Pickleball Noise Planning Guidelines: City of Ottawa

File No. AC3372

October 30, 2024

BAP Acoustics Ltd
office@bapacoustics.com

Authorization

City of Ottawa – Noise Planning Guidelines for Outdoor Pickleball Courts
AC3372

Prepared for:

City of Ottawa
110 Laurier Avenue West
Ottawa, ON
K1P 1J1

Prepared by:

Alex Mendes, B.Eng., EIT
Acoustic Engineer

Reviewed by:

Eric de Santis, M.Sc., P.Eng.
Partner

TABLE OF CONTENTS

1 INTRODUCTION

This guideline is intended to provide the City of Ottawa with planning strategies aimed at minimizing the potential community noise impacts associated with outdoor pickleball (PB) courts. The strategies provided herein were developed based on past studies conducted by BAP Acoustics, which have included measuring, modelling, and assessing noise from outdoor PB courts in the province of British Columbia.

2 PICKLEBALL NOISE

There are two primary sources of noise associated with pickleball games:

- Ball hits (i.e., the ball contacting the paddle), and
- Players' voices.

Both noise sources have characteristics associated with increased risks of community noise annoyance. The ball hits create impulsive noise and the players' voices produce sound containing information.

The results of equipment sound level testing indicate that ball hits are the dominant source of pickleball noise in terms of the L_{Aeq}. The players' voices, however, should still be considered an important source of noise.

Please refer to Appendix A for definitions of technical terms such as L_{Aeq} and dBA as well as discussion of the relationship between the character of sound and community annoyance,

3 NOISE CRITERIA

The following discussion assumes that outdoor PB courts would not operate outside of the daytime period, which is typically defined in noise regulation and guidelines as the period from 07:00 hours to 23:00 hours.

3.1 City of Ottawa Noise Bylaw

Section 2 of the City of Ottawa Noise Bylaw (2017-255) states that no person shall cause or permit any unusual noise or noise that is likely to disturb inhabitants of the City. While PB noise is likely subject to this restriction, the bylaw does not provide quantitative guidance as to levels of noise that are to be deemed unacceptable in this context. The bylaw does, however, provide quantitative restrictions for other noise sources such as mechanical equipment (e.g. air conditioners, heat pumps), which are limited to 50 dBA at an outdoor point of reception (e.g. neighbouring property line), and sound reproduction devices, which are limited to 55 dBA between during the period of 07:00 – 23:00 hours.

3.2 Ontario Ministry of Environment NPC-300 Guideline

The Ontario Ministry of Environment (MOE) Environmental Noise Guideline Publication NPC-300 provides sound level limits and noise control guidance in land use planning to minimize conflicts between noise-sensitive receptors and stationary noise sources.

Stationary sources are broadly defined as noise sources operated within a facility's property lines or on private premises, excluding noise resulting from the gathering of people at restaurants, fairs, and parks. Examples of stationary sources subject to NPC-300 include:

- auxiliary transportation facilities;
- commercial facilities;
- industrial facilities;
- natural gas facilities;
- repair or storage garages for public vehicles;
- routine loading and unloading facilities (truck terminals, assembly plants commercial facilities, etc.);
- solar farms / solar panel systems;
- storage, maintenance and repair facilities;
- warehousing and truck terminal facilities; and
- works yards

The noise level limits in NPC-300 are developed for these examples, typically serving commercial or industrial purposes. These limits have not been developed for noise associated with recreational activities and may be overly restrictive for PB courts in public parks.

3.3 Health Canada Noise Guidelines

A common approach to assessing environmental noise impacts during the daytime is to evaluate the potential for noise-induced speech interference. In the 2017 document *Guidance for Evaluating Human Health Impacts in Environmental Assessment: NOISE*, Health Canada recommend keeping outdoor noise levels below 55 dBA to sustain adequate speech comprehension.

3.4 Recommended Criteria

In accordance with relevant legislation, a logical design noise criterion to adopt for PB noise within the City of Ottawa would be a 55 dBA limit at the nearest relevant point of reception. This criterion is consistent with both Health Canada's 55 dBA daytime limit for noise-induced speech interference and the City of Ottawa Noise Bylaw limit for sound reproduction devices. However, due its impulsive nature, PB noise tends to be more objectionable than other types of community noise. In accordance with ISO 1996-1:2006, a +5 dBA adjustment is recommended to better account for noise with these characteristics. Under this approach, the recommended design limit for PB noise is 50 dBA.

4 NOISE CONTROL

The following section discusses various approaches to mitigating community noise impacts from PB courts. Since every situation will be unique, a qualified acoustical engineer should be consulted before implementing any of the mitigation measures discussed below.

4.1 Setback Distances

In most cases, maximizing the setback distance between outdoor PB courts and any nearby residences is the most cost-effective means of limiting PB noise impacts. Section 7.2 provides recommended setback distances.

4.2 Barriers

Installing noise barriers around the PB courts is the most practicable means of engineered noise control. There are noise barrier products available which are dense, heavy sheets that can be attached to the existing chain link fences that surround many PB courts (subject to wind loading and structural review). Examples of surface-mounted barrier products include the sound reflective material Acoustifence, and the sound absorptive material Kinetics KBC-100RBQ. It should be noted that the purpose of sound absorptive barriers is not to provide superior acoustical performance relative to sound reflective barriers, but rather to avoid noise impacts due to reflected sound. Situations warranting the use of sound absorptive barriers are discussed later in this section.

Figure 1 shows an example of a sound reflective barrier material installed on the chain link fence at the Murdo Fraser PB courts in North Vancouver.

Figure 1: PB courts surrounded by reflective noise barrier.

Based on analysis using computerized noise modelling, a 3 m-tall reflective barrier is expected to provide at least a 5 dBA reduction in PB noise at a nearby, ground level receptor (i.e., a receptor within approximately 100 m of the courts and elevated no more than 2 m relative to the court surface).

For optimal mitigation, barriers should have the following properties:

- A minimum surface density of 5 kg/m^2.
- The barrier should extend at least 3 m above the court surface and be largely free of gaps or holes.
- Where possible, installed at a setback distance of at most 3 m from the court lines.
- The barrier should surround at least three sides of the court. In cases where there are residences located within approximately 70 m of two or more sides of the court, the barrier should surround all four sides.
- Where three-sided barriers are used, the open side should face away from any residential receptors which are closer than the setback distances recommended in Section 5.2. If this is not possible, a sound absorptive barrier should be used. Otherwise, there is potential for reflected sound to impact nearby residences as shown in Figure 2.
- Where dwellings overlook a PB court with barriers (i.e., upper storeys of buildings that still have a clear line of sight into the courts despite the presence of the barrier), sound absorptive barriers should be used if the setback distances recommended in Section 5.2 cannot be

maintained. Otherwise, there is potential for reflected sound to impact nearby residences as shown in Figure 3.

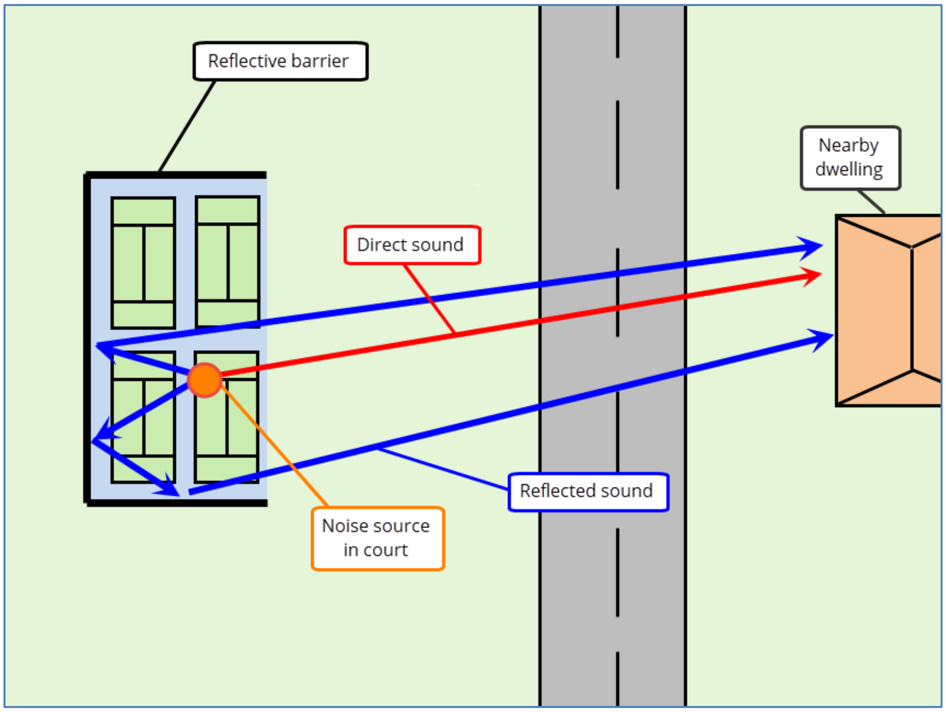

Figure 2: Reflected sound from barrier impacting residences facing the open side of the court.

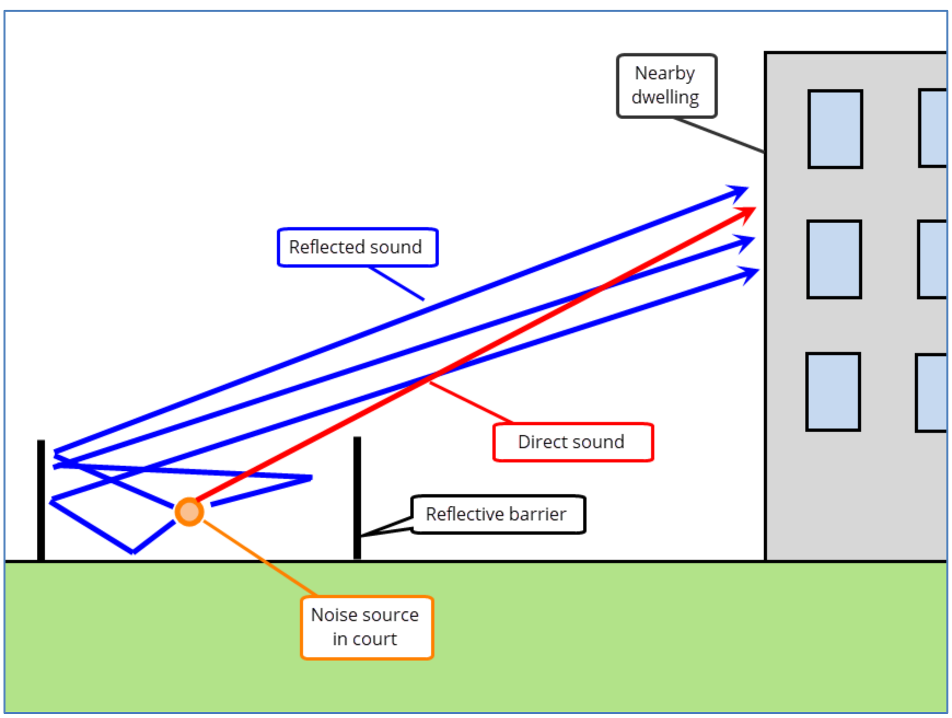

Figure 3: Reflected sound from barrier impacting multi-level building.

4.3 Earth-Berms

Earth-berms can also act as effective sound barriers. Unlike vertical barriers made from common building materials, berms have an angled slope which is beneficial in controlling undesirable reflections. To be effective, an earth berm would typically need to be higher than a corresponding fence-line barrier since the berm would be located further away from the PB court. Given that berm slopes are typically at least 2:1 (horizontal:vertical), a 4 m to 5 m earth berm would require approximately 15 m to 20 m of land. As such, opportunities for their use will be limited by the amount of park area available.

4.4 Foliage

Dense foliage, such as tree belts and forests, has been shown to be effective in attenuating noise. Like an effective barrier, it breaks the line of sight to the receiver. Noise attenuation from forests and tree belts is due to the combined effect of high-frequency noise scattering from tree and undergrowth foliage and low-frequency ground absorption from the soft, porous forest ground. There is potential to obtain up to 10 dBA noise attenuation per 100 linear meters of forest, whether deciduous or coniferous. Additionally, noise attenuation is stronger when the foliage extends close to the ground. Therefore, forest plantation planning should allow for the presence of undergrowth. The forest should be composed of both coniferous and deciduous stands to ensure foliage presence during the winter season. It is important to note that single rows of hedges or trees, that are typical of urban parks, are not effective barriers to noise.

4.5 Other Approaches

Other approaches to mitigating PB noise include:

- Requiring players to use “quieter” equipment, and
- Introducing signage to remind players not to raise their voices or shout.

Certain equipment (i.e., “quieter” equipment) has been measured by BAP Acoustics to produce sound levels up to 5 dBA lower than the average levels as reported in this guideline. It may therefore be possible to reduce the typical noise levels produced by PB courts by up to approximately 5 dBA through use of “quieter” equipment selections. A 5 dBA reduction is significant as it is generally considered to be the threshold of effectiveness for community noise mitigation.

Since these are difficult to enforce, preference should be given to the other mitigation strategies presented in this guideline. Further research is needed to verify the effectiveness of using “quieter” equipment to mitigate PB noise.

5 SITING

5.1 General Considerations

When considering a site for outdoor PB courts, the following should be considered:

- **Setback Distance:** Setback distance between the courts and the nearest residential receivers will typically be the primary determinant of whether the introduction of a PB court will result in noise complaints.
- **Ground Type:** Preference should be given to sites where there is acoustically soft ground (e.g., grass, foliage) between the PB courts and residential areas.
- **Terrain obstacles:** Wherever possible, PB courts should be sited to take advantage of naturally occurring terrain obstacles (e.g., locating the PB courts behind a berm). Conversely, situations should be avoided where residences or the upper-level dwellings of high-rise buildings will overlook the courts.
- **Foliage:** In certain situations, it may be possible to site the PB courts to take advantage of the shielding provided by dense foliage. A 50 m-wide tree belt consisting of tall trees and dense foliage is expected to reduce PB noise by approximately 3 to 5 dBA.

5.2 Recommended Setback Distances

We provide herein recommended setback distances to meet the 50 dBA target, presented in tabular format. Note that these setback distances apply to the perimeter of the court lines, rather than to the fence line, to provide guidance with respect to an invariant point of reference.

Each table includes setback distances applicable to the following scenarios:

- No noise mitigation and intervening terrain between the courts and residences is acoustically hard (e.g., pavement).
- No noise mitigation and intervening terrain between the courts and residences is acoustically soft (e.g., grass, loose soil).
- 3 m-tall noise barrier around courts and intervening terrain between the courts and residences is acoustically hard (e.g., pavement).
- 3 m-tall noise barrier around courts and intervening terrain between the courts and residences is acoustically soft (e.g., grass, loose soil).

- 4 m-tall noise barrier around courts and intervening terrain between the courts and residences is acoustically hard (e.g., pavement).
- 4 m-tall noise barrier around courts and intervening terrain between the courts and residences is acoustically soft (e.g., grass, loose soil).

Note that the setback distances provided for barrier scenarios do not apply to circumstances in which residences are overlooking the courts and have line of sight to PB noise sources.

Recommended setback distances to meet the 50 dBA limits are provided in Table 2.

Table 1: Minimum setback distances to meet 50 dBA criteria.

Number of Courts	Setback Distance (m)					
	No Noise Mitigation		3 m Noise Barrier		4 m Noise Barrier	
	Hard Ground	Soft Ground	Hard Ground	Soft Ground	Hard Ground	Soft Ground
1	45	35	25	20	22	18
2 (1x2 grid)	65	50	35	30	31	26
4 (2x2 grid)	90	75	50	45	45	41
6 (2x3 grid)	105	85	55	50	49	45
8 (2x4 grid)	120	90	60	50	52	44
12 (3x4 grid)	160	115	75	60	66	53
14 (2x7 grid)	175	120	80	65	71	58

APPENDIX A: BASIC ACOUSTICS

Basics of Sound

The phenomenon we perceive as sound results from fluctuations in air pressure close to our ears. These fluctuations result from vibrating objects, such as human vocal cords, loudspeakers and engines etc. Sound pressure is measured using the Pascal. The ratio of the quietest to the loudest sound that the human ear can hear is a billion to one. Therefore, sound pressure is commonly expressed using the logarithmic decibel (dB) unit. When sound pressure is expressed in decibels, it is called sound pressure level. The loudest sound pressure level we can hear without immediately damaging our hearing is 120 dB and the faintest sound we can detect is 0 dB.

Human sound perception depends on both the level and the frequency content of a given sound source. Frequency is defined as the number of times per second that pressure fluctuations occur. The frequency reflects the pitch of the sound. It is expressed in Hertz (Hz). The average young human listener can perceive sound frequencies from 20 Hz to 20,000 Hz. Human hearing is less sensitive to low frequency sound levels (below 200 Hz) and to high frequency sound levels (above 5000 Hz). The human ear is most "tuned" to the vocal frequency range between 200 Hz and 5,000 Hz. For acoustic engineering purposes, the audible frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the range that is typically used for environmental purposes is from 31 Hz to 8 kHz (octave bands).

Acoustic Metrics

A-weighting

The microphone of a sound level meter, unlike the human ear, is designed to be equally sensitive to sound throughout the audible frequency range. To compensate for this, the A-weighting filter of a sound level meter is used to approximate the frequency sensitivity of the human ear. As such, A-weighted sound pressure levels (dBA) give less emphasis to low and high frequencies and are correspondingly tuned to the vocal frequency range between 200 Hz and 5000 Hz.

L_{Aeq}

The A-weighted equivalent continuous sound pressure level (L_{Aeq}) is the most common acoustic metric used to describe sound levels that vary over time. The L_{Aeq} is an energy average. It is calculated by storing and logarithmically averaging the sound of all events recorded during the measurement period. The L_{Aeq} can be measured over any time period. However, a 24-hour measurement period is commonly used for community noise assessments. Other common time intervals include the daytime L_{Aeq} (or L_d) and the nighttime L_{Aeq} (L_n). The L_d time interval is from 07:00 to 22:00 hours, and the L_n time interval is from 22:00 to 07:00 hours.

L_{dn}

The day-night equivalent sound level (L_{dn}) is a 24-hour equivalent sound level which is based on the energy sum of day-time equivalent sound level (L_d) and the night-time equivalent sound level (L_n) plus 10 dB. The 10 dB addition to the L_n is a penalty which reflects the increased sensitivity to noise during the nighttime.

L_{90}

The ninetieth percentile sound level (L_{90}) is a statistical metric that is the defined as the sound pressure level exceeded 90% of the time in a given measurement period. This figure is commonly used to quantify the background noise environment and is typically A-weighted (L_{A90}).

Basics of Outdoor Sound Propagation

As sound waves propagate through the environment, energy is lost through geometrical divergence, atmospheric absorption, refraction in the atmosphere, ground effects and the screening of obstacles.

Geometrical Divergence

Sound intensity decreases with increasing distance from a sound source. Losses from geometrical divergence result from the spreading of the sound source energy over larger and larger areas as the distance between the original sound source and receiver position increases. Sound attenuation through geometrical divergence is nominally independent of frequency, weather, and atmospheric absorption losses.

Atmospheric Absorption

Sound waves propagating through free air are attenuated through a combination of classical (heat conduction and shear viscosity) losses and molecular relaxation losses. At long outdoor propagation distances and for higher frequencies, attenuation due to atmospheric absorption is usually much greater than the attenuation due to geometrical divergence.

Refraction

The speed of sound relative to the ground is a function of temperature and wind velocity. Both temperature and wind velocity vary with height. Temperature and wind gradients therefore cause sound waves to propagate along curved paths. On a hot summer day, solar radiation heats the earth's surface resulting in warmer air near the ground. This condition is called a temperature lapse and causes sound rays to curve upwards. An opposite condition, called a temperature inversion, results when air is cooler at the ground surface than at higher elevations. Sound paths curve downwards during such a condition.

Wind also causes sound waves to bend upwards or downwards. Sound must propagate upwind when source is downwind of a receiver. Wind speeds increase with height, causing a negative sound speed gradient. Sound waves bend upwards under this condition.

Ground Effect

The ground effect refers to the interference (destructive and constructive) between sound reflected off the ground surface and sound travelling directly between a source and receiver. Ground effect interference has the potential to both enhance and attenuate sound as it propagates through the outdoors. The ground effect is sensitive to the acoustical properties of the ground surface.

Screening

Intervening terrain and artificial barriers (such as buildings or noise barriers) can attenuate sound by interrupting its path to a receiver. Screening effects are most pronounced when the screening obstacle completely blocks line of sight from the receiver to the sound source.