Sandringham Outdoor Netball Project

Acoustic Report

Prepared for: Bayside City Council

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Revision

Revision	Date	Comment	Prepared By	Approved By
2	22/02/2021	Issued for comments	Saliha Kiraz	André Verstappen
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1. Introduction

Stantec have been engaged by Bayside City Council to provide acoustic services for the proposed outdoor netball courts associated with the Sandringham College Community Sport Facility located on Holloway Road.

This report presents the noise emission design targets applicable to the project and assesses the likely noise impact of the proposed outdoor netball courts on nearby residential land uses. Acoustic design targets presented in this report are based upon the EPA Publication 1254 October 2008 Noise Control Guidelines, World Health Organization guidelines and Stantec experience.

The objectives of this report are to:

- Establish relevant environmental noise targets to limit noise impact from the project upon sensitive receivers.
- Identify critical noise sources potentially affecting the residences.
- Evaluate the likely noise impact from these noise sources on the nearest sensitive receivers.
- Provide preliminary mitigation measures where noise emissions from the future Netball courts are predicted to exceed established noise emission targets.

This document has been prepared considering Sandringham College Community Sport Facility Schematic Design Report 2021 prepared by LAW Architects (dated 15/01/21).

It is noted that Stantec has received an acoustic report for this project prepared by Waveform acoustics on behalf of the residents of 223 Bay Rd, however the scope of the Stantec report does not include a formal peer review of that document.

The acoustic terms used in this report are presented in Appendix A.

This report relates to this particular project and must not be applied to any other project without consultation with Stantec. Project designs and conditions can vary between projects causing significant variations in acoustic performance and relevant subsequent advice to one project may not apply to another.

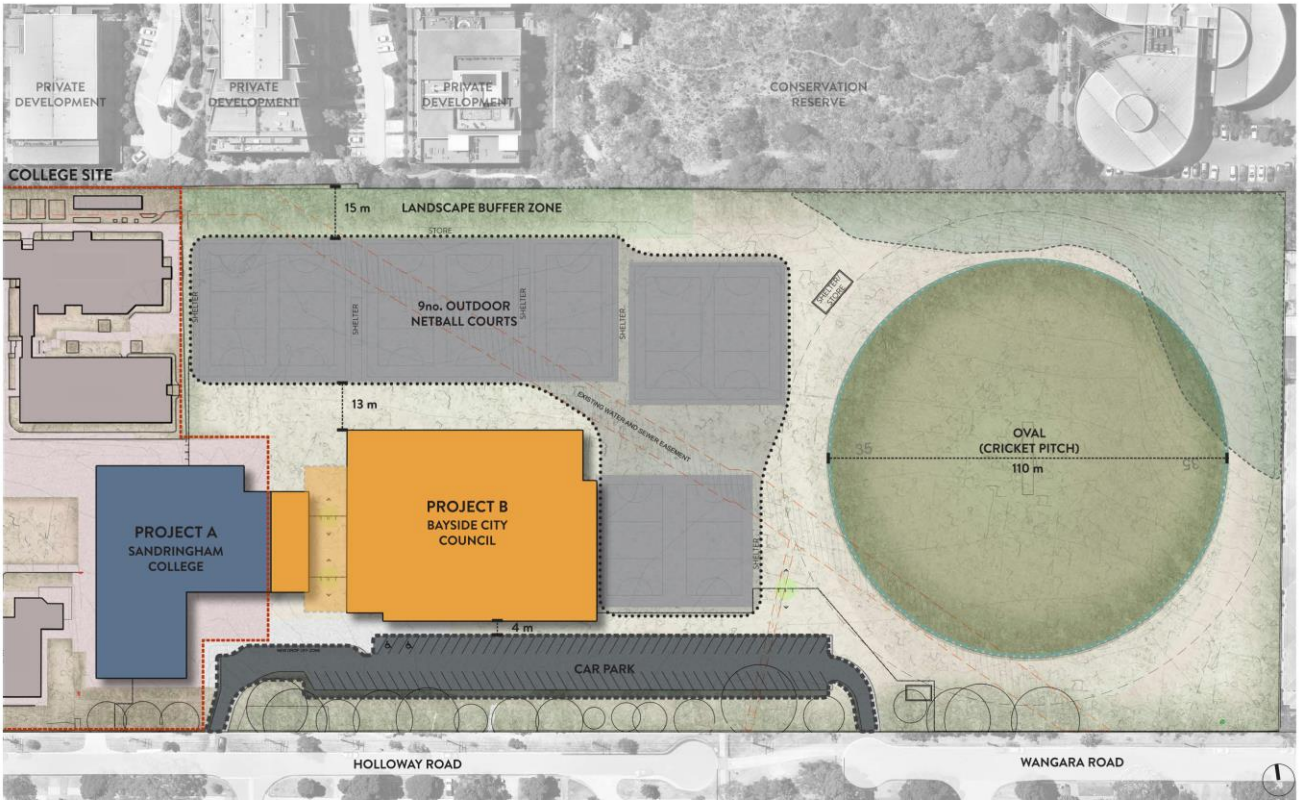
2. Project Overview

2.1 Project description

The proposed Netball facility is to be located at the community sport facility near Sandringham College, North of Holloway Road. The facility will consist of 12 netball courts, 3 of them indoors, with open air Covered Outdoor Learning Areas. The proposed facility is split into 2 sections, Project A and Project B.

Figure 1 below provides an overview of the currently planned layout for the proposed development. The nine outdoor courts associated with Project B (as highlighted grey in Figure 1) are considered in the acoustic assessment provided within this report. Assessment of noise associated with activity from the other elements of the broader project are beyond the scope of this document and are not discussed.

Figure 1 Layout of the proposed development

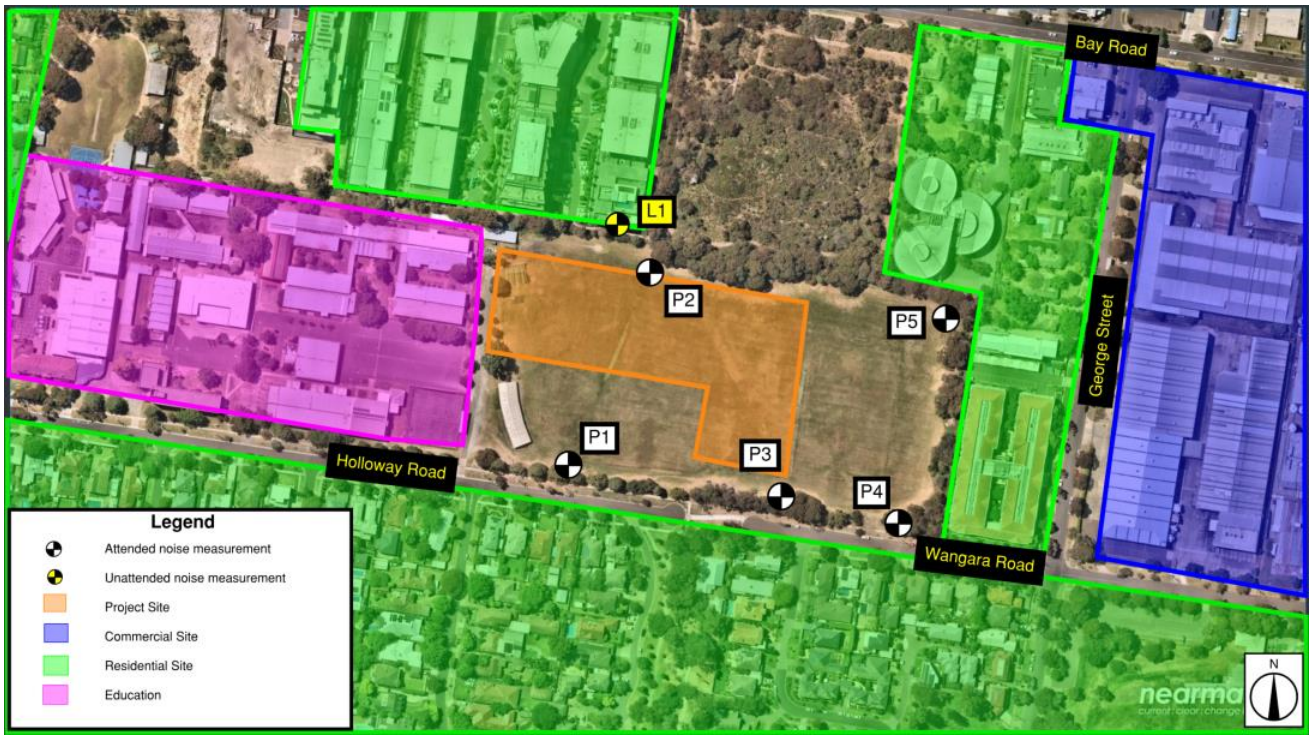


Source: Law Architects Schematic design report

2.2 Surrounding area and sensitive receivers

Overlays showing the surrounding area composition can be seen in Figure 2. Residential receivers are shown in green. commercial sites are marked in blue overlay, and Sandringham College is marked pink. The approximate extent of the proposed project site is shown in orange. Attended and unattended measurement locations are also noted within the figure.

Figure 2 Aerial view of the site



Source: Nearmaps/Stantec

As Figure 2 shows, the Project site is bounded by:

- Residential buildings (6 to 8 levels) to the north of the site.
- Holloway Rd with existing residential buildings (1-2 storeys) beyond to the south of the site.
- Sandringham College to the west of the site.
- Residential buildings (1 to 3 levels) to the east of the site.

It is noted that apartments immediately to the north of the site are multistorey buildings overlooking the proposed site. Due to the aspect of these buildings and the project site layout, these properties are considered the most sensitive receivers to activity noise from the proposed outdoor netball courts.

2.3 Key Acoustic Issues

The key acoustic issues associated with the project are as follows:

- External noise associated with the future activity of the proposed outdoor netball courts should not adversely affect the residential receivers located along Holloway Rd, George St and Bay Rd.

2.4 Hours of Operation

It is understood that the outdoor netball courts will be operating during the following hours:

- Weekdays 4pm to 8.30pm
- Saturday 8am to 8pm
- Sunday 9am to 4pm
- School holidays 9am to 8.30pm (weekdays only assumed)
- Tournament days 8am to 6pm (5 instances per year)

Consequently, the above hours have been considered in the assessment detailed in this report.

3. Noise Survey

An environmental noise survey was conducted around the proposed development site as per VIC EPA Guidelines. Stantec undertook attended and unattended noise measurements.

The noise survey was undertaken to characterise the noise environment around the site and provide acoustic recommendations for amenity. The following equipment was used for the noise surveys:

- Sound Calibrator, Pulsar Model 105, S/N 72910.
- NTI XL2 Noise logger, S/N A2A-14215-E0
- B&K Sound Level Meter Model 2250, S/N 86300.

All equipment was calibrated before and after the measurements and no significant drift was found. Data affected by rainfall has been excluded from the calculations and it's shown as shaded grade in the logger graph in Appendix B.

3.1 Noise measurement locations

Attended and Unattended noise measurements were conducted between 5 and 10 February 2021 in order to determine the existing background noise levels present at the site and at nearest sensitive receivers. The noise survey locations are presented in Figure 2 and correspond to:

L1: Noise logger installed on second floor balcony of 265/223 Bar Road apartment overlooking the project site. This is considered a suitable location for assessing noise at the most sensitive receiver.

P1-P5: Attended short term noise measurement locations to characterise various locations around the future site.

3.2 Attended noise survey results

Attended noise measurements were conducted on two days at several locations around the future project site as seen as Figure 2. The noise values presented in this section are intended to aid in characterisation of the noise environment around the site. Table 1 presents the results of attended short-term ambient (L_{Aeq}) and background (L_{A90}) noise levels, and observations of the soundscape around the site.

Table 1 Summary of short-term attended measurement- Overall levels

Location	Date & Time	Duration [mm:ss]	Ambient Noise Level $L_{Aeq,t}$ dB(A)	Background Noise Level $L_{A90,t}$ dB(A)	Noise ambient comment
P1	05/02/2021 10:41am	09:29	54	49	Fresh wind, birds, people pass by
P2	05/02/2021 12:08pm	10:02	51	43	Fresh wind, crickets, bird, distant construction noise (excluded)
P3	05/02/2021 12:24pm	07:44	50	44	Fresh wind, birds, wind, leaves
P4	10/02/2021 12:39	10:02	44	38	Light wind, bird, leaves, light-no traffic
P5	10/02/2021 12:50	00:10:02	45	41	Light wind, birds, crickets and leaves

3.3 Unattended noise survey results

Unattended noise measurements were taken from 5th February to 10th February at 265/226 Bay Road, Sandringham, second floor balcony facing the site. The measurement location is provided in Figure 2 and Figure 3. A summary of the unattended noise measurements are provided shown in Table 2 and in the logger trace in Appendix B.

Figure 3 Measurement location

Source: Stantec

Table 2 Summary of unattended long-term ambient (overall LAeq,period) and background (Average LA90,15min) noise levels

Day	Period[1]	Ambient Noise Level $L_{Aeq,period}$ in dB(A)	Background Noise Level Average $L_{A90,15min}$ over time period in dB(A)
Friday 05/02/21	Day (partial): 12pm – 6pm	52	41
	Evening: 6pm – 8.30pm	51	43
Saturday 06/02/21	Day: 8am – 1pm	51	39
	Evening: 1pm – 6pm	54	41
	Night: 6pm – 8pm	51	39
Sunday 07/02/21	Evening: 9am – 4pm	51	44
Monday 08/02/21	Day: 9am – 6pm	50	42
	Evening: 6pm – 8.30pm	47	41
Tuesday 09/02/21	Day: 9am – 6pm	49	42
	Evening: 6pm – 8.30pm	53	44
Average	Day	51	41
	Evening	52	42
	Night	51	39
	All periods	**51**	**42**

Note 1: Noise periods have been extracted from EPA State Environment Protection Policy No. N-1 (SEPP N-1). While SEPP N-1 is not applicable to this assessment, the noise periods defined within are considered appropriate for application to this project. Details of the periods are provided in Table 3 below.

Table 3 SEPP N-1 applicable time periods for noise limit selection

Time Period for Noise Limits Selection	Time
Day	07.00 am to 18.00 pm Monday to Friday 07.00 am to 13.00 pm Saturdays
Evening	18.00 pm to 22.00 pm all days 13.00 pm to 18.00 pm Saturdays 07.00 am to 18.00 pm Sundays and Public Holidays
Night	22.00 pm to 07.00 am all days

4. Acoustic Design Principles and Noise Criteria

It should be noted that there is no mandatory EPA noise criterion applicable to activity noise from a sport facility upon sensitive receivers. In the absence of specific criteria, design targets for limiting noise emission from the proposed development have been established to minimize the risk of complaints from the sensitive receivers. Additionally, based on current information, playback of music at the outdoor courts is not planned. Consequently, no assessment of music noise emissions for compliance with SEPP N2 has been conducted.

4.1 VIC EPA Publication 1254 October 2008-Noise Control Guidelines

The Victoria EPA define guidelines for noise control in the Publication 1254 October 2008. Section 13 of this document covers noise control for Public Address (PA) systems associated with sporting activities. This document states the following:

> *'(..)the environmental objective should be noise intrusion of not more than 5 dB(A) above background at any affected residences or other noise sensitive locations. Corrections for tonal or impulsive noise usually are not necessary, and further tolerance of up to 5 dB(A) may be allowed for unique or very infrequent activities with recognised social merit. Amplifier level settings must be minimised whilst ensuring conveyance of information to audience or participants is adequate. Restrictions on the times of use of public address systems should be considered. Noise from PA systems must not be audible inside a residential dwelling during normal sleeping hours.'*

Consequently, based on the results from the noise survey and considering an additional +3dB allowance to account for the social benefits of the proposed development, the design target applicable to the PA associated with the project is proposed as per below:

Table 4 Applicable ambient noise target to the project

Period	Background Noise Level Average $L_{A90,15min}$ over time period in dB(A)	Allowance above the existing background	Proposed design target $L_{Aeq,15min}$ dB(A)[1]
Day	41	+8	**49**
Evening	42	+8	**50**
Night	39	+8	**47**

Note 1: Publication 1254 does not prescribe the duration over which values of L_{Aeq} should be assessed. Stantec proposes a 15-minute period is suitable to capture PA events (one quarter of a netball game) for evaluation of all present noise sources and to provide a reasonable overall noise level assessment.

In the absence of additional guideline for noise impact for other noise sources associated with a sport facility, the above design target for noise has been extended to all noise sources from the proposed netball courts.

4.2 World Health Organization (WHO) Europe-Night Noise Guidelines for Europe 2009

Considering the proposed hours of operation of the netball courts, it is reasonable to consider potential noise impact of the development in regard to sleep disturbance for the nearby receivers. This is relevant only for game operations starting before 9am, particularly on weekends (Saturday only). While the only 'night period' operation occurs on Saturday between 6pm and 8pm, it is reasonable to anticipate that some residents may still be sleeping at 8am.

The World Health Organization (WHO) Europe-Night Noise Guidelines for Europe 2009 provides guidelines for noise control especially in relation with sleep disturbance. The document refers to the Guidelines for community noise (WHO, 1999) which evaluates the impact of night-time exposure to noise and sleep disturbance:

> *"If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dBA indoors for continuous noise. If the noise is not continuous, sleep disturbance correlates best with LAmax and effects have been observed at 45 dB or less. This is particularly true if the background level is low. Noise events exceeding 45 dBA should therefore be limited if possible. For sensitive people an even lower limit would be preferred. It should be noted that it should be possible to sleep with a bedroom window slightly open (a reduction from outside to inside of 15 dB). To prevent sleep disturbances, one should thus consider the equivalent sound pressure level and the number and level of sound events. Mitigation targeted to the first part of the night is believed to be effective for the ability to fall asleep."*

However, the document recognises that in the light of more recent studies the thresholds are now known to be lower than L_{Amax} of 45 dB at the bed head for a number of effects. Furthermore, the document established a threshold of 42dBA L_{Amax} inside for awakening during the night and/or too early in the morning.

Considering a 10dB reduction between façade incident level and internal noise level from an open window, a design target of 52dBA L_{Amax} at the façade of the residences is proposed for impulsive noise. Compliance with such design target is anticipated to address sleep disturbance at the nearby receivers for early morning games. It is noted that in the event that the façade windows/doors are closed, the internal noise levels are likely to be even lower.

4.3 AS2107:2016 Internal Noise levels

Internal noise levels are subject to the guidelines outlined in Australian Standard AS2107-2016: Recommended design sound levels and reverberation times for building interiors. The internal noise levels provided in AS2107:2016 are intended for steady-state or quasi-stead noise sources. This includes control of continuous intrusive noise through the building envelope but excludes impulsive noise.

Table 5 AS 2107 Internal Acoustic Design Requirements

Type of Occupancy / Activity	Recommended Design Sound Level Range, $L_{eq, dB(A)}$
Living areas	30 to 40
Sleeping areas (night-time only)	30 to 35

Considering a maximum of 40dBA inside a living space as per the table above and a 10dB reduction between facade incident noise levels and internal noise levels for an open window, 50dBA $L_{Aeq,T}$ should be targeted at the façade of the receivers to maintain the recommended internal noise level to living areas

Compliance with the criteria presented in Section 4.1 will automatically provide compliance with the criterion presented above.

Due to the proposed operating hours of the facility, steady-state noise exposure during night-time is not applicable and sleep arousal is addressed with the L_{Amax} criterion in Section 4.2.

4.4 Summary of the design targets applicable to the project

Based on the noise criteria presented above, the following design targets have been applied to the project:

Table 6 Proposed acoustic design targets for the project

Noise Character	Proposed Criterion (Assessed at the façade of the nearest receivers)	
Ambient noise levels	Day	49 dB(A), $L_{Aeq,15min}$
	Evening	50 dB(A), $L_{Aeq, 15min}$
	Night	47 dB(A) $L_{Aeq, 15min}$
Impulsive Events	Between 10pm – 9am	52 dB(A) L_{Amax}

5. Environmental Noise Assessment

5.1 Noise Sources from the future netball courts

Following information provided by the client and considering the proposed arrangement of the new netball outdoor courts, the receivers are predicted to be acoustically exposed to the following noise sources:

- Impulsive events:
  - Whistling from the referee
  - Sirens at the start and end of games
- Ambient noise levels:
  - Public Address (PA) system
  - General noise from voices of players and spectators
  - Whistles and sirens

Whistles and sirens are by nature impulsive and short events. The repetitions of occurrences of such events during use of the facilities are, on average, also contributing to the overall ambient noise emissions from the proposed development. Therefore, they have also been considered as noise sources for ambient noise levels with assumptions made on the durations and number of occurrences.

Ambient noise levels should be assessed against the design target established for ambient noise levels whereas impulsive events should be compared with noise criteria to prevent sleep disturbance in terms of L_{max}.

For the purpose of the assessment, a number of reasonable assumptions in relation to the noise sources listed above has been made. It should be noted that a conservative approach has been taken for these assumptions, in order to consider a robust case. These assumptions are presented for each noise source in the sections below.

5.1.1 PA System

The following assumptions has been made for the PA system:

- One bollard speaker will be located adjacent to either end of the shelters (i.e. two bollards per shelter) situated next to each court, at a height of 0.9m above local ground level.
- Each bollard speaker presents an omni-directional sound source with equal noise emission in all directions.

- The sound power level of each PA loudspeaker has been calibrated to achieve on average L_p 61dB(A) on all courts, at a height of 1.6m. Such a sound pressure level, being 10dB above the existing ambient noise level, is considered as sufficient to be clearly audible for all players. A sound power of 90dB(A) with a spectrum shape equivalent to a male (worst-case) normal vocal effort has been used to satisfy the above and is consistent with "normal vocal effort" according to ISO 9921-1.
- The PA will operate for 10% of the time during the hours of operation.

5.1.2 Siren

It is understood that the primary function of the siren is to alert the referees to start and end of game quarters. The following assumptions have been made for the siren:

- The siren will run through the same bollard speakers as the PA system and will be subject to the same output levels as the PA system.
- Each court will be served by the two (2) bollard loudspeakers associated with the closest courtside shelter and pairs of bollards operate independently.
- The sound power level of the siren loudspeakers has been calibrated to achieve no less than L_p 61dB(A) on each court, at a height of 1.6m with the closest pair of bollard loudspeakers operating. Such a sound pressure level being 10dB above the existing ambient noise level is considered as sufficient to be audible for all players and will present a higher signal level for referees located closer to the bollards. A sound power of 91dB(A) with a flat spectrum signature has been used to satisfy the above.
- The siren will play 8 times per hour, once for the start and stop of each game's quarter.

5.1.3 Noise from voices of players and spectators

Predictions of the likely noise emissions due spectators located at the spectator viewing area and players on courts have been conducted based on the methodology described in technical paper *'Predictions of Noise from Small to Medium Sized Crowds'* (M.J. Hayne , J.C. Taylor, R.H. Rumble and D.J. Mee) and a number of reasonable assumptions:

- 30 spectators, and 5 players per court, talking simultaneously
- All courts are active for the entirety of the operating hours

The above has been used to model horizontal area sources at the spectator viewing area and on each court at a height of 1.6m above ground level.

5.1.4 Whistles

The following assumptions has been made for the whistling from the referees:

- One whistle at a time will occur.
- As a worst case the referee will be located adjacent to the closest netball court to the receivers.
- 30 whistling events per 15 minutes, per court, will occur

One whistle has been modelled as an omnidirectional point source located adjacent to the closest court to the receivers at a height of 1.6m above ground level.

The noise emission level from a whistle can vary depending on the type of whistle and the strength of blow. Reference is made to noise emissions data from Table 4 given for various types of whistles and blown at low, moderate and high strength. The loudest measured whistle (ACME Thunderer) presents sound pressure levels of 91dBA, 88dBA and 77dBA at 10m and has been used in the assessment as a worst case to provide a conservative approach. To account for the strong tonal character of the whistle, a spectrum shape concentrating most of the spectral energy in the 2k and 4kHz octave bands has been used.

Table 7 Measured Noise levels of various whistle blows

Description of Noise Source	Distance from source	Measured L_{Amax} dBA
ACME Tornado MUGA Peas-less Whistle blown with low strength	10m	77
ACME Tornado MUGA Peas-less Whistle blown with medium strength	10m	85
ACME Tornado MUGA Peas-less Whistle blown with hard strength	10m	87
ACME Thunderer Official Referee Whistle blown with low strength	10m	80
ACME Thunderer Official Referee Whistle blown with medium strength	10m	88
ACME Thunderer Official Referee Whistle blown with hard strength	10m	91
Sifflet Whizzball Hand Held Whistle blown with low strength	10m	61
Sifflet Whizzball Hand Held Whistle blown with medium strength	10m	66
Sifflet Whizzball Hand Held Whistle blown with hard strength	10m	77

Source: Acoustic Dynamics report; *Churchill Place Courts Project 2823*

An adjustment of +3dB to account for the impulsive nature of the whistle has been used in the assessment of the ambient noise emissions from the site.

5.2 Noise Modelling

Further to the information above, Stantec has conducted noise modelling and calculations to determine predicted noise emissions levels at the nearest sensitive receiver's location resulting from the use of the proposed outdoor netball courts.

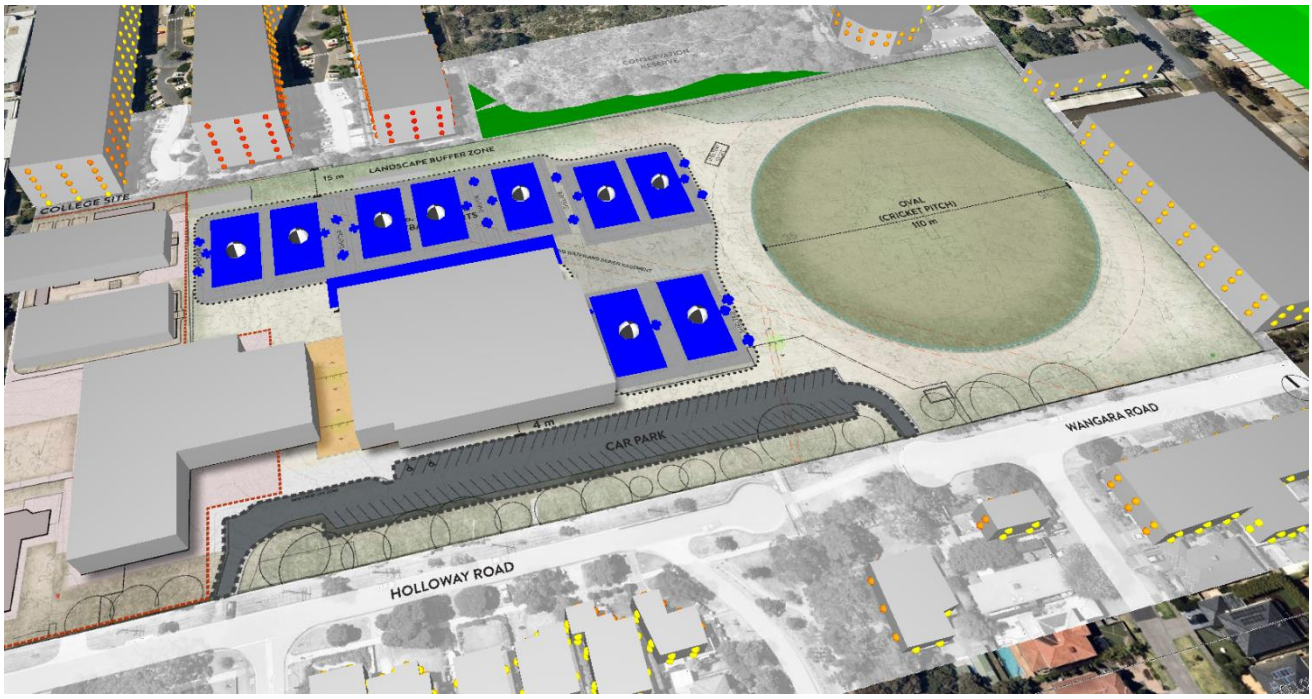
5.2.1 Model Considerations

To provide accurate noise emission predictions for the proposed facility, a 3D acoustic model of the facility and surrounding areas was created in acoustic modelling software package Cadna-A. The 3D model provides accurate site and equipment layouts relative to the various noise sensitive receivers, along with atmospheric effects, acoustic screening provided by built structures, and local topography.

Noise emission levels as discussed in Section 5.1 have been used as the input for the noise model.

Figure 4 below provides a snapshot of the facility as per current design. Surrounding sensitive receiver structures are shown in the background. Noise data for the various noise sources has been included in the model, along with their locations and the facility envelope structure. Point noise sources are indicated as blue crosses in the figures below, blue rectangles are horizontal area sources and the spheres indicate noise receivers at the residences or on the proposed development site as used for calibration of the model.

Figure 4 Cadna-A noise model - 3D View



Source: CadnaA/Stantec

5.2.1 Predicted noise levels – No mitigation treatment

Predicted noise levels due to activity occurring at the proposed netball courts are presented in Table 8 below for various noise sources. The sound pressure levels $L_{Aeq,15min}$ from impulsive events like whistles and sirens have been calculated based on the impulsive noise levels L_{Amax}, averaged over a 15min period, for a number of occurrences of the event as per assumptions detailed in section 5.1.

Table 8 Predicted noise levels due to the proposed netball courts at the nearest receivers

Noise Source	Predicted noise Level at receivers $L_{Aeq,15min}$ or L_{Amax} (dBA)	Design target $L_{Aeq,t}$ or L_{Amax} (dBA)	Exceedance
Extended events	$L_{Aeq15min}$ at the façade of the receivers		
PA[1]	47	Day 49 Evening 50 Night 47	-2 -3 0
Spectators and players	58	Day 49 Evening 50 Night 47	9 8 11
Whistle[2]	69	Day 49 Evening 50 Night 47	20 19 22
Siren[3]	39	Day 49 Evening 50 Night 47	-10 -11 -8
All combined	69	Day 49 Evening 50 Night 47	20 19 22
Impulsive events	L_{Amax} at the façade of the receivers (10pm – 9am)		
Whistle: • 91dBA @ 10m • 88dBA @ 10m • 77dBA @ 10m	 82 79 68	52	 30 27 16
Siren	56	52	4
Whistle +Siren • 91dBA @ 10m • 88dBA @ 10m • 77dBA @ 10m	 82 79 68	52	 30 27 16

Note 1: Noise levels for the PA are based on the PA operating for 10% of the assessment period time. The instantaneous levels at the façade during PA use will be up to 10 dB higher.

Note 2: Based on loudest whistle type (ACME Thunderer) blown with hard strength and 30x 0.5 second events in a 15 minute period (all courts).

Note 3: Based on 2x 3 second siren soundings in a 15 minute period (all courts)

As seen in Table 8, the noise emissions associated with the use proposed netball courts are predicted to be exceeding the established design targets. The greatest contributors to exceedance are whistles and voices from players and spectators.

Noise from all considered noise sources are anticipated to be audible at the nearest receivers and present a high risk of disturbance at these locations. Additionally, impulsive events from whistles are expected to cause sleep disturbance for games occurring early on Saturday morning.

These results indicate that the noise emissions resulting from the use of the proposed netball courts are predicted to adversely affect the nearest receivers and mitigation measures should be implemented.

5.3 Mitigation Measures & Recommendations

5.3.1 Voices from Players and Spectators

The only methods for reducing impact of voices from a sporting venue is to provide increased distance separation between the source of noise and sensitive receivers or introduce acoustic barrier elements between the source and receiver.

Due to the arrangement of the site and height of the nearest sensitive apartment buildings along Bay Road, mitigation by installation of a noise barrier is not a practical solution as the barrier would be required to span a significant height to produce any meaningful shielding (>10m).

Additional distance separation would only be possible through rearrangement of the site plan, and this solution alone is unlikely to reduce noise emission levels sufficiently to achieve the proposed noise emission criteria.

5.3.2 PA System and Siren

Noise emission from the PA and siren systems could be controlled through re-selection of loudspeaker type and installation of a noise limiter.

Bollard speakers present an equal dispersion of sound in all directions. Alternative loudspeaker types (e.g. horn speakers) can be selected to present a more directional sound emission pattern which reduces noise to areas behind the speaker location. Additionally, noise limiters can be installed to control the maximum output of loudspeakers, and if necessary, process the signal to reduce low frequencies which propagate further and are less easy to direct away from sensitive locations.

While the current PA and siren emission levels achieve compliance for ambient levels over a 15 minute period, it is noted that instantaneous noise levels at the nearest receivers during PA use will result in higher noise levels which may result in disturbance to the residential receivers.

It is recommended that a combination of noise limiter installation, selection of PA loudspeaker type, and strategic location of loudspeakers should be employed to achieve the design criteria at all effected residential receivers. It is expected that appropriate consideration of these variables will enable a functional PA system at the venue while minimizing disturbance to residents.

5.3.3 Whistles

It is clear from data provided within Table 7 that selection of whistles can significantly reduce the noise emission from whistle events. As it is unreasonable to assume that referees could be expected to consistently produce low strength whistle output, selection of a quieter whistle type (e.g. Sifflet Whizzball Hand Held) is recommended to most effectively reduce impact from whistle events. Management controls to ensure use of quieter whistles at the site are recommended to this end.

It is highlighted that selection of a quieter whistle will not currently result in compliance for ongoing noise or impulsive noise at the proposed site.

5.3.4 Hours of operation

To avoid potential sleep disturbance events, it is recommended that the operating hours of the venue be altered so no games begin before 9am (currently only Saturday morning and tournament days). This would remove the impulsive noise (sleep disturbance) criteria. It is noted that in the event that the Saturday games finish by 6pm, the nighttime criteria will no longer be required.

5.3.5 Site layout

As mitigation of whistle noise and voices from players and spectators cannot be addressed through traditional means (noise barrier) with the current site layout, it is suggested that to achieve the proposed design criteria at residential receivers the site would require rearrangement to provide the following conditions:

- Indoor court buildings moved to the north-west of the proposed site to provide screening of the multi-storey apartment buildings on Bar Road from the outdoor netball courts.
- Location of outdoor courts central to the site location to keep distance separation from residences across Holloway Road and Wangara Road.
- Installation of a noise barrier to the south of the outdoor courts to protect residential receivers across Holloway Road and Wangara Road.

6. Conclusion

An acoustic assessment for the proposed outdoor netball facilities, to be located at the current site of Sandringham sports facility, East of Sandringham College, has been conducted to evaluate the potential noise impact associated with operation of the facilities upon the adjacent residential receivers.

No mandatory noise emission criteria are applicable to activity noise from a sport facility upon sensitive receivers. In the absence of specific criteria, design targets for limiting noise emission from the proposed development have been established to minimize the risk of disturbance to sensitive receivers. Design targets are presented following recommendations in EPA Publication 1254 for PA systems, WHO guidelines for sleep disturbance, and are based on the results of a noise survey exercise undertaken on site.

An assessment of the likely noise impact of the outdoor netball courts upon sensitive receivers has been conducted with the use of a noise model. The assessment is based on a number of assumptions detailed in this report corresponding to a conservative approach.

Results from the noise model indicate exceedance above the stated design target, inducing risk of disturbance for the occupants of the adjacent receivers if no acoustic mitigation is carried out.

With the present arrangement of the proposed site and aspect of overlooking multi-storey apartment buildings along the northern site boundary, limited mitigation measures are possible:

- Installation of an acoustic barrier is not practical to protect residents to the north due to the required height of the barrier (>10m)
- PA and siren noise can be controlled to achieve the proposed criteria through appropriate equipment selection, installation of noise limiters, and considered location of PA loudspeakers.
- Whistle noise can only be controlled as far as whistle type, and will not achieve the proposed criteria even with a quieter whistle selection.
- Voices from players and spectators cannot be mitigated through traditional means without rearrangement of the site latout.

To achieve compliance to the proposed noise emission criteria, it is Stantec's opinion that the site layout would require rearrangement to present:

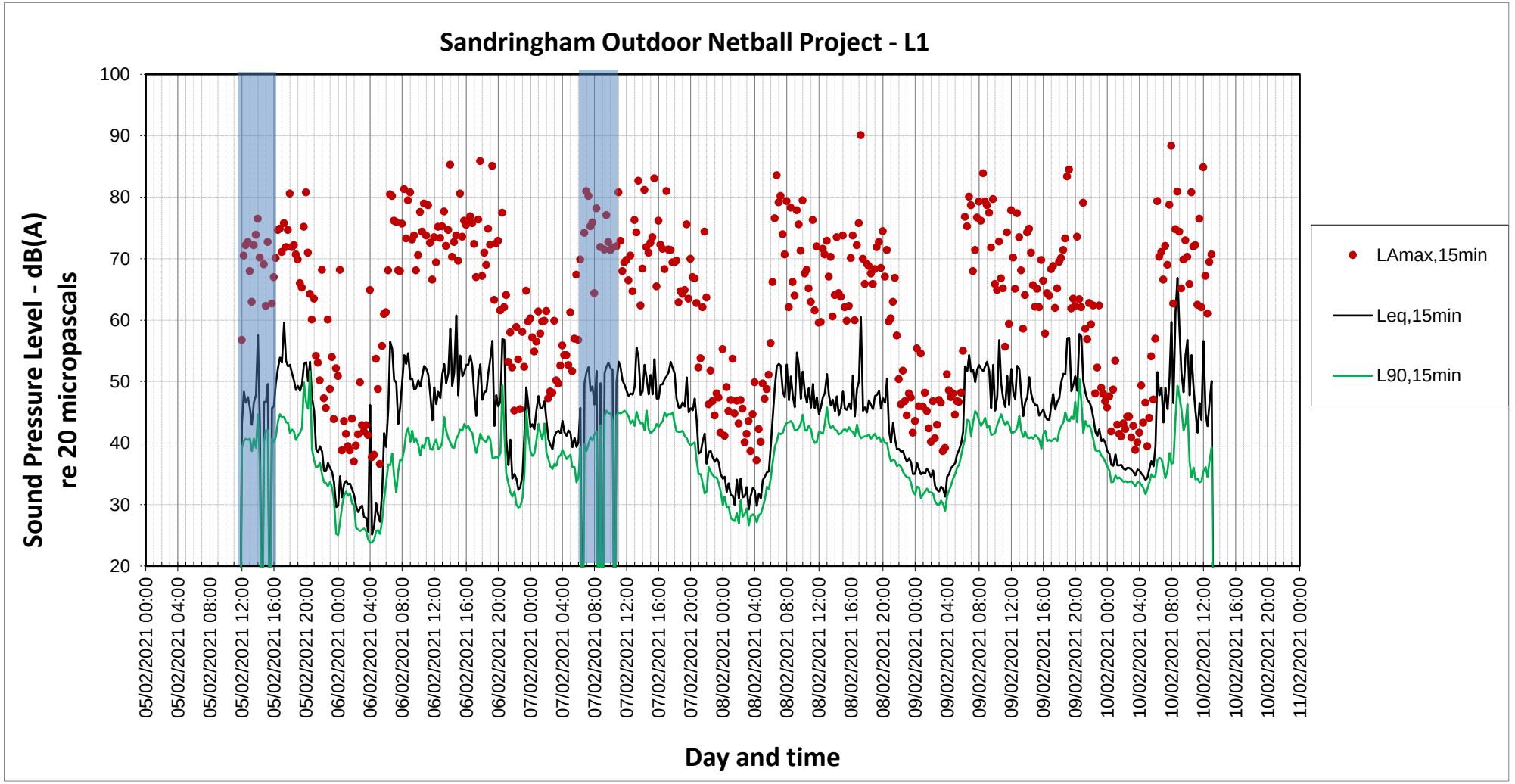
- Indoor court buildings moved to the north-west of the proposed site to provide screening of the multi-storey apartment buildings on Bar Road from the outdoor netball courts.
- Location of outdoor courts central to the site location to keep distance separation from residences across Holloway Road and Wangara Road.
- Installation of a noise barrier to the south of the outdoor courts to protect residential receivers across Holloway Road and Wangara Road.

Appendix A Glossary of Acoustic Terms

Term	Definition
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.

LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix B Measurements Results – Logger Trace



Highlighted areas correspond to periods when there was rain near Sandringham. The corresponding measurements have been excluded from our analysis.

Design with
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