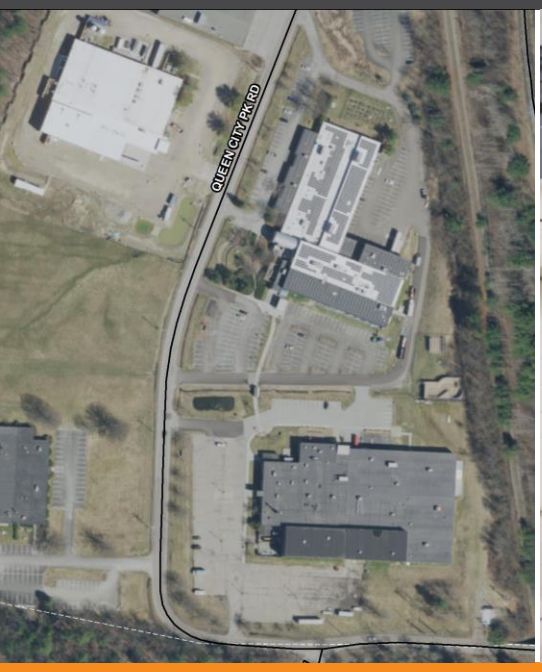
RSG
the science of insight

BURTON SNOWBOARDS & HIGHER GROUND

HUB PROJECT

Noise Assessment | April 20, 2020



PREPARED FOR:
BURTON SNOWBOARDS & HIGHER GROUND

SUBMITTED BY:
RSG

IN COOPERATION WITH:
JOHN CAULO, PROJECT MANAGER

55 Railroad Row
White River Junction, VT 05001
802.295.4999
www.rsginc.com

CONTENTS

1.0 INTRODUCTION 1
2.0 PROJECT DESCRIPTION 2
3.0 NOISE STANDARDS AND GUIDELINES 4
3.1 LOCAL STANDARDS 4
BURLINGTON STANDARDS 4
SOUTH BURLINGTON STANDARDS 4
3.2 STATE STANDARDS 5
3.3 COMMUNITY NOISE GUIDELINES 5
WORLD HEALTH ORGANIZATION 6
AMERICAN NATIONAL STANDARD, ANSI S12.9 PART 5 6
3.4 HUB PROJECT EVALUATION 6
4.0 BACKGROUND SOUND LEVELS 8
5.0 SOUND PROPAGATION MODELING 9
5.1 MODELING METHODOLOGY 9
5.2 NOISE SOURCES 10
EXTERIOR SOURCES 10
INTERIOR SOURCES 11
5.3 PLANNED MITIGATION 14
5.4 MODEL RESULTS 15
6.0 CONCLUSIONS 18
APPENDIX A. ACOUSTICS PRIMER 20
APPENDIX B. MODEL INPUT DATA 28
APPENDIX C. DETAILED MODEL RESULTS 31

LIST OF FIGURES

FIGURE 1: SITE MAP 3
FIGURE 2: MAP OF MODELED SOUND SOURCES 13
FIGURE 3: MODEL RESULTS - CONCERT MODEL 16
FIGURE 4: MODEL RESULTS - END-OF-CONCERT MODEL 17
FIGURE 5: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL NOISE SOURCES 21
FIGURE 6: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME 25

LIST OF TABLES

TABLE 1: SOUND POWER LEVELS OF MODELED OUTDOOR SOURCES (dBZ, UNLESS SPECIFIED OTHERWISE) 11
TABLE 2: MODELED INTERIOR SOUND PRESSURE LEVELS (dBZ, UNLESS SPECIFIED OTHERWISE) 12
TABLE 3: MODELED POINT SOURCES 28
TABLE 4: MODELED AREA SOURCES 29
TABLE 5: MODELED TRANSMISSION LOSS OF ROOFS AND EXTERIOR WALLS (dB) 29
TABLE 6: MODEL PARAMETER SETTINGS 30

1.0 INTRODUCTION

Burton Snowboards is planning to renovate a manufacturing and warehouse building at 266 Queen City Park Road, adjacent to their headquarters at 180 Queen City Park Road. The renovation is called the Burton Global Hub Project ("Hub Project" or "Project") and includes an indoor concert venue, restaurants, retail space, indoor recreation area, office space, manufacturing, and prototyping workshop. Higher Ground, currently located in South Burlington, plans to operate the indoor concert venue.

In preparation for permitting the Project, RSG was retained to evaluate exterior noise due to rooftop mechanical equipment and the concert venue. This assessment includes:

- A description of the site and the surrounding area.
- A review of the applicable noise limits and guidelines.
- Discussion of background sound levels in the area.
- Sound propagation modeling method and results.
- Conclusions.

A primer on acoustics is provided in Appendix A.

There are no quantitative noise standards for the City of Burlington, but there is a qualitative noise ordinance discussed in Section 3.1. As a result, we evaluate the Project against other commonly applied community noise guidelines that are quantitative, yet parallel to the Burlington noise ordinance and Act 250's Quechee Test, as discussed in Section 3.3. The information provided in this report leads us to conclude that the proposed concert venue can be constructed and operated in such a way as to:

- Comply with Sec. 21-13(b)(1) of the Burlington Noise Control Ordinance.
- Not cause an "undue adverse impact on aesthetics" with regard to noise as evaluated under Act 250.
- Comply with WHO Community Noise Guidelines.

2.0 PROJECT DESCRIPTION

Burton Snowboards' headquarters is located at 180 Queen City Park Road[1] (180), and they also own the adjacent manufacturing and warehouse building at 266 Queen City Park Road (266). The parking lot at 266 is currently used by Burton staff at both 180 and 266 during the day, and a portion of the interior space at 266 is currently used as a prototyping workshop.

The area around 180 and 266 Queen City Park Road is zoned as "Enterprise – Light Manufacturing." There are other manufacturing facilities along Queen City Park Road and a CCTA[2] bus facility to the north. Queen City Park Road wraps around the west and south sides of 266, and along the southside of Queen City Park Road is the Burlington/South Burlington city line. Over the city line in South Burlington is a VELCO substation to the south, Red Rocks Park to the southwest, and a Green Mountain Power substation and the Champlain Water District treatment facility. Just east of 180 and 266 is a Vermont Rail System train track.

Across the rail line to the east are the closest residences to the Project on Arthur Court (approximately 390 to 590 feet away[3]). Other nearby residences are along South Crest Drive and Pine Street to the northeast (720 to 1,370 feet), along Maple Avenue to the south in South Burlington (765 to 885 feet), and at the Redstone Condominiums to the west off of Austin Drive (985 to 1,400 feet).

Part of the Hub Project involves redeveloping the south side of the building at 266 into a concert venue which would be operated by Higher Ground. Another part of the Hub Project involves redeveloping the northwest corner of the building at 266 into a restaurant space that could serve Burton staff during the day and concertgoers in the evenings. The primary sources of sound from these proposed uses include rooftop mechanical equipment (HVAC and ventilation fans) and sound transmitted through the walls and roof of the building during a concert.

The concert venue is expected to have a similar schedule to the Higher Ground facility currently located in South Burlington. This includes occasional daytime events, but most events would occur in the evening starting generally between 7:30 and 9 PM and ending generally between 11 PM and 2 AM. Sound checks would occur before the event during the day, and attendees would start arriving generally up to an hour before the start of the event.

A map showing the surrounding area and the components of 266 assessed in this study is provided in Figure 1.

[1] Formerly Industrial Parkway
[2] Chittenden County Transportation Authority
[3] Distances are from residences to the concert venue portion of the building at 266.

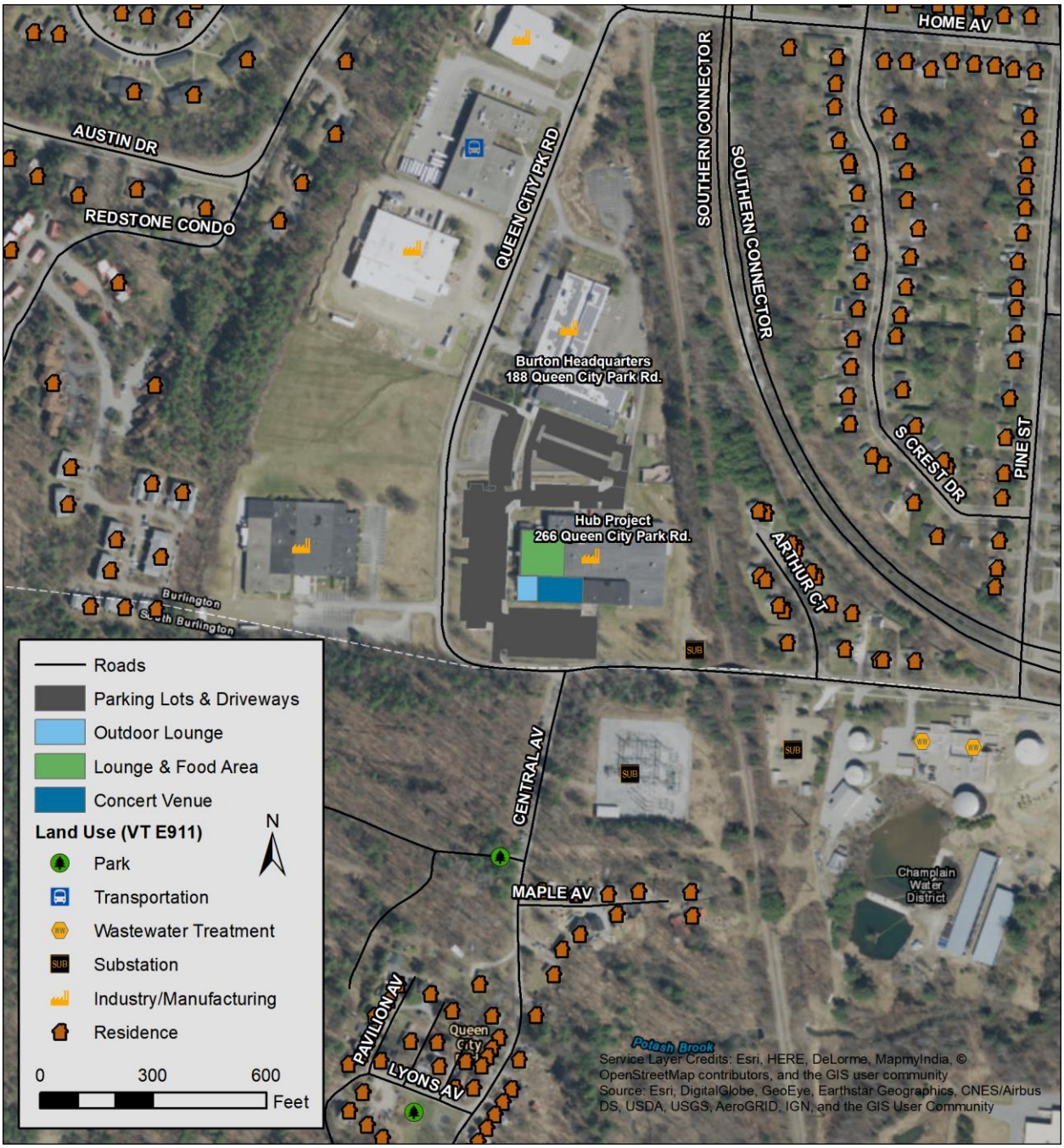


FIGURE 1: SITE MAP

3.0 NOISE STANDARDS AND GUIDELINES

3.1 LOCAL STANDARDS

Burlington Standards

The Hub Project is located in the City of Burlington and subject to Burlington regulations. There are no Burlington statutes or regulations that establish quantitative noise standards applicable to this Project. There is, however, a noise ordinance for the City of Burlington that prohibits unreasonable noise. The noise ordinance states:

> *It shall be unlawful for any person to make or cause to be made any loud or unreasonable noise. Noise shall be deemed to be unreasonable when it disturbs, injures or endangers the peace or health of another or when it endangers the health, safety or welfare of the community. Any such noise shall be considered to be a noise disturbance and a public nuisance.*

The ordinance also provides more specific prohibitions for music:

> *The operation or permitting the use or operation of any musical instrument, radio, television, phonograph, or other device for the production or reproduction of sound in such a manner as to be plainly audible through walls between units within the same building, from another property or from the street between the hours of 10:00 p.m. and 7:00 a.m. or in such a manner as to unreasonably disturb the peace, quiet or comfort of the public.*

South Burlington Standards

While the Project is located in Burlington and subject to Burlington regulations, the City of South Burlington is just south of the Project parcel. South Burlington has qualitative standards in its noise ordinances, and also quantitative noise standards in the South Burlington Land Development Regulations. These South Burlington regulations do not directly apply to land uses located in another municipality; however, they are being discussed and are relevant because they influence the character of the area in South Burlington and thus may be considered under Act 250. The specific sound level limits are defined in Section A.3(b)(ii) which states:

> *It shall be a violation of these Regulations for any property owner to create or allow the creation of noise in excess of the following stated limits in the City during the hours of 12:00 AM and 8:00 AM:*
>
> *a. 45 dBA based on a one-hour average measured at any point where the property on which the noise emanates adjoins any property used for residential purposes.*

b. *60 dBA based on a one-hour average measured at any point where the property on which the noise emanates adjoins any property used for commercial purposes.*

3.2 STATE STANDARDS

There are no Vermont statutes or regulations that establish quantitative noise standards applicable to this Project.

Noise from the Hub Project will be assessed in the Act 250 proceeding under Criterion 8, aesthetics. Noise is evaluated under Criterion 8 via the Quechee Test which first asks if the project will cause an adverse impact on aesthetics with regard to noise, by comparing the existing character of the area with the future character of the area given the proposed project. If a project is considered to cause an adverse impact, the Quechee Test then asks if the project will cause an undue adverse impact on aesthetics with regard to noise. To determine if the adverse impacts are undue three questions must be considered:

1. Is the project so out of character with the area that it would offend the sensibilities of the average person? Does it rise to the level of being considered shocking and offensive?
2. Has the applicant failed to take generally available mitigating steps which a reasonable person would take to improve the harmony of the Project with its surroundings?
3. Does the project violate a clear, written community standard regarding noise or acoustical aesthetics?

If there is an affirmative answer to any of these questions, then the project is considered to cause an undue adverse impact, and it fails the Quechee Test. Under the Quechee Test, the proposed Project must:

- Not be considered shocking and offensive to the average person.
- Implement reasonable mitigation measures to reduce potential impacts.
- Meet local noise standards.

3.3 COMMUNITY NOISE GUIDELINES

Both the World Health Organization (WHO) and the American National Standards Institute (ANSI) have community noise guidelines that are quantitative. These guidelines also speak to many of the same qualitative features of the Burlington noise ordinance and Act 250's Quechee Test. The WHO guidelines, discussed below, specifically address potential health impacts. This parallels the Burlington noise ordinance which prohibits the endangering of "health, safety or welfare of the community."

The WHO guidelines also address noise annoyance, which parallels the Quechee Test's "shocking and offensive" requirements. The ANSI standard discussed below speaks to land use compatibility as it relates to sound from different land uses which also parallels the Quechee Test's "shocking and offensive" requirements. That is, if the soundscape of one land use is found to be compatible with that of a neighboring land use, then the soundscape should not be considered shocking and offensive to the average person.

World Health Organization

The WHO has studied and adopted various noise guidelines to address health and aesthetic issues. In the WHO's Community Noise Guidelines[4], they write, "The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professional trying to protect people from the harmful effects of noise in non-industrial environments."

The WHO guideline to protect against serious annoyance is 55 dBA averaged over a 16-hour daytime period from 7 AM to 11 PM outside of a residence and to protect against moderate annoyance the WHO recommends a limit of 50 dBA averaged over a 16-hour daytime period. The WHO guideline for night (11 PM to 7 AM) is 45 dBA averaged over an 8-hour period to protect against sleep disturbance. These WHO guidelines are to be measured outdoors.

The WHO guidelines also establish a recommended limit for entertainment venues to protect against hearing impairment of attendees which 100 dBA averaged over a 4-hour period.

American National Standard, ANSI S12.9 Part 5

For additional context regarding land use compatibility, we can look to the American National Standard, ANSI S12.9 Part 5, "Quantities and Procedures for Description and Measurement of Environmental Sound – Part 5: Sound Level Descriptors for Determination of Compatible Land Use." ANSI S12.9 Part 5 provides ratings of compatibility for varying sound levels for different land uses in Annex A of the standard. The standard uses an annual average of the day-night average sound level (DNL)[5]. For urban/suburban residential areas, the standard lists a DNL of up to 55 dBA as being compatible, and a DNL of up to 60 dBA as being marginally compatible.

3.4 HUB PROJECT EVALUATION

For this study, we assess if the Project meets WHO and ANSI guidelines to provide quantification to the Burlington and Act 250 standards. Note that the guidelines are not absolute

[4] "Guidelines for Community Noise," Edited by Birgitta Berglund, Thomas Lindvall, Dietrich H. Schwela, World Health Organization, Geneva, 2000.
[5] A day-night level is the average frequency-weighted sound level with a 10-dB penalty applied to nighttime sound levels between 10 PM and 7 AM.

limits. The most stringent guideline is the WHO's nighttime level of 45 dBA (L_8). If the Hub Project meets the WHO's nighttime limit, it will also meet the WHO's annoyance limits and the ANSI limits for being compatible with urban/suburban residential areas.

4.0 BACKGROUND SOUND LEVELS

Background sound levels were not measured for this Project, because they have been quantified on several occasions throughout the Project area on other projects[6]. Background sound levels (L_{eq}) during the day (7 AM to 10 PM) are in the upper 40s to low 50s dBA; generally, between 47 and 52 dBA. During the quietest times during the day the sound levels can be down in the upper 30s dBA. The primary sources of noise during the day is local and distant traffic, aircraft flyovers, and equipment at the surrounding industrial, utility, and transportation facilities.

Background sound levels (L_{eq}) at night (10 PM to 7 AM) are generally in the low 40s between 40 and 45 dBA. During the quietest times at night, sound levels can be in the low 30's dBA. The primary sources of noise during the night are similar to the daytime sources (distant traffic and mechanical/electrical equipment at surrounding properties) but are at lower levels than during the day due to less traffic on roads and less equipment that is in use at night.

There are also biogenic (i.e. birds and insects) and geophonic (i.e. wind through trees) sound sources that occur throughout the day and night.

These sound levels are existing, but both daytime and nighttime sound levels are expected to increase in the area along Queen City Park Road, Arthur Court, South Crest Drive, Pine Street, Central Avenue, and Maple Avenue once the Southern Connector Project is constructed.

[6] Southern Connector, VELCO Queen City Substation, Chittenden County Noise Map

5.0 SOUND PROPAGATION MODELING

Sound propagation modeling was conducted to estimate the sound levels throughout the area due to rooftop mechanical equipment and concert events at 266.

5.1 MODELING METHODOLOGY

Modeling for the study was completed using the International Standards Organization ISO 9613-2 standard, “Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation,” as implemented in the Cadna A acoustical modeling software. The ISO standard states,

> This part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level … under meteorological conditions favorable to propagation from sources of known sound emissions. These conditions are for downwind propagation … or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The model takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain.

Cadna A is an internationally accepted acoustical model, used by many other noise control professionals in the United States and abroad. It has also been accepted for many years as a reliable noise modeling methodology by Act 250 commissions, the former Environmental Board, the Vermont Superior Court Environmental Division, and the Vermont Supreme Court.

Standard modeling methodology takes into account moderate nighttime inversions or equivalently, moderate downwind conditions. For this study, we modeled sound propagation in accordance with ISO 9613-2 with spectral ground attenuation, using hard ground on roadways and parking lots (G=0), partly hard and partly porous ground (G=0.6) within the neighboring substations, and porous ground (G=1) elsewhere. Model input data is provided in Appendix B.

A 10-meter by 10-meter (33-foot by 33-foot) grid of 1.5 meter (5 foot) high receivers was set up in the model, covering approximately 190 acres around the site. A receiver is a point above the ground at which the computer model calculates a sound level. In addition, 192 discrete

receivers were modeled at nearby residences[7] at a height of 4 meters (13 feet). Their locations are provided in Appendix C.

5.2 NOISE SOURCES

Exterior Sources

The exterior sources associated with the concert venue and food services area include rooftop air handling units, hood exhaust fans, hood intake fans, vehicle movements in the parking lots, and people socializing in the outdoor lounge on the southwest corner of the building. In addition, there are already some existing rooftop air handling units that will remain in place.

A total of 11 existing air handling units were included in the model. An additional eight new air handling units were modeled for the study, five of which are associated with the concert venue and three that are associated with food services. Five hood exhaust fans and five hood intake fans were also modeled. The sound power levels of each piece of rooftop equipment is provided in Table 1. The sound emissions for rooftop equipment are from manufacturer data of representative equipment.

Also provided in Table 1, are the sound emissions used for people socializing in the outdoor lounge. No outdoor music is proposed for the outdoor lounge area. The sound emissions were derived from 15 “loud” male voices[8] all speaking simultaneously.

Lastly, onsite vehicle noise was modeled in two ways. In one model run, it was assumed that 100 vehicles would access (enter or exit) parking spacing while a concert was underway. In a second model run, it was assumed that 500 vehicles access (exit) parking spaces at the end of a concert for a sold-out event. The modeled sound power level for each parking lot scenario is provided in Table 1.

[7] The locations and types of discrete receivers included in the model were identified through Vermont E911 data.
[8] Harris, Cyril M., “Handbook of Acoustical Measurements and Noise Control”

TABLE 1: SOUND POWER LEVELS OF MODELED OUTDOOR SOURCES (dBZ, UNLESS SPECIFIED OTHERWISE)

Modeled Outdoor Sources	Octave Band Center Frequency (Hz)									Overall Sound Power Level (dBA)
	31.5	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	
New HVAC 20 Ton		96	88	84	84	82	78	73	66	87
New HVAC 25 Ton		97	88	84	83	81	77	73	67	86
Existing Carrier 48HC 24	96	96	88	84	84	82	78	73	66	87
Existing Carrier 48HC A06		88	83	76	74	71	67	64	60	78
Existing Carrier 48HC D08		91	84	80	79	77	72	67	64	82
New Hood Exhaust		75	83	82	73	68	66	59	53	77
New Hood Intake		84	81	80	76	75	74	69	66	81
Outdoor Lounge	65	65	70	80	87	84	78	76	67	88
Parking Lot (100 Cars)										93
Parking Lot (500 Cars)										100

Interior Sources

The interior source is for the concert venue is amplified music. The type and level of music will vary from concert to concert. To represent a conservatively high sound level scenario, RSG conducted sound level monitoring at Higher Ground's existing facility in South Burlington during a hard rock concert on August 17, 2019. The event was selected in consultation with Higher Ground to ensure that it would be a representative of an event that produces conservatively high sound levels compared to other events that are held by the venue.

The interior sound level (L_{eq}) during the concert while music was being played was 99 dBA.[9] This value is typical for a loud concert and consistent with World Health Organization Guidelines for entertainment events, discussed in Section 3.3 above, to protect against hearing impairment of attendees. For the sound propagation model, the same levels were used inside the proposed concert space at 266. In addition, an interior sound level of 86 dBA was modeled in the adjacent building spaces (backstage, lobby, and food area). The interior sound levels were than transmitted through the exterior walls and roof taking into account the sound transmission loss of those building elements.

The spectra of the modeled interior sound levels are provided in Table 2, and modeled sound transmission loss of the exterior walls and roof are provided in Appendix B. The spectra shown

[9] While there were brief periods when the interior sound level exceeded 99 dBA, the 99 dBA is representative of the diffuse field (where the sound pressure is nearly the same around the room, except near the sound source) that would impinge on the building envelope while music is being played, and is therefore an appropriate value to use in modeling breakout noise through the structure.

in Table 2 and used in the model, are representative of the full music frequency range including bass, midrange, and treble.

TABLE 2: MODELED INTERIOR SOUND PRESSURE LEVELS (dBZ, UNLESS SPECIFIED OTHERWISE)

Modeled Interior Sources	Octave Band Center Frequency (Hz)									Overall Interior Sound Pressure Level (dBA)
	31.5	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	
Hard Rock Concert	84	100	100	94	90	89	80	79	75	99
Sound in Adjacent Spaces During Hard Rock Concert	76	92	89	83	76	76	67	66	62	86

A map showing all the modeled sources of sound is provided in Figure 2. Point sources are shown by symbols on the roof and area sources are identified by orange callout boxes.

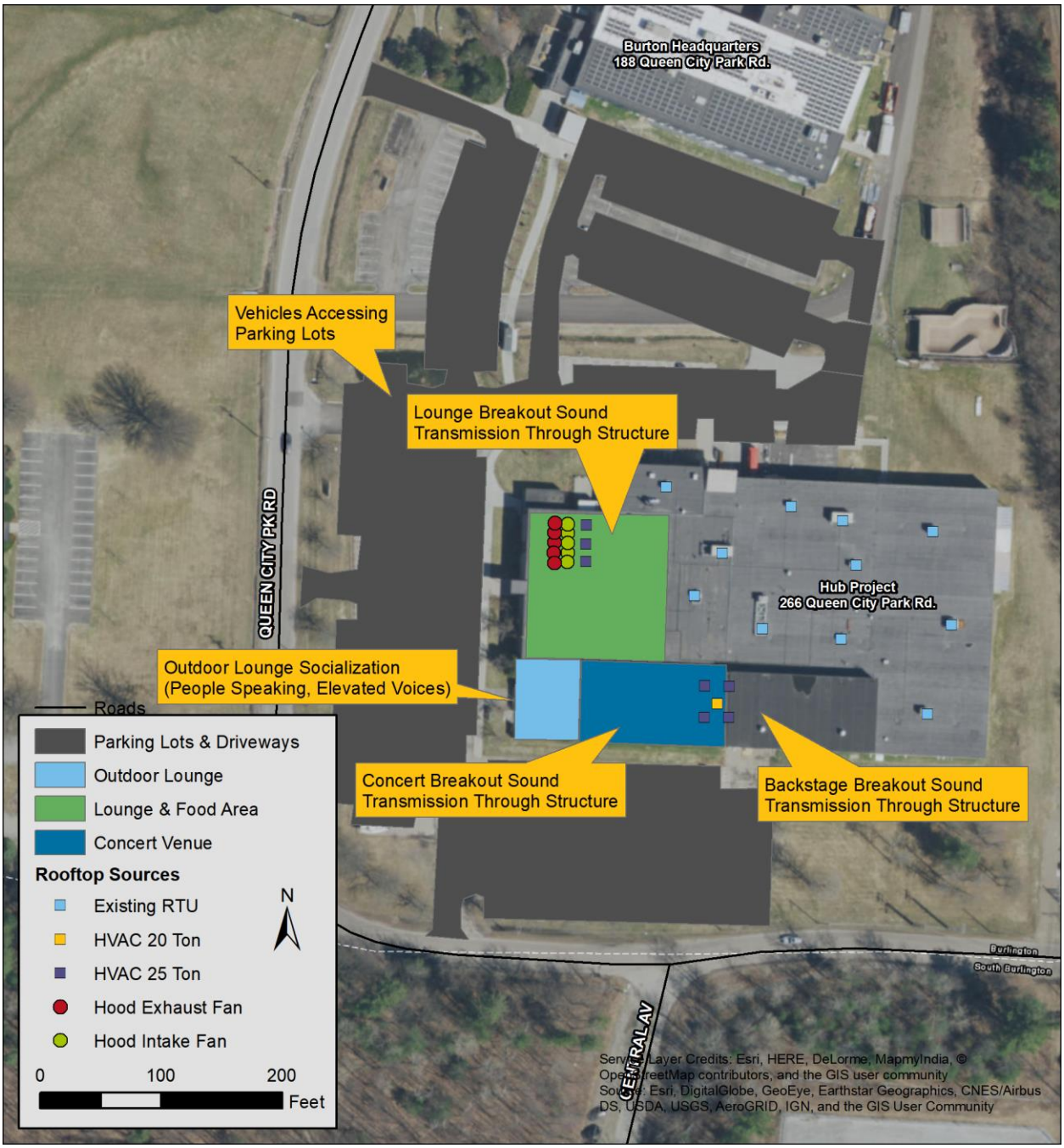


FIGURE 2: MAP OF MODELED SOUND SOURCES

5.3 PLANNED MITIGATION

There are a few mitigation measures that have been incorporated into the plans for the Hub Project that are included in the sound propagation model results. Higher Ground is working with another acoustical consultant to fit-up the interior of the concert venue and this mitigation will be incorporated into those plans:

1. The transmission loss of the concert venue roof will be increased, particularly at low frequencies. This could be completed in several ways that are under consideration. The transmission loss of the ceiling/roof assembly over the concert venue in the model assumed a layer of sheetrock was added to the underside of the existing steel trusses. Specifically, the transmission loss of the modeled ceiling/roof assembly is modeled at:

	OCTAVE BAND CENTER FREQUENCY (HZ)								
	31.5	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***
Ceiling/Roof Transmission Loss (dB):	17	20	36	52	62	67	64	75	79

2. Most of the exterior walls of the facility are made of concrete block, but a portion of the southern exterior wall of the concert venue is currently just metal siding. The transmission loss of the area that is just metal siding will be increased. This could be completed in several ways that are under consideration, but in the model insulation and 5/8-inch Type X drywall was added to the interior side of the wall resulting in a modeled transmission loss of:

	OCTAVE BAND CENTER FREQUENCY (HZ)								
	31.5	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***
Southern Exterior Wall with Insulation & Drywall (currently just metal siding) Transmission Loss (dB):	13	14	21	36	46	52	55	44	48

3. The main entrance and the exit to the outdoor lounge area will have double sets of doors that act as a sound lock that prevent music propagating out an open door to the exterior.

These steps would represent reasonable mitigation measures for this Project.

5.4 MODEL RESULTS

Two scenarios were modeled. The first scenario included all of the sources shown in Figure 2, which is representative of the facility in full use during a hard rock concert while music is playing (Concert Model). The second scenario only included rooftop mechanical equipment and 500 vehicles leaving the parking lot which would be representative of people leaving at the end of a sold-out show (End-of-Concert Model). Both scenarios include all rooftop equipment (existing and proposed) operating at the full capacity simultaneously. This is unlikely to be a frequent occurrence but is a conservative assumption for assessing projected sound levels.

The results for the Concert Model are presented in Figure 3. The highest modeled sound level at a residence for this scenario is 42 dBA which occurs at 20 Arthur Court just east of the venue. The results for the End-of-Concert Model are presented in Figure 4. The highest modeled sound level at a residence for this scenario is 44 dBA which also occurs at 20 Arthur Court. Model results for all 192 modeled residences are provided in tabular format in Appendix C.

The sound levels from these modeled scenarios represent conservative conditions under which the highest sound levels are expected to occur, specifically highest hourly average nighttime sound levels ($L_{eq,1\text{-}hr}$). The proposed concert venue may be used for a variety of music and performance genres. Most other genres are expected to produce lower sound levels than those of a hard rock concert. In addition, the End-of-Concert Model, assumes the vehicle load in the parking lot is for a sold-out show. Many shows would have less than the modeled number of vehicles resulting in lower sound levels.

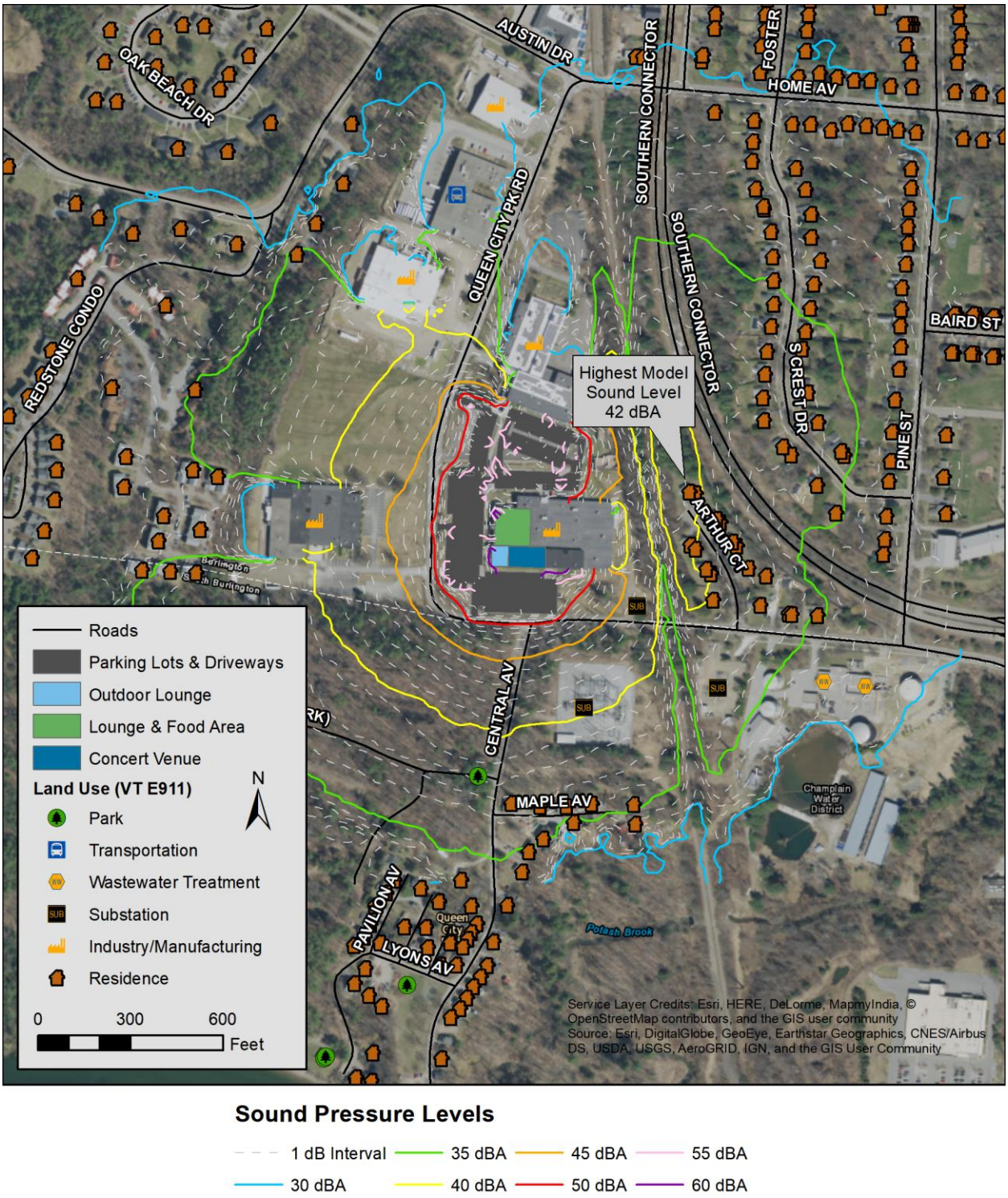
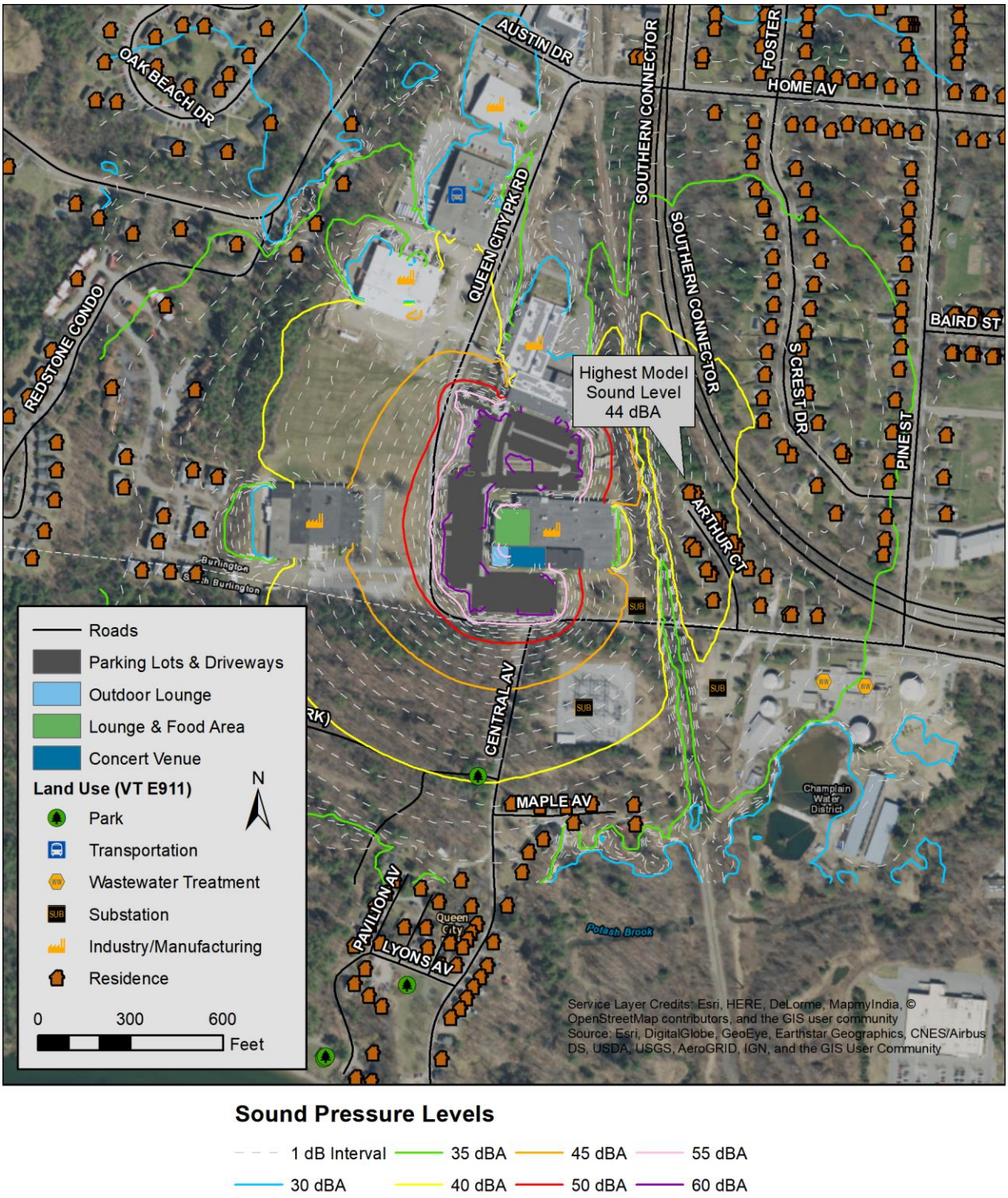


FIGURE 3: MODEL RESULTS - CONCERT MODEL (L_{EQ} WHILE MUSIC IS PLAYING)



Sound Pressure Levels

1 dB Interval — 35 dBA — 45 dBA — 55 dBA
30 dBA — 40 dBA — 50 dBA — 60 dBA

FIGURE 4: MODEL RESULTS - END-OF-CONCERT MODEL

6.0 CONCLUSIONS

Burton Snowboards is applying for permits to redevelop the property at 266 Queen City Park Road, adjacent to their headquarters, into the Burton Global Hub Project which includes an indoor concert venue and restaurants among other uses. Higher Ground, currently located in South Burlington, plans to operate the concert venue. RSG was retained to evaluate the exterior noise from rooftop equipment and the concert venue.

The character of the area surrounding the Project parcel is a mixture of industrial, transportation, utility, and residential land uses along a planned transportation corridor (Southern Connector). Background sound levels in the area are generally in the upper 40s to low 50s dBA during the day and in the low 40s dBA at night. Typical sound sources in the area include traffic noise, aircraft flyovers, mechanical equipment from the industrial and utility land uses in the area, bird calls, and wind through the trees. The City of South Burlington is just south of the Hub Project and while the noise regulations for South Burlington, discussed in Section 3.1, do not directly apply to the Hub Project, they inform the character of the area to the south.

Sound propagation modeling was conducted to predict the highest hourly average sound pressure levels ($L_{eq,\ 1\text{-}hr}$) that could occur at night from the proposed concert venue. Two scenarios were modeled: sound levels during a hard rock concert and sound levels at the end of a sold-out concert when people are leaving the site. Model results indicate that all modeled receptors will experience sound levels of 45 dBA or less. These projected sound levels are:

- Comparable to existing nighttime sound levels in the area (Section 4.0);
- Below the WHO's nighttime noise guideline of 45 dBA $L_{eq,8\text{-}hr}$ (Section 3.3);
- Considered compatible with urban/suburban residential areas, per ANSI S12.9 Part 5 (Section 3.3); and
- Below the sound level limits set in the South Burlington noise ordinance (Section 3.1).

Given that projected sound levels are comparable to existing nighttime sound levels in the area, below WHO's nighttime noise guideline, and considered compatible with urban/suburban residential areas, the Hub Project should not create noise that would be considered "unreasonable" or that "endangers the health, safety or welfare of the community" as discussed in the Burlington noise ordinance. As such, the Hub Project can be constructed and operated in such a way as to comply with Sec. 21-13(b)(1) of the Burlington Noise Control Ordinance.

Given that the projected sound levels are comparable to the existing nighttime sound levels in the area and considered compatible with urban/suburban residential areas, noise from the Project should not be considered shocking and offensive to the average person. As discussed in

Section 5.3, the applicant is planning mitigation measures through working with Higher Grounds acoustical consultant to fit-up the interior of the concert venue to increase the transmission loss of the building shell. And the projected sound levels from Hub Project are less than the South Burlington noise ordinance, to the extent it would be deemed a clear, written community standard regarding noise. As such, the Hub Project can be constructed and operated in such a way as to not cause an undue adverse impact on aesthetics with regard to noise as evaluated under Act 250.

APPENDIX A. ACOUSTICS PRIMER

Sound consists of tiny, repeating fluctuations in ambient air pressure. The strength, or amplitude, of these fluctuations determines the sound pressure level. “Noise” can be defined as “a sound of any kind, especially when loud, confused, indistinct, or disagreeable.”

Expressing Sound in Decibel Levels

The varying air pressure that constitutes sound can be characterized in many different ways. The human ear is the basis for the metrics that are used in acoustics. Normal human hearing is sensitive to sound fluctuations over an enormous range of pressures, from about 20 micropascals (the “threshold of audibility”) to about 20 Pascals (the “threshold of pain”).[10] This factor of one million in sound pressure difference is challenging to convey in engineering units. Instead, sound pressure is converted to sound “levels” in units of “decibels” (dB, named after Alexander Graham Bell). Once a measured sound is converted to dB, it is denoted as a level with the letter “L.”

The conversion from sound pressure in pascals to sound level in dB is a four-step process. First, the sound wave’s measured amplitude is squared and the mean is taken. Second, a ratio is taken between the mean square sound pressure and the square of the threshold of audibility (20 micropascals). Third, using the logarithm function, the ratio is converted to factors of 10. The final result is multiplied by 10 to give the decibel level. By this decibel scale, sound levels range from 0 dB at the threshold of audibility to 120 dB at the threshold of pain.

Typical sources of noise, and their sound pressure levels, are listed on the scale in Figure 5.

Human Response to Sound Levels: Apparent Loudness

For every 20 dB increase in sound level, the sound pressure increases by a *factor* of 10; the sound *level* range from 0 dB to 120 dB covers 6 factors of 10, or one million, in sound *pressure*. However, for an increase of 10 dB in sound *level* as measured by a meter, humans perceive an approximate doubling of apparent loudness: to the human ear, a sound level of 70 dB sounds about “twice as loud” as a sound level of 60 dB. Smaller changes in sound level, less than 3 dB up or down, are generally not perceptible.

[10] The pascal is a measure of pressure in the metric system. In Imperial units, they are themselves very small: one pascal is only 145 millionths of a pound per square inch (psi). The sound pressure at the threshold of audibility is only 3 one-billionths of one psi: at the threshold of pain, it is about 3 one-thousandths of one psi.

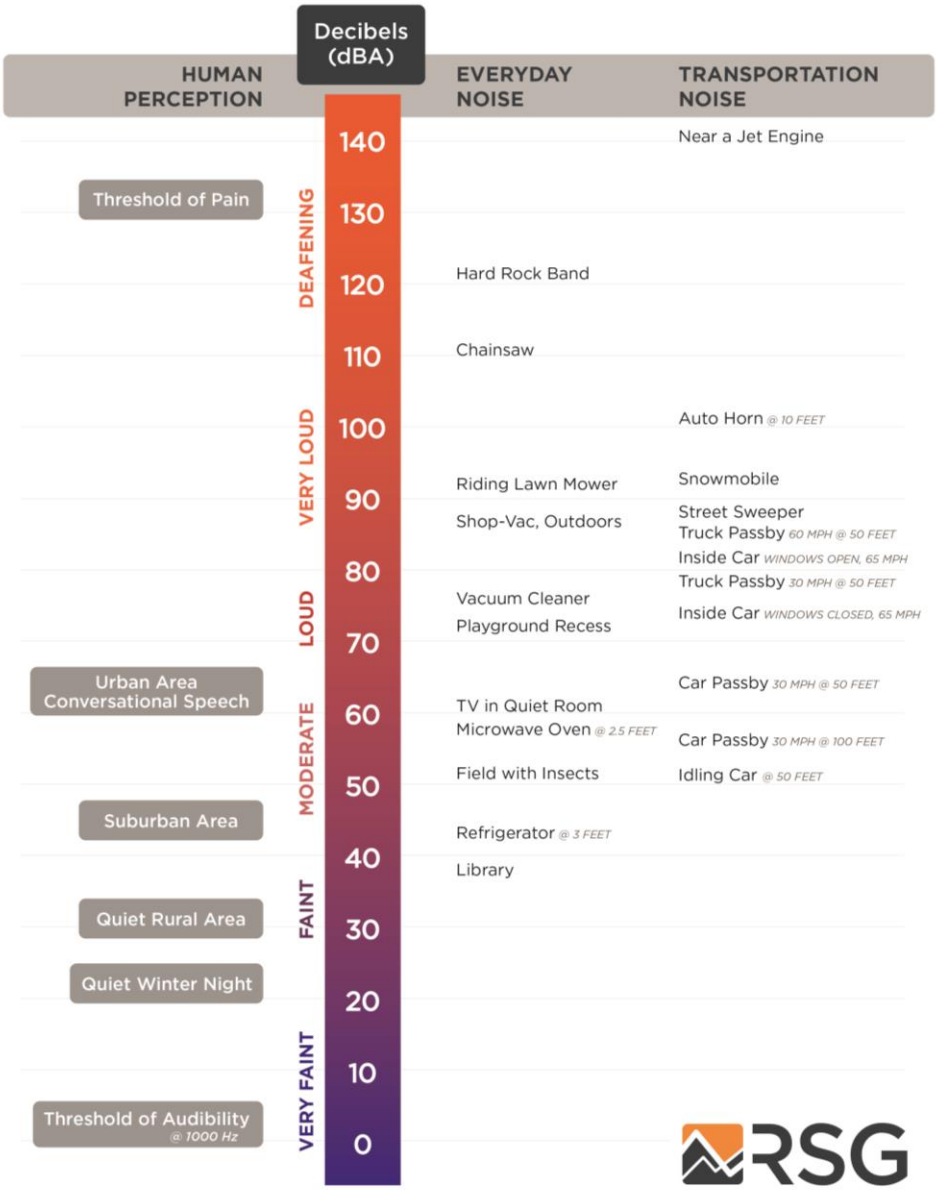


FIGURE 5: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL NOISE SOURCES[11]

[11] While a "Hard Rock Concert" is noted as 120 dBA in this figure, it should be noted that this is a generalized value that represent how loud some concerts can get and is representative of short-term sound levels that can cause hearing loss. The sound levels that are produced by any given concert are dependent on architecture of the venue and how the concert venue runs their facility. As with other noise studies, the best sound data is what we can measure of the actual operation under real world conditions that is representative of how that particular facility or equipment operates. This is the approach RSG took in this study and is discussed in Section 5.2 of this report.

Frequency Spectrum of Sound

The “frequency” of a sound is the rate at which it fluctuates in time, expressed in Hertz (Hz), or cycles per second. Few sounds occur at only one frequency: most sound contains energy at many different frequencies, and it can be broken down into different frequency divisions, or bands. These bands are similar to musical pitches, from low tones to high tones. The most common division is the standard octave band. An octave is the range of frequencies whose upper frequency limit is twice its lower frequency limit, exactly like an octave in music. An octave band is identified by its center frequency: each successive band’s center frequency is twice as high (one octave) as the previous band. For example, the 500 Hz octave band includes all sound whose frequencies range between 354 Hz (Hertz, or cycles per second) and 707 Hz. The next band is centered at 1,000 Hz with a range between 707 Hz and 1,414 Hz. The range of human hearing is divided into 10 standard octave bands: 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1,000 Hz, 2,000 Hz, 4,000 Hz, 8,000 Hz, and 16,000 Hz. For analyses that require finer frequency detail, each octave-band can be subdivided. A commonly-used subdivision creates three smaller bands within each octave band, or so-called 1/3-octave bands.

Human Response to Frequency: Weighting of Sound Levels

The human ear is not equally sensitive to sounds of all frequencies. Sounds at some frequencies seem louder than others, despite having the same decibel level as measured by a sound level meter. In particular, human hearing is much more sensitive to medium pitches (from about 500 Hz to about 4,000 Hz) than to very low or very high pitches. For example, a tone measuring 80 dB at 500 Hz (a medium pitch) sounds quite a bit louder than a tone measuring 80 dB at 60 Hz (a very low pitch). The frequency response of normal human hearing ranges from 20 Hz to 20,000 Hz. Below 20 Hz, sound pressure fluctuations are not “heard,” but sometimes can be “felt.” This is known as “infrasound.” Likewise, above 20,000 Hz, sound can no longer be heard by humans; this is known as “ultrasound.” As humans age, they tend to lose the ability to hear higher frequencies first; many adults do not hear very well above about 16,000 Hz. Most natural and man-made sound occurs in the range from about 40 Hz to about 4,000 Hz. Some insects and birdsongs reach to about 8,000 Hz.

To adjust measured sound pressure levels so that they mimic human hearing response, sound level meters apply filters, known as “frequency weightings,” to the signals. There are several defined weighting scales, including “A,” “B,” “C,” “D,” “G,” and “Z.” The most common weighting scale used in environmental noise analysis and regulation is A-weighting. This weighting represents the sensitivity of the human ear to sounds of low to moderate level. It attenuates sounds with frequencies below 1000 Hz and above 4000 Hz; it amplifies slightly sounds between 1000 Hz and 4000 Hz, where the human ear is particularly sensitive. The C-weighting scale is sometimes used to describe louder sounds. The B- and D- scales are seldom used. All of these frequency weighting scales are normalized to the average human hearing response at

1000 Hz: at this frequency, the filters neither attenuate nor amplify. When a reported sound level has been filtered using a frequency weighting, the letter is appended to “dB.” For example, sound with A-weighting is usually denoted “dBA.” When no filtering is applied, the level is denoted “dB” or “dBZ.” The letter is also appended as a subscript to the level indicator “L,” for example “L_A” for A-weighted levels.

Time Response of Sound Level Meters

Because sound levels can vary greatly from one moment to the next, the time over which sound is measured can influence the value of the levels reported. Often, sound is measured in real time, as it fluctuates. In this case, acousticians apply a so-called “time response” to the sound level meter, and this time response is often part of regulations for measuring noise. If the sound level is varying slowly, over a few seconds, “Slow” time response is applied, with a time constant of one second. If the sound level is varying quickly (for example, if brief events are mixed into the overall sound), “Fast” time response can be applied, with a time constant of one-eighth of a second.[12] The time response setting for a sound level measurement is indicated with the subscript “S” for Slow and “F” for Fast: L_S or L_F. A sound level meter set to Fast time response will indicate higher sound levels than one set to Slow time response when brief events are mixed into the overall sound, because it can respond more quickly.

In some cases, the maximum sound level that can be generated by a source is of concern. Likewise, the minimum sound level occurring during a monitoring period may be required. To measure these, the sound level meter can be set to capture and hold the highest and lowest levels measured during a given monitoring period. This is represented by the subscript “max,” denoted as “L_{max}.” One can define a “max” level with Fast response L_{Fmax} (1/8-second time constant), Slow time response L_{Smax} (1-second time constant), or Continuous Equivalent level over a specified time period $L_{eq,max}$. Note that, in the Act 250 precedents set by the former Environmental Board and the Vermont Superior Court Environmental Division utilizes $L_{Smax.}$

Accounting for Changes in Sound over Time

A sound level meter’s time response settings are useful for continuous monitoring. However, they are less useful in summarizing sound levels over longer periods. To do so, acousticians apply simple statistics to the measured sound levels, resulting in a set of defined types of sound level related to averages over time. An example is shown in Figure 6. The sound level at each instant of time is the grey trace going from left to right. Over the total time it was measured, the sound energy spends certain fractions of time near various levels, ranging from the minimum (about 28 dB in the figure) to the maximum (about 65 dB in the figure). The simplest descriptor is the average sound level, known as the Equivalent Continuous Sound Level. Statistical levels

[12] There is a third time response defined by standards, the “Impulse” response. This response was defined to enable use of older, analog meters when measuring very brief noises; it is no longer in common use.

are used to determine for what percentage of time the sound is louder than any given level. These levels are described in the following sections.

Equivalent Continuous Sound Level - L_{eq}

One straightforward, common way of describing sound levels is in terms of the Continuous Equivalent Sound Level, or L_{eq}. The L_{eq} is the average sound pressure level over a defined period of time, such as one hour or one day. L_{eq} is the most commonly used descriptor in noise standards and regulations. L_{eq} is representative of the overall sound to which a person is exposed. Because of the logarithmic calculation of decibels, L_{eq} tends to favor higher sound levels: loud and infrequent sources have a larger impact on the resulting average sound level than quieter but more frequent noises. For example, in Figure 6, even though the sound levels spends most of the time near about 34 dBA, the L_{eq} is 41 dBA, having been “inflated” by the maximum level of 65 dBA.

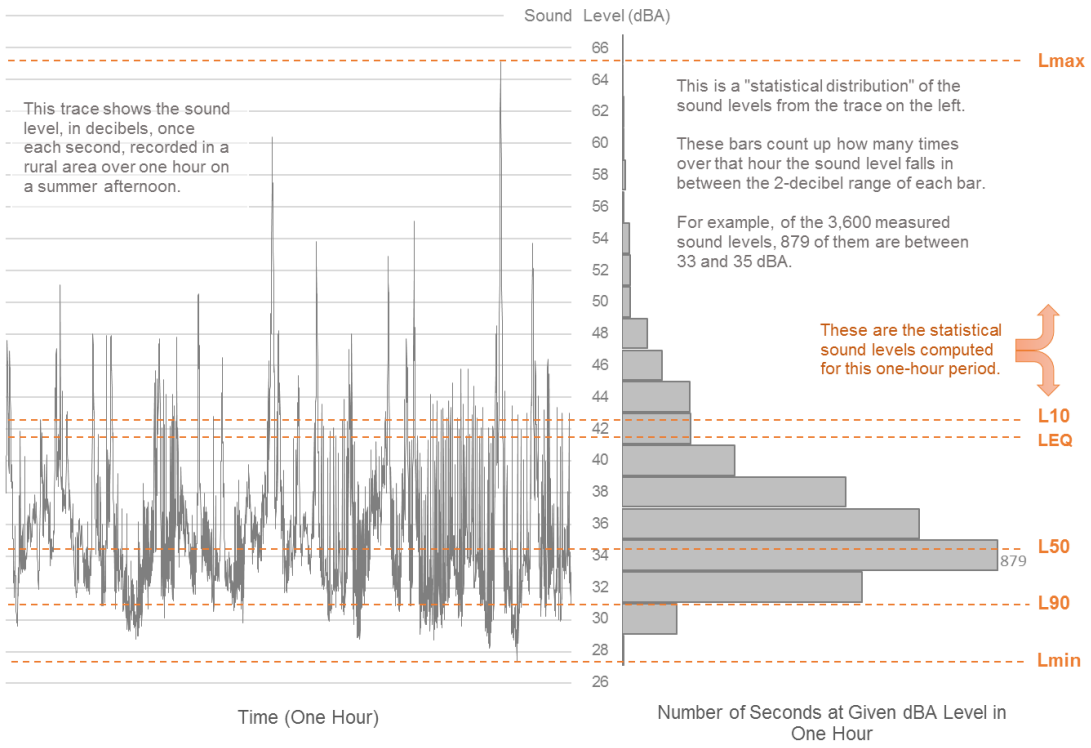


FIGURE 6: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME

Percentile Sound Levels – Ln

Percentile sound levels describe the statistical distribution of sound levels over time. "L_N" is the level above which the sound spends "N" percent of the time. For example, L_{90} (sometimes called the "residual base level") is the sound level exceeded 90% of the time: the sound is louder than L_{90} most of the time. L_{10} is the sound level that is exceeded only 10% of the time. L_{50} (the "median level") is exceeded 50% of the time: half of the time the sound is louder than L_{50}, and half the time it is quieter than L_{50}. Note that L_{50} (median) and L_{eq} (mean) are not always the same, for reasons described in the previous Section.

L_{90} is often a good representation of the "ambient sound" in an area. This is the sound that persists for longer periods, and below which the overall sound level seldom falls. It tends to filter out other short-term environmental sounds that aren't part of the source being investigated. L_{10} represents the higher, but less frequent, sound levels. These could include such events as barking dogs, vehicles driving by and aircraft flying overhead, gusts of wind, and work operations. L_{90} represents the background sound that is present when these event noises are excluded.

Note that if one sound source is very constant and dominates the noise in an area, all of the descriptive sound levels mentioned here tend toward the same value. It is when the sound is varying widely from one moment to the next that the statistical descriptors are useful.

Sound Levels from Multiple Sources: Adding Decibels

Because of the way that sound levels in decibels are calculated, the sounds from more than one source do not add arithmetically. Instead, two sound sources that are the same decibel level increase the total sound level by 3 dB. For example, suppose the sound from an industrial blower registers 80 dB at a distance of 2 meters (6.6 feet). If a second industrial blower is operated next to the first one, the sound level from both machines will be 83 dB, not 160 dB. Adding two more blowers (a total of four) raises the sound level another 3 dB to 86 dB. Finally, adding four more blowers (a total of eight) raises the sound level to 89 dB. It would take eight total blowers, running together, for a person to judge the sound as having “doubled in loudness.”

Recall from the explanation of sound levels that a difference of 10 decibels is a factor of 20 in sound pressure and a factor of 10 in sound power. (The difference between sound pressure and sound power is described in the next Section.) If two sources of sound differ individually by 10 decibels, the louder of the two is generating *ten times* more sound. This means that the loudest source(s) in any situation always dominates the total sound level. Looking again at the industrial blower running at 80 decibels, if a small ventilator fan whose level alone is 70 decibels were operated next to the industrial blower, the total sound level increases by only 0.4 decibels, to 80.4 decibels. The small fan is only 10% as loud as the industrial blower, so the larger blower completely dominates the total sound level.

The Difference Between Sound Pressure and Sound Power

The human ear and microphones respond to variations in sound *pressure*. However, in characterizing the sound emitted by a specific source, it is proper to refer to sound *power*. While sound pressure induced by a source can vary with distance and conditions, the power is the same for the source under all conditions, regardless of the surroundings or the distance to the nearest listener. In this way, sound power levels are used to characterize noise sources because they act like a “fingerprint” of the source. An analogy can be made to light bulbs. The bulb emits a constant amount of light under all conditions, but its perceived brightness diminishes as one moves away from it.

Both sound power and sound pressure levels are described in terms of decibels, but they are not the same thing. Decibels of sound pressure are related to 20 micropascals, as explained at the beginning of this primer. Sound power is a measure of the acoustic power emitted or radiated by a source; its decibels are relative to one picowatt.

Sound Propagation Outdoors

As a listener moves away from a source of sound, the sound level decreases due to “geometrical divergence”: the sound waves spread outward like ripples in a pond and lose energy. For a sound source that is compact in size, the received sound level diminishes or attenuates by 6 dB for every doubling of distance: a sound whose level is measured as 70 dBA at 100 feet from a source will have a measured level of 64 dBA at 200 feet from the source and 58 dBA at 400 feet. Other factors, such as walls, berms, buildings, terrain, atmospheric absorption, and intervening vegetation will also further reduce the sound level reaching the listener.

The type of ground over which sound is propagating can have a strong influence on sound levels. Harder ground, pavement, and open water are very reflective, while soft ground, snow cover, or grass is more absorptive. In general, sounds of higher frequency will attenuate more over a given distance than sounds of lower frequency: the “boom” of thunder can be heard much further away than the initial “crack.”

Atmospheric and meteorological conditions can enhance or attenuate sound from a source in the direction of the listener. Wind blowing from the source toward the listener tends to enhance sound levels; wind blowing away from the listener toward the source tends to attenuate sound levels. Normal temperature profiles (typical of a sunny day, where the air is warmer near the ground and gets colder with increasing altitude) tend to attenuate sound levels; inverted profiles (typical of nighttime and some overcast conditions) tend to enhance sound levels.

APPENDIX B. MODEL INPUT DATA

TABLE 3: MODELED POINT SOURCES

SOURCE	SOUND POWER LEVEL (dBA)	HEIGHT ABOVE ROOF (m)	COORDINATES (VT STATE PLANE)		ELEVATION + SOURCE HEIGHT (m)
			X (m)	Y (m)	
HVAC 25 Ton	86	1.5	442715	216607	61
HVAC 25 Ton	86	1.5	442714	216597	61
HVAC 25 Ton	86	1.5	442714	216602	61
HVAC 25 Ton	86	1.5	442750	216558	66
HVAC 25 Ton	86	1.5	442744	216558	66
HVAC 25 Ton	86	1.5	442751	216566	66
HVAC 25 Ton	86	1.5	442744	216566	66
HVAC 20 Ton	87	1.5	442748	216562	66
Hood Intake	81	0.6	442710	216600	60
Hood Exhaust	77	0.6	442706	216602	60
Hood Exhaust	77	0.6	442706	216605	60
Hood Intake	81	0.6	442710	216604	60
Hood Intake	81	0.6	442710	216607	60
Hood Intake	81	0.6	442710	216597	60
Hood Intake	81	0.6	442710	216602	60
Hood Exhaust	77	0.6	442706	216600	60
Hood Exhaust	77	0.6	442706	216597	60
Hood Exhaust	77	0.6	442707	216607	60
Existing RTU	87	1.5	442779	216608	61
Existing RTU	87	1.5	442748	216599	61
Existing RTU	77	1.0	442800	216559	61
Existing RTU	77	1.0	442807	216581	61
Existing RTU	77	1.0	442802	216605	61
Existing RTU	82	1.0	442779	216578	61
Existing RTU	82	1.0	442782	216596	61
Existing RTU	82	1.0	442766	216611	61
Existing RTU	82	2.0	442759	216580	62
Existing RTU	82	1.0	442735	216616	61
Existing RTU	82	1.0	442742	216589	61

TABLE 4: MODELED AREA SOURCES

AREA SOURCES	ORIENTATION	SOUND POWER LEVEL (dBA)	TRANSMISSION LOSS ID	AREA (m^2)
Concert Roof Breakout	Horizontal	84	Concert Roof	752
Lounge Roof Breakout	Horizontal	86	Commercial Roof	1286
Outdoor Lounge	Horizontal	88	NA	NA
Backstage Roof Breakout	Horizontal	84	Commercial Roof	745
South Lounge Wall	Vertical	65	Existing Concrete Block	84
West Lounge Wall	Vertical	69	Existing Concrete Block	222
North Lounge Wall	Vertical	67	Existing Concrete Block	127
West Concert Wall	Vertical	80	Existing Concrete Block	226
Southwest Concert Wall 1	Vertical	82	Existing Concrete Block	371
Southeast Concert Wall 2	Vertical	82	Improved Metal Siding	432
North Concert Wall	Vertical	82	Existing Concrete Block	365
East Concert Wall	Vertical	77	Existing Concrete Block	105
Loading Door South	Vertical	74	Existing Metal Siding	21

TABLE 5: MODELED TRANSMISSION LOSS OF ROOFS AND EXTERIOR WALLS (dB)

TRANSMISSION LOSS ID	OCTAVE BAND CENTER FREQUENCY (HZ)								
	31.5	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***
Existing Concrete Block	13	26	31	36	40	42	45	45	45
Existing Metal Siding	7	13	12	23	27	29	31	36	35
Commercial Roof	6	10	27	47	57	61	63	54	66
Concert Roof	17	20	36	52	62	67	64	75	79
Improved Metal Siding	13	14	21	36	46	52	55	44	48

TABLE 6: MODEL PARAMETER SETTINGS

MODEL PARAMETER	SETTING
Atmospheric Absorption	Based on 10°C and 70% RH
Foliage	None
Ground Absorption	ISO 9613-2 spectral, G=0 on roads and parking lots, G=0.6 in substations, and G=1 elsewhere
Receiver Height	1.5 meters for sound level isolines and 4.0 meters for discrete residential receivers
Search Radius	2000 meters from each source
Reflection	2 orders of reflection
Buildings	Only buildings along Queen City Park Rd at heights between 3 and 11 meters.

APPENDIX C. DETAILED MODEL RESULTS

Residence Address	Modeled Sound Level (dBA)		Coordinates (VT State Plane)		Elevation + Receiver Height (m)
	Concert Model	End-of-Concert Model	X (m)	Y (m)	
80 AUSTIN DR	28	31	442305	217013	48
209 AUSTIN DR	29	33	442309	216896	54
80 AUSTIN DR	27	30	442314	217051	48
80 AUSTIN DR	27	30	442320	217082	48
161 AUSTIN DR	33	36	442321	216729	68
80 AUSTIN DR	28	31	442326	217011	48
161 AUSTIN DR	33	36	442333	216631	66
161 AUSTIN DR	33	36	442335	216661	66
197 AUSTIN DR	31	34	442342	216881	57
161 AUSTIN DR	35	37	442351	216549	67
80 AUSTIN DR	27	30	442364	217075	48
80 AUSTIN DR	28	31	442365	217046	48
161 AUSTIN DR	35	37	442367	216578	67
161 AUSTIN DR	35	37	442372	216603	67
161 AUSTIN DR	34	36	442374	216810	61
80 AUSTIN DR	28	31	442377	217028	49
161 AUSTIN DR	36	38	442379	216548	66
80 AUSTIN DR	29	32	442387	216965	49
181 AUSTIN DR	32	35	442389	216886	55
80 AUSTIN DR	27	30	442391	217087	47
80 AUSTIN DR	28	31	442397	217026	49
161 AUSTIN DR	35	38	442402	216648	65
161 AUSTIN DR	36	38	442404	216727	62
161 AUSTIN DR	37	39	442405	216546	64
161 AUSTIN DR	35	38	442408	216588	64
80 AUSTIN DR	28	30	442412	217086	47
161 AUSTIN DR	35	39	442426	216641	63
80 AUSTIN DR	29	31	442428	217023	49
80 AUSTIN DR	30	32	442435	216962	50
80 AUSTIN DR	28	31	442437	217038	49
165 AUSTIN DR	34	36	442445	216870	56
80 AUSTIN DR	27	30	442456	217133	47
80 AUSTIN DR	28	31	442457	217056	48

Residence Address	Modeled Sound Level (dBA)		Coordinates (VT State Plane)		Elevation + Receiver Height (m)
	Concert Model	End-of-Concert Model	X (m)	Y (m)	
80 AUSTIN DR	28	31	442474	217084	47
80 AUSTIN DR	29	32	442478	216991	50
155 AUSTIN DR	36	38	442504	216860	60
145 AUSTIN DR	33	36	442523	216891	60
121 AUSTIN DR	34	36	442550	216931	60
91 AUSTIN DR	30	33	442558	216989	53
80 AUSTIN DR	28	31	442588	217124	48
9 PAVILION AVE	33	35	442593	216230	53
11 PAVILION AVE	33	36	442601	216243	54
9 PLEASANT AVE	33	36	442627	216235	54
35 CENTRAL AVE	35	37	442666	216243	59
26 CENTRAL AVE	37	39	442716	216318	60
34 CENTRAL AVE	35	37	442726	216251	59
32 CENTRAL AVE	35	37	442733	216271	59
4 MAPLE AVE	37	39	442744	216315	60
28 CENTRAL AVE	36	38	442747	216283	59
6 MAPLE AVE	37	39	442770	216316	60
7 MAPLE AVE	36	38	442777	216300	58
8 MAPLE AVE	36	39	442795	216318	60
12 MAPLE AVE	36	38	442837	216318	60
11 MAPLE AVE	35	37	442838	216298	58
6 HOME AVE	30	32	442839	217055	51
8 HOME AVE	30	32	442846	217055	51
20 ARTHUR CT	42	44	442892	216626	61
13 ARTHUR CT	41	43	442893	216573	61
18 ARTHUR CT	42	43	442897	216624	61
11 ARTHUR CT	41	42	442898	216569	61
42 BATCHELDER ST	31	32	442904	217051	51
40 BATCHELDER ST	31	32	442905	217057	50
9 ARTHUR CT	41	42	442908	216549	61
7 ARTHUR CT	41	42	442913	216545	61
38 BATCHELDER ST	29	31	442915	217115	49
364 QUEEN CITY PARK RD	41	41	442915	216519	61
32 BATCHELDER ST	29	31	442915	217129	49
52 BATCHELDER ST	30	31	442916	217083	50
29 HOME AVE	32	34	442916	217000	53

Residence Address	Modeled Sound Level (dBA)		Coordinates (VT State Plane)		Elevation + Receiver Height (m)
	Concert Model	End-of-Concert Model	X (m)	Y (m)	
48 BATCHELDER ST	30	31	442918	217098	50
14 ARTHUR CT	40	42	442918	216599	61
12 ARTHUR CT	40	42	442922	216596	61
10 ARTHUR CT	39	41	442934	216576	61
8 ARTHUR CT	39	41	442939	216572	61
2 ARTHUR CT	39	40	442950	216550	62
19 S CREST DR	33	35	442954	216952	57
17 S CREST DR	33	34	442954	216972	56
5 S CREST DR	32	34	442955	216992	55
29 S CREST DR	34	36	442957	216925	58
147 FOSTER ST	31	33	442962	217040	53
378 QUEEN CITY PARK RD	38	40	442962	216514	62
145 FOSTER ST	30	32	442963	217066	52
99 S CREST DR	38	40	442964	216719	63
35 S CREST DR	34	36	442965	216908	58
115 FOSTER ST	29	30	442965	217142	49
103 S CREST DR	38	40	442965	216696	63
37 S CREST DR	34	36	442966	216905	58
91 S CREST DR	38	40	442966	216742	62
139 FOSTER ST	30	31	442967	217081	51
133 FOSTER ST	29	31	442967	217097	51
382 QUEEN CITY PARK RD	38	40	442968	216543	62
85 S CREST DR	37	39	442968	216764	62
127 FOSTER ST	29	31	442969	217112	50
123 FOSTER ST	29	31	442971	217124	50
79 S CREST DR	36	38	442972	216789	62
45 S CREST DR	34	36	442972	216883	60
53 S CREST DR	35	37	442974	216858	60
69 S CREST DR	36	38	442975	216811	61
59 S CREST DR	35	37	442975	216835	62
109 S CREST DR	38	40	442984	216670	64
388 QUEEN CITY PARK RD	37	39	442990	216505	62
115 S CREST DR	38	40	442992	216662	64
390 QUEEN CITY PARK RD	37	38	442993	216505	62
53 HOME AVE	32	34	442993	216989	57
20 S CREST DR	33	35	442997	216945	59

Residence Address	Modeled Sound Level (dBA)		Coordinates (VT State Plane)		Elevation + Receiver Height (m)
	Concert Model	End-of-Concert Model	X (m)	Y (m)	
146 FOSTER ST	31	33	443000	217035	56
84 S CREST DR	36	38	443003	216767	63
144 FOSTER ST	30	32	443006	217061	55
30 S CREST DR	36	38	443006	216924	60
78 S CREST DR	33	35	443006	216784	63
138 FOSTER ST	30	32	443008	217082	54
98 S CREST DR	37	39	443008	216724	64
130 FOSTER ST	29	31	443010	217097	53
70 S CREST DR	35	37	443011	216807	63
126 FOSTER ST	29	30	443011	217111	51
59 HOME AVE	32	34	443011	216989	59
46 S CREST DR	34	36	443012	216877	61
38 S CREST DR	33	35	443012	216900	61
116 FOSTER ST	28	30	443013	217145	50
60 S CREST DR	35	37	443014	216831	63
129 S CREST DR	37	38	443018	216633	64
396 QUEEN CITY PARK RD	36	38	443018	216504	62
112 S CREST DR	37	38	443019	216694	65
56 HOME AVE	31	33	443020	217039	59
54 S CREST DR	34	36	443021	216854	63
57 MORSE PL	28	30	443030	217143	51
65 HOME AVE	32	34	443031	216983	61
135 S CREST DR	36	38	443036	216605	64
68 HOME AVE	31	33	443037	217035	61
124 S CREST DR	36	38	443041	216666	65
128 S CREST DR	36	38	443045	216662	65
75 HOME AVE	31	33	443048	216989	62
76 HOME AVE	31	33	443054	217032	62
65 MORSE PL	28	30	443055	217143	52
83 HOME AVE	31	33	443066	216987	64
82 HOME AVE	31	32	443071	217032	63
69 MORSE PL	27	29	443074	217143	53
967 PINE ST	28	30	443080	217104	57
85 HOME AVE	31	33	443083	216986	64
1149 PINE ST	34	36	443083	216564	61
1143 PINE ST	34	36	443085	216579	62

Residence Address	Modeled Sound Level (dBA)		Coordinates (VT State Plane)		Elevation + Receiver Height (m)
	Concert Model	End-of-Concert Model	X (m)	Y (m)	
1135 PINE ST	34	36	443086	216602	63
1125 PINE ST	34	36	443089	216636	64
1123 PINE ST	34	36	443090	216656	65
88 HOME AVE	30	32	443090	217026	63
1119 PINE ST	35	36	443092	216685	65
1099 PINE ST	34	36	443095	216717	66
89 HOME AVE	31	33	443098	216983	65
1085 PINE ST	34	36	443099	216747	66
1073 PINE ST	34	35	443100	216790	67
1079 PINE ST	34	35	443100	216769	66
1069 PINE ST	34	35	443101	216806	67
1061 PINE ST	33	35	443101	216827	67
977 PINE ST	28	30	443104	217088	59
1053 PINE ST	33	35	443105	216851	68
981 PINE ST	29	31	443106	217067	61
975 PINE ST	28	30	443106	217088	59
1045 PINE ST	33	34	443107	216871	68
1037 PINE ST	33	34	443108	216888	68
1033 PINE ST	32	34	443109	216905	67
961 PINE ST	27	29	443109	217127	55
963 PINE ST	27	29	443109	217126	55
973 PINE ST	28	30	443109	217087	59
957 MORSE PL	26	29	443110	217142	54
1021 PINE ST	32	33	443111	216945	66
1027 PINE ST	32	34	443111	216926	67
991 PINE ST	29	31	443111	217050	62
92 HOME AVE	30	32	443112	217026	64
971 PINE ST	27	30	443112	217087	59
95 HOME AVE	31	33	443116	216981	65
1124 PINE ST	33	34	443143	216641	64
1120 PINE ST	33	35	443145	216682	65
1132 PINE ST	32	34	443145	216604	63
1 BAIRD ST	33	34	443151	216763	67
3 BAIRD ST	33	34	443153	216763	67
2 BAIRD ST	32	34	443153	216801	67
106 HOME AVE	29	31	443154	217021	64

Residence Address	Modeled Sound Level (dBA)		Coordinates (VT State Plane)		Elevation + Receiver Height (m)
	Concert Model	End-of-Concert Model	X (m)	Y (m)	
4 BAIRD ST	32	34	443155	216801	67
990 PINE ST	28	30	443156	217050	62
968 PINE ST	27	29	443158	217095	59
984 PINE ST	27	30	443158	217065	61
956 PINE ST	26	28	443158	217141	55
960 PINE ST	26	29	443158	217125	56
964 PINE ST	26	29	443158	217111	58
974 PINE ST	27	29	443160	217078	61
105 HOME AVE	30	32	443162	216975	66
5 BAIRD ST	32	34	443170	216762	66
6 BAIRD ST	32	34	443172	216801	67
7 BAIRD ST	32	34	443173	216762	66
1110 PINE ST	32	34	443174	216722	65
8 BAIRD ST	32	33	443175	216801	67
112 HOME AVE	28	30	443177	217020	64

55 Railroad Row
White River Junction, VT 05001
802.295.4999
www.rsginc.com

White River Junction & Burlington, VT

Arlington, VA

Chicago, IL

Evansville, IN

Portland, OR

Salt Lake City, UT

San Diego, CA

RSG promotes sustainable business practices that minimize negative impacts on the environment. We print all proposals and reports on recycled paper that utilizes a minimum of 30% post-consumer waste. RSG also encourages recycling of printed materials (including this document) whenever practicable. **For more information on RSG's sustainability practices, please visit www.rsginc.com**.