise level criteria are achieved.

7.5 TYPICAL EXTERNAL GLASS SELECTIONS

As part of this assessment an assessment of internal noise levels within future apartments has been conducted and typical façade constructions selected which would be required to comply with criteria detailed in this report for both traffic and sports ground noise levels.

The following constructions are typical constrictions only, details of window to be used will be provided as part of the Constriction Certificate.

Table 13 – Typical Glazing Requirements

Location	Room	Glazing Requirements	Acoustic Seals
Southern Façade facing Captain Cook Drive Façade	Bedrooms	10.38mm laminated	Yes
	Living rooms	6.38mm laminated	Yes
Northern Façade	Bedrooms	4mm Float	Yes
	Living rooms	4mm Float	Yes
Eastern Façade facing Captain Cook Drive Façade	Bedrooms	10.38mm laminated	Yes
	Living rooms	6.38mm laminated	Yes
Western Façade facing neighbouring sports Ground	Bedrooms	6.38mm laminated	Yes
	Living rooms	6.38mm laminated	Yes
All other facades	Bedrooms	4mm Float	Yes
	Living rooms	4mm Float	Yes
All Hotel facades	Bedrooms	6.38mm laminated	Yes
	Living rooms	6.38mm laminated	Yes

Thicker glazing may be required for structural, safety or other purposes. Where it is required to use thicker glazing than scheduled, this will also be acoustically acceptable. Glazing to all units not listed in the table may be 6mm thick, float or toughened glass for windows and doors.

In addition to complying with the minimum scheduled glazing thickness, the STC rating of the glazing fitted into openable frames and fixed into the building opening should not be lower than the values listed in Table 13 for all rooms.

Table 14 - Minimum STC of Glazing

Glazing Assembly	Acoustic Seals	Minimum STC of Installed Window
4mm Float	Yes	28
6.38mm laminated	Yes	30
10.38mm laminated	Yes	35

8 MECHANICAL PLANT TREATMENTS

As detailed plant selections have not been conducted at this time a detailed acoustic assessment of noise impact can not be conducted which is typically of the DA submission stage.

A detailed mechanical noise assessment will be conducted once plant selections and services drawings have been finalised as part of the construction documentation to ensure noise levels comply with the criteria detailed in this report. Details will be provided as part of the CC submission of the project.

Based on experience with similar development acoustic treatments are both possible and practical using acoustic treatments such as lining of ductwork, acoustic silences, variable speed controllers, time switches, acoustic screens etc. General requirements for a number of potential plant items on the site are expanded on below.

8.1 CHILLERS / AIR HANDLING UNITS

Units can be located on roof tops with an acoustic screen or in basement areas, with acoustic treatment to intake and exhaust as necessary.

These units would predominantly operate during the day, with the potential to operate with extended hours. Acoustic treatment to these units may be required to ameliorate noise impact to the surrounding residents and to comply with the criteria specified in this report and verified at CC stage.

8.2 SUPPLY / EXHAUST FANS

Supply and exhaust fans may be located within the underground plant rooms or in rooftop plant areas. These units typically emit high noise levels and require acoustic treatment such as silencers and internal lined ductwork. Silencer requirements would be determined once fan selections have been completed at CC stage.

8.3 CONDENSER UNITS

Condensing units typically emit relatively low noise levels and with careful selection, it is possible that no further acoustic treatment would be necessary.

8.4 MINOR PLANT

Other minor plant items, such as bathroom or kitchen exhaust fans, will be required. These items typically emit relatively low noise levels and may require minimal acoustic treatment of a standard nature., such as internally lining of ductwork.

9 TOWRA POINT NATURE RESERVE

An acoustic (including noise and vibration) investigation into the potential impacts from the proposed development on the Towra Point nature reserve has been conducted. Based on the proximity of the reserve to the development site, approximately 2km, there will be no additional noise and vibration impact above those already experiences from the existing environment (including Captain Cook Drive and Southern Cross Group Stadium).

10 FUTURE RETAIL/COMMERCIAL AREA

Design of any the proposed Woolooware Bay Town Centre, Stage 4 Residential/Hotel including the integrated retail centre and revitalised club will be developed to minimise the acoustic impact to existing and future residential properties. Noise level will be designed to comply with criteria detailed in this report as required by the EPA's INP and council criteria as detailed in Section 5 of this report.

The acoustic treatments and controls for a number of specific areas have been investigated and include the following:

- Acoustic treatment of loading docks and delivery areas – Based on the location of the loading dock and delivery areas no additional acoustic controls are required to comply with the relevant criteria.

- Limit deliveries and waste removal to day time hours

- No playing of recorded music externally to tenancies.

11 CONSTRUCTION NOISE AND VIBRATION

A construction noise and vibration plan will be prepared for the site once construction activities are finalised. The noise and vibration plan has been developed in conjunction with the following:

- Australian Standard AS2436:1981 "Guide to noise control on construction, maintenance and demolition sites

- Department of Environment Climate Change and Water - Construction Noise Guideline

An acoustic (including noise and vibration) investigation into the potential impacts from the constructions of the proposed development on the Towra Point nature reserve has been conducted. Based on the proximity of the reserve to the development site, approximately 2km, there will be no additional noise and vibration impact above those already experiences from the existing environment (including Captain Cook Drive and the Southern Cross Group Stadium).

This section of the report details the predicted noise impact to surrounding natural areas to the site during the construction stage of the project as well as on completion during normal operating hours.

11.1 CONSTRUCTION NOISE CRITERIA

It is proposed to utilise Australian Standard AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*, which is the standard commonly applied by Councils for the regulation of construction noise, the New South Wales Construction Noise Guideline developed by The NSW Environmental Projected Authority (EPA) and OH&S requirements are presented in this section of the report.

11.1.1 Australian Standard AS2436:1981 "Guide to noise control on construction, maintenance and demolition sites

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"* nominates the following:

- That reasonable suitable noise criterion is established,

- That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and

- The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the demolition, excavation and construction site.

11.1.2 EPA Construction Noise Guideline

The Environmental Protection Authority have developed a specific construction noise guideline in the aid of reducing the impact of construction associated noise.

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic comprises between construction sites and potential noise affected receivers.

11.1.3 EPA Construction Noise Guideline - Qualitative Assessment Method

The guideline refers to a qualitative assessment method in which construction noise is assessed on a case by case basis with regard to various activities to be conducted on site. This assessment method was developed to smaller scale projects.

Essentially this method of assessment requires that the proponent take into consideration and employ all reasonable and feasible measures to ensure that the impact on noise receivers is minimised. This is generally conducted in the following manner:

- The drafting of a noise management plan outlining all reasonable and feasible mitigation methods for the reduction of noise impact;
- The assessment of high impact equipment such as rock-hammers and piling equipment for lower noise producing methods of construction/excavation;
- The implementation of a complaints handling register and community consultation system;
- Employee (builders, contractors etc) education in effective noise reducing techniques and site etiquette; and
- The operation of plant in a quiet and efficient manner (i.e. turning off machinery when not in use).

This qualitative assessment method has been used for the basis of this report and has been used as the basis for the development of acoustic management and treatments of proposed construction activities.

In addition, the guideline specifies goals which can be used in the effort of minimising noise from construction related activities. These noise goals are presented within the table below.

Table 15 – EPA Recommended Construction Noise Goals

Governing Body	Receiver Type	External sound level Goal, $L_{eq\ 15\ min}$ dB(A)
EPA	Residential (also adopted for school receivers)	Background + 10 dB(A)[1]
		75 dB(A)[2]

1: Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. (DECC CNG, 2008).

2: Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided. (DECC CNG, 2008).

These criteria for resultant noise from construction activities are aimed at maintaining comfort levels within the surrounding residential dwellings. Additionally, noise mitigation techniques as discussed in this report should be used if noise emissions exceed the above criteria. All work is to be carried out in accordance with AS 2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*.

11.2 CONSTRUCTION VIBRATION CRITERIA

Construction vibration criteria associated with works on the Project when measured at the potentially affected receivers should not exceed the following sets of vibration criteria to ensure no architectural or structural damage to surrounding buildings and human comfort is maintained. These standards have been selected as they are widely used in the assessment of vibration associated with construction activities within Australia, namely:

- German Standard DIN 4150-3 (1999-02): *"Structural Vibration – Effects of Vibration on Structures"*; and
- British Standard BS 6472:1992 *"Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

The criteria and the application of these Standards are discussed in separate sections below.

11.2.1 German Standard DIN 4150-3 (1999-02)

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in the Table below.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 16 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			**Plane of Floor of Uppermost Storey**
		< 10Hz	**10Hz to 50Hz**	**50Hz to 100Hz**	**All Frequencies**
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

11.2.2 British Standard BS 6472:1992

British Standard BS 6472:1992 develops criteria relating to levels of building vibration that may be expected to give rise to *"adverse comment"*, in the frequency range most applicable to impacts associated with construction, which is 1 to 80Hz. These threshold values are used as criteria for assessing the loss of amenity and are presented below in Table 3.

Table 17 – BS 6472:1992 Criteria to Avoid *"Adverse Comment"*

Type of Occupancy	Time of Day	Peak Particle Velocity (mms^{-1}) between 1Hz to 80Hz Likely to Cause *"Adverse Comment"*			
		Continuous Vibration		Intermittent Vibration and Impulsive Vibration Excitation with Several Occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Residential	Day	0.3 to 0.6	0.8 to 0.6	8.4 to 12.6	24 to 36
	Night	0.2	0.6	2.8	8
Offices	Day	0.6	1.6	18	51
	Night	0.6	1.6	18	51
Workshops	Day	1.2	3.2	18	51
	Night	1.2	3.2	18	51

The limits indicate that people in buildings are significantly less susceptible to horizontal vibration than to vertical vibration. Furthermore, Section 4.1 of BS 6472 notes that situations can exist where vibration magnitudes above those generally corresponding to minimal *"adverse comment"* levels can be tolerated, particularly for temporary disturbances and infrequent and intermittent events such as those associated with construction projects.

11.3 CONTROL OF CONSTRUCTION NOISE AND VIBRATION

As a part of the noise management of noise and vibration on each site the following process should be conducted when investigating the impact and construction activities.

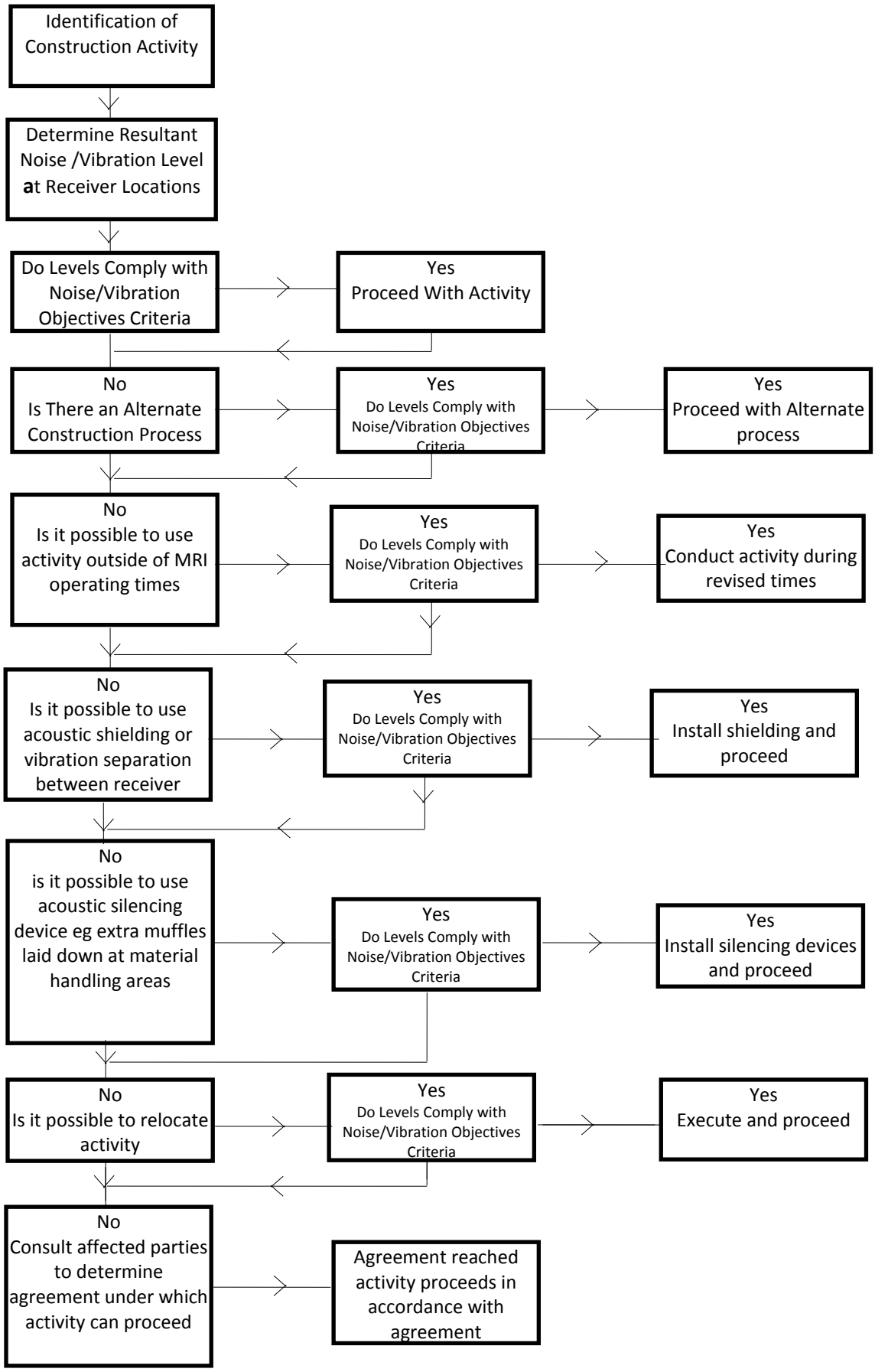


Figure 1 – Process Flowchart

11.4 NOISE AND VIBRATION CONTROL METHODS

The determination of appropriate noise control measures will be dependent on the particular activities and construction appliances. This section provides an outline of available methods.

11.4.1 Selection of alternate appliance or process

Where a particular activity or construction appliance is found to generate excessive noise levels, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

11.4.2 Acoustic Barrier

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (tower cranes). Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependant on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance that is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10mm or 15mm thick plywood (radiata plywood) would be acceptable for the barriers.

11.4.3 Silencing devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

11.4.4 Material handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

11.4.5 Treatment of specific equipment

In certain cases it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

11.4.6 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. A noise plan will be developed for this project outlining work procedures and methods for minimising noise.

11.4.7 Regular noise checks of equipment

To determine the requirement for silencing devices on machinery it is proposed to undertake fortnightly noise check. Noise levels of all machines on site will be measured and if they are found to be higher than nominated for that equipment type, items such as mufflers and engine shrouds will be examined to ensure they are in good working order.

A record of these measurements will be kept on a form similar to that shown in Appendix 1. This measure is expected to maintain noise at constant levels, and prevent any increases.

11.4.8 Treatment of Equipment

An effective method of mitigating vibration on existing equipment would be to vibration isolated mounts to existing equipment and installations. Vibration isolation would be required to be investigated on a case by case basis and consist of neoprene mounts as specified (such as waffle pads, supershear flex or the like).

Based on investigations conducted at the site the areas which may be suitable for treatment include tables with sensitive equipment such as microscopes and the like.

11.4.9 Noise and vibration Monitoring

Noise and vibration monitoring is required be undertaken to determine the effectiveness of measures which are been implemented. The results of monitoring can be used to devise further control measures.

11.4.10 Combination of methods

In some cases it may be necessary that two or more control measures be implemented to minimise noise.

11.4.11 Saw cutting

Introduction of a saw cut to manage vibration impacting on surrounding receivers from construction activities.

11.5 COMMUNITY INTERACTION AND COMPLAINTS HANDLING

11.5.1 Establishment of direct communication with affected parties

In order for any construction noise management programme to work effectively, continuous communication is required between all parties, which may be potentially impacted upon including the builder, neighbours and other areas of the Prince of Wales Hospital. This establishes a dynamic response process which allows for the adjustment of control methods and criteria for the benefit of all parties.

The objective in undertaking a consultation processes is to:

- Inform and educate the groups about the project and the noise controls being implemented;
- Increase understanding of all acoustic issues related to the project and options available;
- Identify group concerns generated by the project, so that they can be addressed; and
- Ensure that concerned individuals or groups are aware of and have access to the Richard Crooks Complaints Register which will be used to address any construction noise related problems should they arise.

To ensure that this process is effective, regular information regarding the proposed works and period when they will be required to be conducted should be provide to neighbouring receivers (including residence and other areas of the Prince of Wales Hospital), until all issues have been addressed and the evidence of successful implementation is embraced by all parties.

11.5.2 Dealing with Complaints

Should ongoing complaints of excessive noise or vibration criteria occur measures shall be undertaken to investigate the complaint, the cause of the exceedances and identify the required changes to work practices. In the case of exceedances of the vibration limits all work potentially producing vibration shall cease until the exceedance is investigated.

The effectiveness of any changes shall be verified before continuing. Documentation and training of site staff shall occur to ensure the practices that produced the exceedances are not repeated.

If a noise complaint is received the complaint should be recorded on a Noise Complaint Form. The complaint form should list:

- The name and location of the complainant (if provided);
- The time and date the complaint was received;
- The nature of the complaint and the time and date the noise was heard;
- The name of the employee who received the complaint;
- Actions taken to investigate the complaint, and a summary of the results of the investigation;
- Required remedial action, if required;
- Validation of the remedial action by a consultant or as detailed in this report; and
- Summary of feedback to the complainant.

A permanent register of complaints should be held.

All complaints received should be fully investigated and reported to management. The complainant should also be notified of the results and actions arising from the investigation.

The investigation of a complaint shall involve where applicable;

- noise measurements at the affected receiver;
- an investigation of the activities occurring at the time of the incident;
- inspection of the activity to determine whether any undue noise is being emitted by equipment; and
- Whether work practices were being carried out either within established guidelines or outside these guidelines.

Where an item of plant is found to be emitting excessive noise or vibration, the cause is to be rectified as soon as possible. Where work practices within established guidelines are found to result in excessive noise being generated then the guidelines should be modified so as to reduce noise emissions to acceptable levels. Where guidelines are not being followed, the additional training and counselling of employees should be carried out.

Measurement or other methods shall validate the results of any corrective actions arising from a complaint where applicable.

11.6 CONTINGENCY PLANS

Where non-compliances or noise complaints are raised the following methodology will be implemented.

- Determine the offending plant/equipment/process
- Locate the plant/equipment/process further away from the affected receiver(s) if possible.
- Implement additional acoustic treatment in the form of localised barriers, silencers, vibration separation etc where practical.
- Selecting alternative equipment/processes where possible

Complaints associated with noise and vibration generated by site activities shall be recorded on a Noise Complaint Form. The person(s) responsible for complaint handling and contact details for receiving of complaints shall be established on site prior to construction works commencing. A sign shall be displayed at the site indicating the Site Manager to the general public and their contact telephone number.

If a noise complaint is received the complaint should be recorded on a Noise Complaint Form as discussed in Section 8.2 of this report.

11.7 EXISTING NOISE LEVELS

Existing noise levels at the site have been recorded at between 50-64 dB(A) at the site and at the Towra Point. Based on the noise levels detailed in the table above noise levels at the Towra Point reserve will not be greater than current noise level impacting the site. Examples of exiting noise levels which impact the surrounding wet lands and Towra Point reserve are approximated in the table below. The existing noise level impacting areas surrounding the site will mark noise from the construction and operation of the development.

Table 18 – Examples of Existing Noise Levels

Location	Noise Source	Approximate Noise level
Towra Point	Boats	65-70 dB(A) L_{10}
	Traffic Noise	50-55 dB(A) L_{10}
	Sporting Events	55-60 dB(A) L_1
	Aircraft Noise	65-70 dB(A) L_{10}
Adjacent Wet Lands	Boats	65-70 dB(A) L_{10}
	Traffic Noise	55-60 dB(A) L_{10}
	Sporting Events	65-70 dB(A) L_1
	Aircraft Noise	65-70 dB(A) L_{10}

11.8 CONSTRUCTION NOISE LEVEL

The predicted noise levels from a number of activities on the site during construction and completion on the surrounding nature areas, including the wet lands directly to the north and Towra Point are presented in the tables below. An assessment of noise impact from a number of construction activities are included which represents the potentially worst case impacts. Calculated noise level are represented as maximum noise levels and as such levels will not be accumulative.

Table 19 – Construction Noise Levels at Surrounding Locations (Maximum Noise Levels)

Equipment Type	Sound Power Level (SWL)	Location					Discussion
		Wet Land directly adjacent to the site	20m from the site	40m from the site	60m From the Site	Towra point 500m from the site	
Hydraulic Hammers*	115	87 dB(A)	81 dB(A)	75 dB(A)	71 dB(A)	50 dB(A)	Intermittent noise level as equipment can not run continuously
Concrete Saw Cutting*	114	86 dB(A)	80 dB(A)	74 dB(A)	70 dB(A)	49 dB(A)	Only when in operation
Excavator (without hammer)	98	70 dB(A)	64 dB(A)	58 dB(A)	54 dB(A)	33 dB(A)	Detailed noise levels based on worst case levels (ie operating at boundary of the site with the wetlands)
Drill Pilling equipment	105	77 dB(A)	71 dB(A)	65 dB(A)	61 dB(A)	40 dB(A)	Detailed noise levels based on worst case levels (ie operating at boundary of the site with the wetlands)

*Note: Operations will be limited as site is predominantly sand.

All noise levels detailed in the table above are presented as the typical maximum dB(A) L_{10} noise levels associated with the presented equipment. Noise levels will only result during periods when the equipment is in operation. All calculated noise levels presented assume no screening and will reduce by 5-8 dB(A) is screening from other structures occurs.

11.9 FUTURE NOISE LEVELS

Future noise levels from the operation of the Woolooware Bay Town Centre, Stage 4 Residential/ Hotel component will be designed to comply with the EPA noise level criteria which are detailed in the table below. This includes all building services noise including mechanical equipment, loading docks, car parking, etc.

Table 20 - Noise Objectives for Surrounding Receivers (Including Wetlands)

Location	Day time Noise Objective dB(A) Leq	Evening Noise Objective dB(A) Leq	Night time Noise Objective dB(A) Leq
Surrounding Receivers	53	45	40

Compliance with the noise levels detailed in the table below will result in levels being inaudible at Towra Point Reserve.

Some additional noise from activities such as the cycle track and play ground will result in noise levels of up to 65 dB(A) in the adjacent wet lands, these noise level represent a level which is no greater than that currently experienced on the site (including the existing sports ground). All play areas and cycle ways on the site will be inaudible at the Towra Point Reserve.

12 CONCLUSION

This report provides the results of Environmental Noise Study for the proposed Woolooware Bay Town Centre, Stage 4 Residential/Hotel project. Noise at the site has been measured and noise goals have been set in accordance with the requirements of the relevant statutory/regulatory authorities including Local Council and the Department of Environment and Climate Change.

Determination of noise assessment criteria based on the EPA's Industrial Noise Policy and ECRTN have been determined based on both unattended and attended noise monitoring conducted at the proposed development.

Based on the assessment detailed in this report the proposed development will comply with all relevant noise and vibration criteria.

We trust this information is satisfactory. Please contact us should you have any further queries.

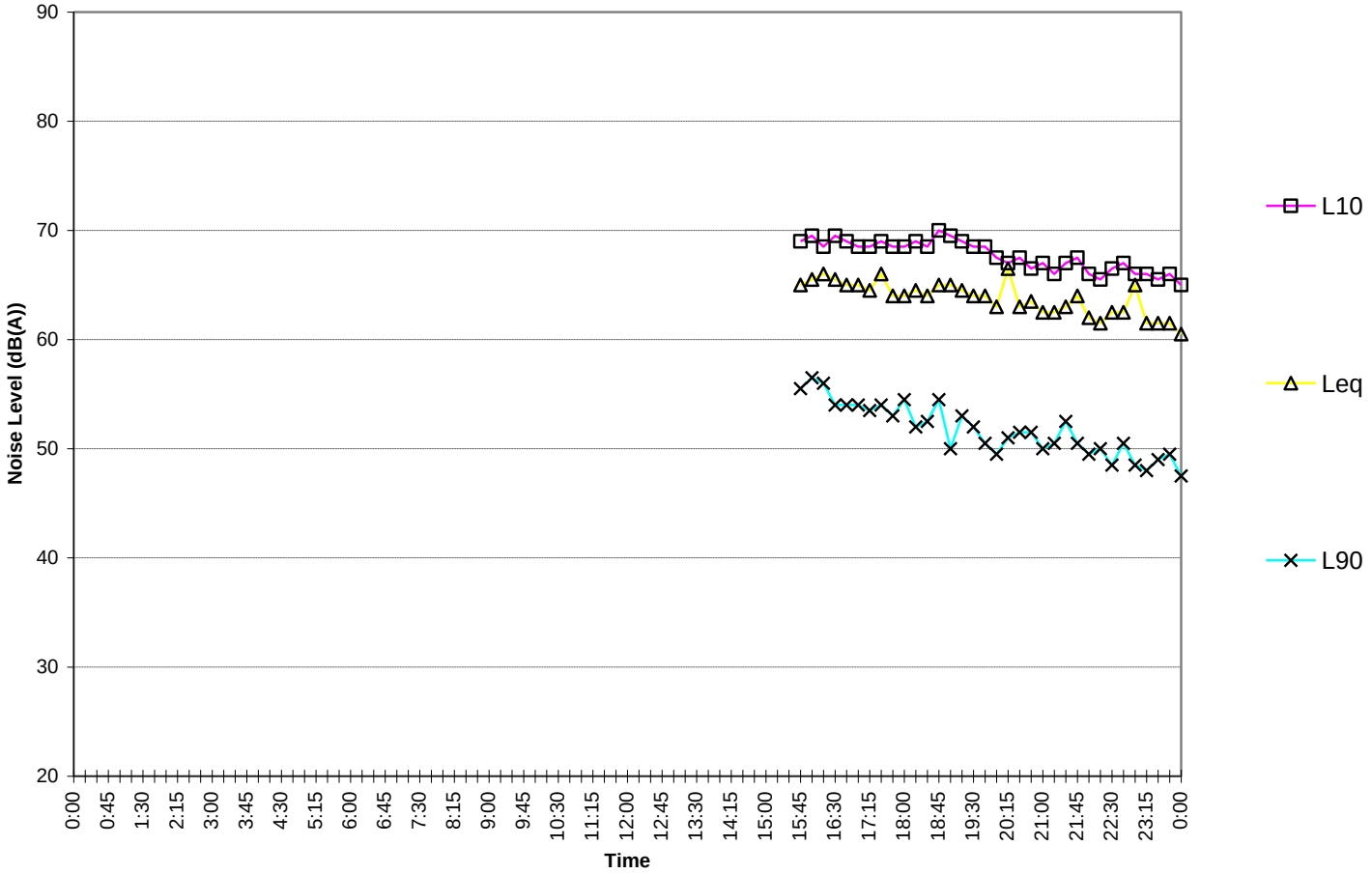
Report prepared by,

ACOUSTIC LOGIC CONSULTANCY PTY LTD
Ben White

APPENDIX A
UNATTENDED NOISE MONITORING RESULTS

Captain Cook Drive

Friday June 10, 2011



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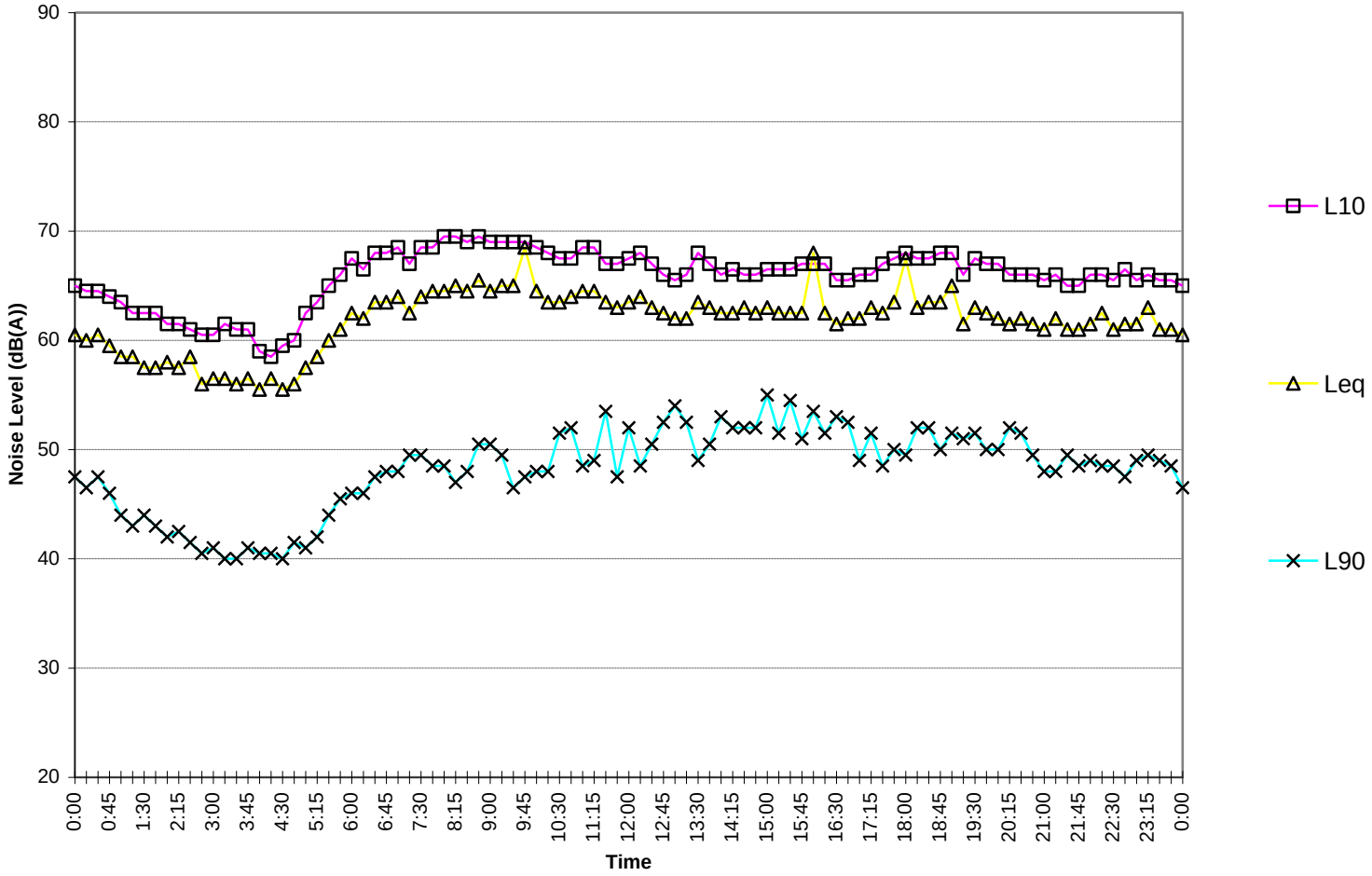

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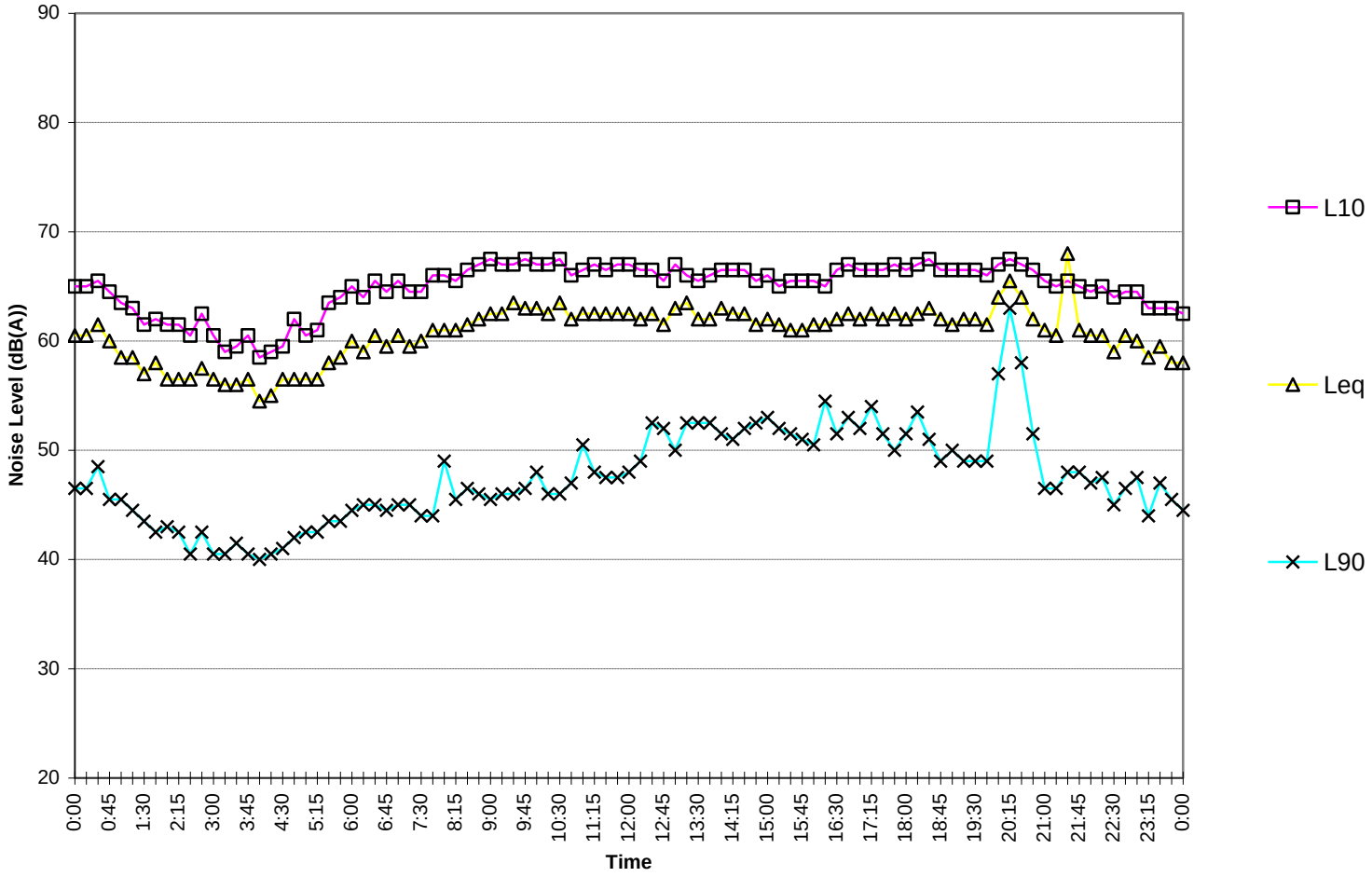

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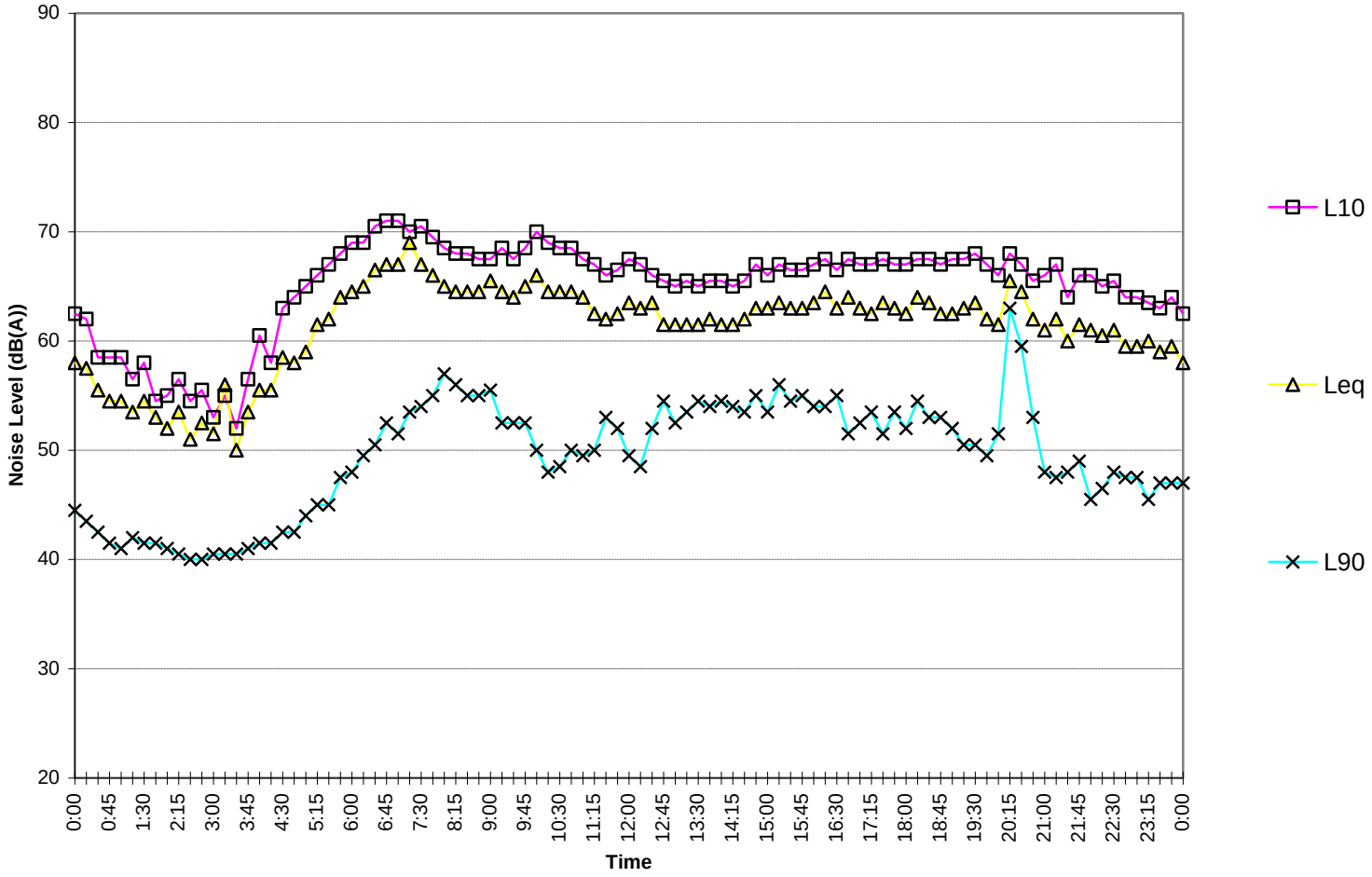

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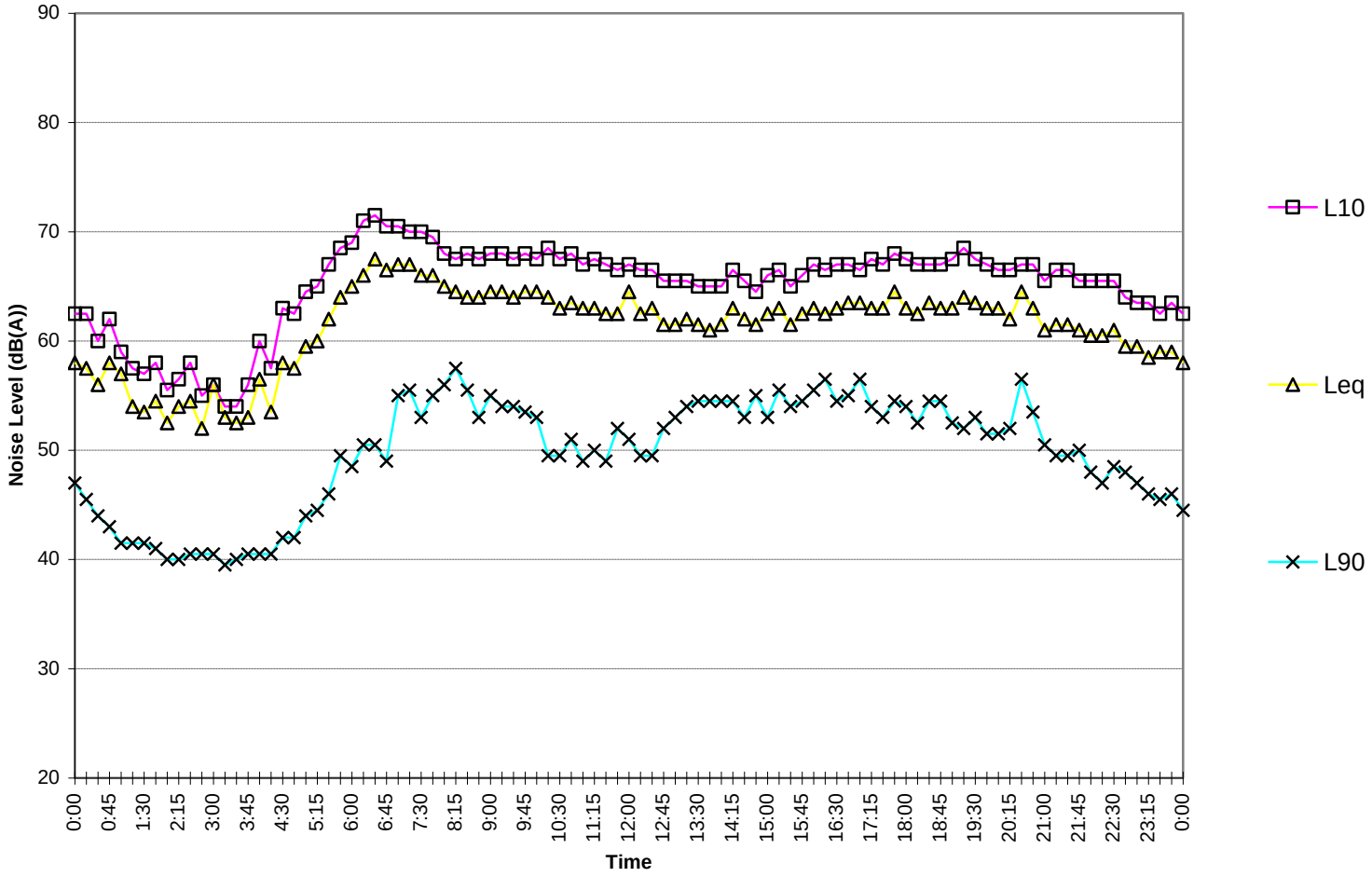

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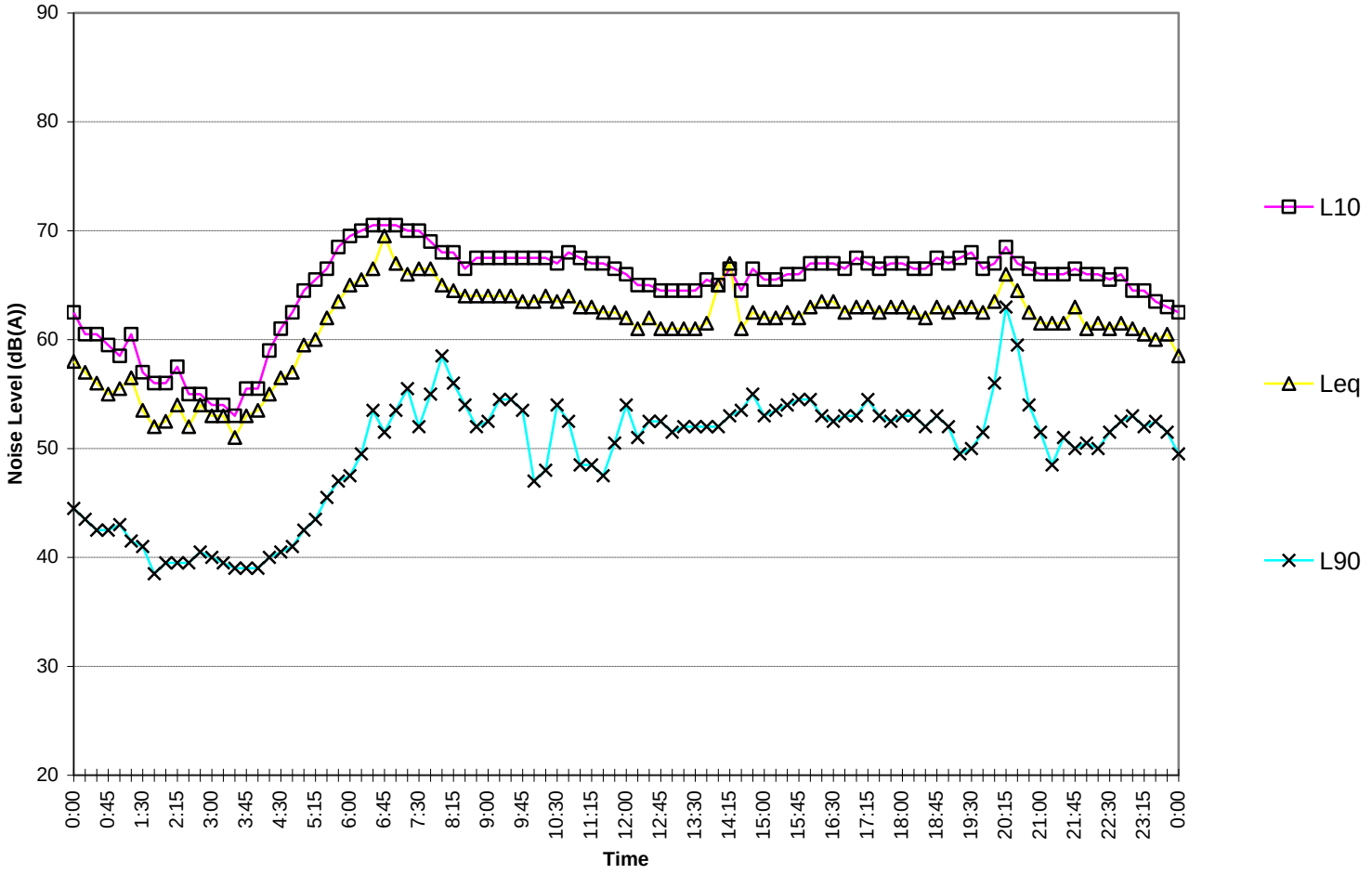

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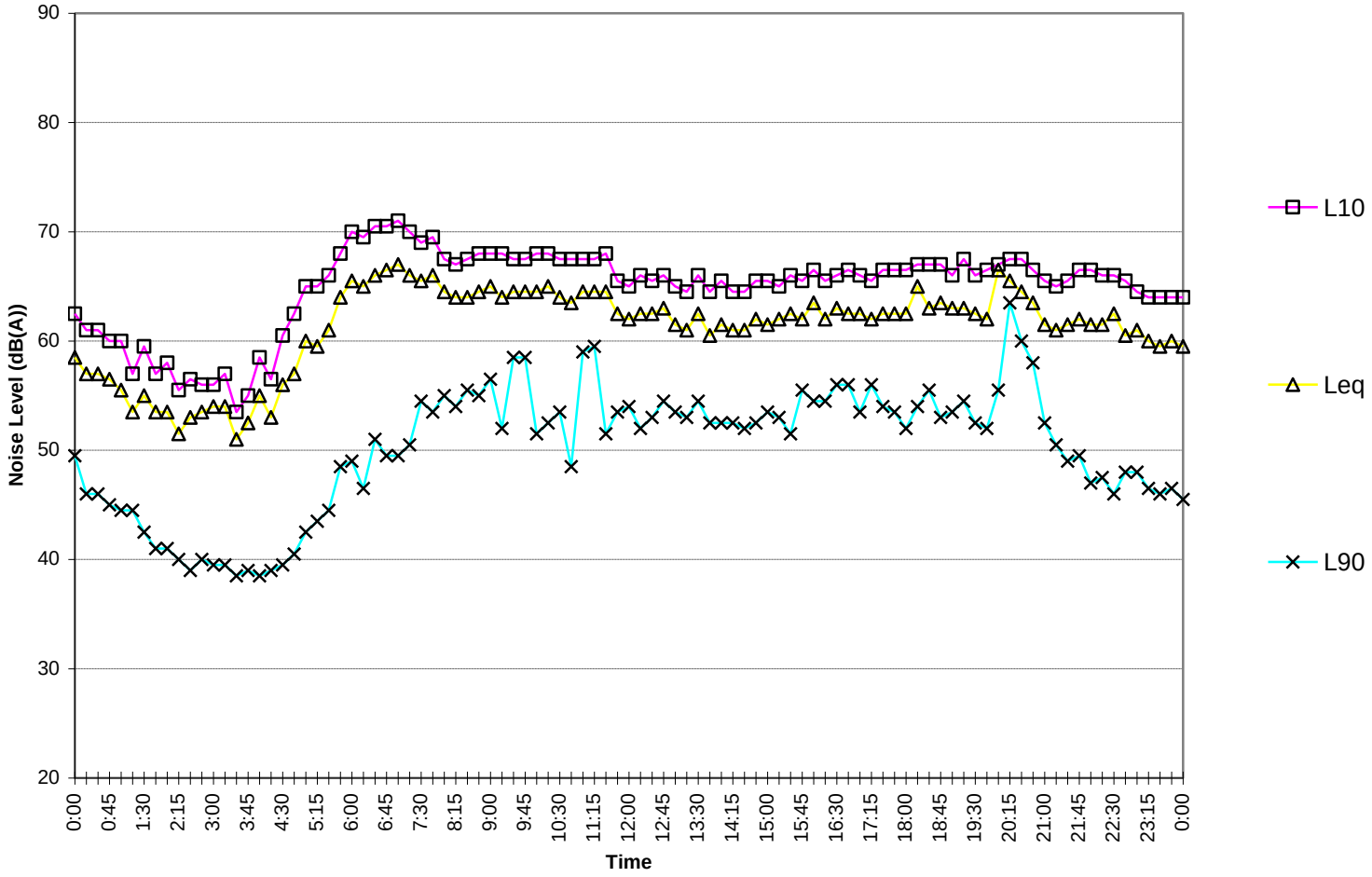

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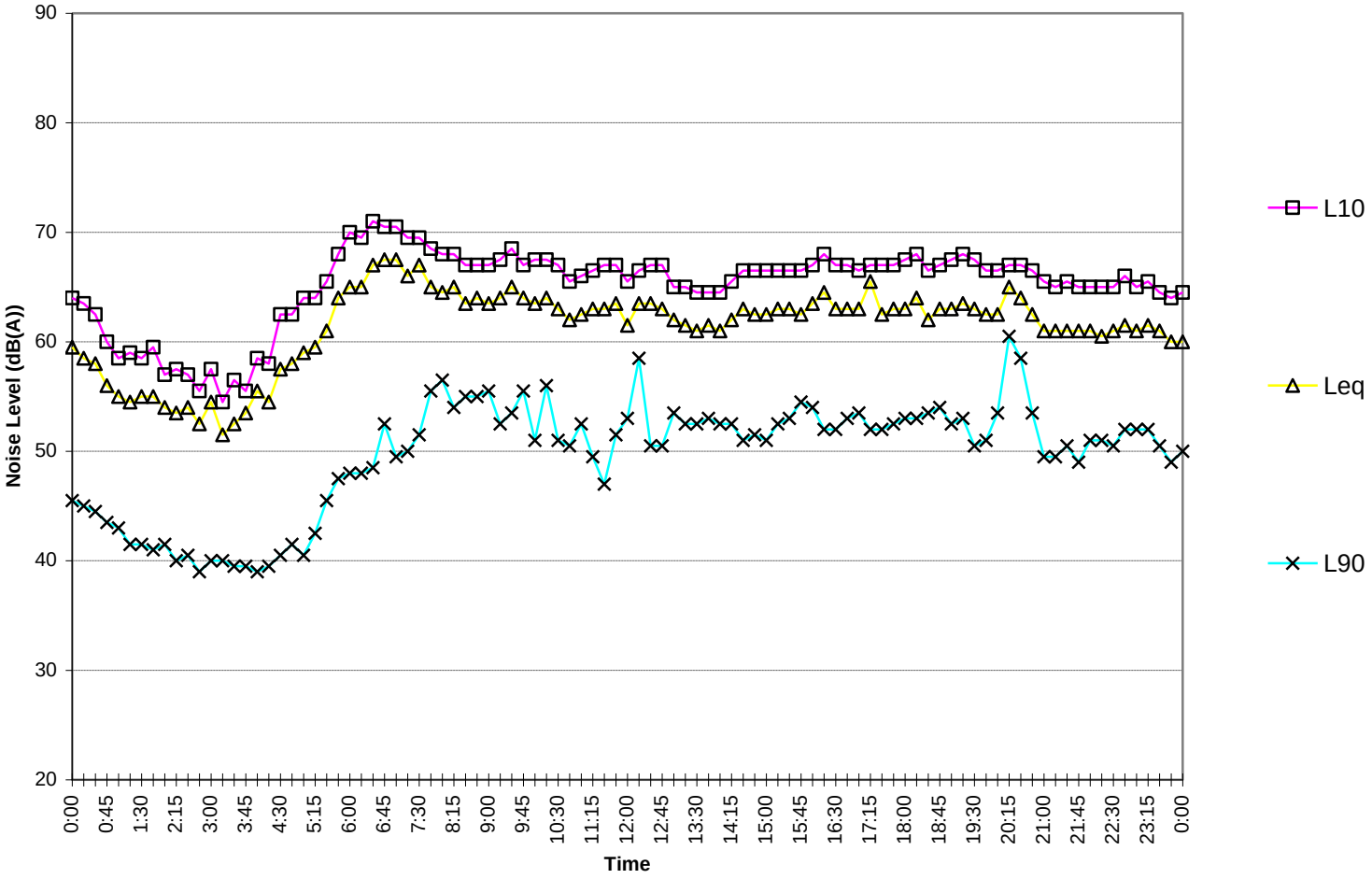

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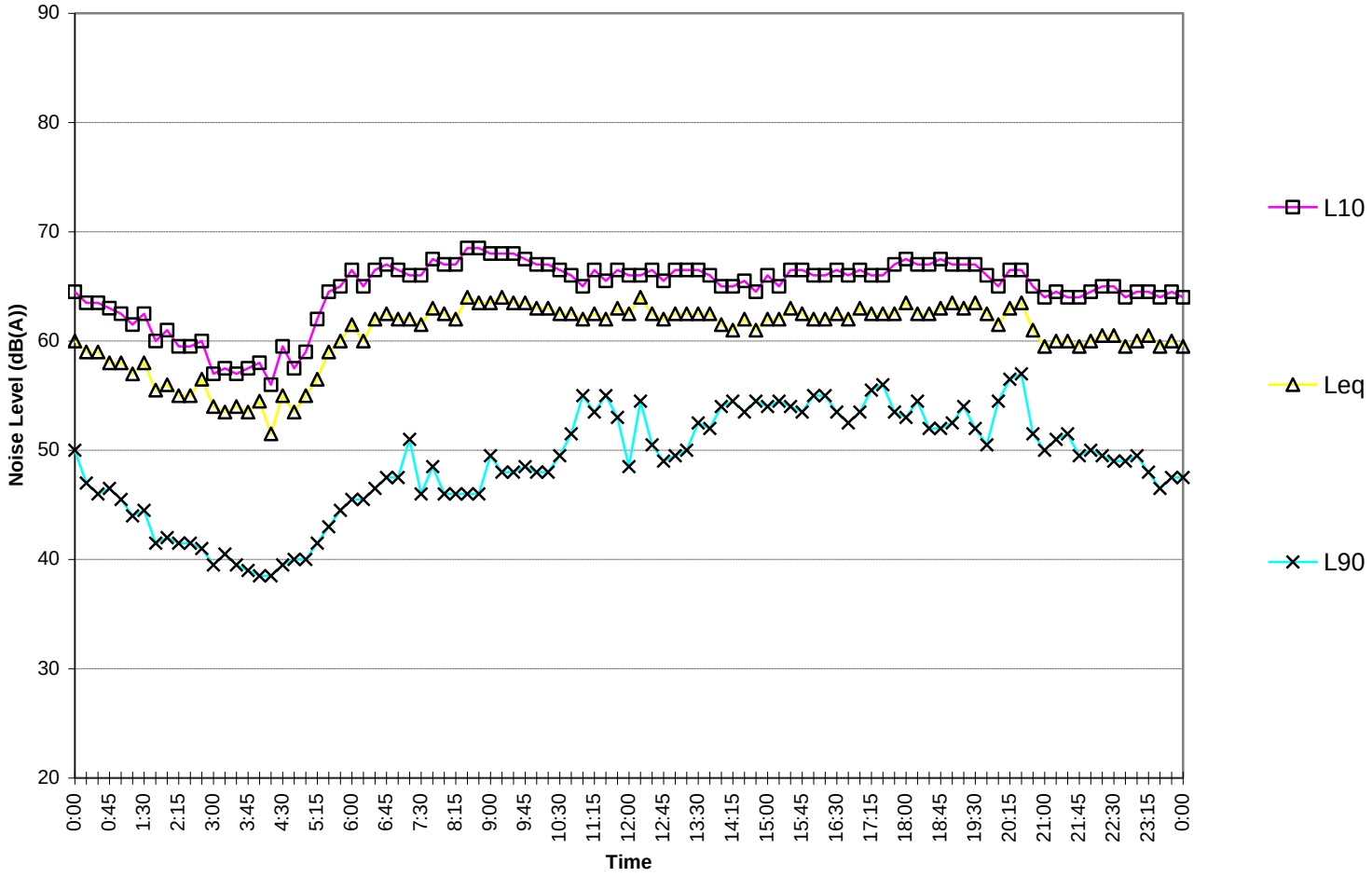

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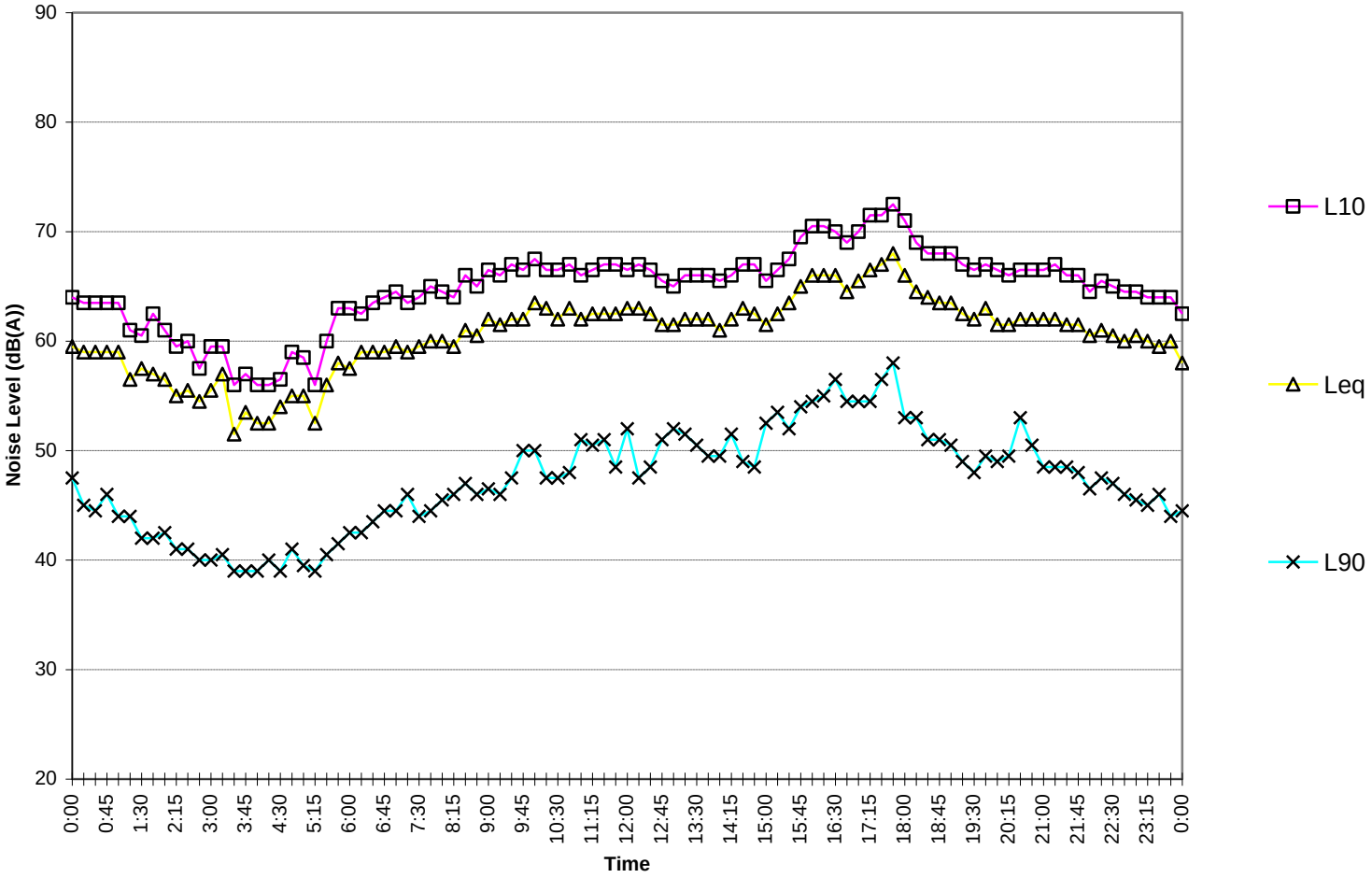
Sunday June 19, 2011



Captain Cook Drive

Monday June 20, 2011