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Re: Queenz LLC - Restaurant Events - Noise Study

Introduction

The operators of Queenz Restaurant, located at 8225 SW Apple Way, Suite 102 in Beaverton, Oregon, have applied for a conditional use permit through the City of Beaverton to hold nighttime events at their restaurant with amplified music. As part of the application requirements, the City of Beaverton has asked for a noise study to demonstrate compliance with the requirements of the Beaverton Development Code (BDC) Section 60.50.25.11 Noise Levels. This report summarizes the results of a noise study conducted by ABD Engineering & Design, Inc. (ABD) to determine compliance with the BDC noise compliance

Background Information

Queenz Restaurant is located at the intersection of Beaverton Hillsdale Highway and SW Laurelwood Ave in Beaverton, OR. The restaurant management intends to hold events with amplified music that will go past 10:00 p.m. and could extend as late at 1:00 a.m. A satellite image showing the restaurant and the surrounding area is provided in Figure 1 below and a floor plan of the restaurant is provided in Figure 2 below. As shown in the satellite image, there are multi-family apartment complexes located approximately 350 feet to the southwest and 350 feet to the southeast of the restaurant. The closest single-family residences to the restaurant are located approximately 200 feet northeast of the restaurant and approximately 450 feet northwest of the restaurant.

The main doors that open into the restaurant face toward the southwest of the restaurant. The stage area is located at the south end of the restaurant with speakers pointed north from the sides of the stage area.

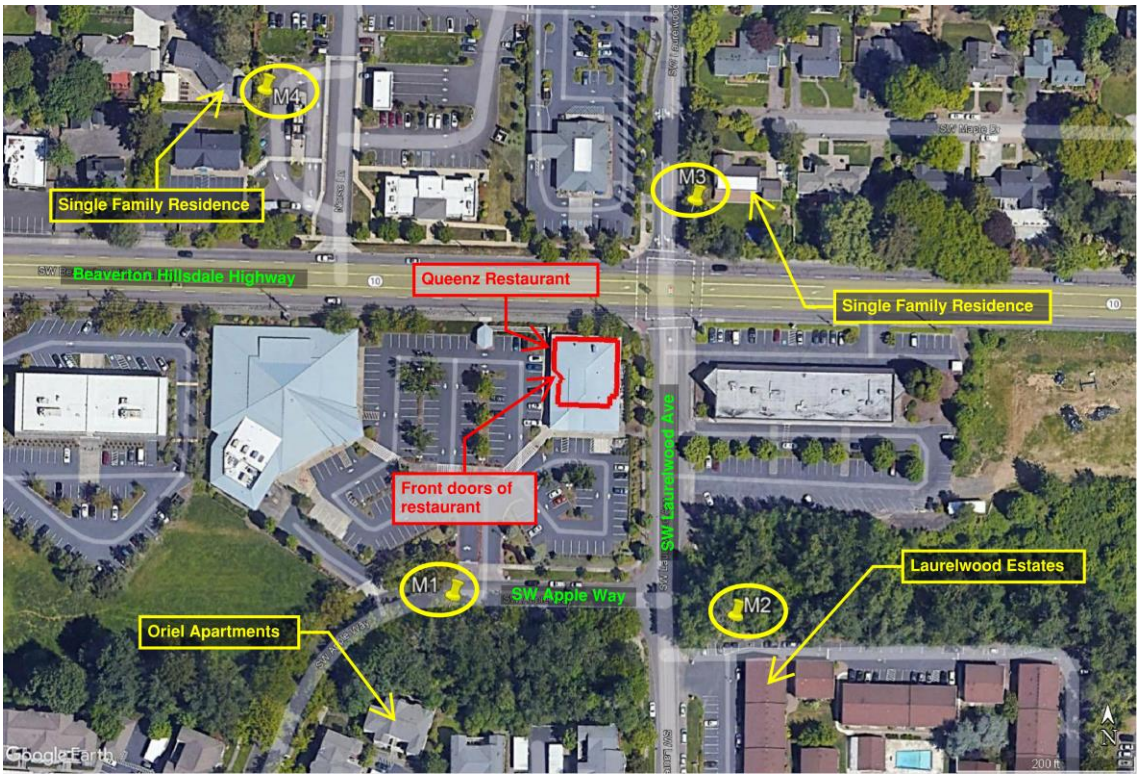

Figure 1: Satellite Image Showing Queenz Restaurant and Surrounding Area

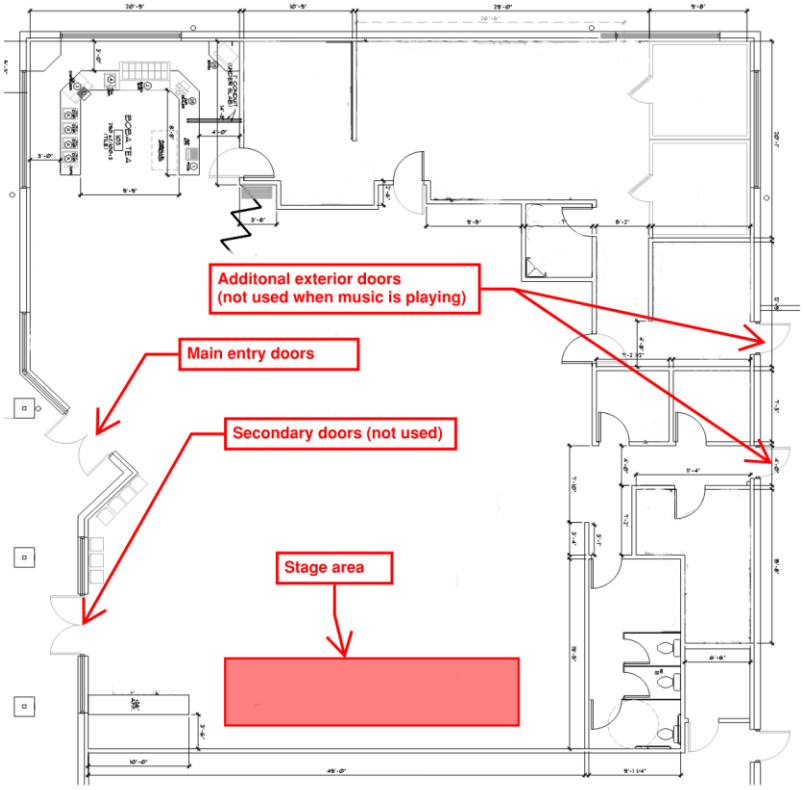

Figure 2: Floor Plan of Queenz Restaurant

Acoustical Terminology and Concepts

When dealing with sound, there is the physical quantity which is expressed as sound level and the perceived level which is expressed as loudness. Sound level is measured in units called decibels (abbreviated dB). Decibels are power ratios and are logarithmic quantities. Audible sound occurs over a wide frequency range, from approximately 20 Hertz (Hz) to 20,000 Hz. Human hearing does not respond equally to sounds at different frequencies (or pitch). Lower frequency sounds that are equally as "loud" have a much higher decibel level than high-frequency sounds.

To accommodate this variation in frequency sensitivity of human hearing, a frequency weighting can be applied to sound level measurements. When the weighting is applied, the resulting sound level measurements are said to be "A-weighted" and the decibel level is abbreviated dBA. Other frequency weighting networks are used to represent the response of the human ear to louder noises, such as the "C-weighted" scale. The C-weighted scale places more emphasis on lower frequency content, so it can be useful in characterizing the sound level of sources with more low frequency content, such as amplified music with a subwoofer.

While the decibel or A-weighted decibel are the basic units used for noise measurement, other indices are also used. One commonly known index, the equivalent sound level, abbreviated as Leq, is commonly used to indicate the average sound level over a period of time. The Leq represents the steady level of sound which would contain the same amount of sound energy as does the actual time-varying sound level. Although it is an average, it is strongly influenced by the loudest events occurring during the time period because these loudest events contain most of the sound energy. Table 1 lists some commonly encountered noises, their A-weighted level, and associated subjective evaluations.

Table 1: Noise Source Comparisons

Pain Threshold	**140 dBA**		**Jet Engine (at 60 ft)**
	130 dBA		**"Hard Rock" Band (near stage)**
	120 dBA		**Thunder (nearby)**
Long-term Hearing Loss	**100 dBA**		**Auto Horn (at 9 ft)**
	90 dBA		**OSHA 8 Hour Noise Exposure Limit**
	80 dBA		**Street Corner in Busy City**
Typical Daily Exposure	**70 dBA**		**Busy Freeway (25 ft to 100 ft)**
	60 dBA		
	50 dBA		**Typical Office Environment**
	40 dBA		
	30 dBA		**Inside Average Residence**
Very Quiet	**20 dBA**		**Whisper**
	10 dBA		**Human Breathing**
Threshold of Hearing	**0 dBA**		

Adapted from *Concepts in Architectural Acoustics* by M. David Egan (1972) and *Architectural Acoustics: Principles and Design* by M. Mehta, J. Johnson, and J. Rocafort (1999)

When the sound energy doubles, the decibel value increases by 3 dB. However, a doubling of sound energy does not correspond to a subjective doubling of loudness. Table 2 gives an idea of the qualitative experience of different changes in sound level. The table can be used as a guide when evaluating the effect of using different partitions or partition elements, such as windows.

Table 2: Subjective Effects of Changes in Sound Levels

Change in Sound Level	Change in Apparent Loudness
3 dB	Just perceptible
5 dB	Clearly perceptible
10 dB	Twice or half as loud
20 dB	Much louder or quieter

Table 12.2 in *Engineering Principles of Acoustics* by Douglas D. Reynolds (1981).

City of Beaverton Requirements

For the conditional use application, the City of Beaverton has asked Queenz personnel to provide documentation showing compliance with BDC 60.50.25.11 – Noise Levels. This section of the development code states, "Noise levels shall meet the standards established by the State of Oregon Department of Environmental Quality."

The Oregon Department of Environmental Quality (DEQ) defines its noise requirements in Oregon Administrative Rule (OAR) Chapter 340 Division 35 – Noise Control Regulations. The Oregon DEQ Noise Control Regulations (340-35-035 – Table 8) define the maximum allowable statistical noise levels that can be received at nearby noise-sensitive properties. A noise-sensitive property is defined as real property normally used for sleeping, or normally used as schools, churches, hospitals, or public libraries.

- For noise sources that operate for at least half an hour in any one hour of a day, the noise level limit is 50 dBA for nighttime (10:00 p.m. to 7:00 a.m.) and 55 dBA for daytime (7:00 a.m. to 10:00 p.m.) operation.
- For noise sources that operate at least 6 minutes out of any hour (but less than 30 minutes of any hour), the allowable daytime and nighttime limits are 60 dBA and 55 dBA, respectively.
- For noise sources that operate at least 6 seconds out of any hour (but less than 6 minutes of any hour), the allowable daytime and nighttime limits are 75 dBA and 60 dBA, respectively.

Sound Measurements

Measurement Setup and Conditions

To determine compliance with the DEQ noise regulations, sound level meters were set up near the closest residential areas to each corner of the restaurant at the locations labeled M1 through M4 in Figure 1. The DEQ noise regulations state that noise measurements should be made 25 feet toward the noise source from the nearest point on the noise-sensitive property to the noise

source. Wherever possible, ABD set meters up in locations that complied with the DEQ measurement locations. However, in some locations, such as the apartment to the southwest of the restaurant, the measurement location was inaccessible (in this case, due to a drainage ditch with running water), so the closest accessible measurement location was chosen. In all cases, the measurement location was at least 25 feet from the noise-sensitive property and located toward the noise source, so the measurement conditions are conservative, as any extra distance from the noise-sensitive property would cause the measurement location to be closer to the sound source (and therefore louder). Each meter was installed at a height of approximately 12 feet above the ground.

The meters installed for the measurements were SoftdB Piccolo II sound level meters, which meet the Class 2 requirements of IEC 61672 and ANSI S1.4. An additional handheld sound level meter, a Larson Davis Model 831, was used for short-term measurements. The Larson Davis meter meets the Class 1 requirements of IEC 61672 and ANSI S1.4. All sound level meters were calibrated with a handheld calibrator prior to the measurement period.

The four SoftdB sound level meters were installed at the locations indicated in Figure 1 on the afternoon of Wednesday, November 9, 2022, and were picked up the morning of Friday, November 11th. Winds were calm throughout the measurement period until the morning of Friday November 11th, when wind speeds increased to 10 mph during the 5:00 a.m. hour. Temperatures ranged from 34 to 52 degrees Fahrenheit during the measurements. Measurements were performed over an extended duration so that the DEQ allowable noise limits could be compared to the existing traffic noise levels for context.

Ambient Sound Measurements

The 1-second history of the sound levels measured at each of the four measurement locations is provided in Figure 3 below. Additionally, the hourly L_{50} sound levels, or the levels exceeded 50% of an hour (30 minutes of an hour), are shown in Figure 4 below. These sound levels provide context for how the allowable sound levels compare to traffic noise levels at the site. The measurements show that short-term sound levels were often much higher than the DEQ limits due to traffic noise, primarily from vehicles traveling on Beaverton Hillsdale Highway. For the loudest receiver locations, the hourly L_{50} sound levels do not fall below the DEQ L_{50} limits until the 11 pm or midnight hours. The restaurant is only responsible for the noise it generates, so if traffic sounds were louder than the allowable DEQ limits at one of the measurement locations, a lull in traffic was required before a reliable measurement of noise generated by the restaurant could be made.

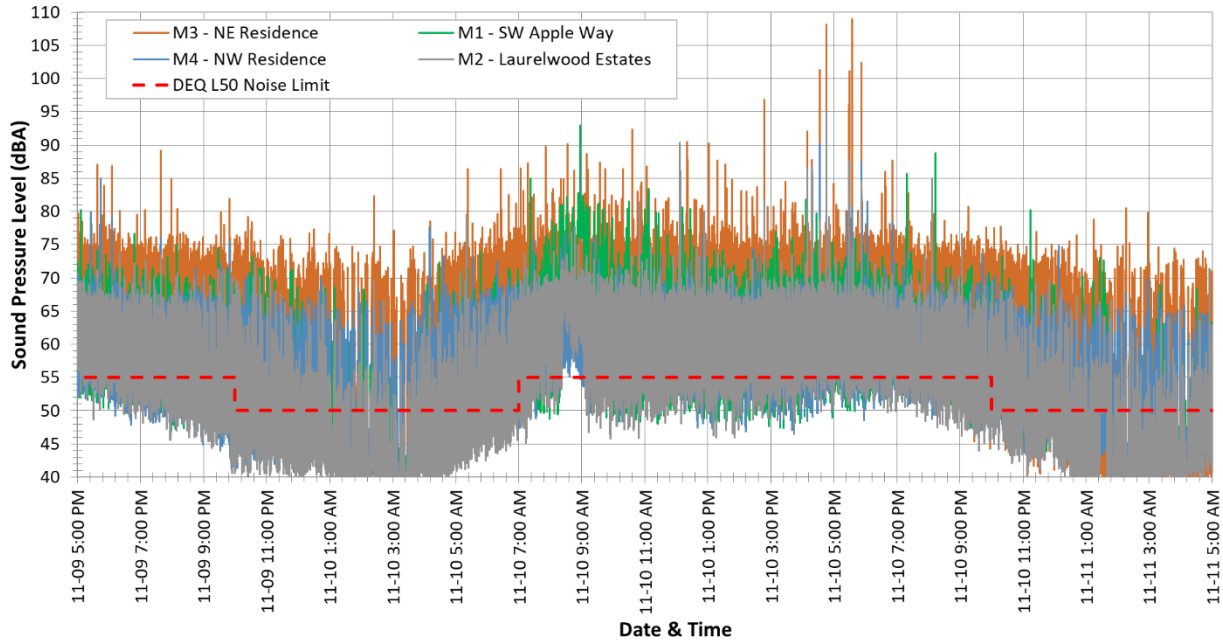

Figure 3: 1-Second Equivalent Sound Levels Measured Near Noise-Sensitive Properties

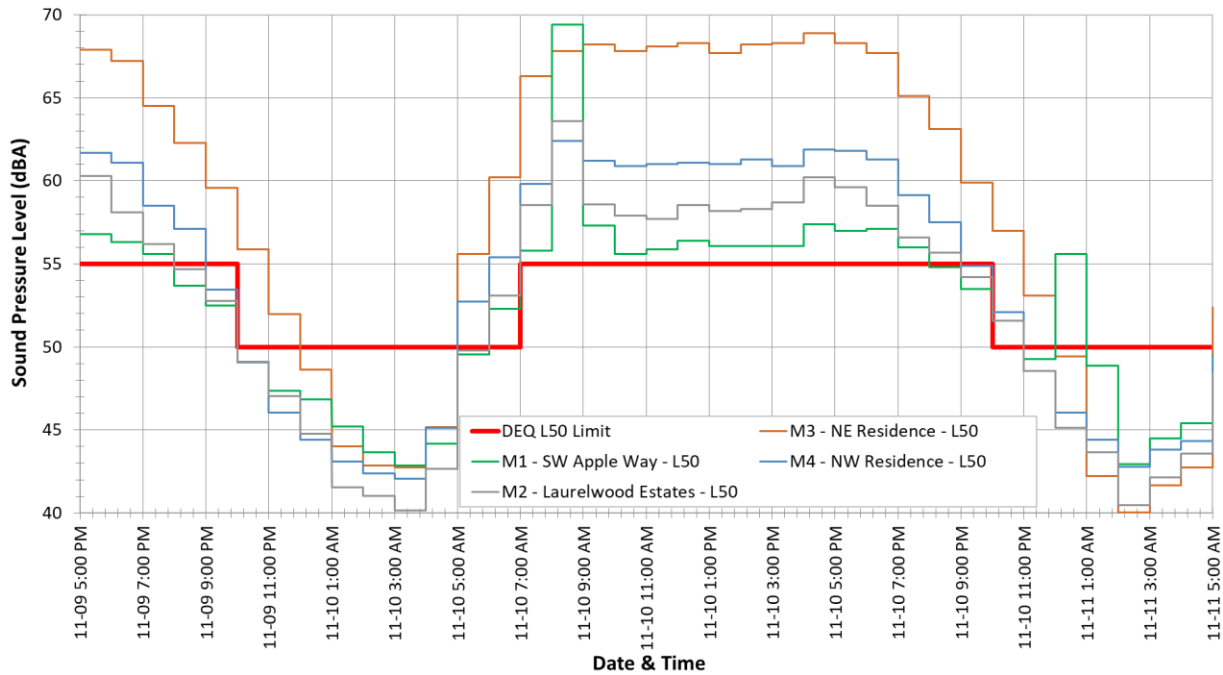

Figure 4: Hourly L_{50} Sound Levels Measured Near Noise-Sensitive Properties

Restaurant Event Measurements

On the night of Wednesday, November 9th, measurements were conducted with a band playing amplified instruments in the Queenz Restaurant. A sound level meter was placed inside the restaurant (at the north end of the dance floor) to measure the interior noise levels while the four

exterior sound level meters measured sound levels near the noise-sensitive properties. The sound level meters were programmed to continuously measure 1-second equivalent sound levels. An additional handheld sound level meter was used to check the sound levels at each of the measurement locations at a measurement height of approximately 5' above the ground.

As previously mentioned, because traffic noise was louder than the allowable DEQ noise limits for much of the measurement period, the sound levels from the music could only be measured during lulls between vehicles passing by the site. Data from a short-term measurement period during one of those traffic lulls is provided in Figure 5 below. During the measurement period, all meters were measuring simultaneously while music was playing in the restaurant (with doors closed). The results show that the measured sound levels at each of the noise-sensitive properties was below 50 dBA when the doors to the restaurant were closed.

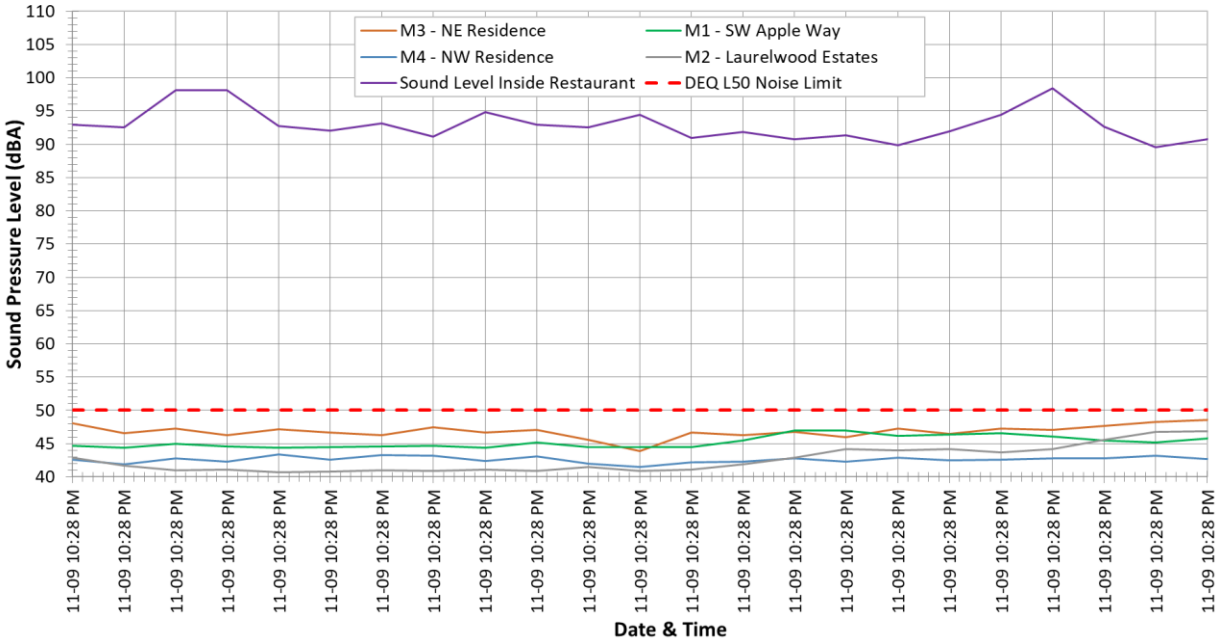

Figure 5: Measured Sound Levels at Noise-sensitive Properties with Music Playing

A summary of the spot measurements that were performed with the handheld sound level meter is provided in Table 3 below. The spot measurements were performed both with the doors to the restaurant closed and open while music was playing. The table indicates that the sound levels measured near the closest noise-sensitive properties were at or below 50 dBA with the doors to the restaurant closed. With the doors open, the loudest measured level was approximately 55 dBA. This means that the doors can be open more than 10% of an hour (six minutes out of an hour) but less than 50% of an hour (30 minutes out of an hour) without exceeding the DEQ allowable noise limits. Although the open-door noise levels meet the DEQ requirements, we recommend minimizing the amount of time the doors are open while music is playing as much as possible.

Note that during the measurements, the sound levels measured inside the restaurant (at the north end of the dance floor) were up to 97 dBA (fast max) and 105 dBC (fast max). These levels can be used by the restaurant staff to set maximum allowable limits for sound levels inside the

restaurant while meeting the DEQ noise limits at the surrounding noise-sensitive properties. The C-weighted sound level is provided in addition to the A-weighted level because the C-weighting puts more emphasis on low frequencies (bass frequencies), so it provides the restaurant staff a way to check that the bass frequencies are not too loud.

Table 3: Measured Noise Levels with Handheld Sound Level Meter

Location	Measurement Condition	
	Music Playing, Doors Closed	Music Playing, Doors Open
M1 – SW Apple Way	48-50 dBA	53-55 dBA
M2 – Laurelhurst Estates	45 dBA	50 dBA
M3 – NW Residence	48 dBA	51 dBA
M4 – NE Residence	42 dBA	45 dBA

Conclusions

The results of ABD's noise study demonstrate that the noise levels of the amplified music proposed for events at Queenz Restaurant meets the nighttime noise requirements from the City of Beaverton Development Code and the Oregon DEQ Noise Control Regulations as long as the interior levels inside the restaurant to do not exceed 97 dBA and 105 dBC (fast max).

Finally, note that our comments only apply directly to acoustics; we cannot comment on such things as local codes, ordinances, electrical systems, fire suppression systems, or any other non-acoustic issues. Our recommendations should be reviewed by the appropriate design professionals for code compliance before they are implemented.

If you have any questions, please contact us.

Sincerely,

ABD Engineering & Design, Inc.

Peter Allen, P.E., INCE Bd. Cert.
Sr. Acoustical Engineer

cc: Melinda Miller, Marci Boks – ABD