Conejo Recreation & Park District

GENERAL MANAGER
Jim Friedl

DATE: January 18, 2024

TO: Board of Directors

FROM: Jim Friedl, General Manager

SUBJECT: **Authorize Trial Pickleball Court Locations in Conejo Recreation and Park District**

RECOMMENDATION

1. Determine that the Triunfo Community Park, Estella Park, and Oakbrook Neighborhood Park Trial Pickleball Courts are categorically exempt from the California Environmental Quality Act (CEQA).

2. Authorize trial pickleball courts at the following park locations:

   a) Triunfo Community Park
   b) Estella Park
   c) Oakbrook Neighborhood Park

DISCUSSION

In June 2023, the Board approved the Fiscal Years 2023-24 and 2024-25 budgets, which included the 10-year Capital Improvement Plan (CIP). The 10-year CIP includes five (5) proposed additional pickleball court locations: which are noted Triunfo Community Park, Oakbrook Neighborhood Park, or Del Prado Playfield in Year 3 of the 10-year CIP, and Rancho Conejo Community Park and Conejo Creek Northwest (future park site) Year 10.

Additionally, due to the community interest throughout the budget process in the development of the new pickleball courts, the operating budget included funding to further assess locations with preliminary planning and potential trial courts. To access the June 15, 2023 Board report, visit www.crpd.org/budget .

CEQA COMPLIANCE

For the Board's consideration and approval, District staff believes the Trial Pickleball Courts at Triunfo Community Park, Estella Park, and Oakbrook Neighborhood Park qualify for a Class 6 Categorical Exemption, pursuant to Section 15306 of the CEQA Guidelines. Class 6 exemptions include basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. These may be strictly for information-gathering purposes or as part of a study leading to an action that a public agency has not yet approved, adopted, or funded.

Additionally, staff believes the Trial Pickleball Courts at Triunfo Community Park, Estella Park, and Oakbrook Neighborhood Park qualify for a Class 3 Categorical Exemption, pursuant to Section 15303 of the CEQA Guidelines. Class 3 exemptions include the conversion of small facilities or structures. In this project, temporary improvements are being made to existing tennis courts to collect data on the recreational use of pickleball.

Trial Review

In September 2023, staff met with the Ad Hoc Committee (Director Huffer and Director Nickles) to discuss the next steps of assessing pickleball development and possible trial courts. The utilization of park sites that currently have paved courts was discussed as the preferred trial locations to keep costs associated with the temporary trial court improvements to only striping, nets, signage, and possibly fencing.

Based on this criteria of the five (5) proposed sites included in the 10-year CIP, Triunfo Community Park and Oakbrook Neighborhood Park were selected with the other three (3) sites not having available paved courts. Additionally, Estella Park was proposed since it is currently striped for two (2) pickleball courts but does not have permanent nets installed due to the shared use of the court with tennis and futsal (5 per side soccer).

Community Outreach Regarding Proposed Trials

In November 2023, staff held six (6) total public outreach meetings, two (2) meetings at each potential trial site (Triunfo Community Park, Estella Park, and Oakbrook Neighborhood Park) to review the proposed trial court layouts (Exhibit A) and receive feedback from the community. Meetings were notified via a mailer to neighbors, signage posted on site, email (pickleball interest group generated from past outreach), and the District website.

Additionally, proposed trial plans and information were posted on the District website for public review and comment before and after the meetings (see www.crpd.org/planning and click the *Pickleball in the Conejo Valley* tab).

At the conclusion of the public outreach meetings, staff and the Ad Hoc Committee discussed the community feedback from the meetings held, emails, and phone calls received. The group's consensus was that an environmental analysis and survey would need to be included in the trial court review process to accurately assess the proposed trials. Thus, as part of the recommendation, staff will coordinate with an environmental consultant to review the park site's sound, traffic, and use and make a public survey available in which the community can participate.

Additional Trial Project Review

As part of staff's planning and review of capital improvement projects, staff utilizes available documentation such as technical reports, case studies or built projects from other municipalities and recreation facility providers to help assess and deliver a successful park project for the District.

In a review of other pickleball court developments and due to the public concern about the use and noise of pickleball, staff is providing a Pickleball Noise Assessment (Exhibit B) and Report (Exhibit C) for the City of Vancouver B.C. Canada from BAP Acoustics. BAP is an acoustic professional services company that provides noise and mitigation analytics, building acoustic design, and exterior noise control in various settings, including civic, residential, leisure, commercial, and industrial, among other land uses. The assessment provides guidelines and considerations when contemplating a site for outdoor pickleball courts, including setback distance from residential areas, ground type, terrain obstacles, and foliage.

Sound is commonly measured in decibels (dB). It measures the loudness of a sound or the strength of a signal, computed as the signal-to-noise ratio. Humans do not hear all frequencies equally. dBA is a weighted scale for judging loudness that corresponds to the hearing threshold of the human ear. It is an adjusted measurement of noise that considers the human ear's sensitivity to the various sound frequencies we can hear.

The following table was provided in the assessment generated from the technical report, which shows the distance required to meet 50 dBA from court lines to property line of residence. Note, locally per the City of Thousand Oaks General Plan – Noise Chapter, Table 11.2, the acceptable dB level guidelines for residential range from 55-65 dB and parks range from 55-75 dB.

Number of Courts	Pickleball Court Setback Distance required to meet 50dBA (feet)*			
	No Noise Mitigation		Approx 10 ft Noise Barrier*	
	Hard Ground	Soft Ground	Hard Ground	Soft Ground
2	213'	164'	115'	98'
4	295'	246'	164'	148'
6	344'	278'	180'	164'
12	524'	377'	246'	196'

*Unit of measurement converted from meters to feet from BAP Acoustics Report.

The table below lists CRPD Trial Pickleball location sites and their distances from proposed court lines to the property line of the nearest residence adjacent to the park property.

Number of Courts	CRPD - Trial Pickleball Court Setback Distances		
	Triunfo Community Park	Estella Park	Oakbrook Neighborhood Park
2	-	10'	270'
4	383'	-	-

In comparing the above tables, two of the three proposed trial courts exceed the required distances per the assessment guidelines with either hard/soft surfaces and without any noise mitigation per the provided Assessment - Exhibit A. Each site has varying characteristics, which should be accounted for when locating pickleball courts.

Trial Pickleball Courts

Based on the feedback from current pickleball court use, information gained from meetings, interaction with the pickleball community and community at large, and past pickleball development projects, District staff formulated, and the Ad Hoc committee concurred with, the below items to be included to provide a suitable trial:

- Temporary improvements (caster nets and fencing/windscreen)
- Painted court striping (not tape due to longevity and safety)
    - (4) Courts at Triunfo Community Park (multi-use with tennis)
    - (2) Courts at Estella Park (existing multi-use tennis/futsal – no nets currently)
    - (2) Courts at Oakbrook Neighborhood Park (replacing netball court)
- Termed 6-month trial (temporary improvements of nets, signage, and fencing will be removed at the end of the trial)
- Environmental Analysis (includes baseline study and incremental review during trial at Triunfo Community and Oakbrook Neighborhood Parks – no environmental analysis to be completed at Estella Park due to existing pickleball striping and use)
- Public Online Survey

The estimated cost of the physical temporary improvements of trial courts would be approximately $5,000-$10,000 per park site plus an estimated $30,000 total for environmental services for all park sites. Due to the enforcement challenges and costs of sound mitigating equipment and court improvements (i.e., paddles approx. $200, fence sound barriers approx. $15,000 per court), mitigation measures will not be included in the Trial Pickleball Courts. However, for the future development of pickleball courts, staff will consider options to incorporate sound mitigation measures.

NEXT STEPS

At the conclusion of the 6-month term of the trial courts, the temporary improvements of nets, signage, and fencing will be removed. Staff will prepare documentation to provide and review with the Ad Hoc committee. Based on the information received, staff will return to the full board to provide data on the trial locations and make possible further recommendations related to pickleball development within District facilities.

STRATEGIC PLAN COMPLIANCE

Meets 2024 Strategic Plan Element Objective and Strategy 2.0: Our objective is to provide and maintain recreational facilities that meet the needs of the community. Our strategy is to effectively plan and allocate resources to implement the District's Master Plan.

Meets 2024 Strategic Plan Goal 2.3: Maintain the 10-Year Capital Improvement Plan. Regularly update the 10-year Capital Improvement Plan to prioritize projects and effectively plan and allocate future resources. As capital funding allows, execute, implement, and develop projects each year in accordance with the plan. This Plan should include funds for accessibility improvements associated with park improvements. Update plan every two years as part of the Capital Budget process.

Meets 2024 Strategic Plan Goal 2.5: Maintain a capital improvement fund. Provide incentives for groups to improve District facilities through a grant funding application program for District approved projects.

Meets 2024 Strategic Plan Goal 4.6: Build, maintain, and support relationships with local organizations engaged in activities consistent with the District's mission. Look for collaborative opportunities to expand services and fill unmet needs.

Respectfully submitted by,

Andrew J. Mooney, Administrator
Parks and Planning

Attachments

EXHIBIT A

Proposed Trial Pickleball Court Layouts


Triunfo Community Park
Pickleball Court 383' From PL
Legend
Court distance
Antares Ct
Tamarack St
Sorrelwood Ct
Nettlebrook St
383'
Stonesgate St
Google Earth
600 ft
N

(4) MULTI-USE PICKLEBALL COURTS AT (2) EXISTING TENNIS COURTS. REMOVABLE PICKLEBALL NETS ON CASTERS.
TENNIS NET TO REMAIN ACT AS BARRIER DURING PICKLEBALL USE.

(1) EXISTING TENNIS COURT TO REMAIN DEDICATED TO TENNIS.

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NORTH

TRIUNFO COMMUNITY PARK
2023 1020
SCALE 1/32" = 1'-0"

Estella Neighborhood Park

Pickleball Court 10' From PL

TO REMAIN EXISTING MULTI-USE COURT:
(2) PICKLEBALL
(1) TENNIS
(1) FUTSAL

PROVIDE REMOVABLE PICKLEBALL NETS ON CASTERS AND PROVIDE BARRIER DURING PICKLEBALL USE.

(1) EXISTING HALF BASKETBALL COURT AND GAME AREA TO REMAIN DEDICATED TO CURRENT USE.

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NORTH

ESTELLA PARK
2023 1020
SCALE 1/32" = 1'-0"

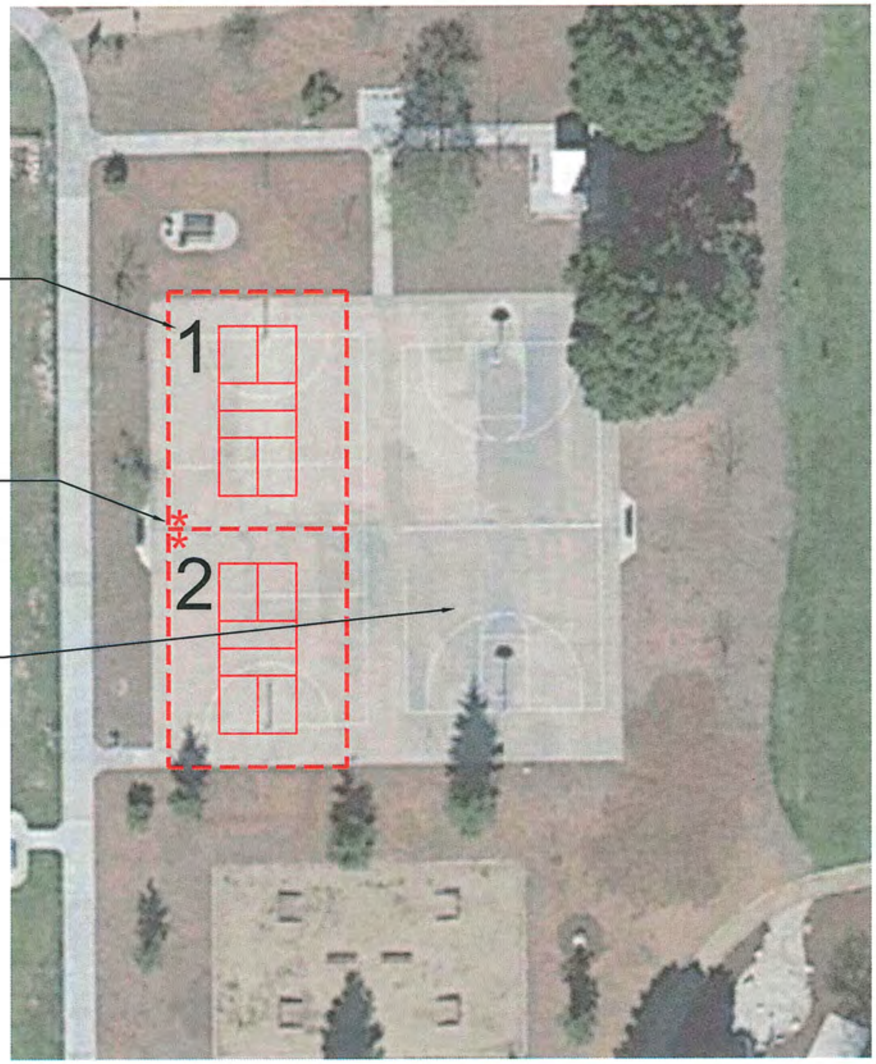
Oakbrook Neighborhood Park

Pickleball Court 270' From PL

(2) DEDICATED PICKLEBALL COURTS AT (1) EXISTING NETBALL COURT. REMOVE NETBALL POST/BASKET.

TEMPORARY PERIMETER FENCE WITH WINDSCREEN AND PEDESTRIAN GATES (1) PER COURT.

(1) EXISTING BASKETBALL COURT TO REMAIN DEDICATED TO BASKETBALL.



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NORTH

OAKBROOK NEIGHBORHOOD PARK
2023 1020
SCALE 1/32" = 1'-0"

EXHIBIT B

Pickleball Noise Assessment

City of Vancouver, B.C. Canada

PICKLEBALL NOISE ASSESSMENT

Purpose

BC Recreation and Parks Association (BCRPA) is pleased to share the following BAP Acoustics report to inform municipal noise mitigation strategies as the first step in pickleball guideline development in BC.

BCRPA is collaborating with Pickleball BC, a Provincial Sport Organization, to provide a consistent approach to court development across BC, beginning with noise mitigation of outdoor pickleball courts.

BCRPA
BC RECREATION AND PARKS ASSOCIATION

PICKLEBALL BC BRITISH COLUMBIA

February 2023

Noise Planning Guideline for Outdoor Pickleball Courts

BC Recreation and Parks Association
Pickleball BC

06 Dec 2022

Authorization

Noise Planning Guideline for Outdoor Pickleball Courts in British Columbia, Canada
AC3124

Prepared for:

BC Recreation and Parks Association 470
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Reviewed by:

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Table of Contents

1 INTRODUCTION

This guideline is intended to provide Pickleball BC with planning strategies aimed at minimizing the potential community noise impacts associated with outdoor pickleball courts. The strategies provided herein were developed based on:

- Our experience with measuring, modelling, and assessing noise from outdoor pickleball courts in the province of British Columbia (BC), and
- The pickleball equipment sound level study that we conducted for Pickleball BC. The results of this study are presented in our August 31st, 2022, report: *Pickleball BC Noise Assessment – Equipment Sound Level Testing*.

2 PICKLEBALL NOISE

Based on our historical studies of pickleball noise, we have concluded that a single active pickleball court produces an A-weighted continuous equivalent sound level (L_{Aeq}) of 55 to 57dBA at a setback of 15m from the perimeter of the court lines.

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 the equipment sound level testing indicate that ball hits are the dominant source of pickleball noise in terms of the L_{Aeq}. The player's voices, however, should still be considered an important source of noise due the characteristics discussed in the preceding section.

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

3 NOISE CRITERIA

The following discussion assumes that outdoor pickleball courts would not operate outside of the daytime period which is typically defined in noise regulation and guidelines as the period from 7:00 a.m. to 10:00 p.m.

3.1 Municipal Noise Bylaws

The typical daytime limit adopted by many municipalities in British Columbia for noise created and received in residential land parcels is 55dBA. Certain of these bylaws (e.g., City of Victoria, City of Richmond) also recommend lowering the limit by 5dBA when the noise in question contains an unpleasant characteristic such as tonality or impulsiveness.

3.2 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 their 2017 document *Guidance for Evaluating Human Health Impacts in Environmental Assessment: NOISE*, Health Canada recommend keeping outdoor noise levels below 55dBA to sustain adequate speech comprehension.

3.3 Recommended Criteria

The pickleball noise level limit recommended in this guideline is 50dBA as measured or predicted at the nearest residential property line.

This guideline limit is based on the 55dBA daytime noise level limit stipulated by municipal bylaws and the 55dBA daytime limit for noise-induced speech interference identified by Health Canada. The 50dBA target was arrived at by reducing the 55dBA limit by 5dBA to account for the impulsive character of pickleball noise.

4 NOISE CONTROL

The following section discusses various approaches to mitigating community noise impacts from pickleball 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 pickleball courts and any nearby residences is the most cost-effective means of limiting pickleball noise impacts. Section 5.2 provides recommended setback distances.

4.2 Barriers

Installing noise barriers around the pickleball 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 pickleball 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 (although they may do so in certain cases), 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 pickleball courts in North Vancouver.

Figure 1: Pickleball courts surrounded by reflective noise barrier

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

To be effective, the barriers should have the following properties:

- A minimum surface density of 5kg/m^2.
- The barrier should extend at least 3m above the court surface and be largely free of gaps or holes.

- The barrier should surround at least three sides of the court. In cases where there are residences located within approximately 70m 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.

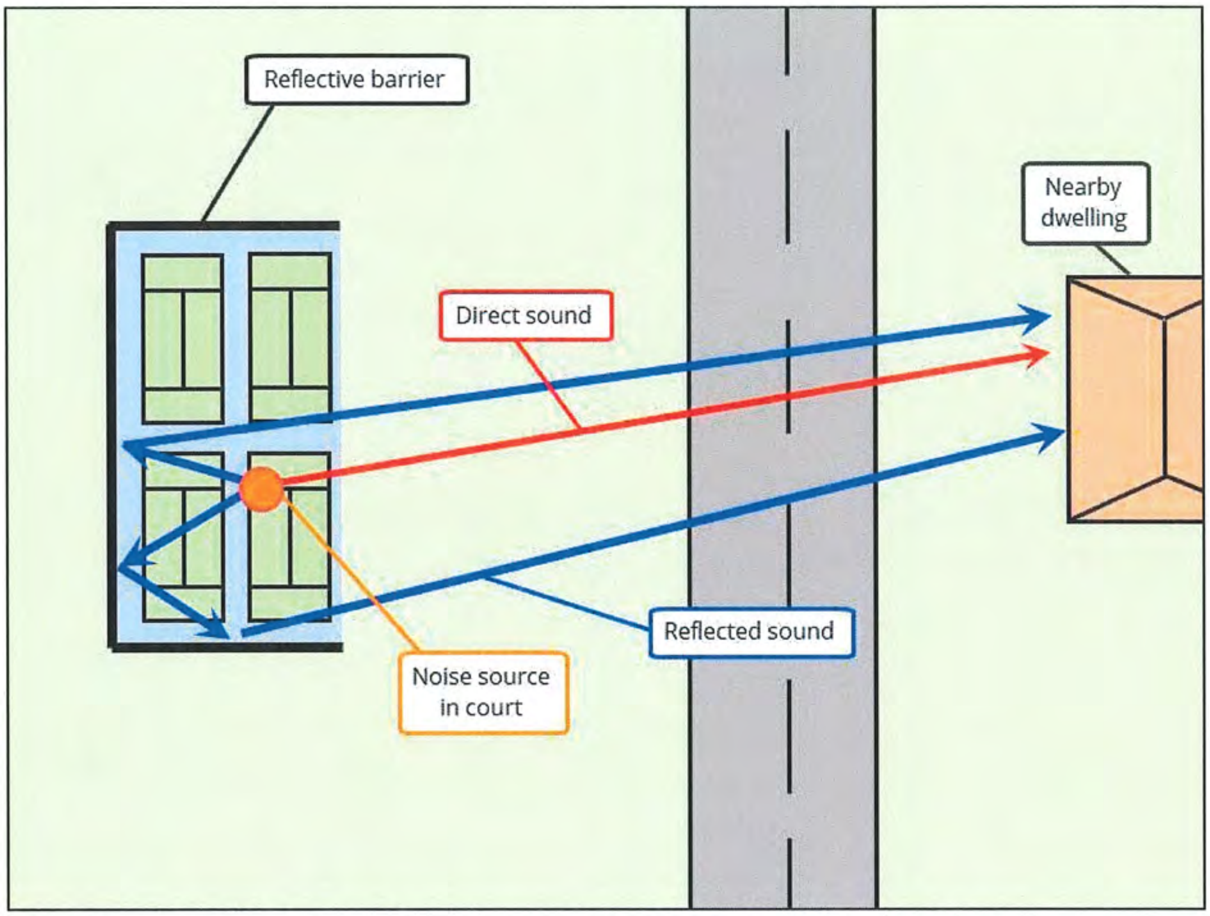

Figure 2: Reflected sound from barrier impacting residences facing the open side of the court

- Where dwellings overlook a pickleball 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 on the following page.

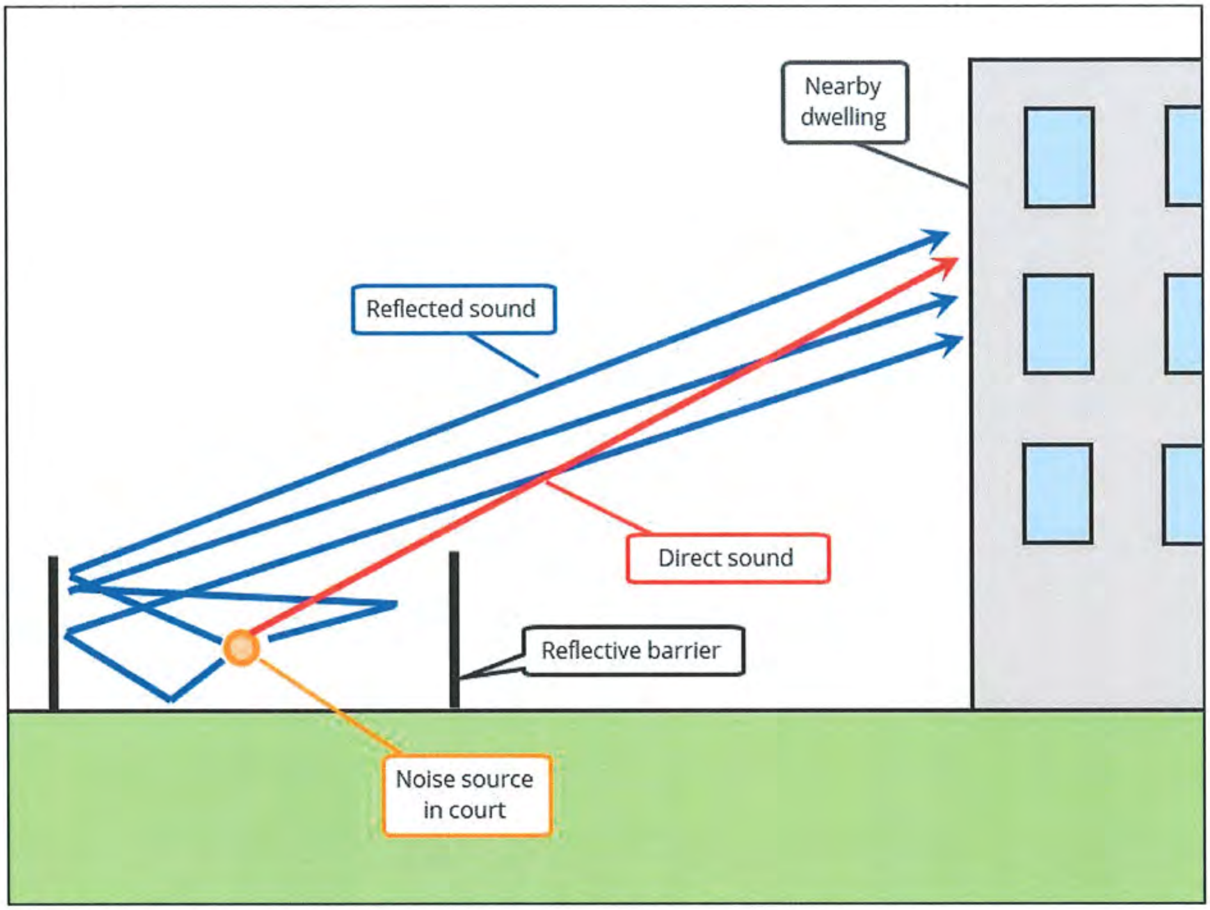

Figure 3: Reflected sound from barrier impacting multi-level building

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 pickleball court. Given that berm slopes are typically at least 2:1 (horizontal:vertical), a 4m to 5m earth berm would require approximately 15m to 20m of land. As such, opportunities for their use will be limited by the amount of park area available.

4.4 Other approaches

Other approaches to mitigating pickleball noise include:

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

The results of the equipment sound level measurements presented in our August 31st, 2022, report found that certain equipment (i.e., "quieter" equipment) produced sound levels that were 5dBA lower than the average levels previously measured by BAP Acoustics. As such, it may be possible to reduce the typical noise levels produced by pickleball courts by up to approximately 5dBA through use of "quieter" equipment selections. A 5dBA reduction is significant as it is generally considered to be the threshold of effectiveness for community noise mitigation.

Since the approaches outlined above would be difficult to regulate, preference should be given to the other mitigation strategies presented in this guideline. As noted in our August 31st, 2022, report, further research is needed to verify the effectiveness of using "quieter" equipment to mitigate pickleball noise.

5 SITING

5.1 General Considerations

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

- **Setback distance:** The setback distance between the courts and the nearest residential area will typically be the most important determinant of whether the introduction of a pickleball court will result in noise complaints. Please refer to Table 1 in Section 5.2 for recommended setback distances.
- **Ground type:** Preference should be given to sites where there is acoustically soft ground (e.g., grass, foliage) between the pickleball courts and residential areas.
- **Terrain obstacles:** Wherever possible, pickleball courts should be sited to take advantage of naturally occurring terrain obstacles (e.g., locating the pickleball 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 pickleball courts to take advantage of the shielding provided by dense foliage. A 50m wide tree belt consisting of tall trees and dense foliage is expected to reduce pickleball noise by approximately 3 to 5dBA.

5.2 Recommended Setback Distances

Table 1 provides the minimum setback distances recommended to meet the 50dBA target. Note that these setback distances apply to the perimeter of the court lines, rather than to the court boundary (i.e., fence line). Specifying setbacks based on the court lines is more accurate as the distance between the court lines and court boundary will vary from court to court.

The table includes four columns of setback distances to address 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).
- 3m tall noise barrier around courts and intervening terrain between the courts and residences is acoustically hard (e.g., pavement).
- 3m tall noise barrier around courts and intervening terrain between the courts and residences is acoustically soft (e.g., grass, loose soil).

Table 1: Minimum setback distances to meet 50dBA

Number of Courts	Setback Distance required to meet 50dBA (m)			
	No Noise Mitigation		3m Noise Barrier[1]	
	Hard Ground	Soft Ground	Hard Ground	Soft Ground
2 (1x2 grid)	65	50	35	30
4 (2x2 grid)	90	75	50	45
6 (2x3 grid)	105	85	55	50
12 (3x4 grid)	160	115	75	60

Table Notes:

1. Does not apply to situations where the point of reception overlooks the court

We have also developed recommended setback distances based on the use of "quieter" equipment. These recommended setback distances assume the use of equipment that results in a single pickleball game producing an L_{Aeq} of 50 to 52dBA at setback distance of 15m. Table 2 presents these recommended setback distances.

Table 2: Minimum setback distances to meet 50dBA with the use of "quieter" equipment

Number of Courts	Setback Distance required to meet 50dBA (m)			
	Quieter Equipment, No Barrier		Quieter Equipment + 3m Noise Barrier[1]	
	Hard Ground	Soft Ground	Hard Ground	Soft Ground
2 (1x2 grid)	35	30	20	15
4 (2x2 grid)	50	45	25	20
6 (2x3 grid)	55	50	30	25
12 (3x4 grid)	75	60	40	35

Table Notes:

1. Does not apply to situations where the point of reception overlooks the court

Appendix A - 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 120dB and the faintest sound we can detect is 0dB.

When sound is received at a given location from two or more sources, the contributions of each source will add together. When expressed in decibels, the addition occurs logarithmically rather than arithmetically. For example, two sound sources producing 50dB would add together to create a total sound level of 53dB; not 100dB. A 3dB change in noise level would be just noticeable to the human ear. A 10dB change in noise level is typically perceived as a halving or doubling of loudness (depending on whether the noise level increased or decreased).

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 20Hz to 20,000Hz. Human hearing is less sensitive to low frequency sound levels (below 200Hz) and to high frequency sound levels (above 5000Hz). The human ear is most "tuned" to the vocal frequency range between 200Hz and 5000Hz. 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, which are the result of subdividing each octave band into three. The bands are described by their centre frequency value. The range that is typically used for environmental purposes is from 31Hz to 8kHz (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 200Hz and 5000Hz.

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.

L_d

The A-weighted equivalent continuous sound pressure level (L_{Aeq}) evaluated over the 15-hour time period between 07:00 to 22:00 hours.

L_n

The A-weighted equivalent continuous sound pressure level (L_{Aeq}) evaluated over the 9-hour time period between 22:00 to 07:00 hours.

L_{90}

The sound exceeded over 90% of the time during the measurement period. The L_{90} represents the background noise level measured between discrete noise events, such as car pass-bys.

Example: A quiet fan is running at a continuous level of 30dBA at a specific measurement location. During a 10-minute measurement period, there are 9 minutes of car pass-by events that exceed the sound level of the fan. The L_{90} of the measurement is 30dBA, because this level was exceeded for over 90% of the measurement duration.

Character of Sound

In addition to the level at which sound occurs, its character can also influence the degree to which it is perceived as unpleasant or undesirable. The two most common characteristics that tend to render sound more objectionable are tonality and impulsivity. It is common in noise legislation and published standard to apply penalties to sounds containing these characteristics.

Tonal Sound

Tonal sound refers to any sound where the acoustic energy is concentrated in a narrow part of the frequency spectrum. Examples of tonal sounds include the "hum" of a fan or heat pump, or the "whine" of a hydraulic pump or power saw.

Impulsive Sound

Impulsive sound refers to any sound with a brief duration, in which the onset is abrupt and the decay rapid. Examples of impulsive sounds include a nail struck by a hammer or a baseball hit with a bat.

Sounds containing information

Sounds that contain information, such as human voices, trigger auditory cognition. Consequently, these sounds tend to be more distracting and intrusive than sounds devoid of information.

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. It 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 will propagate upwind when a source is downwind of a receiver. Wind speeds increase with height and this leads to a negative sound speed gradient. Sound waves will 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.

EXHIBIT C

Pickleball Noise Report

City of Vancouver, B.C. Canada

BAP
acoustics

August 30th, 2021

Nicole Taddune
Vancouver Board of Parks and Recreation
2099 Beach Avenue
Vancouver, BC
V6G 1Z4

AC2930: Noise Assessment and Guidelines for Outdoor Pickleball Courts in Vancouver Technical Report

Dear Nicole,

As requested, we have conducted a community noise assessment for outdoor pickleball (PB) courts within City of Vancouver parks. The assessment involved measuring PB noise levels at four City of Vancouver parks, comparing the measured PB noise levels to the City of Vancouver Noise Bylaw, and developing PB noise models to assist in the development of a planning guideline. This report presents the results of our assessment.

1 NOISE CRITERIA

The City of Vancouver Noise Control Bylaw No. 6555 (hereafter referred to as the "Noise Bylaw") restricts noise levels in Quiet Zones (i.e., residential zones) to 55dBA during the daytime (7:00 a.m. to 10:00 p.m.) at a relevant point of reception. For noise emitted from a park and received on a residential property, the point of reception would typically be the sidewalk adjacent to the property.

A logical design noise criterion for PB noise within the City of Vancouver would then be a 55 dBA limit at the nearest relevant point of reception. However, the impulsive nature of PB noise (i.e., racquet strikes, players yelling) tends to render it more objectionable than other types of community noise. In accordance with ISO 1996-1:2006, we recommend applying a +5dBA to the level of measured or predicted PB noise at the nearest points of reception to better account for the impulsive characteristics of PB noise. Under this approach, the design limit for PB noise would then be effectively reduced to 50 dBA.

2 MEASUREMENT DESCRIPTION

Noise surveys were carried out at the following parks:

- Queen Elizabeth Park (5:15 p.m.-6:30 p.m., June 9, 2021)
- Memorial West (5:15 p.m.-6:30 p.m., June 10, 2021)
- Pandora Park (12:00 p.m.-12:30 p.m., June 19, 2021)
- Cedar Cottage Park (10:45 a.m.-11:15 a.m., June 19, 2021)

While at least one PB court was active, we measured the resulting noise levels at the nearest residential properties and at a 15 m setback position. All measurements were performed at a height of approximately 1.7 meters above ground level using Type 1 sound level meters which meet the international standards of IEC 61672-1:2002. The sound level meters were calibrated before the measurements and checked afterwards.

2.1 Queen Elizabeth Park

At Queen Elizabeth Park, there are eight dedicated PB courts that were converted from tennis use. Seven of the PB courts are clustered at the northeast corner of the park (see attached Figure1). The eighth court is in the southeast. There is a concrete wall which runs along a section of the eastern edge of the northeast PB courts. Due to its location, this wall would not be influencing noise levels at the residences. The PB courts are elevated above the residences along Kersland Drive and 37th Avenue. As such, the intervening terrain provides some noise shielding to the residences.

2.2 Memorial West Park

At Memorial West Park, there are four shared PB/tennis courts at the northeast area tennis court. The intervening terrain between the courts and residences on West 31st avenue is flat.

2.3 Pandora Park

At Pandora Park, there are six shared PB/tennis courts at the two south tennis courts. The intervening terrain between the courts and residences on West 31st Avenue is flat.

2.4 Cedar Cottage Park

At Cedar Cottage Park there are two shared PB/tennis courts located in the basketball courts. The intervening terrain between the courts and residences on East 10th Avenue is flat.

3 MEASUREMENT RESULTS

Table 1 summarizes the results of the PB noise measurements in terms of the equivalent sound level (L_{eq}) measured at the residential properties and at the 15 m setback positions (Please refer to Appendix A for a definition of L_{eq} and other acoustical terminology). Figures 1 to 4 (attached) provide site plans for the four parks showing the layouts of the PB courts and locations of the noise measurements.

Table 1: Pickleball noise measurement results

Park	Measurement Location	Setback Distance (m)	# of Active Courts	Dominant Noise Source	L_{eq} (dBA)
Queen Elizabeth	East of courts (north)	15	7	PB	59
	East of courts (centre)	15	7	PB	52
	East of courts (south)	15	7	PB	56
	280 West 37th Avenue	69	7	Local road traffic, tennis	53
	5207 Kersland Drive	149	7	Local road traffic, tennis	54
Memorial West	East of courts	15	1	PB	53
	3749 West 31st Avenue	25	1	PB	51
Pandora	West of courts	15	1	PB	53
	2272 Franklin Street	19	2	PB	46
Cedar Cottage	South of courts	15	1	Clarke Road Traffic	57
	1324 East 10th Avenue	5	1	Clarke Road Traffic	59

The following sub-sections discuss the measurement results in more detail.

3.1 Queen Elizabeth Park

At the time of the measurements, the seven northeast PB courts were active. PB noise was not clearly audible at the residential measurement locations relative to other sources of community noise such as local road traffic and tennis. While the noise levels measured at the residential locations were dominated by noise from local traffic, they were lower than the 55 dBA Noise Bylaw limit. As such, it can be concluded that PB noise was in compliance with the Noise Bylaw.

3.2 Memorial West

At the time of the measurements, one of the four PB court was active. Noise levels at the residential measurement location were dominated by PB noise and were in compliance with the Noise Bylaw.

3.3 Pandora Park

At the time of the residential measurements, two of the six PB court were active. Noise levels at the residential measurement location were dominated by PB noise and were in compliance with the Noise Bylaw.

3.4 Cedar Cottage Park

At the time of the measurements, one of the two courts was active. Noise levels at the residential measurement location were dominated by Clarke Road traffic noise. As such, while overall noise levels were higher than the Noise Bylaw limit, it is unclear if PB noise was in exceedance.

4 NOISE MODEL

4.1 Description

We used Datakutisk's CadnaA software to create noise propagation models for the PB courts at each of the four parks. The software implements the outdoor sound propagation procedure presented in standard ISO 9613-2 for modelling noise emissions from industrial sources (i.e., point sources, line sources, and area sources) under meteorological conditions that are favorable to sound propagation (i.e., downwind noise receivers or temperature inversion).

The models were created using data collected from the noise measurements and from the City of Vancouver's GIS database. The models were then used to investigate the effectiveness of noise mitigation measures. In addition, we also developed a generalized PB court model to assist with development of the planning guidelines.

To establish a generalized sound emission level for a single PB court, we reviewed the sound data collected from the four parks. We were unable to use the data from Cedar Cottage Park due to the dominance of traffic noise at both measurement locations. Our analysis indicated that the sound power level of a single court varied from 91 to 92 dBA between the three parks with an average level of 91 dBA. The measurement results were then very consistent between the three parks.

To account for the distributed nature of pickle ball court noise (i.e., the potential for noise to be created at any position within the court), we modelled PB noise as an area source. In the model, PB noise is evenly distributed over the entire court area. We positioned the area source at a height of 1.5 m above the court. This height was chosen based on a conservative estimate of the median height at which PB noise would typically be produced (elevated sources then to produce higher noise levels, especially at greater setback distances).

The models consider the following factors which affect sound propagation:

- **Geometric divergence**: As sound waves travel away from their source; the wavefront increases in size and the acoustic energy becomes distributed over larger and larger areas. Consequently, the sound level decreases as the distance from the source increases.
- **Atmospheric absorption**: As sound propagates through the atmosphere, it loses energy losses due to molecular friction and relaxation processes. Atmospheric absorption primarily affects higher frequency sounds.
- **Ground effect**: Sound travelling over acoustically "soft" ground (e.g., grass, loose dirt) attenuates more rapidly than sound travelling over acoustically "hard" ground (e.g., pavement, water).
- **Reflections:** Surfaces can reflect sound and increase the resulting sound level at a point of reception.
- **Shielding:** Obstacles such as walls, screens, or earth berms placed between the sound source and sound receptor can "shield" the sound receptor and reduce the resulting sound level. In general, an obstacle or barrier that breaks the line-of-sight between the sound source and sound receptor will achieve a reduction of approximately 5 dBA.

These phenomena are described in more detail in Appendix A.

4.2 Model Results – Full-Capacity Noise levels

Since our measurements did not always reflect full capacity courts, or in other cases were contaminated by other source of community noise, we used the noise models to predict full-capacity PB noise levels for comparison with the Noise Bylaw. Table 2 presents the results of this modelling.

Table 2: Model results, full court capacity pickleball noise levels

Park	Number of Courts	Residential Property	Full-Capacity PB Noise Level
Queen Elizabeth	7	280 West 37th Avenue	44
Queen Elizabeth	8[1]	280 West 37th Avenue	50
Memorial West	4	3749 West 31st Avenue	57
Pandora	6	2272 Franklin Street	60
Cedar Cottage	2	1324 East 10th Avenue	59

Table Notes:

1. Includes the isolated pickleball court to the south of the main pickleball court area.

Our analysis indicates that there is a potential for bylaw non-compliance at three of the four parks.

4.3 Model Results – Mitigation

The most feasible approach to mitigating PB noise would be to construct noise barriers around the courts. While we understand there are "quiet" PB paddles and balls commercially available, we do not expect these would be a viable mitigation measure as they would be difficult to regulate. Since most PB courts are surrounded by chain-link fences, the noise screens could be constructed by attaching dense, solid sheets to the fences (e.g., Acoustifence). Alternatively, sound absorptive noise screens are also available but are significantly more expensive (e.g., Kinetics KBC).

For a noise barrier to be effective, it should have the following characteristics:

- Solid and to the extent possible free of gaps.
- A minimum height of 3 m.
- Constructed of a material with a minimum surface density of 5 kg/m^2.

To avoid impacts from reflected sound:

- 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 Tables 4 and 5 or a sound absorptive barrier should be used.
- Where dwellings overlook a pickleball court, sound absorptive barriers should be used if the setback distances recommended in Tables 4 and 5 cannot be maintained.

The noise models were used to evaluate the effectiveness of surrounding the courts with 3 m, sound-reflective screens. For each park, noise levels were then calculated at the nearest residential properties with and without the noise screens in place. Table 3 presents the results of this analysis including the insertion losses (i.e., reductions in pickleball sound levels) predicted for each of the screens.

Table 3: Model results, mitigation

Park	Number of Courts	Residential Property	PB Specific Noise Level L_{eq}(dBA)		Insertion Loss (dBA)
			No Screen	3 m Screen	
Queen Elizabeth	7	280 West 37th Avenue	44	40	4
Queen Elizabeth	8[1]	280 West 37th Avenue	50	41	9
Memorial West	4	3749 West 31st Avenue	57	48	9
Pandora	6	2272 Franklin Street	60	52	8
Cedar Cottage	2	1324 East 10th Avenue	59	52	7

Table Notes:

1. Includes the isolated pickleball court to the south of the main pickleball court area.

Table 3 shows that with a 3 m noise screen in place, PB noise levels are predicted to range from L_{eq} 40 to 52 dBA at the four parks. The variation in results between the parks are due to differences in setbacks, numbers of courts, court layouts, and the intervening terrain.

At the three parks where Noise Bylaw exceedances were predicted (Memorial West, Pandora, and Cedar Cottage), the introduction of the 3 m noise screen is predicted to reduce PB noise levels below the 55 dBA limit.

4.4 Model Results – Setback Investigation

We used the generalized PB noise model to investigate setback distances that would be required to meet the 55 dBA Noise Bylaw limit and the proposed 50 dBA design target. Results were generated for scenarios involving varying numbers of courts, varying ground surfaces, and with and without a 3m noise screen. To be conservative, we have assumed:

- Flat ground
- No attenuation due to foliage
- An average reduction of 5 dBA due to the introduction of a 3 m screen.

Tables 4 and 5 present the results of this analysis which can be used to assist in development of a planning guideline. Please note that the setback distances for the mitigated courts assume the point of reception is at most 2m above ground level. If the point of reception is elevated above the courts (i.e. multi-family building), the mitigation will not be effective.

Table 4: Model results, setback distances for 55 dBA

Number of Courts	Setback Distance required to meet 55 dBA (m)			
	No Noise Screen		3 m Noise Screen[1]	
	Hard Ground	Soft Ground	Hard Ground	Soft Ground
2 (1x2 grid)	35	30	20	15
4 (2x2 grid)	50	45	25	20
6 (2x3 grid)	55	50	30	25
9 (3x3 grid)	70	55	35	30

Table Notes:

1. Does not apply to situations where the point of reception overlooks the courts

Table 5: Model results, setback distances for 50 dBA

Number of Courts	Setback Distance required to meet 50 dBA (m)			
	No Noise Screen		3 m Noise Screen[1]	
	Hard Ground	Soft Ground	Hard Ground	Soft Ground
2 (1x2 grid)	65	50	35	30
4 (2x2 grid)	90	75	50	45
6 (2x3 grid)	105	85	55	50
9 (3x3 grid)	140	105	70	55

Table Notes:

1. Does not apply to situations where the point of reception overlooks the courts

We trust this has provided you with all the information you require at this time. Please let us know if you have any questions.

Sincerely,

Andrew Williamson, P.Eng.
Principal Consultant

Figure 1: Queen Elizabeth Park Pickle Ball Courts and Measurement Locations

Figure 2: Memorial West Park Pickle Ball Courts and Measurement Locations

Figure 3: Pandora Park Pickle Ball Courts and Measurement Locations

Figure 4: Cedar Cottage Park Pickle Ball Courts and Measurement Locations

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 120dB and the faintest sound we can detect is 0dB.

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 5000 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, which are the result of subdividing each octave band into three. The bands are described by their centre frequency value. 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.

L_d

The A-weighted equivalent continuous sound pressure level (L_{Aeq}) evaluated over the 15-hour time period between 07:00 to 22:00 hours.

L_n

The A-weighted equivalent continuous sound pressure level (L_{Aeq}) evaluated over the 9-hour time period between 22:00 to 07:00 hours.

L_{90}

The sound exceeded over 90% of the time during the measurement period. The L_{90} represents the background noise level measured between discrete noise events, such as car pass-bys.

Example: A quiet fan is running at a continuous level of 30dBA at a specific measurement location. During a 10-minute measurement period, there are 9 minutes of car pass-by events that exceed the sound level of the fan. The L_{90} of the measurement is 30dBA, because this level was exceeded for over 90% of the measurement duration.

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. It 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 will propagate upwind when a source is downwind of a receiver. Wind speeds increase with height and this leads to a negative sound speed gradient. Sound waves will 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.