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August 11, 2020

Alan Ives Construction Co.
1949 St. Johns Ave., Ste. 200
Highland Park, IL 60035
Attn: Mr. Paul Gotta

Subject: Campus Oaks Apartments Phase 2 Swimming Pool Noise Assessment

Dear Mr. Gotta:

At your request, j.c. brennan & associates, Inc. has conducted an analysis of potential noise levels associated with the proposed Campus Oaks Apartments Phase 2 swimming pool. It is our understanding that the City of Roseville has requested the noise analysis to address the noise impacts at the residences to the west. Figure 1 shows the project site, location of the swimming pool, single family residences to the west, and a cross-section from the pool to those residences.

## BACKGROUND INFORMATION ON NOISE

### *Fundamentals of Acoustics*

Acoustics is the science of sound. Sound may be thought of as mechanical energy of a vibrating object transmitted by pressure waves through a medium to human (or animal) ears. If the pressure variations occur frequently enough (at least 20 times per second), then they can be heard and are called sound. The number of pressure variations per second is called the frequency of sound, and is expressed as cycles per second or Hertz (Hz).

Noise is a subjective reaction to different types of sounds. Noise is typically defined as (airborne) sound that is loud, unpleasant, unexpected or undesired, and may therefore be classified as a more specific group of sounds. Perceptions of sound and noise are highly subjective from person to person.

Measuring sound directly in terms of pressure would require a very large and awkward range of numbers. To avoid this, the decibel scale was devised. The decibel scale uses the hearing threshold (20 micropascals), as a point of reference, defined as 0 dB. Other sound pressures are then compared to this reference pressure, and the logarithm is taken to keep the numbers in a practical range. The decibel scale allows a million-fold increase in pressure to be expressed as 120 dB, and changes in levels (dB) correspond closely to human perception of relative loudness.

The perceived loudness of sounds is dependent upon many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable, and can be approximated by A-weighted sound levels. There is a strong correlation between A-weighted sound levels (expressed as dBA) and the way the human ear perceives sound. For this reason, the A-weighted sound level has become the standard tool of environmental noise assessment. All noise levels reported in this section are in terms of A-weighted levels, but are expressed as dB, unless otherwise noted.

The decibel scale is logarithmic, not linear. In other words, two sound levels 10 dB apart differ in acoustic energy by a factor of 10. When the standard logarithmic decibel is A-weighted, an increase of 10 dBA is generally perceived as a doubling in loudness. For example, a 70 dBA sound is half as loud as an 80 dBA sound, and twice as loud as a 60 dBA sound.

Community noise is commonly described in terms of the ambient noise level, which is defined as the all-encompassing noise level associated with a given environment. A common statistical tool is the average, or equivalent, sound level ($L_{eq}$), which corresponds to a steady-state A weighted sound level containing the same total energy as a time varying signal over a given time period (usually one hour). The $L_{eq}$ is the foundation of the composite noise descriptor, $L_{dn}$, and shows very good correlation with community response to noise.

The day/night average level ($L_{dn}$) is based upon the average noise level over a 24-hour day, with a +10 decibel weighing applied to noise occurring during nighttime (10:00 p.m. to 7:00 a.m.) hours. The nighttime penalty is based upon the assumption that people react to nighttime noise exposures as though they were twice as loud as daytime exposures. Because $L_{dn}$ represents a 24-hour average, it tends to disguise short-term variations in the noise environment. Table 1 lists several examples of the noise levels associated with common situations. Appendix A provides a summary of acoustical terms used in this report.

### *Effects of Noise on People*

The effects of noise on people can be placed in three categories:

- Subjective effects of annoyance, nuisance, and dissatisfaction
- Interference with activities such as speech, sleep, and learning
- Physiological effects such as hearing loss or sudden startling

Environmental noise typically produces effects in the first two categories. Workers in industrial plants can experience noise in the last category. There is no completely satisfactory way to measure the subjective effects of noise or the corresponding reactions of annoyance and dissatisfaction. A wide variation in individual thresholds of annoyance exists and different tolerances to noise tend to develop based on an individual's past experiences with noise.

Thus, an important way of predicting a human reaction to a new noise environment is the way it compares to the existing environment to which one has adapted: the so-called ambient noise level. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged by those hearing it.

With regard to increases in A-weighted noise level, the following relationships occur:

- Except in carefully controlled laboratory experiments, a change of 1 dBA cannot be perceived;
- Outside of the laboratory, a 3 dBA change is considered a just-perceivable difference;
- A change in level of at least 5 dBA is required before any noticeable change in human response would be expected; and

- A 10 dBA change is subjectively heard as approximately a doubling in loudness, and can cause an adverse response.

Stationary point sources of noise – including stationary mobile sources such as idling vehicles – attenuate (lessen) at a rate of approximately 6 dB per doubling of distance from the source, depending on environmental conditions (i.e. atmospheric conditions and either vegetative or manufactured noise barriers, etc.). Widely distributed noises, such as a large industrial facility spread over many acres, or a street with moving vehicles, would typically attenuate at a lower rate.

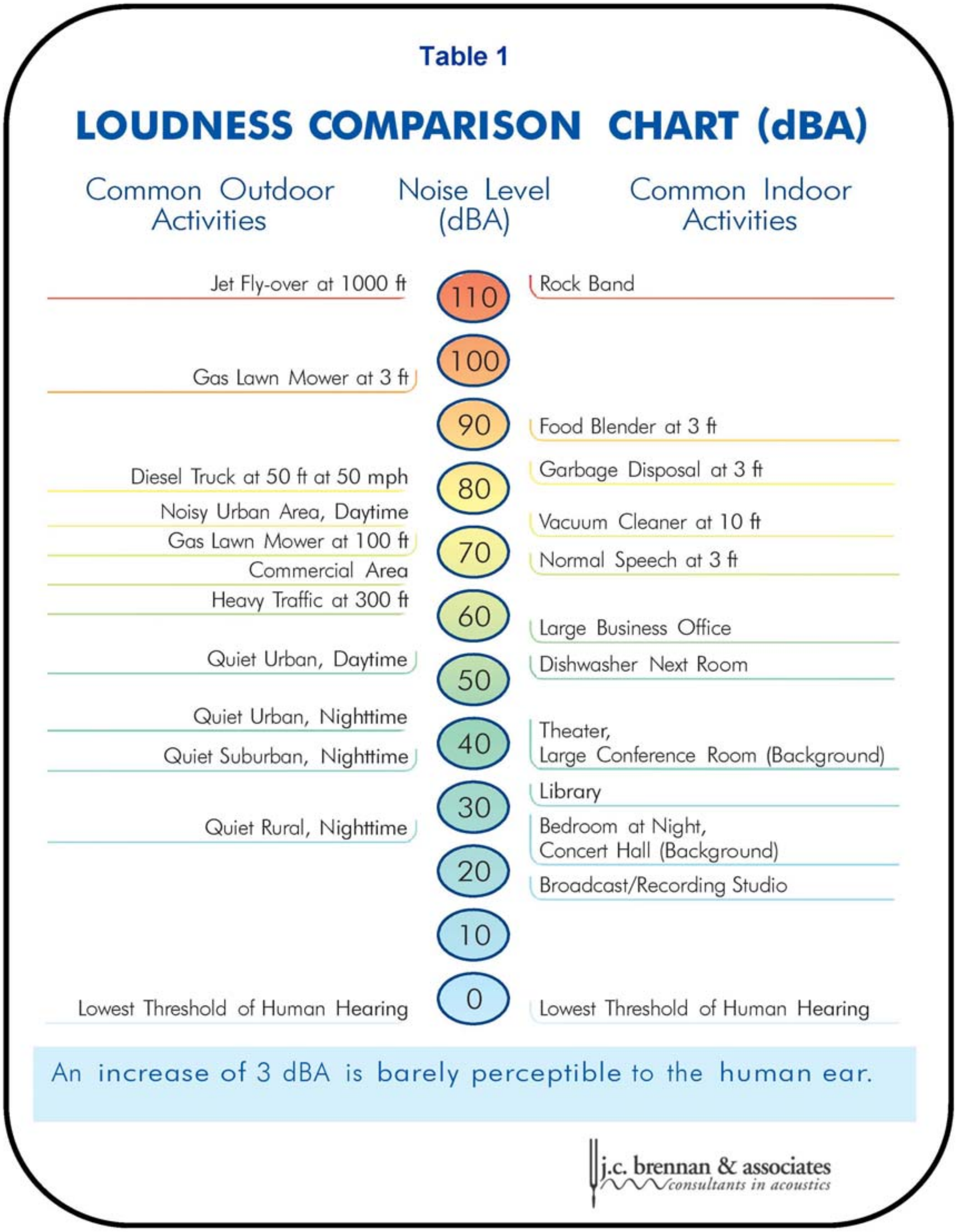
Table 1
LOUDNESS COMPARISON CHART (dBA)
Common Outdoor Activities
Noise Level (dBA)
Common Indoor Activities
Jet Fly-over at 1000 ft
110
Rock Band
100
Gas Lawn Mower at 3 ft
90
Food Blender at 3 ft
Diesel Truck at 50 ft at 50 mph
80
Garbage Disposal at 3 ft
Noisy Urban Area, Daytime
Vacuum Cleaner at 10 ft
Gas Lawn Mower at 100 ft
70
Normal Speech at 3 ft
Commercial Area
Heavy Traffic at 300 ft
60
Large Business Office
Quiet Urban, Daytime
50
Dishwasher Next Room
Quiet Urban, Nighttime
40
Theater, Large Conference Room (Background)
Quiet Suburban, Nighttime
30
Library
Quiet Rural, Nighttime
Bedroom at Night, Concert Hall (Background)
20
Broadcast/Recording Studio
10
Lowest Threshold of Human Hearing
0
Lowest Threshold of Human Hearing
An increase of 3 dBA is barely perceptible to the human ear.
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# PC Attachment 1

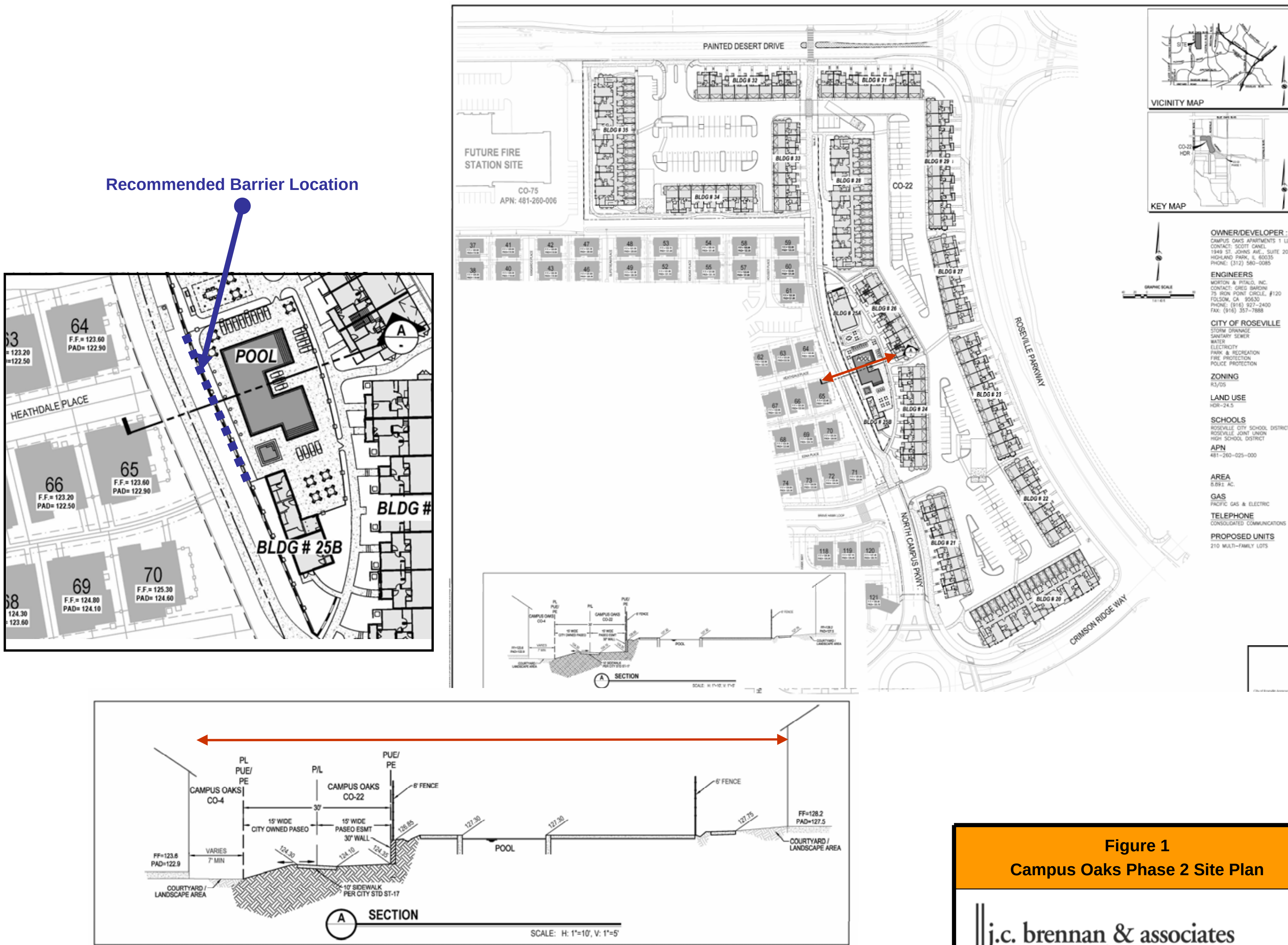


**Figure 1**
**Campus Oaks Phase 2 Site Plan**

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*Rev. 1/11/17*

### CITY OF ROSEVILLE NOISE LEVEL CRITERIA

For stationary noise sources, the City of Roseville establishes noise level performance standards, which are shown in Table 2 below.

**TABLE 2**
**(TABLE IX-3 OF THE CITY OF ROSEVILLE GENERAL PLAN NOISE ELEMENT)**
**PERFORMANCE STANDARDS FOR NON-TRANSPORTATION NOISE SOURCES**

| Noise Level Descriptor | Daytime (7 a.m. - 10 p.m.) | Nighttime (10 p.m. - 7 a.m.) |
|---|---|---|
| Hourly Average ($L_{eq}$) | 50 dB | 45 dB |
| Maximum Level ($L_{max}$) | 70 dB | 65 dB |

Each of the noise levels specified above should be lowered by five dB for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises. Such noises are generally considered by residents to be particularly annoying and are a primary source of noise complaints. These noise level standards do not apply to residential units established in conjunction with industrial or commercial uses (e.g., caretaker dwellings).

No standards have been included for interior noise levels. Standard construction practices should, with exterior noise levels identified, result in acceptable interior noise levels.

Source: City of Roseville, 2035 General Plan.

It is important to note that the footnote in the Table 2 above states the following:

> *Each of the noise levels specified above should be lowered by five dB for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises. Such noises are generally considered by residents to be particularly annoying and are a primary source of noise complaints.*

Since the noise levels associated with the proposed pool are generally associated with voice and speech, the 5 dB penalty does apply in this case. Therefore, the daytime (7 a.m. - 10 p.m.) hourly standards are 45 dB Leq, and 65 dB Lmax, and are to be applied at the property line. The pool will not be open during the nighttime hours, and therefore, the nighttime standards do not apply.

### ANALYSIS OF REFERENCE POOL NOISE LEVELS

As a means of determining the potential noise levels associated with the pool at the Campus Oaks Phase 2 Apartments, j.c. brennan & associates, Inc. conducted noise level measurements of pool noise at the Campus Oaks Phase 1 pool, which is located directly south of the proposed project.

Noise measurements were conducted on Saturday August 8th, 2020. The noise measurements were conducted during the mid-afternoon from 2:00 p.m. to 4:00 p.m. Based upon discussions with the apartment manager at the Campus Oaks Phase 1 complex, the Saturday afternoon time period is the typical busy time for the pool activities.

Noise measurements were conducted using Larson Davis Laboratories (LDL) Model 820 precision integrating sound level meters. The meters were calibrated before and after use with an LDL Model CAL200 acoustical calibrator to ensure the accuracy of the measurements. The equipment used meets all pertinent specifications of the American National Standards Institute for Type 1 sound level meters (ANSI S1.4).

The sound level meters were programmed to record the maximum, median, and average noise levels at each site during the survey. The maximum value, denoted $L_{max}$, represents the highest noise level measured. The average value, denoted $L_{eq}$, represents the energy average of all of the noise received by the sound level meter microphone during the monitoring period. The median value, denoted $L_{50}$, represents the sound level exceeded 50 percent of the time during the monitoring period.

During the noise measurements, people were gathering on the pool deck, children and adults were in the pool and lap swimmers were also using the pool. The results of the noise measurements indicated that the hourly noise levels due to pool activities were 53 dB Leq, and 72 dB Lmax, at a reference distance of 50-feet from the center of the pool.

### ANALYSIS OF CAMPUS OAKS PHASE 2 POOL NOISE LEVELS

Based upon the cross-section shown in Figure 1, the residential property line to the west of the pool is 50-feet from the center of the pool. In addition, the Campus Oaks Phase 2 project site includes a 6-foot tall wall / fence located at the west property line. In addition, the residential property line to the west is approximately 3-feet below the grade of the pool and base of the barrier. This is important when calculating the effectiveness of the barrier.

Using the reference noise level data, and using a barrier performance analysis, the predicted noise levels at the residences to the west are 43 dB Leq, and 62 dB Lmax. Appendix B shows the barrier calculation results.

### CONCLUSIONS

The results indicate that the pool noise will comply with the City of Roseville daytime noise level standards. This includes the -5 dB correction applied to the noise level standards for noise levels consisting primarily of speech. Figure 1 shows the recommended location of the barrier. Barriers should consist of concrete block, precast concrete, or other materials which have a density of 3 pounds per square foot. If wood is used, it shall not allow flanking of noise through cracks or openings. Barriers shall not allow sound to flank at the bottom. There are several prefabricated sound barriers available which can be researched.

If you or the City of Roseville staff have questions, please feel free to contact me.

Respectfully submitted,

j.c. brennan & associates, Inc.

Jim Brennan
President
Member: Institute of Noise Control Engineering
File: 2020-123 Campus Oaks Apts Phase 2 Pool Noise Assessment

## Appendix A
**Acoustical Terminology**

| | |
|---|---|
| **Acoustics** | The science of sound. |
| **Ambient Noise** | The distinctive acoustical characteristics of a given space consisting of all noise sources audible at that location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study. |
| **Attenuation** | The reduction of an acoustic signal. |
| **A-Weighting** | A frequency-response adjustment of a sound level meter that conditions the output signal to approximate human response. |
| **Decibel or dB** | Fundamental unit of sound, A Bell is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure squared. A Decibel is one-tenth of a Bell. |
| **CNEL** | Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three and nighttime hours weighted by a factor of 10 prior to averaging. |
| **Frequency** | The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz (Hz). |
| **$L_{dn}$** | Day/Night Average Sound Level. Similar to CNEL but with no evening weighting. |
| **$L_{eq}$** | Equivalent or energy-averaged sound level. |
| **$L_{max}$** | The highest root-mean-square (RMS) sound level measured over a given period of time. |
| **$L_{(n)}$** | The sound level exceeded a described percentile over a measurement period. For instance, an hourly $L_{50}$ is the sound level exceeded 50% of the time during the one hour period. |
| **Loudness** | A subjective term for the sensation of the magnitude of sound. |
| **Noise** | Unwanted sound. |
| **NRC** | Noise Reduction Coefficient. NRC is a single-number rating of the sound-absorption of a material equal to the arithmetic mean of the sound-absorption coefficients in the 250, 500, 1000, and 2,000 Hz octave frequency bands rounded to the nearest multiple of 0.05. It is a representation of the amount of sound energy absorbed upon striking a particular surface. An NRC of 0 indicates perfect reflection; an NRC of 1 indicates perfect absorption. |
| **Peak Noise** | The level corresponding to the highest (not RMS) sound pressure measured over a given period of time. This term is often confused with the AMaximum@ level, which is the highest RMS level. |
| **$RT_{60}$** | The time it takes reverberant sound to decay by 60 dB once the source has been removed. |
| **Sabin** | The unit of sound absorption. One square foot of material absorbing 100% of incident sound has an absorption of 1 Sabin. |
| **SEL** | Sound Exposure Level. SEL is s rating, in decibels, of a discrete event, such as an aircraft flyover or train passby, that compresses the total sound energy into a one-second event. |
| **STC** | Sound Transmission Class. STC is an integer rating of how well a building partition attenuates airborne sound. It is widely used to rate interior partitions, ceilings/floors, doors, windows and exterior wall configurations. |
| **Threshold of Hearing** | The lowest sound that can be perceived by the human auditory system, generally considered to be 0 dB for persons with perfect hearing. |
| **Threshold of Pain** | Approximately 120 dB above the threshold of hearing. |
| **Impulsive** | Sound of short duration, usually less than one second, with an abrupt onset and rapid decay. |
| **Simple Tone** | Any sound which can be judged as audible as a single pitch or set of single pitches. |

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Appendix B

## Barrier Insertion Loss Calculation

**Project Information:**

Job Number: 2020-123
Project Name: Camphus Oaks Phase 2
Location(s): Pool Leq

**Noise Level Data:**

Source Description: Pool
Source Noise Level, dBA: 53
Source Frequency (Hz): 1000
Source Height (ft): 5

**Site Geometry:**

Receiver Description: Residences to the west
Source to Barrier Distance ($C_1$): 30
Barrier to Receiver Distance ($C_2$): 30

Pad/Ground Elevation at Receiver: 0
Receiver Elevation[1]: 5
Base of Barrier Elevation: 3
Starting Barrier Height 6

**Barrier Effectiveness:**

| Top of Barrier Elevation (ft) | Barrier Height (ft) | Insertion Loss, dB | Noise Level, dB | Barrier Breaks Line of Site to Source? |
|---|---|---|---|---|
| 9 | 6 | -10 | 43 | Yes |
| 10 | 7 | -11 | 42 | Yes |
| 11 | 8 | -13 | 41 | Yes |
| 12 | 9 | -13 | 40 | Yes |
| 13 | 10 | -14 | 39 | Yes |
| 14 | 11 | -15 | 38 | Yes |
| 15 | 12 | -15 | 38 | Yes |
| 16 | 13 | -16 | 37 | Yes |
| 17 | 14 | -17 | 36 | Yes |
| 18 | 15 | -17 | 36 | Yes |
| 19 | 16 | -17 | 36 | Yes |

**Notes:** 1.Standard receiver elevation is five feet above grade/pad elevations at the receiver location(s)

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**Appendix B**

## Barrier Insertion Loss Calculation

**Project Information:**

Job Number: 2020-123
Project Name: Camphus Oaks Phase 2
Location(s): Pool Lmax

**Noise Level Data:**

Source Description: Pool
Source Noise Level, dBA: 72
Source Frequency (Hz): 1000
Source Height (ft): 5

**Site Geometry:**

Receiver Description: Residences to the west
Source to Barrier Distance ($C_1$): 30
Barrier to Receiver Distance ($C_2$): 30

Pad/Ground Elevation at Receiver: 0
Receiver Elevation[1]: 5
Base of Barrier Elevation: 3
Starting Barrier Height 6

**Barrier Effectiveness:**

| Top of Barrier Elevation (ft) | Barrier Height (ft) | Insertion Loss, dB | Noise Level, dB | Barrier Breaks Line of Site to Source? |
|---|---|---|---|---|
| 9 | 6 | -10 | 62 | Yes |
| 10 | 7 | -11 | 61 | Yes |
| 11 | 8 | -13 | 60 | Yes |
| 12 | 9 | -13 | 59 | Yes |
| 13 | 10 | -14 | 58 | Yes |
| 14 | 11 | -15 | 57 | Yes |
| 15 | 12 | -15 | 57 | Yes |
| 16 | 13 | -16 | 56 | Yes |
| 17 | 14 | -17 | 55 | Yes |
| 18 | 15 | -17 | 55 | Yes |
| 19 | 16 | -17 | 55 | Yes |

**Notes:** 1.Standard receiver elevation is five feet above grade/pad elevations at the receiver location(s)

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